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CBA

College Of
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كلية إدارة الأعمال

INTERNATIONAL JOURNALS

Customer Satisfaction on Supply Chain Management Practices: A Study of Toyota and Tata Motors in Kingdom of Saudi Arabia

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Abstract

Automobile industry has been a major driver growth of a nation's economy and is a significant contributor to the global economy. The Automobile has been described as both a form and function based product involving high level of engineering as well as being positioned as a fashion product. Supply chain management is typically viewed to lie between fully vertically integrated firms where the entire material flow is owned by a single firm, and those where each channel members operates independently. For the automobile industry the crucial element in the supply chain management is its ability to forecast demand accurately. The objective of the current study was to find out the level of customer satisfaction on supply chain management practices of Toyota and Tata motors in KSA. A total of 250 randomly drawn respondents were taken for the survey using questionnaire method. It was found that the customer having Toyota are more satisfied on the dimension of time taken for delivery, promised time delivery, accessories and spare parts, after sales services, grievances handling and supply chain management as compare to Tata motors. It was also found that young generations are more satisfied with Toyota while old customer are more satisfied with Tata motors. Majority of the customers of both the companies are also showing satisfaction with Dealership network.

Keywords: Customer Satisfaction, Supply Chain Management, Promised Time Delivery, Grievance Handling Mechanism

INTRODUCTION

Universally, the automobile industry has been a major driver of growth of a nation's economy and is a significant contributor to the global economy. The automobile has been described as 'both a form and function based product' involving high level of engineering as well as being positioned as a fashion product. There have been significant changes taking place in the automotive industry. Worldwide, average margins have fallen from 20% to 5%, with many companies losing the game. The profitability performance is reflected in the industry's market capitalization; despite its huge revenues and employment, the automotive industry accounts for only 1.6% of the stock market in Europe, and 0.6% in the U.S. These facts make a wide range of operational and financial performance.

The changing business conditions of the 21st century has led to companies facing issues ranging from globalization, economic uncertainty to new technologies and increasing consumer demands. In the automobile industry, as manufacturers design and build vehicles globally, their supply chains become increasingly complex with challenges that often stand in the way of profitability and higher shareholder value such as long order-to-delivery lead times, unreliable production schedules, excess inventory across the supply chain, lengthy demand planning cycles and lack of visibility of suppliers. The effect of the global economic meltdown increased the pressure on automotive executives to make right decisions about their supply chain for better performance. In a highly challenging and competitive environment, where supply chain is a popular tool for improving the organizational competitiveness, an efficient and effective supply chain strategy is a must for automotive manufacturers and their component manufacturers so as to meet changing consumer demands.

Supply Chain Management is typically viewed to lie between fully vertically integrated firms, where the entire material flow is owned by a single firm and those where each channel member operates independently. Therefore coordination between the various players in the chain is key in its effective management.

According to Christopher (1992), leading-edge companies have realized the real competition is not company against company, but rather supply chain against supply chain. Cooper, Lambert, and Pagh argue that organizational relationships tie firms to each other and may tie their success to the supply chain as a whole. In this context, a supply chain as a whole may have its own identity and function like an independent firm. However, to accomplish this ultimate supply chain, all companies' in the supply chain must have a supply chain orientation. The result is a fully managed supply chain.

According to Lambert, Stock, and Ellram (1998), however, there exist important differences between the definition of supply chain management and the Council of Logistics Management's (1985) definition of logistics: "Logistics is the process of planning, implementing and controlling the efficient flow and storage of raw materials, in-process inventory, finished goods, services, and related information from point of origin to point of consumption (including inbound, outbound, internal and external movements) for the purpose of conforming to customer requirements." CLM (1998) apparently agreed, since its new definition states, "Logistics is that part of the supply chain process that plans, implements, and controls the efficient flow and

storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements" (emphasis added). Thus, CLM has also distinguished between logistics and supply chain management, and acknowledged that logistics is one of the functions contained within supply chain management.

Charan (2012), defines Supply Chain Management is the integration of key business processes across the supply chain for the purpose of creating value for customers and stakeholders.

Literature Review:

Jamehshooran (2015) found that in recent years, supply chain performance measurement has received much attention from researchers and practitioners. Effective supply chain performance through supply chain antecedents such as business analytics has become a potentially valuable way of securing competitive advantage and improving supply chain performance. This study addressed the lack of the empirical studies by developing a comprehensive model to examine the effect of business analytics on supply chain performance. A quantitative methodology using a cross-sectional survey method was used to investigate the relationship between variables. Data were collected from automotive companies in Iran. The relationships between variables were examined using structural equation modeling (SEM) technique and partial least squares (PLS) software was used. The results revealed there is a significant positive relationship between business analytics and supply chain performance. The study combined resource-based theory, resource dependence theories to develop a new theoretical framework to demonstrate the importance of businesses analytics; in improving supply chain performance. Kumar et al (2015) found that Supply chain structure, characteristics, and applicable policies differ between developing and developed countries. Lack of effective supply chain management practices and supply chain disruptions. Devarajan (2015) observed that Supply chain processes and challenges in India have been so dynamic and are going through rapid changes. To understand where these changes stem from and also to determine the current status with respect to challenges in supply chain management, a two pronged approach is adopted and executed. The results of the approach are presented in this paper. The first step is to review current status based on literature review of available-published research (articles, journals, magazines, interview, etc.) between the years 2011 and 2015. The second step is to get industry perspective (interviews, surveys, meetings with business executives in India) to understand pressing issues that they face in handling their supply chain. Based on these two steps, a solution framework (supply chain challenges grouped under 15 categories), list of key best practices, and two specific action items (processes) are provided to help companies set a plan (short term, medium and long terms) and navigate through their supply chain challenges. Stefanovic (2014) identified that Today's business climate requires supply chains to be proactive rather than reactive, which demands a new approach that incorporates data mining predictive analytics. This paper introduces a predictive supply chain performance management model which combines process modeling, performance measurement, data mining models, and web portal technologies into a unique model. It presents the supply chain modeling approach based on the specialized Meta model which allows modeling of any supply chain configuration and at different level of details. It was also found that the supply chain semantic business intelligence (BI) model which encapsulates data sources and business rules and includes the data warehouse model with specific supply chain dimensions, measures, and KPIs (key performance indicators). Next, the paper describes two generic approaches for designing the KPI predictive data mining models based on the BI semantic model. KPI predictive models were trained and tested with a real-world data set. Finally, a specialized analytical web portal which offers collaborative performance monitoring and decision making is presented. The result also shows that these models give very accurate KPI projections and provide valuable insights into newly emerging trends, opportunities, and problems. This should lead to more intelligent, predictive, and responsive supply chains capable of adapting to future business environment.

Wanke (2014) In his study aims to investigate whether, and the means by which, supply chain managers of large manufacturing companies adopt a context-dependent approach (also called it empirically explores the correlation between logistics complexity-related contextual conditions and supply chain management (SCM) objectives and decision areas. The study adopted survey data (based on a sample of 108 large manufacturing companies in Brazil), using cluster analysis, factor analysis and binary logistic regression and investigated the major effects of supply chain objectives and decision areas as predictors of the logistics complexity of manufacturing but also investigate their second order interactions. Statistically significant relationships were found between logistics complexity-related contextual conditions and objectives and decision areas involving the supply chain. Varsei et al., (2014) observed that each key supply chain member can achieve economic advantage only when they make a long-term dedication to sustainable development. Based on the studies of three dimensions, it can be said that implementation of TBL provides economic advantage As a result of increasing trend to sustainable practices; many firms have been implemented to a wide-scale adoption that they collaborate with their suppliers and customers. They improve their efficiency for operation and environment. These improvements help firms gain customer satisfaction and profitability and competitive advantage. Fabbe-

Costes et al., (2014) identified that financial performance is the first priority for the economical aspect of SSCM. For the environmental performance, environmental responsibility holds minimum environmental standard regulated by government that is important. The social performance stresses social fairness, which should be considered as minimum standard of social objectivity and justice. Some of the benefits of SSCM are enhanced through corporate reputation, improved operational and financial performance (As a performance side, the pursuit of SSCM targets leads to consciousness within corporations of the environmental and social changes of their operations and forces to reduce environmental footprint. With SSCM implementation as a model it could continue and improve economic results, but tighten from environmental laws. When social and environmental friendly corporations produce any output, they are most likely chosen by stakeholders. As a result, these corporations could get a higher margin by marketing considerable quantity at a higher price to compensate any deviation expense. Reddy and Raja (2013) in his study presented a number of characteristics, that are found in effective performance measurement system for SCM and categorizes performances measures in two groups: qualitative performance measures and quantitative performance measures, Qualitative performance measures are those for which there is no single direct numerical measurement. Customer satisfaction, flexibility, information and material flow integration, effective risk management, and supplier performance are presented as qualitative performance measures. Chen et al. (2013) examined three types of risks, namely supply risk, demand risk and process risk in relation to three types of collaboration, namely supplier collaboration, customer collaboration and internal collaboration, as a mechanism to mitigate those risks. They defined that the supply risk and demand risk arise from external operations, while process risks from internal operations. Also, process risk increases from the unexpected changes in the supply or orders changes from customer. The survey was carried out and resulted that supply chain risk can be better mitigated and managed through supply chain collaboration. Rao, R (2012) measure supply chain management in Automobile Industry – A Study of Select Companies of variables that capture the impact of SCM on Hero Honda and Bajaj wide revenues and costs. They draw on responses to a survey of 20 extended supply chains across two industry groups. He defines six variables that reflect different approaches to measure supply chain performance. These variables are inventory, time, order fulfillment, quality, customer focus, and customer satisfaction.

Hypothesis

In the above backdrop, an attempt has been made in the present study to examine the Supply Chain Management Practices in Automobile Industry with special reference to Select Automobile Companies in Kingdom of Saudi Arabia viz., Toyota Motors and Tata Motors and decided to not formulate any hypothesis rather make the study exploratory in nature and thus framed following objectives

- 1) To study the Supply Chain Management practices adopted by Toyota Motors and Tata Motors.
- 2) To evaluate Supply Chain Management Practices satisfaction among the customers of Toyota and Tata Motors.
- 3) To offer suggestions to make the Supply Chain Management Practices more satisfying to Customers.

Methodology

Sample:

In K.S.A almost every house owns a car. It has got highest percentage of car ownership with more than 80 percent of the population owning a car. Most of the families had more than one car to be used by different family members for different purposes. The researcher approached the dealers of the concerned companies to get the list of the customers. 200 car owners of Toyota Motors and 120 car owners of Tata Motors were selected randomly as sample.

Tools Used:

A Customer Satisfaction Questionnaire on Supply Chain Management practices has been used to collect the data. The questionnaire revealed satisfaction on five dimensions of supply chain management practices i.e. Time Taken for Delivery, Satisfaction level of Customer on Promised Time delivery, Availability of Accessories Spare Parts and Components, Quality of Service Center Facilities and Grievances Handling Mechanism.

Tools of Analysis

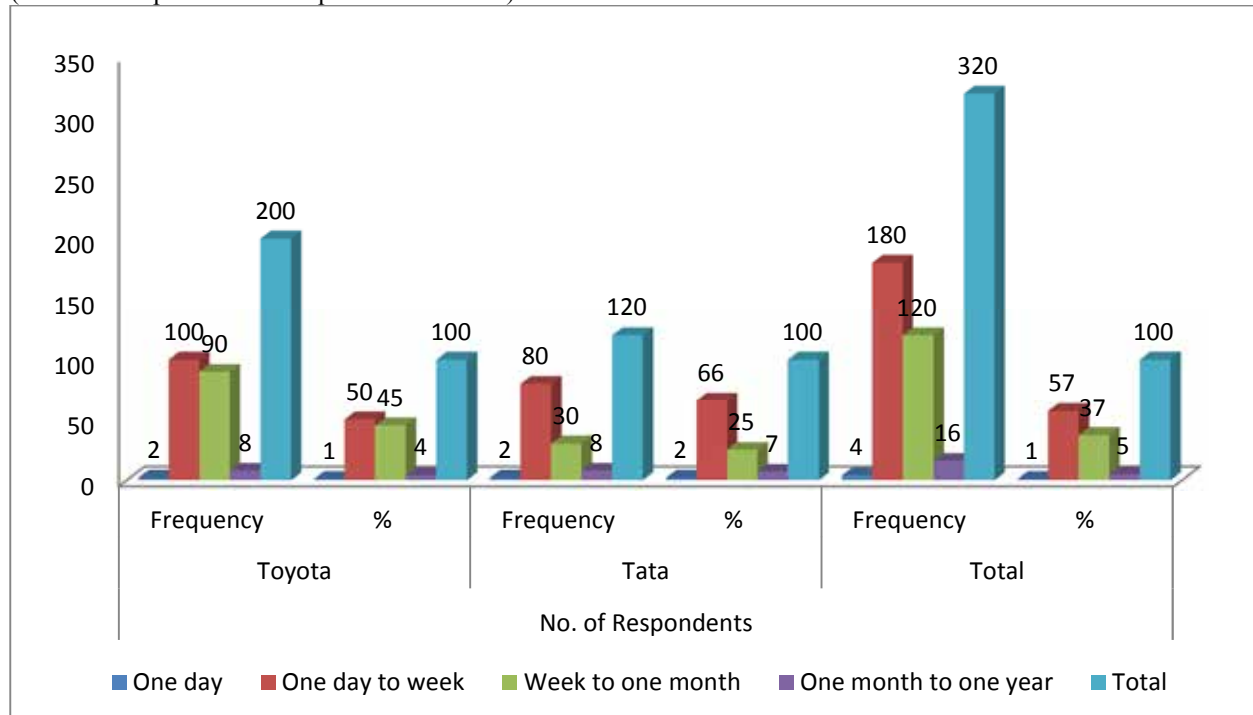
An appropriate statistical tool has been used to analyze the data and put it in the tabular form for the analysis of results and discussions.

Result and Discussions

Table - 1 Showing Satisfaction level of Customer on Time Taken for Delivery by Toyota and Tata Motors

Time taken for delivery	No. of Respondents					
	Toyota		Tata		Total	
	Frequency	%	Frequency	%	Frequency	%
One day	2	1	2	2	4	1
One day to week	100	50	80	66	180	57
Week to one month	90	45	30	25	120	37
One month to one year	8	4	8	7	16	5
Total	200	100	120	100	320	100

(Source: compiled from the questionnaire data)



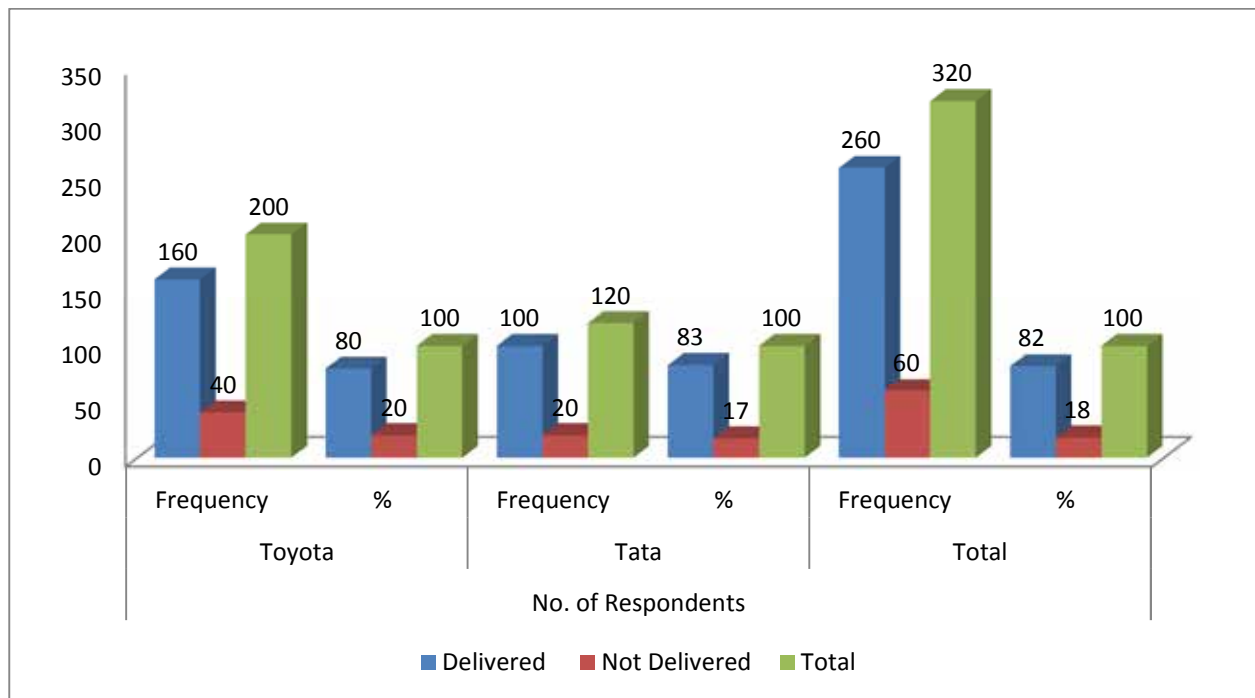
It is shown in Table 1 that a majority of the respondents stated that the dealers are taking about a week's time for delivering the vehicle after placing the order, while it was a period ranging from one week to one month by the 37 percent of sample respondents reporting it. It is very interesting to state that 5 percent of the respondents revealed that, in some cases the dealers are taking almost a year, when enquired into reasons for the delay the customers admitted that it was because of their choice, preference for a particular variant, color and style etc. The dealer is taking such a long time, this is happening only with Tata Motor. Intercompany analysis reveals that it was 66 percent of the sample customer stated that order delivery lead time was one week. While it was 50 percent in case of Toyota. In case of those who stated the lead time as one week to one month reverse was the case. It was 45 percent in case of Toyota while it was 25 percent with Tata. Delivery lead time is on another important dimension of customer service. Delivery reliability essentially captures the degree to which a firm is able to service its customers within the promised delivery time. Delivery reliability measures the fraction of customer's order that is satisfied within promised delivery lead time.

Order delivery lead time is the time taken by supply chain to complete all the activities from customer order to product delivery to the customer. This dimension of customer service has significant impact on responsiveness of supply chain. Customers always expect much shortened delivery lead time. Shorter lead time, higher responsiveness and higher reliability will lead to better customer service.

Table -2: Showing Satisfaction level of Customer on Promised Time delivery

Time taken for delivery	No. of Respondents					
	Toyota		Tata		Total	
	Frequency	%	Frequency	%	Frequency	%
Delivered	160	80	100	83	260	82
Not Delivered	40	20	20	17	60	18
Total	200	100	120	100	320	100

(Source: compiled from the questionnaire data)



Delivery of Cars on Promised Time:

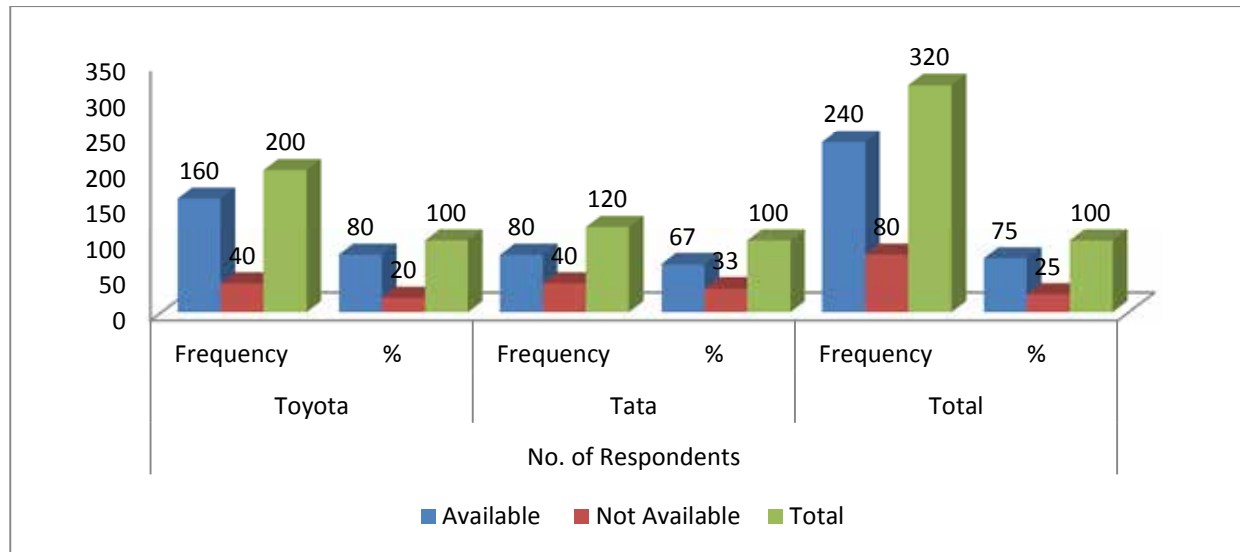
Table 2 reveals heartening result to note that, the dealers of both the select companies are able to keep up the promise to deliver the vehicles on promised time as more than 80 percent of the customer of the dealers of both the companies reporting it. Remaining 18 percent of the respondents stated that the dealers failed to deliver the vehicles on time. This speaks of the successful delivery reliability metrics of the dealer of both the select companies and thus majority of the customers are highly satisfied.

Delivery lead time is as another important dimension of customer service. Delivery reliability essentially captures the degree to which a firm is able to service its customers within the promised delivery time. Delivery reliability measures the fraction of customer's order that is satisfied within promised delivery lead time.

Table-3: Availability of Accessories, Spare Parts and Components

Availability of Accessories, Spare Parts and Components	No. of Respondents					
	Toyota		Tata		Total	
	Frequency	%	Frequency	%	Frequency	%
Available	160	80	80	67	240	75
Not Available	40	20	40	33	80	25
Total	200	100	120	100	320	100

(Source: compiled from the questionnaire data)



Availability of Accessories, Genuine Spare Parts and Components

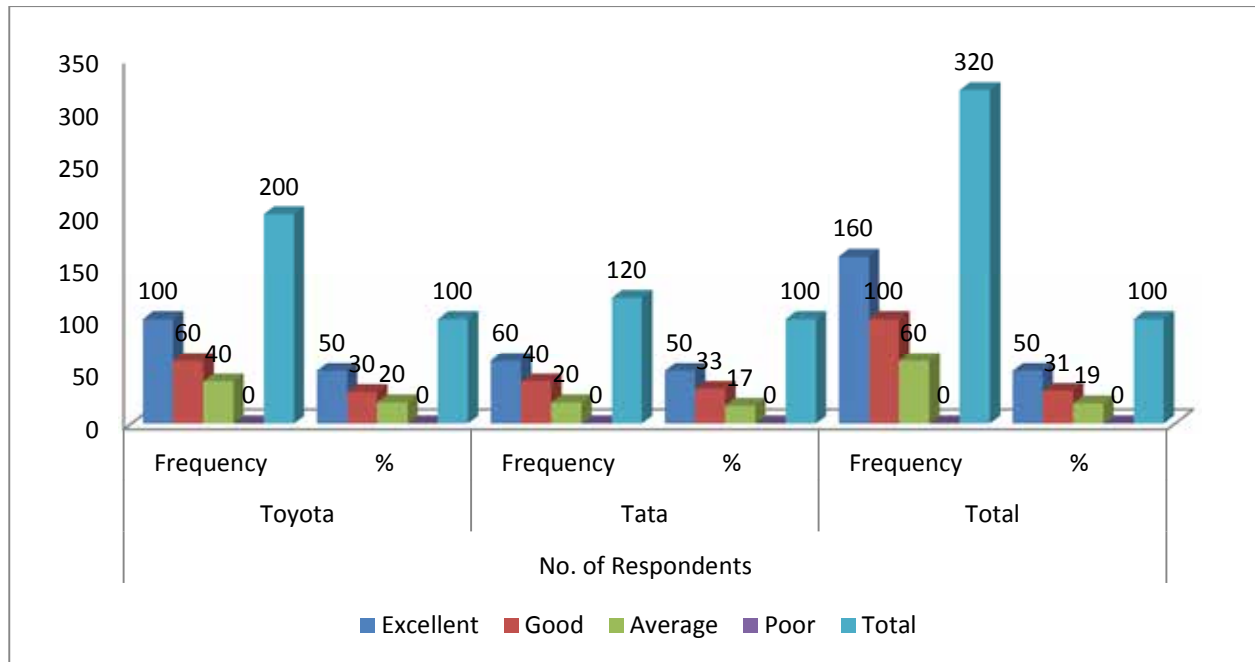
Table-3 shows the opinion of customers on the availability of accessories genuine spare and components. About 80 and 67 percent of customers from Toyota and Tata Motors respectively revealed that, the spare parts and components are available in the market. At the same time 20 percent and 33 percent of customer said spare parts are not available at their location. This indicates that, the dealers are providing with accessories and spare part components to their customers at their centers, ensuring a very positive supply of supply chain management practice. On the whole a great majority of 75 percent respondents states that accessories and spare parts are available at different point of purchase, while a significant portion of 25 percent respondents reported that the desired accessories and spare parts are not available.

The repair and maintenance of a vehicle involves a complex chain of various actors, it is called as automotive after-market. Each stage within this aftermarket supply chain has its importance, each operator fulfilling a special role to keep replacement parts, repair and maintenance competitive and efficient. A truly competitive automotive market is the prerequisite to keep mobility affordable throughout the entire life of a vehicle. That's is the reason, why vehicle manufacturers supply their dealers and authorized service centers and repairs of their distribution network the full range of genuine spare parts and components to ensure that spare parts and components are easily available in market to customers.

Table-4: Quality of Service Center Facilities of Select Motor Companies

Rating from Service Center facilities	No. of Respondents					
	Toyota		Tata		Total	
	Frequency	%	Frequency	%	Frequency	%
Excellent	100	50	60	50	160	50
Good	60	30	40	33	100	31
Average	40	20	20	17	60	19
Poor	0	0	0	0	0	0
Total	200	100	120	100	320	100

(Source: compiled from the questionnaire data)



Quality of Service Center Facilities

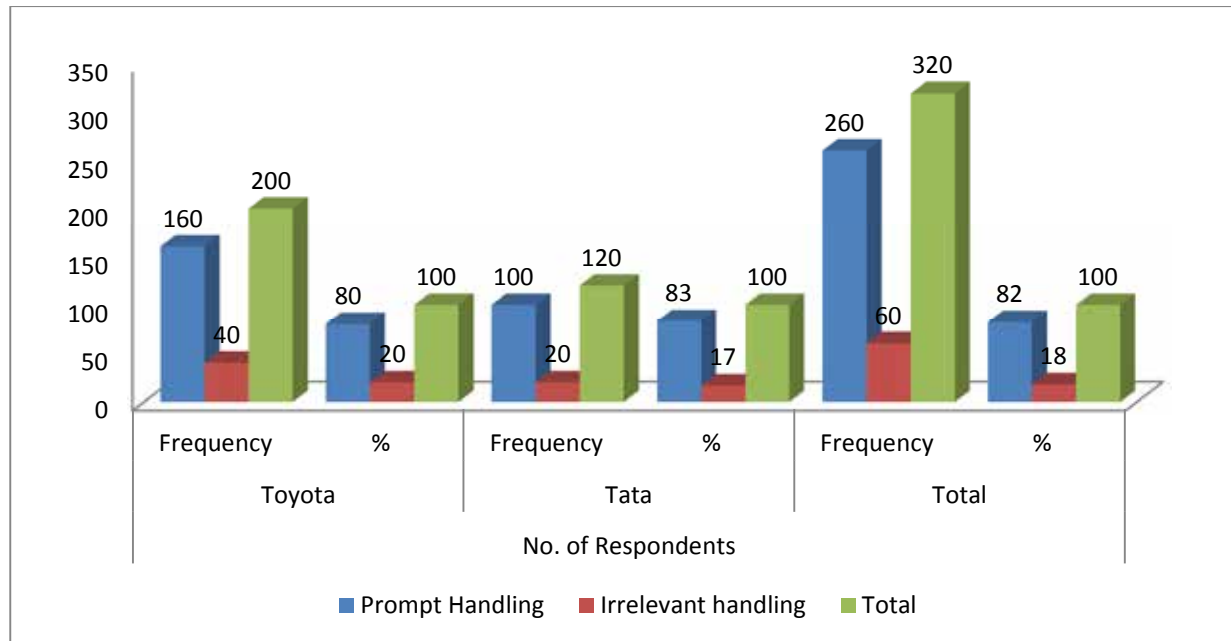
Table-4 shows that, 50 percent of respondents from the Toyota and Tata Motors said that, service center facility was excellent while 30 and 33 Percent respondents each stated that service center facility was good. 20 and 17 percent respondents each from these two companies open that it was average in the Quality of service centers of Toyota and Tata Motors Very interestingly no customers reported that quality of Service Centre as poor front both the companies. The overall analysis also reveals a similar trend.

The service centers play a key role in making after sales service effective and supply chain efficiency. It is responsibility of the companies in automobile sector to not only provide service center in all the locations, but also to have trained and skilled manpower (mechanics) and advanced automated machines for quick and effective servicing of vehicles. The service center requires infrastructure, spare parts, components and accessories for replacement at the time of vehicle servicing and repairing. All these factors and facilities will have strong impact on maintaining customer satisfaction.

Table-5: Grievances Handling Mechanism

Grievances addressed on Time	No. of Respondents					
	Toyota		Tata		Total	
	Frequency	%	Frequency	%	Frequency	%
Prompt Handling	160	80	100	83	260	82
Irrelevant handling	40	20	20	17	60	18
Total	200	100	120	100	320	100

(Source: compiled from the questionnaire data)



Grievances Handling Mechanism by the Dealers of Select Companies:

Table 5 shows the data related to addressing of grievances on time. About 80 percent of customers from Toyota Motors and 83 percent of customers from Tata Motors reported that their grievances were addressed on time, while 20 and 17 percent of respondents from Toyota and Tata stated that their grievance with vehicles were not addressed by Company on time.

When it comes to automobile performance of the vehicle and after sales service are the top most priorities to the customers, if dealer/company fails to provide these, customer will start complaining. Complain handling not only helps vehicle manufacturers to manage product performance, but also provides direct product feedback that companies can use to improve their products and services. Efficient customer grievances handling system addresses the grievances on time and improves the customer loyalty, retention and has a positive impact on company's reputation. The grievances of customers with vehicle have to be attended quickly and complaints of customers on service should be address on time so that customer gets satisfied with grievance handling mechanism of the company.

Conclusion and Suggestions:

It can be concluded that the customer having Toyota Motors are more satisfied supply chain management practices on the dimension of time taken for delivery, promised time delivery, accessories and spare parts, after sales services, and grievances handling mechanism as compare to Tata motors. It was also found that young generations are more satisfied with Toyota motors while old customer are more satisfied with Tata motors this may attributed to outer look of the vehicle and may be the image of the company in the mind of new generations. While old aged customers believe in durability and cost involved hence getting attracted towards Tata motors. It is suggested that the grievance handling system of Tata and Toyota has to integrate dealers' manufacturers, employees and customers to improve the performance of supply chain in resolving customer grievances/complaints on product performance, product quality and after sales service etc. The companies are advised to standardize a complain management system, which increase responsiveness of supply chain and also to provide direct product feedback that companies can use to improve their products and services. Both the Tata and Toyota are advised to concentrate on automation of its service centres at dealer's point. Tata and Toyota companies are advised to arrange for fully automated service centres at their dealers point, and the employees in the service centres must be trained, so that vehicle can be serviced quickly and effectively. Spare parts availability in the market at customer proximity is one of the key indicators of aftermarket performance of automobile supply chain. The Tata Company is advised to streamline its spare parts supply chain and it has to supply spare parts to all the dealers with required levels of stocks. Further, Tata has to supply spare parts not only to dealers to ensure the genuine spare parts to customers, it should supply spare parts to sub-dealers, authorized service centres and local automobile spare parts retail shops for easy availability of spare parts to customers at their proximity. Infrastructure development in Saudi Arabia must keep pace with the growth of automobile on the road. Impediments to the construction of the Golden Quadrilateral, the highway connecting the country's major metropolitan cities in a giant ring, would directly affect the sale of these two companies in specific and motor vehicles in general.

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Developing in-House ERP System for the Construction Industry in a Developing Country: A Case Study

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Abstract

Benefits reaped from implementing Enterprise Resource Planning (ERP) systems have made them a critical part of organisations. These systems, which are developed on best business practices, are sometimes unable to satisfy unique organisational needs, such as those specific to the construction industry which present a unique set of challenges different from those of manufacturing and service industries. This paper aims to study the development of in-house ERP system in an organisation in a developing country, and seek to explore and understand the development of ERP system designed exclusively around the needs of an organisation. This study adopts a case study based qualitative research methodology. Primary data is collected through a series of interviews, discussions with the project manager, development staff and end users. The outcome of the study shows that through proper planning coupled with detailed needs analysis, suitable change management strategy, an experienced project team and selecting the appropriate software development process, any organisation can design and develop ERP system that caters for the organisation specific needs. Therefore, eliminating the need of complex software customisation or altering business processes. Further, by developing an in-house system, the probability of a failed implementation is greatly reduced thus allowing the organisation to focus on its core business while benefitting from the new system.

Keywords: ERP system, human resources, in-house ERP, construction industry

1. Introduction

Enterprise Resources Planning (ERP) system enhances organisational performance of companies across the globe. ERP system are sets of packaged application software modules with integrated architectures used by organisations integrating data and processing information in real time across their supply chain. The results derived from implementing ERP system have made them essential part of today's organisation, making them the most popular new business software for past decade (Ehie & Madsen, 2005; Beheshti, 2006; Wagner et al., 2006; Kamhawi, 2008; Baiyere, 2012).

ERP system implementing organisations have experienced substantial increase in productivity (Davenport, 1998); improved operational performance (McAfee, 2002; Shatat & Uddin, 2012); better integration and process enhancement (Davenport et al., 2004); increased firm's market value (Meng & Lee, 2007) with improved financial performance (Hendricks et al., 2007). In addition to these benefits, ERP system enables organisation to achieve competitive advantages through cost reduction, integration of operations and departments, business process improvement, and increased effectiveness (Vlachos, 2006; Mukti & Priyanka, 2014). Whilst Huang and Handfield (2015) suggest that ERP users are proficient in strategic sourcing, category management and supplier relationship management. Indeed, according to Lucintel research report (2012), the global ERP software industry reached an estimated \$47.5 billion in 2011, with a 7.9 percent Compound Annual Growth Rate (CAGR). This is further forecasted to grow to an estimated \$67.7 billion by 2017 with a 6.1 percent CAGR during the period 2012-2017.

Even with its benefits, ERP implementation is a highly complex undertaking, which requires the organisation to completely transform their business processes around the new ERP system. This can often lead to implementation failures, such as, in case of Fox-Meyer Drug, Dell, Unisource Worldwide, Inc., Dow Chemical and Hershey, where ERP implementation resulted in a "complete failure" (Davenport, 1998; Wah, 2000). This comes about because, instead of realigning their business strategy to suit the new ERP system, organisations

customise the ERP system according to their business processes. The customisation process could be a long and complex undertaking which requires careful planning and attention to details with a low probability of success.

ERP systems, which are developed on best business practices, sometimes may not be able to satisfy the unique organisational needs. The construction industry presents a unique set of challenges different from those of the manufacturing and service industries. For example, in the construction industry, each construction project is unique with its different designs, resources, and operational requirements. Moreover, projects are dispersed geographically and have multiple teams working on them concurrently. This creates a demand for effective resource allocation, project planning, employees tracking and most importantly information sharing. Due to their unique requirements, and the very limited availability of construction industry software in developing countries, organisations in these countries are generally reluctant to adopt ERP systems. For organisations to reap the benefits of ERP systems, this study discusses design and development of an in-house ERP Human Resources Management (HRM) system which is developed specifically according to the unique characteristics and requirements of the construction industry. This custom designed and in-house built system does not require organisations to change their business processes since the new system is designed around their specific needs. In addition, it could be cost-effective since organisations can utilise their internal resources (IT, project managers, manpower, etc.) for system development.

This paper is organised as follows: Section 2 discusses ERP implementation challenges followed by a brief organisation's background in section 3. The need for a new ERP system is discussed in section 4, followed by a detailed discussion on design and development in section 5. This is followed by discussion and then some concluding thoughts are offered.

2. ERP System Implementation Challenges

Implementation is the process through which technical, organisational and financial resources are configured and integrated to deliver an effective operational system (Fleck, 1994). ERP system is complex, and implementing a system can be a challenging and costly for an organisation (Shehab et al., 2004). There are several reasons for complexities of the ERP system noted in the literature. One of the reasons is the wide variety of functionalities offered by ERP system covering hundreds of business activities (Daneva & Wieringa, 2008). The author suggests that complexities and associated challenges in implementation are due to the nature of ERP which integrates business processes and delivers a shared system. Therefore, creating system capabilities far beyond the sum of the ERP components' individual capabilities; and each functionality offered matches the unique needs of each stakeholder group (Daneva & Wieringa, 2008).

Since the ERP system is developed on "best business practice" model, its implementation requires organisations to restructure their business processes around those practices. Maguire et al. (2010) found that the ERP implementation demands critical organisational changes which could cause conflicts within organisations resulting in loss in productivity and sometimes, failed implementation. The causes of the conflict include system integration, issues with legacy system and establishing methods to revise business processes. These required realignments are most often cited source of implementation failures (Soh et al., 2000). Organisations planning to implement ERP system without a "realignment strategy" face technical and administrative challenges often resulting in project delays or on occasion, a complete implementation failure (Hirt & Swanson, 2001).

It is due to aforementioned reasons about 70 percent of ERP implementation fails to deliver anticipated benefits (Al-Mashari, 2000), while Nelson (2007) found that only 34 percent of IT projects initiated by Fortune 500 companies are successfully completed. These implementation projects are on average 178 percent over budget, take 2.5 times longer to implement than intended and deliver only 30 percent of committed goals (Zhang et al., 2005).

As discussed in the previous section, the construction industry has unique characteristics in comparison with other industry sectors. They have operational requirements which can vary from one organisation to another, and, therefore, need special attention. Shi and Halpin (2003) suggest that in the construction industry, in order to make good business decisions, maximise business goals, and survive the competitive environment, proper utilisation of internal and external resources are essential. ERP system answers this call by offering functionalities to enhance the business process and integrate the diverse operations. However, due to the complex nature of the ERP system, implementation could be risky and costly with success not guaranteed. Therefore, in this scenario, generally, organisations have a difficult choice to make: either alter their business processes around the ERP system or customise the ERP system according to their organisational needs.

3. Case Study: Organisation's Background

Principal Engineers and Constructors (PEC) was established in 1987 and has since followed a steady path of growth in the construction industry. The organisation prides itself in delivering quality and reliable construction service as their mission statement suggests, *"to create a lasting relationship with our clients by exceeding their expectations, and gaining their trust by maintaining high standards of integrity and professionalism"* (Principal, 2014). Over the years, PEC has constructed major projects, including residential and office buildings, bridges, warehouses, educational institutions, power plants and highways. PEC has achieved 100% on-time completion accuracy with zero arbitrary/litigation history, confirming its commitment to service and quality. Some of their major clients include Coca-Cola, DHL, ICI, Toyota, Engro, Berger, USAID, Unilever, Walls, Nando's, Siemens and Tapal.

Currently, PEC employs around 500 staff members and the majority of them (approximately 70-80 percent) work on the construction sites at any given day. Over time with business expansion, lack of integration and coordination between departments became more visible and the need of a central information repository was critically realised. To overcome these organisational needs, senior management and the IT department considered several different software applications available in the market. However, they were unable to find a system that completely satisfies their organisational needs. As a second option, the management and the IT team came up with an idea to develop an in-house enterprise resource system. The proposed system would be developed exclusively to cater for organisational requirements without the need of any changes to the current business processes, thus saving from implementation complexities.

4. Need for ERP System

Since its inception, different departments in PEC worked in silos with the absence of any central information depository and the majority of the work performed was paper-based. This resulted in difficulty to access information, especially past information. The process was painstaking slow since the employee had to visit the particular department to get the required information by going through the paper files manually. This increases the probability of human error and, therefore, impacted information reliability. According to PEC IT manager, *"the primary issue was not the availability of information, rather access to the information"*. While office employees had limited access to information, employees working on construction sites lacked any access to information. Therefore, if an on-site staff required information, a staff member physically needed to leave the site and go to the main office to get the information. Similarly, when the administration at the main office required information, a staff member was sent to the construction site to collect the required information. Otherwise, they had to wait till the end of the month when all the data sheets and the information was sent to the main office.

In addition, due to the lack of centralised operation and information, the Standard Operational Procedures (SOPs) were subjective. For example, a department would design the process flow according to their needs and later would do any local changes as required without considering their impact on other departments or overall operation. This frequently resulted in chaos and confusion, therefore undermining the organisational performance and leading to project completion delays.

Several other reasons in favour of developing an in-house ERP system are:

- i. It happened very often that HR either didn't know or struggled to keep track of a number of employees and their location since projects were dispersed across the country and employees reported directly to the construction site.
- ii. The process of salary payment was challenging. Some employees did not have a bank account and preferred to be paid in cash. While those who had bank accounts received salary cheques. To compound the difficulty in processing payments, a group of employees wanted their salaries to be divided into cash and cheque. There was no HR module available which offered the cash payment option or option to divide salary into cash and cheque payment.
- iii. Construction industry's employee designations are different from those in other business sectors. Therefore, a construction industry-specific ERP system offering industry-related designations was required.
- iv. The current legacy system was unable to keep up with the ever updating movement of employees across the projects. Similarly, often whole teams moved from one site to another. Keeping track of their movement was cumbersome in the old legacy system.

- v. Due to the absence of a central database of information, every department had its own database (such as procurement, HR, sales, etc.). Frequently, the system failed to recognise a user if his/her profile was not set up in that particular department. So, a new individual profile had to be created for the department.
- vi. Besides salary, there were two different types of allowances given to the employees, namely, general allowance and convenience allowance. A system was required to keep track of these allowances.
- vii. There are professional licences for engineers issued by a government body in the construction industry. A system was needed to keep track of employees' licences, their expiration dates, upcoming renewals, etc.

In the next section design and development of an ERP system are discussed.

5. Design and Development

Software development is a dynamic and complicated process since there are several interrelated factors throughout the software development process. It is observed that quality suffers when appropriate and individual focus is not given to each development phase which may lead to project delay, over budget and/or cancellation.

Software development is unlike other product design and development since software is intangible; it is devoid of physical properties of manufacturing products. A software development process starts with some sets of requirements drawn from the organisational or market needs. The next important steps are design, code development and testing and going live phase (Mahanti & Antony, 2005). Software development revolves around a lifecycle which consists of five phases: *needs analysis and planning, design, development, testing, and going-live*. Figure 1 presents a waterfall model software development. The waterfall model is a sequential designing process in software development illustrating progress flowing steadily downwards through different development phases. The lifecycle model presents the iterative relationship between successive development phases. It is derived from the strategy that as each step progresses and design and development process are further detailed, there is iteration with preceding and succeeding steps. These phases encompass all the activities carried out to define, develop, test, deliver, operate and maintain a software product.

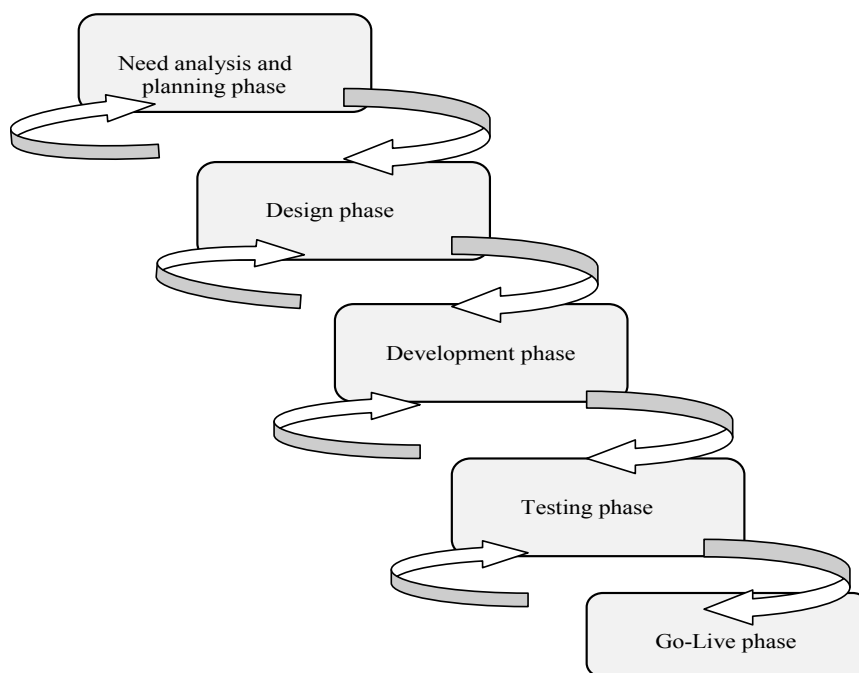


Figure 1. Software development lifecycle

5.1 Needs Analysis and Planning Phase

The needs analysis and planning phase involved two steps. At first, a comprehensive needs analysis was performed to identify the organisational needs and expectations from the new system. Once the needs were identified, the IT team in collaboration with management started planning for the design and development phases. This phase also involved team formation, formulating a working strategy, setting up standard operational procedures, ensuring resources availability and establishing a line of communication.

5.2 Design Phase

As previously stated, software development begins with some set of requirements, which form the basis of the design phase, and around which the complete designing process revolve. Once the need for customised ERP HRM module was established, the next process involved designing the proposed system. As a first step, a team started reviewing and analysing the PEC workflows, businesses processes, organisational needs while simultaneously reviewing essential operational documentations. An essential part of the system design was to keep in consideration that the new system was flexible enough to be easily aligned to the current system. In addition, the new system should have had more visibility, mobility and easy accessibility to the information which lacked in the previous system.

The design team arranged series of meetings with the HR department and one on one session with line managers to understand work requirements. In addition, the team visited each department to observe how employees processed information, job roles and feedback. Once the required information had been collected, it was analysed to find out users' expectations and their interaction with the new system. Based on the conclusion drawn, a use case diagram was constructed (shown in Figure 2). A use case diagram is a representation of a user's interaction with the system that shows the relationship between the user and different use cases (list of action, or even steps) in which a user is involved. It also identifies types of users of a system and different use cases.

Figure 2 shows the first stage of an HR System that has two users:

- HR Admin
- Super Admin

Both of them nearly do the same work except that Super Admin can edit (add/delete) financial information, a company work history/designations and add new designations.

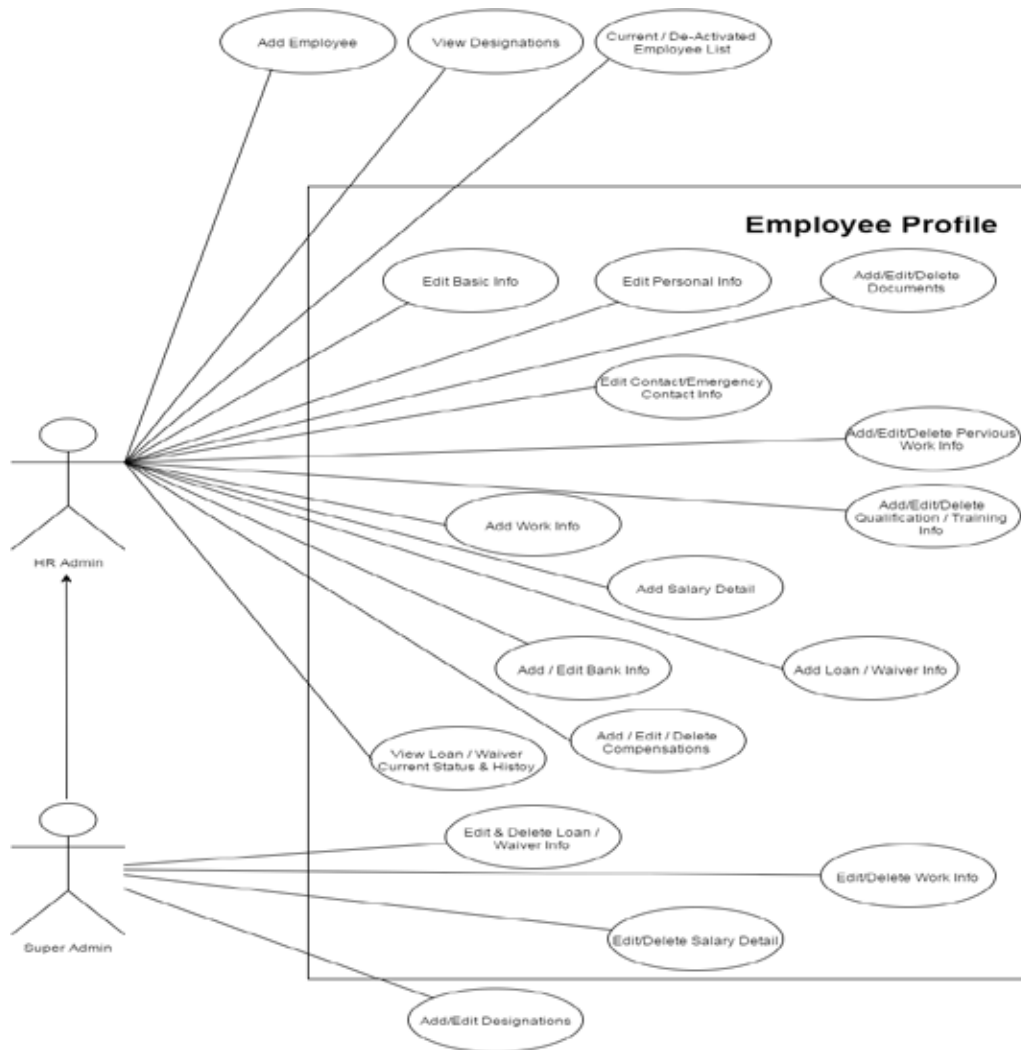


Figure 2. Use case diagram

During the system planning phase, management weighed the benefits of hosting the software on the cloud-based module over the in-house server based system. Since the web-based cloud module offers several advantages, such as allowing employees working on-site or off-site to access information to perform their tasks, there is no need for software download or installation. Updating the system is quick and easy; it is available 24/7; an online training option is available; and it provides easy integration with mobile devices. Due to these benefits offered, PEC selected the cloud-based module over the in-house server based system.

5.3 Development Phase

The current cluster of isolated programs at PEC was developed in MS Excel. Over the period of time, with business expansion and the resulting increase in HR needs, the systems struggled to satisfy organisational requirements. To overcome this challenge, PEC decided to develop a new program to cope with the increasing demand. The project team decided to select C programming language for code writing to develop it since it is a general-purpose computer programming language which supports structured programming.

Simultaneously, a separate team started working on compiling and structuring the HR related information. Their goal was to create a central database of employees' personal and work-related information such as their names, home addresses, pay scales, education and certification, job titles, current locations, etc. In order to work efficiently, this goal was divided into several objectives handled by teams and sub-teams working on different sections of the module such as salary sheet, personal information, location, licencing, etc. The process of developing employee database took four months. Once the design team had acquired a complete understanding

of the business process, they developed an Entity Relationship diagram (ER). This is a graphical representation of entities and their relationships to one another which is extensively used in organising data within the database. Figures 3 and 4 present the initial and final ER diagram which shows the database structure of the HR system. As shown below, “employee” is the main actor in the HR system. Therefore, all other entries are directly linked to the employee. The first target of the HR system is to handle the information related to employees. Accordingly, the first ER-Diagram of HR contains the information of employees.

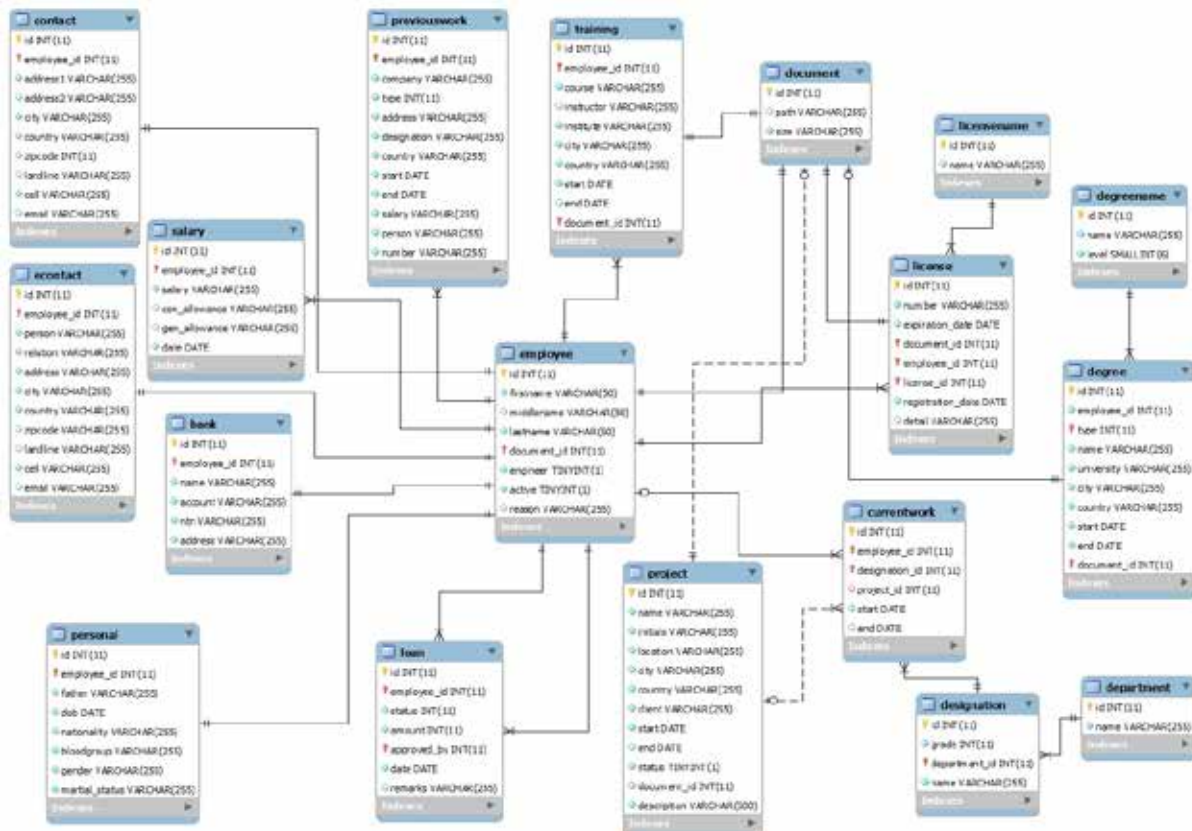


Figure 3. Initial ER diagram

After some initial success with coding in C language, the development team began noticing the limitations of C language which would result in its inability to reflect the functionalities offered by the ERP module. After careful deliberation, the team decided to replace C language either with PHP or ASP, programming languages. The team selected PHP over ASP for two main reasons. The first, it is used in developing millions of websites; and the second is that all major hosts support it. PHP is an open source general purpose programming language which has many frameworks to facilitate development. It is also supported by a huge developer community that contributes to it. Since PHP is an open source, it has a wide list of supporting plugins and frameworks available such as Codeigniter, Symfony, Zend, Cake PHP and Laravel.

The development team selected Symfony web application since it is the modern and complete Model-View-Controller (MVC) framework. It is supported by a powerful toolbar to ease debugging. Depending on requirements, some of its components could be used independently without the entire framework. It also provides the proper platform to run functional, unit and behavioural tests.

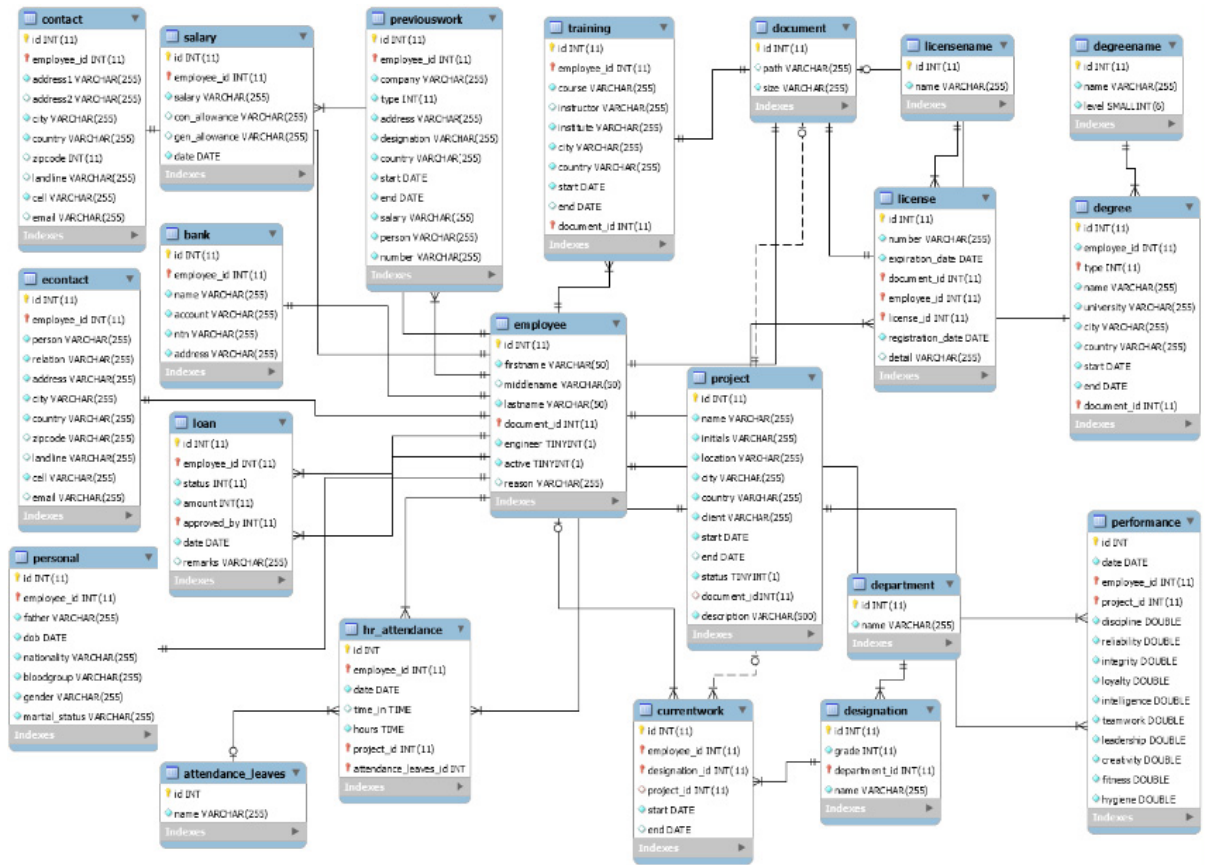


Figure 4. Final ER diagram

Next, the developer team set up two types of environments for the new system, i.e., the production and deployment environments. The production environment was set up on PCs and had all the essential development tools needed by the team for system development. These PCs also functioned as server and client. Therefore, if the developer wanted to run a developed program, instead of uploading it to the main server, developer used the PC as a server to run the developed program.

The deployment environment was used to run the developed application on the main server. Hence, all the testing was done in the development environment. Once the testing was performed satisfactorily, the developed application was deployed on the main server and could be accessed by users across the organisation.

During the development process, as planned, module development work was carried out in parallel with the current system working. This process is called parallel conversion and it allows both the existing and new systems to operate at the same time for the certain amount of time (Zhang & Li, 2006). This strategy also enabled the development team to improve the quality of the system while uploading the new information on the web-server.

Once the ERP system was ready to be deployed, PEC purchased the hosting service with dedicated IP and decided to move on semi-dedicated hosting or Virtual Private Server (VPS) as per requirement. These servers are Dual Quad Core Servers (16 cores) with 24GB Servers RAM (minimum). They used C panel as a control panel Lite speed Web Server pre-installed.

Before going live, there are several checks to ensure that the product being developed satisfy the organisational needs. These checks include design review, code reviews, inspections, unit testing, system testing, integration, etc., and are used during and after software development to uncover and correct defects (Mahanti & Antony, 2005). The software testing process is explained in the next section.

5.4 Testing Phase

Initially, a beta version of the HRM module was developed for testing purposes. The development team adopted the strategy of breaking down the complete module into small segments to perform testing. Once the testing had been carried out successfully, the specific section of the module was uploaded back into the main module. This strategy enabled performing rigorous testing of the new system. The testing team comprised of members from diverse backgrounds, including users. The testing process lasted four weeks.

Not only does the testing process examine the performance of the module, but also it assists in evaluating the usability of the module and possibility of further improvement.

5.5 Go-live Phase

This is the last phase in software development and requires comprehensive planning involving a focus on focus on “what-if” scenarios; preparation for on-going support; and finalising the documentation processes. Once the system goes live, it is constantly monitored to ensure that system in functioning as planned and the supporting process are running smoothly. Seven months after the idea was conceptualized, the module went live in late 2012 after careful go-live planning. Currently, the system is fully functional and being used throughout the organisation.

Loan Status Sheet

Sep 2015

2015-09

Status						
#	Employee	Previous Status	Loan Granted	Waiver	Payments	Status
30	██████████	6,000.00	0.00	0.00	2,000.00	4,000.00
29	██████████	18,000.00	0.00	0.00	3,000.00	15,000.00
28	██████████	13,000.00	0.00	0.00	2,000.00	11,000.00
27	██████████	7,000.00	0.00	0.00	0.00	7,000.00
26	██████████	13,000.00	0.00	0.00	2,000.00	11,000.00
25	██████████	594,019.00	0.00	0.00	0.00	594,019.00
24	██████████	3,000.00	0.00	0.00	2,000.00	1,000.00
23	██████████	0.00	30,000.00	0.00	0.00	30,000.00
22	██████████	95,000.00	0.00	0.00	15,000.00	80,000.00
21	██████████	9,000.00	0.00	0.00	1,500.00	7,500.00
20	██████████	18,000.00	0.00	0.00	2,000.00	16,000.00
19	██████████	46,000.00	0.00	0.00	0.00	46,000.00
18	██████████	-3,000.00	0.00	0.00	0.00	-3,000.00
17	██████████	20,000.00	0.00	0.00	5,000.00	15,000.00
16	██████████	64,223.00	0.00	0.00	0.00	64,223.00

Figure 5. Loan status sheet in ERP system

6. Discussion

According to IT manager, the process of designing and developing the HRM module also assisted in senior management recognition and appreciation of the latest IT technology and advantages of using an enterprise system to enhance planning, operations and control. With this new management support, the IT department started new in-house employee training initiatives and IT skills development programmes.

Further, according to the operations manager, the in-house developed HRM module has enabled the company to keep up-to-date information of the employees working on-site and off-site efficiently. It also enabled correct

calculation of payrolls and issuance of pre-advance warnings about renewal or expiration dates of employees' professional licences or certifications which are necessary job requirements. In addition, it has enabled them to develop a performance management system which is necessary for decision making with regards to job promotion and salary increase. The development process contributed towards the creation of proper hierarchy inside the organisation. In contrast to past practices when only major job roles and positions were identified, the new ERP system facilitated the creation of new job designations, job roles and hierarchy. This effectively streamlined decision making, delegation of authority, account ability and workflow.

#	Project	# of Emp	Salary	G/A	C/A	T/S	Tax	Payable	Deductions	Net	Bank1	Bank2	Cash
1	EMAAR	16	388,500	27,000	134,000	546,500	1,708	547,792	15,000	532,792	282,292	114,000	136,500
2	IOBM	10	279,000	16,500	81,500	377,000	2,408	374,592	0	374,592	227,592	85,000	62,000
3	BAHL	9	200,000	8,500	46,000	254,500	0	254,500	0	254,500	95,500	0	159,000
4	S1	5	96,000	0	5,000	101,000	0	101,000	0	101,000	33,000	0	68,000
5	H-O	38	2,191,500	129,000	550,000	2,870,500	78,668	2,791,832	22,000	2,769,832	898,832	1,257,000	504,000
6	MID	2	71,000	3,000	18,000	92,000	333	91,667	25,000	66,667	45,667	21,000	0
7	WS	3	57,000	0	0	57,000	0	57,000	2,000	55,000	18,000	0	37,000
8	AND	2	48,000	8,000	24,000	80,000	0	80,000	0	80,000	33,000	32,000	15,000
9	GG	37	925,500	20,500	91,000	1,037,000	2,707	1,034,293	5,000	1,029,293	441,459	0	530,667
10	AHU	8	212,500	11,500	80,000	304,000	3,958	300,042	0	300,042	190,042	0	106,000
11	COM3	21	543,000	18,500	23,000	584,500	5,956	578,544	17,000	561,544	360,044	0	201,500
12	FML	31	888,000	15,000	193,500	1,096,500	4,374	1,092,126	13,500	1,078,626	422,792	68,000	587,834
13	PALWAL	4	57,000	0	0	57,000	0	57,000	3,000	54,000	0	0	54,000

Figure 6. Salary interface of HR module

The major issues faced during the implementation process included employees fear of change and unwillingness to share information. It was observed that in many instances employees were reluctant to release information. They also had fears about incoming changes and the impact these would have on job roles and, more importantly, job security. The employees' fears were overcome by involving them in the planning process and updating them with the benefits the new system would bring. However, in some instances, higher management was asked to intervene to resolve the information sharing issues.

In the next phase, PEC planned to redesign and upgrade the system by adding extra options and enabling easier user interface. While doing so, the IT team compared the in-house module with the ERP HRM modules available in the market. Based on the outcome, the team developed an enhanced and competitive module.

7. Conclusion

Implementing an ERP system is a complex undertaking. The need to realign business strategies with the software often becomes a nightmare exercise. Whilst the other option to customise the ERP system around organisation's business processes has led to failure in major implementations. To overcome these challenges, this paper presents a case study of an organisation that embarked upon designing and developing an in-house ERP system specifically designed to cater for their organisational needs successfully. This provides organisations with a viable option of developing enterprise systems instead of buying off the shelf ones.

Several lessons can be learned from the development process which could be beneficial to an organisation embarking on developing a system. These are:

- i. It is essential that the organisation performs a detailed needs analysis involving all the key stakeholders. This first step will provide guidance as to what is required from the new system.
- ii. An analysis of currently available resources which could contribute towards smooth implementation is needed. This can assist in resource allocation planning during the implementation phase.

- iii. A proper change management strategy should be in place to manage any resistance. The benefits of the new system should be clearly communicated to users showing how it would benefit them. This should be supported by training programs incorporated in the process.
- iv. The business process should be identified and mapped in early stages. This will provide solid foundation for the new system.
- v. The software development approach should be identified and chosen based on the implementation strategy. Major available approaches are: waterfall development, prototyping, incremental development, spiral development and rapid application development.
- vi. It is critical that the implementation team is comprised of members belonging to diverse backgrounds representing management and various departments.

The main critical advantage of developing an in-house system is that there is no need for customisation of an ERP system or realignment of business strategies. A good planning and complete understanding of the business processes and their functions is the primary requirement. The author believes that this option has not been sufficiently explored and studied by many organisations. Therefore, this study could serve as a guidance and source of information for an organisation which is planning to implement an ERP system; and for those who are considering the option of developing an in-house system. Further, there is a potential of further research in this area aiming at studying the feasibility and development of other ERP modules for various business sectors.

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Job satisfaction has been defined as the "positive emotional state resulting from the appraisal of one's job"(Locke 1976). Job satisfaction has many dimensions such as: organization system, work itself, wages, and recognition, rapport with supervisors and coworkers, and chance for advancement. Each dimension contributes to an individual's overall feeling of satisfaction with the job itself, but different people define the "job" differently. The purpose of this study was to identify the factors which influence the job satisfaction of faculty members and to identify the factor which improves the satisfaction level of faculty members. The study was conducted on 240 faculty members working in various universities and, was randomly drawn using questionnaire method. It was found that organization vision (1), respect(4), result feedback and motivation(3), management system(3), pay and benefits(2), and work environment(2), all six major factors were contributed towards the faculty satisfaction. The results also suggest that the factors had satisfactorily explained job satisfaction and that the policy makers should focus on the factors that affect employee job satisfaction, if the universities want to enhance their performances.

Key Words: Pay and Benefits, Management System, Work Environment, Result Feedback and Motivation, Job Satisfaction

Introduction

Job satisfaction represents the physical and mental wellbeing of the employees. Hence, an understanding of the factors relating to job satisfaction is an important task for organizations. It reflected in the form of absenteeism ratio, employee turnover over all performance of employees. Job satisfaction of academic staff in Higher Education Institute is important because it influences their motivation and performance to establish and maintain an environment conducive to learning. Therefore, teacher requirements must be fulfilled to improve the working environment and enable teachers to achieve outstanding research and teaching performance.

Job satisfaction has been defined as the "positive emotional state resulting from the appraisal of one's job"(Locke 1976). Job satisfaction has many dimensions such as: organization system, work itself, wages, and recognition, rapport with supervisors and coworkers, and chance for advancement. Each dimension contributes to an individual's overall feeling of satisfaction with the job itself, but different people define the "job" differently. Feldman and Arnold (1983) defined Job satisfaction as the amount of overall positive affect (or feelings) that individuals have towards their jobs. Robert and Angelo (1995) described, Job satisfaction is an affective or emotional response toward various facets of one's job. This definition means job satisfaction is not a unitary concept.

Keith and Newstrom (1989) explained Job satisfaction is a set of favorable or unfavorable feelings with which employees view their work."Andrew (1988) stated that job satisfaction is the amount of pleasure or contentment associated with a job.

Improving educational performance ranks high on the national agenda, with educators and policymakers focusing on testing, accountability, curriculum reform, teacher quality, school choice, and related concerns. A high quality teaching staff is the cornerstone of a successful system. Researchers, policymakers, and education leaders agree that teacher satisfaction is a vital factor that affects student achievement. Teachers' job satisfaction is one of the key factors in institutional dynamics and is generally considered to be primary dependent variable in terms of which effectiveness of an organization's human resource is evaluated (Jyoti & Sharma, 2009). Satisfied and motivated teachers are important for any educational system. The success or failure of the education system depends mainly on satisfied teachers, but also on satisfied school managers and administrators.

Review of Literature:

The dimensions of the determinants for employee satisfaction surveys vary among different businesses or organizations, but the differences are not obvious; moreover, the structure of employee satisfaction models for higher education is also identical. The following documents were referred to in discussing the determinants of employee satisfaction in the field of higher education.

Noorshella et. al. (2017) revealed that teaching and learning, benefits and governance has significant effect on the job satisfaction of academicians in public universities of Malaysia. Particularly benefits and

governance have been found to have a highly significant effect on the job satisfaction level of academics. In order to enhance job satisfaction among the academics, the packages and policies of universities should therefore focus on improving benefits for the academicians.

Lien (2017) conducted a research to reveal the factors affecting lecturer job satisfaction in universities of Vietnam. It was observed that, three out of six variables (including Salary and Fringe benefits, Recognition, and Communication) have influential relationship with lecturer job satisfaction.

Gichinga (2016) revealed in her study conducted in universities in Mogadishu Somalia that, work environment and leadership style have significant and positive effects on employee job satisfaction, while organizational culture have insignificant effects on employee job satisfaction.

Pan et. al. (2015) found in their study that Chinese university teachers had a moderate level of job satisfaction. Demographic, working characteristics and Perceived organizational support were associated with factors for job satisfaction and shown a strongest association with job satisfaction.

Hinai and Bajracharya (2014) revealed six factors that affect job satisfaction of academic staff in higher education institution , remuneration and development, management support, students, colleagues, workload, and status of job.

Bolin (2007), in a study on teacher job satisfaction and factors that influence it, examined five dimensions that could possibly lead to job satisfaction, namely self fulfilment, workload, salary, leadership and collegial relationships. The researcher's finding showed that teacher satisfaction was low with regard to the income dimension. In other words, teachers were not satisfied with their income.

Weiqi (2007) examined 10 factors of job satisfaction and its influence on teacher attrition and work enthusiasm. The factors were leadership and administration, work achievements, student quality, the educational and social environment, social status, income and welfare, collegial relationships, social acknowledgment, workload and stress, and working conditions.

Chem et. al. (2006) identified six different factors for measuring employee satisfaction in higher education, obtained from understanding the functions of higher education and discussing with experts obtained. These factors were organization vision (seven items); respect (four items); result feedback and motivation (five items); management system (eight items); pay and benefits (six items); and work environment (nine items).

According to Kim (2005), the job aspects such as salary, job security, worth of providing a public service, the work itself, and promotion prospects that are important and valued by female employees are different from those that are important to male employees, because what women look for in a job is different to what men look for.

Comm and Mathaisel (2000) used SERVQUAL to conduct questionnaire surveys on 606 employees of a private higher education organizations to identify the determinants of satisfaction within educational organizations. The findings were as follows: workload; work atmosphere; decision-making;

ethics/fairness; customer focus; supervision; goals and objectives; training and development; pay; and benefits. Mengistu (2012), identify job satisfaction factors in secondary school teachers in Ethiopia as: working conditions, interpersonal relationships, variables related to the intrinsic characteristics of the job, and demographic variables.

Metle (2003) conducted employment satisfaction surveys on female employees in the Kuwaiti public government sector (KGS), and identified the following employment satisfaction factors: overall job satisfaction; pay and security; co-workers; supervision; promotion; and content of work.

Ku"sku" (2001) proposed applying employee satisfaction surveys to the employees of a Turkish college, and applied the following dimensions for measuring their satisfaction: general satisfaction; management satisfaction; colleagues; other working group satisfaction; job satisfaction; work environment; and salary satisfaction.

Oshagbemi (1997) measured job satisfaction for 566 college teachers, as shown below: teaching; research; administration and management; present pay; promotions; supervision/supervisor behaviour; behaviour of co-workers; and physical conditions/working facilities.

The objective of the study is as follows:

1. To identify the factors which influence the job satisfaction of faculty members.
2. To identify the factor which improves the satisfaction level of faculty members.
3. To suggest the remedies for improving job satisfaction level of faculty members.

Research Methodology:

The study is diagnostic in nature as it tries to find satisfaction level and identify the factors which influence the job satisfaction of faculty member in higher educational institutions.

Sample Size & Design:

Faculty members working in higher and technical universities of Punjab region in India has been selected as respondents for the sample. 246 faculty members were approached for collection of data out of which 6 did not return the questionnaire but remaining 240 responded properly and, were used as sample. They were also ensured about the confidentiality of the data and use of data strictly for academic purpose.

Tool used:

The most common way of measurement is the use of rating scales where employees report their reactions to their jobs. Questions are related to pay, work responsibilities, variety of tasks, promotional opportunities the work itself and co-workers. Chem et. al. (2006) scale for measuring employee satisfaction in higher education, were used for data collection. Importance-satisfaction model (I-S model) and employee satisfaction model were used in the study. The results of importance-satisfaction model for each quality attribute are placed in the model and then improvement strategies are considered based on

the position of each item. There were six factors in the employee satisfaction model i.e. organization vision (seven items); respect (four items); result feedback and motivation (five items); management system (eight items); pay and benefits (six items); and work environment (nine items).



Source: Yang (2003a)

This questionnaire was divided into two parts as:

- (1) Importance Survey. The importance survey scale ranged from 1 to 5 (with 1 representing extremely low importance and 5 representing extremely high importance).
- (2) Satisfaction Survey. The satisfaction survey scale ranged from 1 to 5 (with 1 representing extremely dissatisfied and 5 representing extremely satisfied).

Reliability of Test

Reliability level for each variable was determined using Cronbach's Alpha. The alpha value for each variable exceeded 0.7 and this is considered acceptable for further analysis.

Table I: Value of Cronbach's Alpha for each variable

Variables	No. of items	Cronbach's Alpha
Organization vision	7	0.79
Respect	4	0.81
Result feedback and motivation	5	0.82
Management systems	8	0.76
Pay and benefits	6	0.85
Work environment	9	0.84

Data Analysis and Results:

Table II Analysis of importance and satisfaction quality attributes

Job Satisfaction Factors	Code	Dimensions	Importance	Ranking	Satisfaction	Ranking
Organization vision	A1	Institution's entire development plan	2.56	37	3.45	22
	A2	Institution's reputation and image	2.67	36	3.55	21
	A3	Institution's participation in local culture or public welfare activities	3.12	34	3.11	29
	A4	Institution's principal's perspective	3.14	33	3.67	14
	A5	Institution principal's and directors' ambition	4.12	11	3.85	10
	A6	Help teachers develop self-visions	3.66	23	2.87	34
	A7	Participation in Institution's major policy decisions	3.45	28	3.12	28
Respect	B1	Professional knowledge is respected	4.44	5	4.23	5
	B2	Mutual respect among teachers	4.34	6	3.56	19
	B3	Respect for their teachers by students	4.11	12	4.12	8
	B4	Students' outstanding performances	3.78	20	3.67	15
Result feedback and motivation	C1	Achievements of teaching and research	3.89	16	3.29	24
	C2	Rewards and glorification for outstanding performances	3.65	24	3.78	11
	C3	Provision of achievements rewards	4.18	9	4.67	1
	C4	Support for the results of teaching and research	4.22	8	3.56	20
	C5	Allow teachers to know Institution's operating conditions	3.98	14	3.66	16
Management systems	D1	Provision of fair promotion systems	4.18	10	4.23	6
	D2	Provision of good management systems	3.78	21	4.61	2
	D3	Clear system of rewards and penalties	3.97	15	3.93	9
	D4	Directors with leadership and managerial capacity	3.43	29	4.21	7
	D5	Open system of directors' assignment	3.99	13	3.41	23
	D6	Provision of smooth communication channels	4.56	3	2.87	35
	D7	Introduction of innovation management systems	3.21	31	2.19	39
	D8	Provision of high-quality service processes	3.55	26	3.24	25

Pay and benefits	E1	Provision of good salaries systems	4.76	2	4.47	3
	E2	Provision of working security systems	4.78	1	3.59	17
	E3	Provision of affiliated kindergartens	3.21	32	2.77	37
	E4	Provision of good retirement systems	3.55	27	3.59	18
	E5	Provision of lodging, travel related welfare allowances	2.85	35	2.97	31
	E6	Provision of subsidies for further education	3.87	17	3.1	30
Work environment	F1	Provision of abundant library facilities	4.33	7	2.89	33
	F2	Provision of complete teaching instruments	4.51	4	4.33	4
	F3	Provision of convenient parking	3.22	30	3.16	26
	F4	Provision of dining diversity	3.79	19	3.76	12
	F5	Independent and spacious research space	3.69	22	3.68	13
	F6	Provision of hygienic dining environments	3.57	25	2.3	38
	F7	Provision of educative and training environments	2.11	39	2.92	32
	F8	Provision of abundant research resources	3.81	18	2.79	36
	F9	Provision of advanced information	2.34	38	3.14	27

Analysis of Importance Quality Attributes

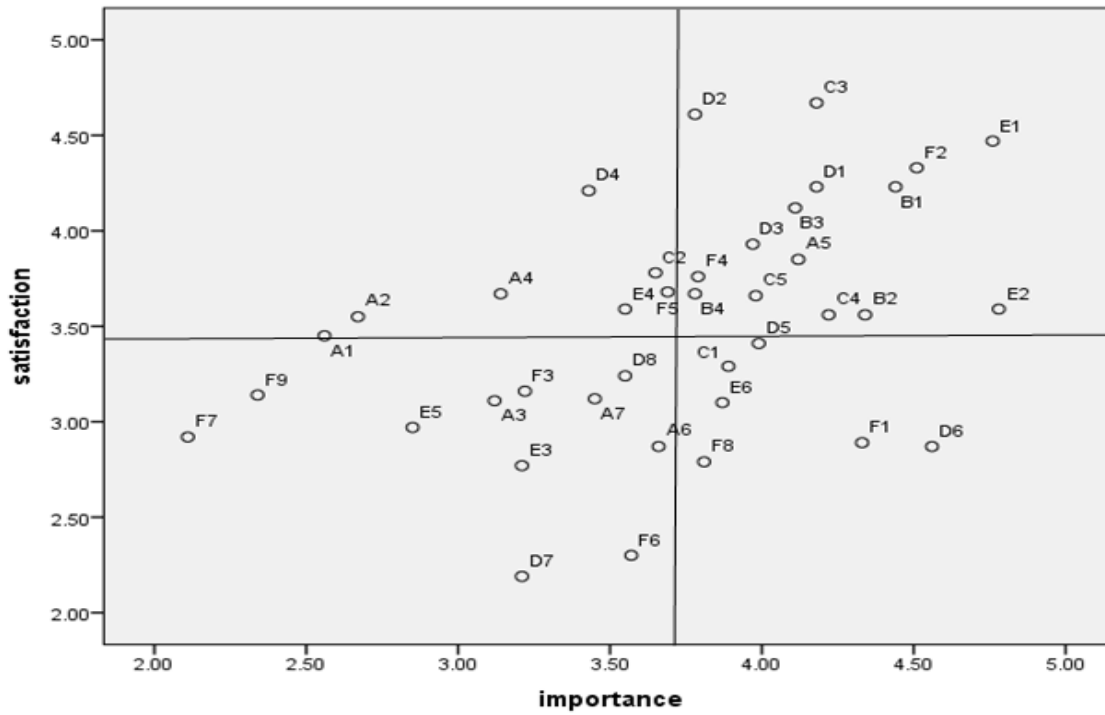
Table 2 shown the ranking of job satisfaction attributes on the bases of Importance and Satisfaction quality attributes. In case of Importance quality attributes faculty members has ranked the following attributes as follows: Provision of working security systems (4.78)¹, Provision of good salaries systems (4.76)², Provision of smooth communication channels (4.56)³, Provision of complete teaching instruments (4.51)⁴ and Professional knowledge is respected (4.44)⁵. Whereas attributes which were on the bottom as follows: Provision of lodging, travel related welfare allowances (2.85)³⁵, Institution's reputation and image (2.67)³⁶, Institution's entire development plan (2.56)³⁷, Provision of advanced information (2.34)³⁸ and Provision of educative and training environments (2.11)³⁹.

Analysis of Satisfaction Quality Attributes:

In case of Satisfaction quality attributes faculty members has ranked the following attributes as follows: Provision of achievements rewards (4.67)¹, Provision of good management systems (4.67)², Provision of good salaries systems (4.47)³, Provision of complete teaching instruments (4.51)⁴, and Professional knowledge is respected (4.23). Whereas attributes which were on the bottom as follows: Provision of smooth communication channels (2.87)³⁵, Provision of abundant research resources (2.79)³⁶, Provision of affiliated kindergartens (2.77)³⁷, Provision of hygienic dining environments (2.30)³⁸ and Introduction of innovation management systems (2.19)³⁹.

Importance-Satisfaction Model (I-S Model) Applications:

The purpose of employee satisfaction surveys is to determine the improvement quality attributes from the results of the analyses, in situations where the low quality attributes are usually those that must be improved. However, whether this objective is correct remains uncertain.

**Area I : Excellent Area**

A5	Institution principal's and directors' ambition
B1	Professional knowledge is respected
B2	Mutual respect among teachers
B3	Respect for their teachers by students
B4	Students' outstanding performances
C3	Provision of achievements rewards
C4	Support for the results of teaching and research
C5	Allow teachers to know Institution's operating conditions
D1	Provision of fair promotion systems
D2	Provision of good management systems
D3	Clear system of rewards and penalties
E1	Provision of good salaries systems
E2	Provision of working security systems
F2	Provision of complete teaching instruments
F4	Provision of dining diversity

The “excellent area”, faculty members are completely satisfied includes 15 quality attributes. Faculty members shown satisfaction with all the dimensions of respect, i.e. “Professional knowledge is respected”, “Mutual respect among teachers”, “Respect for their teachers by students”, and “Students’ outstanding performances”. Faculty members has also shown satisfaction with “provision of good salary system” and “provision of working security system”. Three attributes, D1, D2 and D3 of management system are the key factors for faculty satisfaction.

Three attributes of “Result feedback and motivation” also played an important role to provide overall satisfaction to the faculty members. Institution’s working environment attributes, F2 and F4 were also considered as important factor for satisfaction of the faculty member.

Area II: To be Improved Area

C1	Achievements of teaching and research
D5	Open system of directors’ assignation
D6	Provision of smooth communication channels
E6	Provision of subsidies for further education
F1	Provision of abundant library facilities
F8	Provision of abundant research resources

Second area of the model was to be improved area, which shown that the teachers are dissatisfied with the quality attributes. As shown in the table there was total 6 attribute contributing towards their dissatisfaction. Institution need to think to overcome the situation and help to make their employee satisfied. “Provision of abundant library facilities” and “Provision of abundant research resources”, the two attribute which are most important for the quality education shown a dissatisfaction among the faculty members. “Achievements of teaching and research”, “Provision of smooth communication channels” and “Provision

of subsidies for further education” were another important factor responsible for the total dissatisfaction.

Area III: Surplus Area

A1	Institution's entire development plan
A2	Institution's reputation and image
A4	Institution's principal’s perspective
C2	Rewards and glorification for outstanding performances
D4	Directors with leadership and managerial capacity
E4	Provision of good retirement systems
F5	Independent and spacious research space

Third part of the model shown the “surplus area”, indicating that the institutions have acceptable performances in these attributes. Total seven attributes contributed the area, which shown the performance of the institutions. Three attribute of organization vision,

“Institution's entire development plan”, “Institution's reputation and image”, and “Institution's principal’s perspective”, are three important attribute responsible for the good performance of institutions. Institutions are also taking care of employees in form of “ Rewards and glorification for outstanding performances”. Three attributes in form of “ Directors with leadership and managerial capacity”, “ Provision of good retirement systems”, and “ Independent and spacious research space, were also played an important role to overall performance of the institutions.

Area IV: Careless Area

A3	Institution's participation in local culture or public welfare activities
A6	Help teachers develop self-visions
A7	Participation in Institution's major policy decisions
D7	Introduction of innovation management systems
D8	Provision of high-quality service processes
E3	Provision of affiliated kindergartens
E5	Provision of lodging, travel related welfare allowances
F3	Provision of convenient parking
F6	Provision of hygienic dining environments
F7	Provision of educative and training environments
F9	Provision of advanced information

The last area of the model was “careless area” which contains 11 attributes; if the institution’s resources are limited, these quality attributes have a low priority.

Conclusions:

Employee job satisfaction can improve service quality and increase employee satisfaction. In this circumstance, policy makers and managers have turned their attention to provide different kinds of facilities to their employees in order to satisfy their employees. This study tested factors affecting job satisfaction for higher educational institutions. The results suggest that the factors had satisfactorily explained job satisfaction and that the policy makers should focus on the factors that affect employee job satisfaction, if they want to enhance organization performances. Based on the results it has been observed that organization vision (1), respect(4), result feedback and motivation(3), management system(3), pay and benefits(2), and work environment(2), all six major factors were contributed towards the faculty satisfaction. Based on the results of the I-S model institutions improved some dissatisfied quality attributes. The study proposed the improvement priority based on the perspectives of importance and satisfaction. Results have shown a bases for institution to determine improvement strategies and priorities to satisfy actual employee requirements. Institutions need to put more efforts to enhance overall working environment of the institutions. Organization vision also need to redefine for employee satisfaction.

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Exploring Shopper Insights of Social Media Use in Saudi Arabia

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ABSTRACT

Social media inspired millions of users from all over the world. This media has made the connection more familiar to ones that are more intelligent. This new medium of communication wins the trust of consumers by connecting with them at a deeper level. Global and local companies have recognized social media marketing as a potential marketing platform and have utilized with innovations to power their advertising campaign their marketing approach through social media. One cannot afford to not having any presence on the social network channel now a day when their counterparts are having waves of products and services in the market. Despite, the spread of social media and the broad adoption of these various communication tools, there is a lack of studies in Saudi region that conceptualized the goals of objectives of the study. A convenience sample survey has been collected from 226 respondents through using the online survey via Google forms and monkey survey during 3 months from October to December 2015. The closed-ended questionnaire was used, and particular care has been taken to reduce the non-response rate and the error arising out of it. After collecting the data, it was manually edited, coded and then recorded on excel sheet. For descriptive analysis statistics (frequency distribution), Chi-square goodness of fitness test at $P = 0.05$ was applied, and result findings were interpreted accordingly in the study.

Keywords: Social Media, User Perceptions, Marketing Communication, Consumer Attitude, Consumer Behavior, Shopper Insight, Saudi Arabia
JEL Classifications: M300, M310, M370

1. INTRODUCTION

Social media refers to the use of Internet technology, and mobile communication technology has changed in interactive dialogue and exchange. Social media includes magazines, microblogs, wikis, podcasts, pictures, photos, videos and assessments such as social bookmarking in various shapes (Barlett-Bragg, 2006). Besides, social networking has become a global phenomenon, as well as a variety of age, culture, attracting numerous people from around the world, such as the level of education. Social networking sites (SNSs), once a day at least, check the files (Joinson, 2008; Lenhart, 2009).

In recent years, Facebook, WhatsApp, and other SNS such as LinkedIn become the world more visited sites. Facebook is much higher than the menu, SNSs in reality facilitate the sharing of images, video with friends sharing multimedia elements in a range that are open to others and they were able to build their communication through the internet use (McLoughlin and Lee, 2007). In the field of marketing, now, especially in the social media consumption activities of digital interaction is growing interested

(Stewart and Pavlou, 2002). The ever-changing consumer behaviors are developing online quickly, both consumer and content consumption are involved and participate in discussions to promote the share of consumer activity with other customers in various activities such as knowledge and awareness, etc. This positive consumer behavior, as they infringed the company's marketing has changed the landscape of media and marketing as indicated by Berthon et al. (2008), Mejias (2005), Ajjan and Hartshorne (2008).

According to the Arab Social Media Report (2012), it is experimental that the growth of social media in the region change the environment of social media usage. All of which has been indicated that "usage of Facebook, YouTube, and Twitter in the movements of the so-called Arab Spring" (Arab Social Media Report). Also, The Arab Social Media Report sequence is part of a larger research initiative by the governance, and innovation program focuses on the promising of social networking applications for growing partnership, information allocation, and improvement, and among government entities, society, and the private sector. Furthermore, the Arab Social Media Report series,

social media habit trends have been explored and analyzed, stated that there is an exponential growth in the number of social media users in the province, and a noticeable move away from the distinctive public and amusement use of the social media.

In a recent study on the activities and user-generated content among the consumer and social media examine the motives of whether the user wants to use or practicing social means (e.g., Park et al., 2009; Baker and White, 2010; Shao, 2009). It has been anticipated that consumers are either active as posters or contributors or passive as lurkers or consumers of content (Schlosser, 2005; Shang et al., 2006; Shao, 2009). However, from the information gathered and reviewed it can be concluded that there is a need for research related to the user impact and insight on social media. Therefore, this study is focusing on the different levels of activities consumers engage in on social media and the motives that drive these social media activities in the region. This study contributes to research and practice in consumer marketing in general and in social media and online communities in particular by describing different user activities associated with user-generated media.

2. OBJECTIVES OF THE STUDY

- I. To know the preferences in using social network types among the respondents
- II. To identify preferable social network sites among the respondents
- III. To find out topics to be involved on social media among the respondents
- IV. To investigate the preferred time to be involved on social network sites among those interviewed
- V. To reveal about the brands following on social media among the respondents
- VI. Identify the types of communication tools respondents interested in social media.

3. LITERATURE REVIEW

Classification of social media currently listed under the generalized term to the more specific categories like blogs, communities, content, SNSs, virtual worlds and virtual worlds and social games (Kaplan and Heinlein, 2010). Also, the platforms and social media including blogs, microblogging, e-mail and SNSs (Mangold and Faulds, 2009). This method is an important way to deliver marketing messages and create a dialogue with consumers. A variety of platforms, which are composed and exchange of information by individuals on the internet (Mangold and Faulds, 2009). In current years, one can notice a significant impact on the business on the internet. Moreover, SNSs provide an opening for companies to participate and intermingle with potential consumers, and to promote greater convergence with customers and establish significant associations with potential consumers feeling (Mersey et al., 2010; Frank, 2009). Social media offers many advantages for consumers and marketers. Also, social media allows for proper targeting of the primary users of the brand, which enabled the integrated marketing communications to be possible with the time with very much less effort than traditional media (Kim and Ko,

2012). The fast development in the practice of social interacting in all countries indicates that companies can use to develop the product or service of interest to consumers. Similarly, the sellers are using today various social media platforms to improve their image and branding companies (Mathur et al., 2012).

In one study, social media positively contributes to the performance of the brand, retail performance, loyalty and individual consumers (Adam et al., 2013). According to the Association of American marketing in 2014, the furthestmost common social network sites; Facebook has more than 1.15 billion users, and marketers are often dealing with consumers to provide great depth of information in a Facebook "fan" pages of a brand or a company (Weinberg and Pehlivan, 2011). Associated with traditional media, direct marketing/ social media marketing, can be vendors and media make strategic changes in front of these observations. Also, it revealed that sellers could practice social media tools to convey info about the products, brand image; consumers can review products and questions that may relate to the product (Obal et al., 2011). In organizational terms, social networks are extremely helpful in forming and maintaining relationships with consumers, and it should integrate into the marketing mix. The community is pretentious increasingly by the social media and social change in the control of media consumption; brand managers understand how to use social media effectively in dialogue with consumers. Moreover, social media is an essential element of the marketing mix, which affects the relationship between consumers and brands (Gensler et al., 2013). Social networks play progressively significant sources of information for explorers. Analysis of results showed that the social media is a big part of the search results, pointing out that the search engines are likely directly to social media sites. This study confirms the growing importance of social media in the field of tourism on the Internet. It also provides evidence of the challenges that the traditional travel-related information faced by providers. Besides, discusses the implications for marketers of travel regarding online marketing strategies (Ulrike and Xiang, 2010). Socialization has become a natural to consumers through communication through social media and the use of social media in marketing growing popularity of these days. Consumer socialize through online with peers networking, it also affects the purchasing decisions in two ways: Straight (by peers) and indirectly by enhancing the participation of the product. Also, the consumer need for the uniqueness of his moderating influence on product selection attitudes communication between peer effects (Xia et al., 2012). De Vries et al. (2012), in his research showed that social media platforms allow consumers to hit the mark and other online consumers through brand communities, and to increase the exchange of information. It is essential that the brand remain transparent in its communication to build trust with consumers and brand loyalty.

These days, customers are the tangle in a diversity of deeds ranging from content consumption to participate in discussions, exchange knowledge with other consumers, and add activities of other users. Considerable interest in SNSs like YouTube, Facebook, Wikipedia, and users contribute actively in content marketing (Kristina, 2011). A SNS provides a platform for social networking on the Internet to build social or social relations among people (for example, interest or activity that has appeared). The rapid growth of online shopping, some retailers that sell goods and services online and

it became the primary channel to expand the market locally and internationally (Alam and Elaasi, 2016).

Besides, the study suggests that the last electronic word-of-mouth products that focus on the health insurance system are a unique phenomenon with important social implications (Shu-Chuan and Yoojung, 2011). This media can bring social benefits of the “identification of customers and the commitment” to drive business performance. On the other hand, the management of social relationships with clients can provide insight, which will help to pay for real innovation and customer-centric. Finally, the knowledge gained in customer behavior and attitudes help on the benefits of unity across the value chain. Affecting providers (such as demand forecasting) and brokers (for example, the formation of promotions in the shop (Woodcock et al., 2011). In addition to ads on social networks, significantly affect consumer behavior, ad clicks act turn positively affect their shopping online (Mir, 2012).

Social networks have developed a profound change in the communications background (Edwards, 2011), and most prominently, the mindset of consumers have changed (Mir and Zaheer, 2012). Communication through social media has a radical influence on the condition of human behavior (Eltantawy and Wiest, 2011; Marzouki et al., 2012). Due to the severe impact of this media it has become hotbeds of marketing and communications in the upper part of the decision-makers in the field of today business agenda. That permits companies to interact directly with their customers promptly and at a lower cost (Kaplan and Haenlein, 2010). The role of the media as a common platform for people all over the world interact with each other information and experiences, exchange and related products, events and issues (Edwards, 2011; Heinrichs et al., 2011). It differs from traditional media as created by users who have greater control over the use and content generation (Dickey and Lewis, 2011). Experimental evidence has supported in the context of online advertising and social networks on the internet. A result found that the marketers should focus on maintaining a social presence through social channels with new and frequent content to attract the participation of consumers; the study highlights the importance of frequent changes and incentives for participants (Christy and Tracy, 2014).

Since 2011, more than half of consumers follow brands on Facebook (De Vries et al., 2012). Brand communities on the way to satisfy consumers’ desire to create a sense of acceptance and social identity through brands with they interact (Fournier and Avery, 2011). Brand loyalty leads to a firm intention to buy, and lovers of the brand facilitate consumers’ brand relationship (Gensler et al., 2013). Similarly, he found that Twitter and Facebook were the ideal channels for brands information with customers. They suggest that companies should provide compelling content relevant and exciting to users and respond to the content presented to consumers. It was also found that consumers feel more committed to organizations when they can send comments, and provide a means for these observations (Mangold and Faulds, 2009).

Now, customers are engaged in a variety of activities ranging from content consumption to participate in discussions and exchange knowledge with other consumers and contribute to the activities

of other users. A keen interest in SNSs like YouTube, MySpace, Facebook, and Wikipedia, it is assumed that consumers were actively marketing content (Kristina, 2011). Moreover, with the increasing prevalence of integrated marketing communications and the use of social networks as the primary channel of communication, research revealed that media and messaging software has a significant influence and participation of consumers (De Vries et al., 2012). Social networks increase consumer involvement with the brand of open source and collaboration with the brand and other consumers to create and share content described. Additionally, consumers can find the social media house and build relationships with the brand and looks like the people who also love that name (Fournier and Avery, 2011).

Through the studies, we found that customer satisfaction and customer insight are the important factors to achieve business objectives. Marketers, in recent time, are trying to develop a new and efficient strategy to meet the needs of the consumers through the use of technology. Although, much research has been undertaken to determine the success and strength of consumers’ perception and its evolving factors to measure the customer insight these days. Despite the implementation of many of research inside the region, as well as around the world towards the consumer use perception of social media there is still a call for to identify and measure the attitudes of the consumers and its success factors to achieve the goals of business because of consumer behavior for the area always changeable. In fact, there is always a need for research on attitudes’ analysis of users, their preferences and using habits of SNSs in the literature, as it does not cover in depth. Therefore, the current study is an attempt in this direction. Furthermore, this paper focuses on customer insight and their using pattern to the social media and its related issues.

4. HYPOTHESIS

The following hypothesis null (H_0) had been assumed for the analysis.

- I. There is no significant difference in preferences using social network types among the respondents
- II. There is no significant difference in most preferred social network types among the respondents
- III. There is no significant difference in the topics to be involved on social media among the respondents
- IV. There is no significance difference in opinion in the timing of involvement in social media among the respondents
- V. There is no significance difference in opinion about the brands following on social media among the respondents.

5. RESEARCH METHODOLOGY

The purpose at the back of this research was to know the interviewees’ thoughts, preferences, perception, and insight of Saudi customers’ towards SNSs. A convenience sample survey has been gathered from 226 respondents through using the online survey via Google forms and monkey survey during 3 months from October to December 2015. To ensure that the perceptions of social media are based on a diverse population of users, this

study employed a national consumer panel with online access for its web-based survey. As internet connection is a necessary condition for the use of social media, an online survey is an appropriate data collection method. With the popularity of the internet, online surveys have been adopted to collect data in social sciences for years (Wimmer and Dominick, 2006). The close-ended questions were used, and distinctive care has been taken to reduce the non-response rate and the error arising out of it. After collecting the data, it was manually edited, coded and then recorded on excel sheet. For descriptive analysis statistics (frequency distribution), Chi-square goodness of fitness test at 95% of a certain level ($P = 0.05$) was applied, and result findings were drawn accordingly.

6. FINDINGS AND DISCUSSION

Respondents' classification on the basis demographic factors such as gender, age, city, educational level, job status and their monthly income can be seen in Table 1. The majority of respondents of the study belongs to male 151 (67%) and female 75 (33%). Most of the respondents reported they belong to in the range of 20-39 (75%) age group and the rest of them were followed by <29 (12%), 40-49 (7%) and above 40 (6%) of the sample of the study. Moreover, from the table it can also be seen that most of the participants belong to the different 22 cities of KSA (51%), capital city Riyadh (26%) and the rest were from Jeddah industrial city that is 23% of the sample surveyed. Each of the city, compared with other cities in the region, have a good representation on the business side.

Educational level of respondents was most of them graduate 31% followed by undergraduate 27%, the high school passed 21%, above graduate 16% and very few had below high school qualification that was only 5%. Regarding the job status of the interviewees it can also be seen in the table that majority 40% were student followed by private/self-employed 23%, the government employed 20%, and the rest were unemployed 17% of the respondents. Furthermore, the table shows that the income levels of the participants; more than 60% of the participants belongs to the monthly family income range of <14,000/- SR group. Less than 40% of the respondents belong to the monthly SAR 14,000 or more of their monthly family income. This result indicates that the majority of the population belongs to the middle-income class of the society.

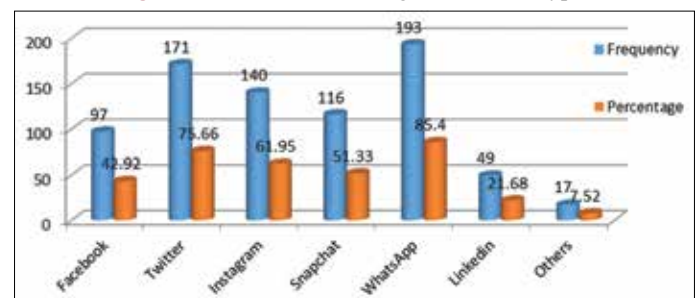
Figure 1 provides the information regarding the preferences in using social media types. It reveals that majority of respondents preferring to use WhatsApp (85%) as social media for communication followed by Twitter (75%), Instagram (61.95%), snapshot (51%), Facebook (42%), LinkedIn (21%) and others (7.52%). Among the respondents, it is resolved that WhatsApp are easy to use and there are not any interferences in our private life.

It was believed in H_1 that there is no significant difference in preferences in using social media types among the respondents, the Chi-square goodness of fit calculated value is 42.798. The $P = < 0.001$ at 95% confident level (Table 2). Therefore, the

Table 1: Demographic status of respondents

Demographic factors	Variables	Frequency (%)
Gender	Male	151 (67)
	Female	75 (33)
	Total	226 (100)
Age (Years)	<19	27 (12)
	20-29	118 (52)
	30-39	51 (23)
	40-49	16 (7)
	50 above	14 (6)
	Total	226 (100)
City	Jeddah	51 (23)
	Riyadh	59 (26)
	Others	116 (51)
	Total	226 (100)
Educational level	Below high school	11 (5)
	High school	48 (21)
	Undergraduate	61 (27)
	Graduate	70 (31)
	Above graduate	36 (16)
	Total	226 (100)
Job status	Student	91 (40)
	Government employed	46 (20)
	Private/self employed	51 (23)
	Unemployed	38 (17)
	Total	226 (100)
Family income (monthly in SR)	<5000	30 (13.24)
	6000-8000	49 (21.68)
	9000-11,000	53 (23.46)
	12,000-14,000	40 (17.70)
	15,000-17,000	27 (11.96)
	18,000-20,000	15 (6.64)
	>20,000	12 (5.32)
	Total	226 (100)

Figure 1: Preferences in using social media types



result is significant at $p \leq 0.05$, and it can be inferred that there is a great difference in preferences in the use of SNSs among the respondents, so the null hypothesis is rejected.

From the Figure 2 it can be seen that the majority of the persons (47.79%) do agree on that WhatsApp is the most preferred among the given media site followed by Twitter (17.7%), Facebook (14%), Snapshot (7.52%) and LinkedIn (5.75%) respectively. This result also proves the previous result that WhatsApp was the highest excellent media site among the respondents of Saudi Arabia. H_2 ; was assumed that there is no significant difference in most preferred social network types among the respondents, the Chi-square goodness of fit calculated value is 141.095 (Table 3). The $P < 0.001$ at 95% confident level. The $P < 0.001$. The result is significant at $P \leq 0.05$. Therefore, the null hypothesis is rejected.

Table 2: Preferences in using social media types

Social media	Observed	Expected	Difference	Difference square	Difference square/exponential fraction
Facebook	97	143.4	-46.40	2152.96	15.01
Twitter	171	143.4	27.60	761.76	5.31
Instagram	140	143.4	-3.40	11.56	0.08
Snapchat	116	143.4	-27.40	750.76	5.24
WhatsApp	193	143.4	49.60	2460.16	17.16

The Chi-square value=42.798

Table 3: Most preferable social media sites

Social media	Observed	Expected	Difference	Difference square	Difference square/exponential fraction
Facebook	32	42	-10.00	100.00	2.38
Twitter	40	42	-2.00	4.00	0.10
Instagram	17	42	-25.00	625.00	14.88
Snapchat	108	42	66.00	4356.00	14.88
WhatsApp	13	42	-29.00	841.00	20.02

The Chi-square value=141.095

After the test result, it can be stated that there is a significant difference in most preferred SNSs among the respondents.

Figure 3 provides the information regarding the preference of topic on which respondents like to be involved on social media. It was revealed the majority of the respondents like the social media for the news updates (149) followed by educational purpose (130), health-related information (113), foods and beverages (77), arts and cultural (56) and music (47) respectively. From the result, it can be concluded that news provider having a great age and impact on social media as well as the educational institute and others can utilize social network sites for the promotion of their organization that is cheaper than another alternative medium of the communicant. For H_3 ; there is no significance difference in opinion in the timing of involvement in social media among the respondents, calculated value of the Chi-square goodness of fit test is 55.333, and the $P < 0.001$ (Table 4). Therefore, the result is significant at $P \leq 0.05$, and hence null hypothesis is rejected, and alternative hypothesis will be accepted.

When respondents were asked regarding the specific timing to be involved on social media. The majority of them agreed afternoon (28.35%) are the preferable for them, evening time (25.37%), not specified or fixed (27%), before sleeping (13.5%) (Figure 4). Moreover, an insignificant percent of respondents stated that the prefer morning (4.78%) that is very insignificance among the other timing slot of using social media. This result is evident that Saudi Arabia is having the rest time afternoon for hours and then company reopen again and close until less or more midnight time. Therefore, it can be proposed that the marketer promotes their product or services afternoon timing to the midnight time and that will have more chances to reach the consumer properly. H_4 ; calculated value of the Chi-square goodness of fit test is 47.850, and the $P < 0.001$ (Table 5). Therefore, the result is significant at $P \leq 0.05$. Thus, the null hypothesis is rejected and alternative hypothesis; there is the impact of inconsistency in the scheduling of involvement in social media among the respondents will be accepted.

Also, brand following on social media majority (63.7%) acknowledged that they do follow the brand on social media networking sites and 36% respondents agreed on that they do

Figure 2: Most preferable social media sites

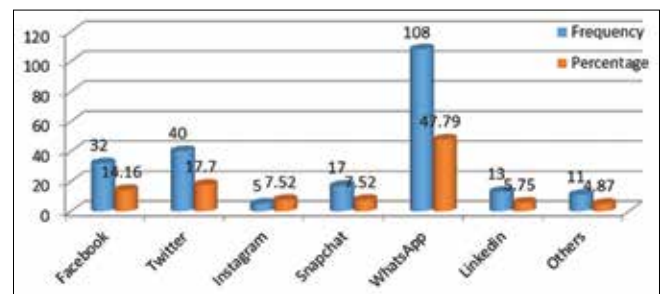


Figure 3: The topic on which respondents like to be involved in social media

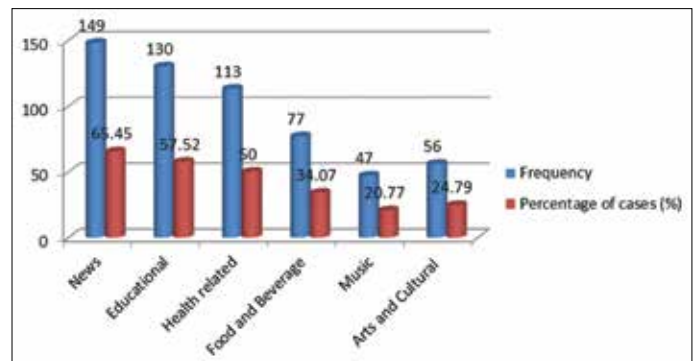
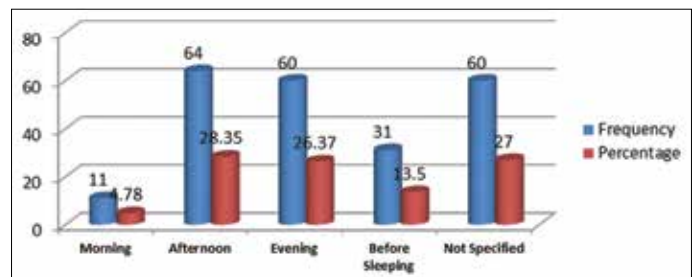


Figure 4: Preferred time to be involved in social media



not follow any brand in the networking sites (Figure 5). From the result, it can recommend that company owner can approach to the customer through the SNSs that can give the lead among the competitors to them who prefer to use this medium along with the

Table 4: Topics on which respondents like to be involved in social media

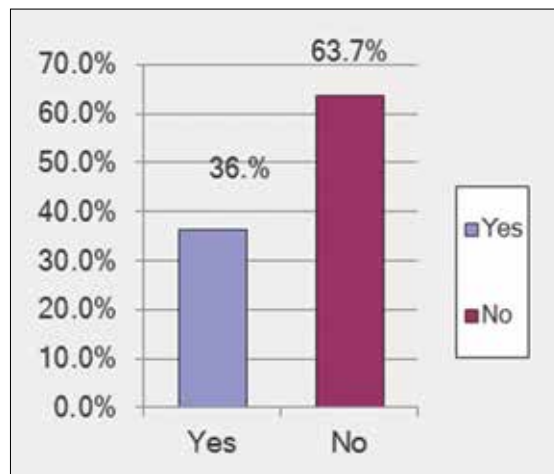
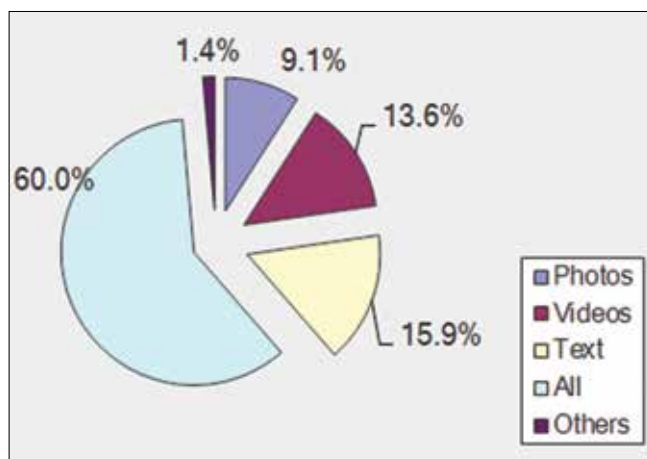
Topics	Observed	Expected	Difference	Difference square	Difference square/exponential fraction
News	149	105	44.00	1936.00	18.44
Educational	130	105	25.00	625.00	5.95
Food and beverages	113	105	8.00	64.00	0.61
Music	77	105	-28.00	784.00	7.47
Arts and culture	56	105	-49.00	2401.00	22.87

The Chi-square value=55.333

Table 5: Preferred time to be involved in social media

Preferred time	Observed	Expected	Difference	Difference square	Difference square/exponential fraction
Morning	11	45.2	-34.20	1169.64	25.88
Afternoon	64	45.2	18.80	353.44	7.82
Evening	60	45.2	14.80	219.04	4.85
Before sleep	31	45.2	-14.20	201.64	4.46
Not specified	60	45.2	14.80	219.04	4.85

The Chi-square value=47.850

Figure 5: Brand follow preferences on social media among the respondents**Figure 6: The types of communication tools respondents interested in social media**

other promotional tools as the majority are involved in following the brands on networking sites. The Chi-square goodness of fit test is 18.124 for H_5 . The $P < 0.001$. Consequently, the result is significant at $P \leq 0.05$, and this hypothesis is discarded, and null hypothesis may accept (Table 6). On the other hand, while

respondents were asked what the types of communication tools they interested in social media are. The answer was in this order; all media were the most important medium followed by, text, videos, and others respectively 60%, 15.9%, 13.6, 9.1% and 1.45. Therefore, from the result it is suggested that marketers must utilize all types of medium of communication to approach consumers especially text messages, videos and photo will be the highly acceptable among the medium of communication (Figure 6).

7. CONCLUSION

A rigorous analysis of the data mentioned above brings the knowledge of the reality that social media has indeed done a commendable job of bridging the communication gap among people. The different social media tools help the people to interact with one another within the shortest possible time. WhatsApp networking sites are the top excellent networking site followed by Twitter, Instagram, and Facebook. These media having a high image in the consumer mind and utilizing of these three locations by the marketer will give them a strong image in the market. As per the result the networking company having different pictures in the minds of the consumer so the marketer should provide careful analysis when selecting any networking sites for the campaign. Moreover, it can be concluded that information related to news, educational, health, foods and beverages, is the most preferable to see through the social media. It is advised to the company like news provider, education institute owner, health care institute and foods and related services provider can take advantage of these very acceptable channels of communication to promote their product and services in the region. The excellent time to approach customer are afternoon, evening and before sleeping time means it is better to the marketer that they should give and send their message and any commercial of the company starting from afternoon up to sleeping hours. Choosing the proper time for business communication will reduce the chance of cluttering for their ads and messages. Besides, it is suggested that marketer can utilize to be in consumer mind from side to side putting their brand advertisement in the dominated network

Table 6: Brand follow preferences on social media among the respondents

Items	Observed	Expected	Difference	Difference square
Yes	81	113	-32.00	1024.00
No	145	113	32.00	1024.00

The Chi-square value=18.124

sites as mentioned above will lead to achieving their marketing goals as well as organizational goals. Moreover, respondents answered regarding communication tools types; all media is the most important medium have been selected, followed by, text, videos, and others respectively, therefore, it is suggested that marketers must utilize all types of communication encoding mediums like text messaging, video, photo, etc. Marketers are recommended to integrate these all the types of encoding platform to be successful a leader among their counterparts’.

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HUMAN RESOURCES MANAGEMENT PRACTICES AND JOB SATISFACTION IN CRITICAL ECONOMY: AN EMPIRICAL STUDY OF PRIVATE BANKING SECTOR OF SAUDI ARABIA.

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ABSTRACT

Human resources are considered to be a critical organizational resource that facilitates an organization to sustain its effectiveness and value. Banking sector in Saudi Arabia is facing furious competition, economic crisis and Saudization as far as human resources are concerned. In such a competitive business environment getting and retaining productive employees is complicated tasks when competitors are struggling for attract human resources from other organizations by providing attractive compensation and promotional plans. In order to retain productive employees it should be ensured that they are satisfied from the human resource practices prevailing in the concerned organization. The purpose of present study is to analyze and achieve a better understanding of the impact of human resource practices on job satisfaction among the employees of private sector banking in Saudi Arabia. The present study was conducted on 146 employees of private banking sector and the multiple linear regression models is applied to assess the influence of HRM practice such as training, performance appraisal, team work, employee participation and compensation on job satisfaction of the employees. The analytical results of the study revealed that training has no significant influence on job satisfaction whereas, other HRM practices like performance appraisal, team work, employee participation and compensation have positive and significant influence on the job satisfaction.

KEYWORDS: Compensation, Employee Participation, Job Satisfaction, Performance Appraisal & Training and Team Work

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INTRODUCTION

Saudi Arabia has a very strong economic condition but because of long reduced crude oil price shock the country economy is suffering and they are looking for some alternate source of arrangement and also making big changes in the policies and procedures to manage the effect. And in this economically critical business environment human resources are considered very vital as machine and material for the success of any organization in general and banking sector in particular. Human resources are capable to convert the machine and material in to output, therefore, human resources are considered as most valuable for the sustainable competitive advantage. The better understanding of relationship between the HRM practices such as performance appraisal, working conditions, training, employee participation, team work, compensation and job satisfaction is essential for planning and to prioritizing the organizational goal. HRM practices are part conceptual, part implementation of an HR strategy, comprised of systems that follow the normal or customary way of doing business. Beardwell et al. (1984) opined, "HRM as a strategic approach to the management of human resources that encompasses all

management decisions and activities, that influence the relationship between the organization and employees". Minbaeva (2005) opined that " HRM practices is a mechanism used by business organization to ensure managerial effectiveness through facilitating the development of competencies that are firm specific, produce complex social relation and generate organization knowledge to sustain competitive advantage." HRM practices are set of practices and philosophy used by an organization to retain the human resources for the effective functioning and growth of the organization. Delery and Doty (1996) highlighted that, HRM practices is an initial attempt to provide managers to effectively placing right personnel at the right job at the right time. HRM practices is conceptualized as combination of internally consistent policies and practices designed and implemented to ensure that a firm's human capital contribute to the achievement of its business objectives. In any organization HRM practices focuses on optimal utilization and management of their human resource effectively in order to achieve organizational objectives. HRM practices refer to strategies aimed at managing the human resource and ensuring that are deployed in order to improve the organizational performance (Schuler and Jackson, 1987). HRM practices are basically related to Organizational policies and practices, philosophies and systems that are developed to attract, develop, motivate, and retain the employees who ensures the excellent functioning and survival of the organization in rapidly changing business scenario.

The satisfaction at work has been characterized as a positive or pleasing emotional state which emerges as the result of evaluating one's work or experiences in the workplace. Job satisfaction is a critical indicator of how employees feel about their job and describes how much they are contented with his or her job. Job satisfaction is the positive feelings about a job, resulting from an evaluation of its characteristics (Robbins & Judge, 2013). The satisfaction level of employees also related with increased effectiveness of the organization. Job satisfaction of an employee is essential to the success of an organization. Thus, keeping employees' satisfaction in their jobs with their careers should be a paramount priority for all the organizations. Several research studied has been conducted by different researcher to find out the universally accepted approach to manage the Human resources. But depending upon the external as well internal environment factors different approaches were applicable for a particular organization as per need of the business requirement. The objective of this study is to investigate and evaluate the influence of human resource management practices on job satisfaction of bank employees.

REVIEW OF LITERATURE

The prime purpose of the present study is to investigate Human Resource Management practices and job satisfaction in context to success of an organization. The academicians, researchers and policy makers have conducted several researches in the related field over different periods of time. Numerous researches have revealed that HRM practices and job satisfaction factors play crucial role in the assessment for employee performance. In the present study an effort has been made to investigate the relationship between the HRM practices and job satisfaction.

Lee and Lee (2007) opined that HRM practices such as training and development, teamwork, compensation, HR planning, performance appraisal, and employee security leads to improvement in organizational performance including output of employees and quality of product. Katou, (2008) carried out a study, to assess the influence of HRM practices on organizational performance in manufacturing sector of Greece. The HRM practices viz-a-viz resourcing and development, compensation and incentives, involvement and job design had influenced on the organizational performance. The study concluded that HRM practices are associated with business strategies will affect organizational performance. Senyucel's (2009) describe "Human Resource Management as a combination of workers oriented management practices that identify

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employees as assets. Its objectives are to facilitate and enable talented and committed workforce to the organization in order to achieve the organizational goals.” Ozutku and Ozturkler (2009) conducted a study, to investigate the influence of various external and internal factors on HR practices. The study revealed that these factors influence significantly across the countries. HRM practices like job definition, training and development, compensation, team work and employees participation were better in the public universities as compared private universities. Stewart and Brown (2011) conducted a study to judge effectiveness of HRM on the workforce and the results of study revealed that, effective HRM procures qualitative workers and motivates them to maximize their performance and helps to meet their emotional and social needs.

Beardwell et al., (2004) summarised the Human Resource Management activities, viz-a-viz organizational design, staffing, performance management appraisal, employment training and organization development and reward systems, benefits and compliance. Human resource management denotes to the policies and practices encompassed in carrying out the human resources characteristics of a management position including human resource planning, job analysis, recruitment, selection, compensation, performance appraisal, training and development, and labour relations (Dessler, 2008). Awang et al. (2010) evaluated the impact of job satisfaction of university lecturers using the variables such as promotional prospects, compensation, working conditions, workload, team work and management style. The results revealed that promotional prospects, workload and team work significantly affect job satisfaction of lecturers. In a study on public sector universities of Pakistan. Padala (2010) examined the search to identify the various parameters for employee job satisfaction and organizational commitment. The results revealed that employees have a positive tendency in their intensity of obligation towards their organization. Age, education, nature of the job, length of service and income have negative relationship between the employee’s job satisfaction and organizational commitment.

There is greater degree of association between job satisfaction and use of specific HR practices in local government organizations in the United Kingdom (Gould, 2003). Singh (2004) conducted a study to investigate relationship between HRM practices and firms level performance in India. In this study he included 359 firms listed in the Center for Monitoring India Economy and 82 respondents replied positively. The results of regression and correlation analysis revealed at there is significant relationship between the HR practices namely training and compensation and perceived organizational and market performance. Ray and Ray (2011) highlighted in their study that variables like performance appraisal, participation in decision making, training and development, empowerment, compensation influencing human resource management practices have significant close association with job satisfaction. Martin (2011) carried out a research to investigate the impact of HRM practices on job satisfaction, organizational commitment and influence on intention to quit. HRM practices include recruitment & hiring, compensation & benefits, training & development, and supervision & evaluation. The study concluded a significant relationship between perceptions of human resource practices and intention to quit, mediated by organizational commitment and job satisfaction. Iqbal, et al. (2011) evaluated the relationship between HR practices (impact of supervisor role, participation in decision making & compensation policy) and employee’s job satisfaction among the employees of manufacturing and service sector of Pakistan. The results of study revealed that supervisor role has strong positive effect on job satisfaction. The employee’s participation in decision making which is the determinant factor about organizational success has lesser positive effect on job satisfaction. Islam et al (2016) conducted a study on 100 employees of hotel industry and found that HRM practices are positively related with job satisfaction but found that compensation has negative effect on job satisfaction, which indicates that most of employees are not satisfied from payment of employer and hence affecting job satisfaction.

OBJECTIVES OF THE STUDY

After reviewing the available literature and discussion it was decided to frame the main objectives of this study as to find out the prevailing HRM practices and job satisfaction status and analyze the impact HRM practices viz. Training, Performance Appraisal, Team Work, Employee Participation and Compensation on job satisfaction among private bank employees.

RESEARCH METHODOLOGY

The present study is an attempts to analyze and evaluate influence of human resource management practices on job satisfaction among private bank employees of Saudi Arabia. In order to investigate the impact of Human resource management practices on Job Satisfaction the below given null hypotheses have been developed.

Formation of Hypotheses

H₀₁: Training has no significant influence on job satisfaction.

H₀₂: Performance Appraisal has no significant influence on job satisfaction.

H₀₃: Team work has no significant influence on job satisfaction.

H₀₄: Eemployees' Participation has no significant influence on job satisfaction.

H₀₅: Compensation has no significant influence on job satisfaction.

Sampling Procedure

The study was conducted in Makkah and Riyadh region and selected questionnaire were distributed to 160 respondents randomly selected for obtaining the relevant information. For gathering information from the employees a well structured questionnaire was used personally by the researchers. But due to busy time schedules of bank employee and their engagement in various activities the investigators were able to obtain the information form 146 employees only. For obtaining the other required and related information the investigators followed unstructured personal discussion and interview method.

The questionnaire followed in this study was adapted from Qureshi and Ramay (2006) scale comprised of 25 items, which contained statements on training, team work, performance appraisal, compensation, and employee participation. HRM practices were also abstracted from the instrument developed by "Feng-Hui Lee and Tzai-Zang Lee" (2007) who conducted a study to investigate the relationship between HRM practices and performance. The reliability and validity of the instrument was found to be within acceptable norms. For measurement of Job Satisfaction scale developed by Singh (1989) containing 20 items was used. Respondents were asked to express their level of agreement or disagreement with each statement on 5-point Likert scale.

Conceptual Framework

Training

The concept of training& development refers to any effort to improve current and future skills, knowledge and abilities of employee (Aswathappa, 2008). Flippo (1971) posited that, training is an act of increasing the knowledge and skill of an employee, for doing a particular job. Beach (1980) stated that, Training is an organized practice, by which people learn knowledge and skills for a certain purpose.

Performance Appraisal

The performance appraisal is a human resource management practice that has attracted significant attention from both practitioners and scholars (Fletcher, 2001). A performance appraisal is a systematic and periodic process that assesses an individual employee's job performance and productivity in relation to certain pre- established and organizational objectives (Manasa, 2009). The application of performance appraisal are promotion, termination, test validation, and performance improvement therefore, improving performance appraisal for everyone should be among the highest priorities of contemporary organization (Muczky 1987).

Team Work

To the achiever of any business efficient teamwork is necessary. As “no man is an island” complete organization can be stimulate due to good effects of fertile teamwork and organization can be lame due to bad effects of deficient teamwork. Korner et al (2015) conducted a study on 272 employees of health rehabilitation centre in Germany and found a positive relationship between high sense of team work and job satisfaction.

Employee Participation

Employee participation is the process whereby employees are involved in decision making processes, rather than simply acting on orders. Employee participation is part of a process of empowerment in the workplace. The best way to improve output is by being determined for the shared goals of employees and managers. By allowing employees input into developing the mission statement, establishing policies and procedures, determining perks etc., leads to improvement in communication and enhancement of morale and satisfaction of employees. Zhu et al (2014) conducted a study on young generation of China working in manufacturing sector and found that the participation of such new generation employees in management, supervision and decision-making has a significantly positive impact on their work satisfaction.

Compensation

Compensation refers to all types of pay or reward going to employees and arising from their employment (Dessler,2008). Organ (1994) revealed that positive and negative awareness about the salary plays a vital role towards job satisfaction. Low level of salary satisfaction affects the job performance. Mabaso and Dlamini (2017) conducted a study on 279 academic staff and found that compensation has positive relationship with job satisfaction but significant relationships were found between benefits and job satisfaction.

RESULTS AND DISCUSSIONS

Table 1: Showing Mean and SD on the Dimensions HRM Practices and Job Satisfaction

(N-146)

S.N.	DIMENSIONS	MEAN VALUE	RANKING	S.D.
1	Training & Development	3.28	I	647
2	Performance Appraisal	2.84	V	638
3	Team Work	3.07	IV	615
4	Employee Participation	3.18	II	627
5	Compensations	3.10	III	757
6	Total HRM Practices	3.09		859
7	Job Satisfaction	3.64		541

As shown in the Table 1 the employees of private banking sector are showing moderate level of satisfaction on prevailing HRM practices among them training and development were found to be highest followed by employee

participation, compensation and team work while performance appraisal practices were found at lowest. Job satisfaction were found to be moderately high among them.

In order to analyze the influence of human resource management practices on job satisfaction the multiple linear regression model is applied. The regression model is illustrated as below:

$$\text{Job Satisfaction}_{it} = \beta_0 + \beta_1 (\text{Training}) + \beta_2 (\text{Performance Appraisal}) + \beta_3 (\text{Team Work}) + \beta_4 (\text{Employee Participation}) + \beta_5 (\text{Compensation}) + e_{it}$$

In the above regression equation β_0 is constant and β_i are the regression coefficient of the explanatory variables, while e_{it} is the residual error of regression.

Dependent and Independent Variables

In regression model the Job Satisfaction of bank employees is taken as dependent variable. The independent variables Training, Performance Appraisal, Team work, Employee Participation and Compensation are used in model.

Regression Results

In order to analyze the existence of multicollinearity problem, the simple correlation matrix among independent variables is analyzed and results are depicted in the table (2). Cooper and Schindler (2003) mentioned that, multicollinearity problem exists, when coefficient of correlation among variables are 0.8 or more.

Table (2)

	Job Satisfaction	Training	Performance Appraisal	Team Work	Employee Participation	Compensation
Job Satisfaction	1.000					
Training	.230*	1.000				
Performance Appraisal	.363*	.232*	1.000			
Team Work	.221*	.145*	.549*	1.000		
Employee Participation	.448*	.323*	.467*	.594*	1.000	
Compensation	.379*	.033*	.445*	.553*	.505*	1.000

*Indicates correlation significant at level 5%

From the table 2 it can be inferred that all HRM practices variables have low correlation indicating the absence of multicollinearity. The results from correlation analysis highlight that job satisfaction of employees has positive correlated with training, performance appraisal, employee participation, team work and compensation.

REGRESSION ANALYSIS RESULTS AND DISCUSSION

The results of regression analysis are depicted in the regression equation form based on regression coefficients are as below:

$$P_{it} = 2.053 + 0.084 (\text{Training}) + 0.174(\text{Performance Appraisal}) - 0.216(\text{Team Work}) + 0.293 (\text{Employee Participation}) + 0.178(\text{Compensation})$$

The significance of Regression Coefficients and their Respective t-Values are Presented in the Table (3).

Table (3):

Explanatory Variables	Constant	Training	Performance Appraisal	Team Work	Employee Participation	Compensation
β_i	2.053* (0.000)	0.084 (0.194)	0.174* (0.023)	-0.216* (0.016)	0.293* (0.001)	0.178* (0.007)
T-Values	7.516	1.306	2.297	-2.448	3.476	2.731

(*) indicates significant at 5% level.

The analysis of regression results reflects that independent variables Training has no significant effect on job satisfaction at 5% level of significance though it was to be ranked I by the employees in HRM practices but it appears that the training is not properly linked with the job requirement hence not inducing element of satisfaction. Other independent variables influencing HRM practices such as Performance Appraisal, Team Work, Employee Participation and Compensation are statistically significant at 5% significance level indicating positive influence on job satisfaction means if we increase the level of these four HRM practices component go up which is currently at moderate level the job satisfaction level among the employees will also go high and that high job satisfaction will leads to better performance of the employees of private banks of Saudi Arabian.

The results of our study highlights that the independent variable training has insignificant influence on Job Satisfaction. The value of regression coefficient for variable training is 0.084, which is statistically insignificant at 5% level of significance. This implies the acceptance of null H_{01} . It indicates that Training has no significant influence on Job Satisfaction in private in private sector banks of Saudi Arabia.

The regression coefficients for independent variables are Performance Appraisal (0.174), Team Work (0.216), Employee Participation (0.293) and Compensation (0.178) respectively. All these regression coefficient are statistically significant at 5% significance level. Thus, the null hypotheses H_{02} , H_{03} , H_{04} and H_{05} are rejected and, in summary regression results support that Performance Appraisal, Team Work, Employee Participation and Compensation have significant influence on Job satisfaction in HRM practices.

CONCLUSION AND RECOMMENDATION

Human Resource management theory reveals that there are several factors which influence job satisfaction of the employees. The employees with high level of job satisfaction have positive attitude towards their works and contribute significantly in their respective organizations. The dissatisfied employees possess negative attitude and their contribution in the performance is minimum. The literature on this subject highlights that their numerous factors contributing to job satisfaction of employees. In the present study, we have made an attempt to analyze the effect of HRM practices such as Training, Performance Appraisal, Team Work, Employee Participation and Compensation on job satisfaction and found that employees were shown moderate level of satisfaction on training and development, employee participation and compensation but were not found satisfied with performance appraisal practices. The results of the study also infer that among the factors like training has no significant influence on Job Satisfaction, where as other variables have significantly influenced the level of job satisfaction in the private banks of Saudi Arabia. The findings of our study are in co inderence with the several studies presented in the review of literature. From the discussion of the above results it has been recommended that the bank should confer special emphasis on training to improve the job satisfaction of the employees. Further, the bank should also intensify the other HRM practices to further enhance the level of job satisfaction of the employees.

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Impact of Conflict Management Style on Ethical Decision-Making Process: Case Study of Saudi Arabia

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Abstract

Managers in organizations experience many conflicting scenarios that negatively impact the process of decision-making. Assisting these managers to manage conflict with efficacy is crucial to enhance the decision-making process from an ethical perception. So, this aimed to examine the impact of conflict management style on ethical decision-making process using Saudi Arabia as a case study. The study was carried out in Saudi Arabia using a convenient sample of 236 participants. A questionnaire was distributed to the participants. After analyzing the feedbacks in SPSS in the areas of ANOVA, regression and Correlation the results showed that oblige was the main style of conflict used in Saudi Arabia. There was a positive correlation between ethnic identity and the conflict management style under the umbrella of ethical decision-making. The findings are crucial to the contribution of social change as it equips the leaders with information on how to manage conflict and improve decision-making.

Key Words: *Conflict Management Styles, Ethical Decision-Making.*

Introduction

Leaders in any organization are faced with the responsibility of upholding high ethical standards. This involves them linking the behaviors of ethics to the ability of concrete decision-making (Li & Madsen, 2011). In the process of upholding ethical conducts and making decision it is worth noting that conflicts may occur since in the workplace people with varied degree of character do exist. As such, several studies have been carried out in the area of managing conflict particularly interpersonal conflict arising in romance (Hubbard, 2001), intercultural (Zhang, Harwood, & Hummert, 2005), and in organizations (Stohl, 2001). Conflict occurs when an individual affects another individual or a group negatively. In terms of definition, various scholars have attempted to define conflict. Marquis and Huston (1996) referred to conflict as a discord that occurs between two or more people as a result of differentiated opinions, ideas, or values. Fisher (2000) used the notion of destruction to define conflict and viewed it as a social circumstance where incompatibilities in the pursuance of goals seem to occur between two or more people. Fisher also affiliated conflict with occurrence of antagonistic feelings towards one another.

The Arabs have formed the focal point of most media in relation to the events that have occurred in their world in the last few decades. The Arab world has several countries tied together by a common religion and language (Barakat, 1993). Political unrest is a common phenomenon to them but previous research has done very little to show how the Arabs manage conflict both in and out of their organizations. However, some studies have evaluated the efficacy affiliated with strategies for solving conflict (George, 2003).

Whenever conflict occurs among people in an organization it becomes important to seek the best resolution methods to deal with the difficult differences in an existing social system. In the wake of finding the best alternative, conflict management has emerged as a primary subfield determining organizational behavior. A previous research by Canary (2003) has showed that managing conflict effectively can improve relationship satisfaction and promote closeness. Nonetheless, effective leadership style and the choice followed in managing conflict are also crucial as they determine the outcomes of conflict management. The ability to embrace creativity in managing conflict is becoming a critical requirement for managers in Arab nations. Today, managers must develop culture and behavior that is capable of accommodating and managing conflict in a manner that benefits all the employees. The achievement of this has however been hindered by the dearth of empirical studies regarding conflict management styles in organizations. Therefore, in the pursuit of extending the available research on conflict management, the present study seeks to evaluate the impact of manager's conflict management style on ethical organization decision process using Saudi Arabia as the case study.

Conflict within organizations leads to increased unethical behaviour and most managers view unethical behaviour as a hindrance towards the prosperity of the organization as it impedes decision-making. The general problem in an organization turns out to be the effect imposed by unethical behaviour on the ability of managers to make sound decisions. On the other hand, a specific problem is that some managers never seem to have effective conflict management style that can be used to uphold ethics in the organization while promoting decision-making process.

The objective of this quantitative correlational study was to evaluate the impact of manager's conflict management style on the ethical organizational decision-making process. Saudi Arabia was used as the case study. The dependent variables for the study were ethical decision-making while the independent variable was conflict management style. The target population was both the managers and employees of various organizations in Saudi Arabia. The implications arising from the positive social change of the study is that it includes encouragement for future research on conflict management styles and ethical decision-making process. In addition, the research will enhance the understanding of the relationship between effective decision-making process and the conflict management styles.

In the line of this purpose, the study seeks to answer several questions particularly;

1. What is the main conflict management styles that Saudi Arabian managers use when making decisions?
2. Is there a correlation between ethical identity and conflict management style used in decision-making?
3. Can ethnic identity predict the conflict management styles that managers use?

Based on this question the study hypothesized that there is a statistically significant effect of conflict management style on the ethical decision-making process.

The theory that underlies this study was that of Drucker (1960) which focuses on the need for leaders to embrace an approach of conflict management that is systematic in order to come up with the best decisions for their organization while upholding ethics. Effective conflict management style defines the scope of a leader to act responsible and in a way, that increases his accountability for determining the need to manage conflict with efficacy to avoid unethical behaviour that can influence sound decision-making (Toubiana & Yair, 2012). The managerial theory used in this research bases on two assumptions revolving around conflict management and decision-making. Firstly, there is the ethical assumption of developing priorities within the framework of conflict management that will generate outstanding outcomes. Secondly, is the ethical assumption that effective ethical decision-making due to better management of conflict will affect the working of an organization positively.

Prolonged focus on the human influence on managerial decisions and conflict management should not always appeal to managers although they are the ones who assist in foreseeing the major trends in the organization (Toubiana & Yair, 2012). The management theory applied to this study because it complements the independent variable of conflict management style as captured in *Section 1* of the questionnaire. The theory also complements the dependent variables of ethics and decision making as captured in *Section 2* of the questionnaire. Conflict management style and ethical decision-making process formed the primary foundation for an evaluation of the various factors that may elucidate the correlation between the two.

This research is important as it contributed its ability to add to the existing knowledge regarding conflict management in organizations with respect to the ability of the manager to make ethically sound decisions. The study could be significant to most managers in Arabian countries as it depicts a broad array of the crucial perspectives on having conflict management style in a workplace. Finally, the research adds up to the efficacy of the practices involved in making an ethical sound decision in the face of conflict. Leaders can address conflicts in a way that boosts the morale of the stakeholders and employees to make ethical valuable decisions that can enhance profitability and productivity (DiGrande et al., 2011).

Literature Review

Managing an organization effectively requires leaders who vary magnificently in influence and scale. In addition, the leaders should possess a vast knowledge of different cultures and most importantly, they should be professionals from a wide array of disciplines making up the paradigms of conflict (Bryant 2003). Culture and leadership under the umbrella of conflict management seem to augur well. Presence of personal and emotional tensions in an organization leading to the conflict is often, as a result, various differences which in one way or the other are components of the culture constituting the organization. The methodology in which the leaders adopt to solve crisis in times of problems, the decision-making process they follow and how they embrace disburse incentives to the employees are all relevant to the culture of the organization. Their perception of power tends to impact the strategies they put in place to solve conflicts while enhancing effective decision-making. As a result, it can be deduced that a manager/leader plays a crucial role in managing the conflict of an organization.

As a leader, the manager has a direct influence on the employees and other individuals in the organization and therefore he/she needs to have many qualities and be skilful enough to handle that various forms of conflicts. A leader who is facilitative has the capability of uniting the antagonistic groups and make them work unanimously towards a particular goal. He/she also encourages, supports, and settles amicably any misunderstanding and deals with any form of an unethical character (Fisher 2000). This is strengthened by the study of Sullivan *et al.* (2003) which revealed that new heads and experienced workers in the nursing arena majorly focused on conflict management under various cultures and personalities as a way of steering their developmental needs. This study, which targeted nurses in the positions of middle management, found out that the role of a nurse manager was so crucial to the success of the organization.

In the pursuit of determining the reasons for conflicts in the public sector and coming up with proper ways of solving conflicts, Al-Sedairy (1994) conducted a survey of 138 construction specialists in Saudi Arabia. His study identified that conflict is a common phenomenon that occurs between contractors and their clients, and between the contractors and their consultants. Perceptual differences and managerial styles were depicted as some of the reasons that contributed to conflicts. This study recommended compromise as a way of solving conflicts.

In another research conducted in 87 groups of students in one of the universities in Dutch Curseu et al (2012) inferred that there existed a relationship between the impact of conflict management and emotional regulation within a group. These researchers found that groups with reduced emotional regulations ended

up with relationship conflicts arising from task conflicts. These findings compounded to a previous research conducted by Holahan et Mooney (2004). Similarly, Rees et al (2012) conducted a study in the mining industry, which found that various external factors outside the scope of a manager influence the style of conflict management.

Effective management of conflict as a leader requires more educational training as denoted by Russell and Scoble (2003). Among the respondents that Russell and Scoble used it was determined that there was a deficiency of knowledge and skills in the area of human resource management and particularly conflict management. Managers deal with conflicts every day. The conflict can appear as either internal or external and manifest in the various forms of altered behaviour, unnecessary authoritarianism, varied beliefs, failing to participate in the decision-making process, and a dearth of managerial support (Hendel, Fish, & Galon, 2005; Rees et al., 2012). In addition, multiculturalism may also influence smooth interactions leading to rise in a conflict which may end up affecting the working environment.

The present study assesses the impact of conflict management style on ethical decision-making with an aim of showing how culture plays a role through examining the relationship between ethnic identity and conflict management style

Conflict forms an integral part of the fabric that makes up a postmodern society that heightens to remain competitive and complex (Hendel, Fish, and Galon, 2005). Much conflict in an organization leads to decrease in the efficacy of the organization while one the hand, too little conflicts makes the organization stagnant. This implies that there is need for managers to embrace the best practices that can be used to manage conflict.

Conflict management refers to the various methods that a party or both the parties involved in a conflict can use to cope with conflict. In the instances of conflicts, Adler and Towne (1990) denoted that there are three courses of actions that can be pursued: 1) living with the problem; 2) embracing change through forcefulness; 3) holding mediations to reach an agreement. These courses can lead to three possible outcomes and in the form of approaches which involve Win-Lose, Lose-Lose, or Win-Win. The choice of conflict management styles is necessarily influenced by the cultural beliefs that an individual hold (McCan & Honeycutt, 2006).

In the pursuit of solving conflicts, the most significant element worth recognizing is being aware of the conflict management strategies and the effects they impose on the wellbeing of the entire organization. Additionally, it is important to be aware of every conflict context in order to come up with up with the appropriate solving strategy that can steer the organization towards identifying its goals. Dahshan and Keshk (2014) suggested that managers use several modes to respond to conflict; that is, competing, comprising, accommodating, collaborating, avoiding among others. In each of these methods, there are the parameters of assertiveness and cooperation that characterize the processes. None of the modes is wrong but there is a critical time that particularly fits every model.

Another factor worth considering in conflict management styles is ethnic. Ethnic identity influences both the decision-making and the conflict management styles used. Saudi Arabia among other Arab countries is built on communism and therefore a group forms the major social unit rather than the individual. As a result, and based on the combination of individualistic and collectivism, it stands out that the self-construal approach appropriately predicts the choice of conflict management style in the Arabian culture which generally is collaboration. It can be considered that Saudi Arabia is a one unit of Arabs that follows one culture although there could be people from different origin and tribe (Hutchings & Weir, 2006). This implies that conflict management in Saudi Arabi particularly bases on the organization. In an early research by Elsayed-Elkhouly (1996) a comparison of conflict management styles was carried between the Arabs and the American managers. The results depicted that the Arabs used the approaches of integrating and avoidance to manage conflicts more often than the American managers did. On the other hand, the

Americans used domination, oblige and, comprising styles to manage conflict more often than the Arabs did. Also, another study by (Hutchings and Weir, 2006) revealed that networking in the Arabian countries was another method that was used to manage the situations of conflict. In the Arabian context, networking implies to connection and mediation.

Arguing in the same line, conflict management style has a significant influence on the decision-making style. In a study that examined various styles of decision-making used by managers in Kuwait, Ali, Taqi, and Krishnan (1997) identified that the managers exhibited much commitment on collectivism rather than individualism. These managers preferred the decision-making styles of consultation and participative to autocracy methods. This implied that autocratic and delegative approaches were never resorted to as effective styles that would lead to enhanced decision-making. For their supervisors, the managers reported that a pseudo consultative approach was used most often. In this approach, the managers highlighted that a decision was made using a collective method. The findings of Ali et al (1997) in a critical way depicted the values of dichotomy and actuality in deeds within the Arab society. It can hence be concluded that the Arabs prefer the conflict management styles that embrace cooperation and consultation.

Following the communism effect in Arabs and the fact that there is culture blend from the various ethnic background, other scholars saw the need to determine the relationship between Identity in the Arabian context and self-construal. In a study that was conducted by Barry et al (2000) involving the relationship between self-construal and ethnic identity among Arab students in the US, it was determined that there was a significant correlation between ethnic identity and the self-construal interdependence. The development of the research question used in the current study was based on the framework that Barry and colleagues used, that is, an individualism-collectivism framework with much focus on the conflict management styles and the self-construal.

Different ethnic identity aligned with different culture calls for the need for managers to apply logical and analytical skills in the decision-making process ethnicity and varied culture dictate the level of ethical behaviour in an organization (Manfredi, Pant, Pennington, & Versmann, 2011). Nevertheless, determining the broad emergence of ethnicity in decision-making in relation to management is a crucial topic that still requires more research particularly to become acquainted with situations when managers can indulge in unethical decision-making (De Cremer, Dick, Tenbrunsel, Pillutla, & Murnighan, 2011). Already, this research could be providing one answer that the style used in managing conflict can dictate the prevalence of the manager indulging in unethical decision-making. It is therefore important for leaders to be accountable for their responsibilities in the same line of ethics as with the employees and they should never reduce their activities of ethnicity to employees (Malik, Naem, & Ali, 2011).

Ethic should be applied to all circumstances irrespective of the status of an individual. As a matter of fact, Kossek et al (2011) recommend that leaders should evaluate the strengths and weaknesses that arise from the approaches of both ethical and unethical decision making as a result of the conflict. In a study conducted by Dyck (2014) involving 13 interviewers with outstanding business leaders in Sri Lanka, it was determined from 87% of the leaders agreed that the ethics pursued in the workplace influence the decision-making ability. All the leaders interviewed concurred unanimously that they used multiple leadership tools including conflict management styles to arrive to the concrete decision in the workplace. The level of ethics to uphold in the work place played a significant role in determining the efficacy of the leader in Sri Lanka to make sound decisions (Dyck, 2014).

Decision making from the perception of ethics requires the embracement of ethical principles to arrive at sound decisions. This is inclusive of conflict management styles during the decision-making process (Curtis & O'Connell, 2011). Decision-making process can inculcate all the principles, include unethical ones or decisions that contribute to unethical results. Based on this notion, Agbim et al., (2013) mentioned a two-step process that incorporated the process of decision-making. The first step involves using proper

communication tactics that can deliver the best principles for decision-making while the second step requires appropriate applications of the principles set for the process (Agbim et al., 2013).

Methodology

The objective of the present study was to evaluate the impact of manager's conflict management style on the ethical organizational decision-making process. Saudi Arabia was used as the case study. The research focused on explaining the relationship between variables to become acquainted with the phenomenon being discussed. Based on the variables of the study the study hypothesized that there is a statistically significant effect of conflict management style on the ethical decision-making process.

After discussing the literature review comprehensively, a research design that would lead to great methodological fit was chosen (Edmondson & McManus, 2007). The rationale for the research design used in the study facilitated the measurement of the research outcomes through a process. A number of researchers in the field of leadership have used quantitative studies to establish their hypothesis. Studies in leadership according to Jackson and Parry (2008) have for a long time been using quantitative methods to defend their hypothesis. The hypothesis for this study was prescribed according to the behaviours and styles affiliated with leadership and social identity and generally how they influence ethical decision-making. The gathering of data followed a questionnaire that captured the right data for testing the hypothesis. With the questionnaire, it would be easy to answer the 'what' questions (such as the best leadership style to embrace to effectively solve conflict). Thus, the questionnaire could be considered for this typical leadership study (Bryman, 2011; Hunter et al, 2007). Therefore, the research followed the principles of the quantitative study.

Based on the target population for the study which was both the managers and the employees in Saudi Arabia multinational companies, a cluster sampling approach was applied. In the first sample, a nonprobability purposive sampling was used to locate the participants but based on cultural diversity. In Saudi, there are foreign workers mixed up with the commoners. The study selected the multinational employees as they represent situations that are likely to have large output data in the area of research (Denscombe, 2014). The second criteria that were used to get the sample involved convenience. It was important for the research to use the most available participants.

Moving to the determination of the sample size the study used 236 participants were chosen for the study. It was crucial to use this size of the sample in order to obtain statistical power in the inferences (Saunders et al., 2011). As Saunders and colleagues that large sample sizes lower the occurrences of error in generalizing the population for a particular reason (p.217). In the current study, there were 169 males and 67 females. These participants came from different ethnic backgrounds based on their countries of origin.

The recruitment of the respondents involved three methods. The white participants, Africans, and mixed were chosen based on their level of participation in the companies while the Asians and the Arabs were recruited through Arabs association in the various companies. All the participants completed a printed version of questionnaire.

Based on the discussed literature, a 3-part questionnaire was developed for data collection. The first part of the questionnaire comprised the conflict management in relation to a manager's ability to make decisions. And the other two parts focused on the ethnicity in relation to conflict management. The questionnaire also captured the demographic data of the participants in terms of gender, age, professional experience and region/country of origin.

An administrative granted permission to carry out the study in the Saudi Arabian companies. The participation was voluntary and the privacy of the participants was ensured. The participants were made

aware that all the data would be treated with a high degree of confidentiality and only be accessible to the researchers alone. The purpose of the study was explained to the participants through a consent form which explained the full rights of the participants.

Following the purpose of the study which was to evaluate the manager's conflict management style on the ethical decision-making process in Saudi Arabia, the participants were provided with the printed questionnaires to answer. In section 1 the participants were required to think of how they manage conflict with their sex peers. A questionnaire was developed to measure the five styles of managing conflict that included; compromise, integration, avoidance, and oblige styles. Along with these were the addition of other items to facilitate the matching of the cross-cultural nature of the study while evaluating the three modes of accessing conflict management style namely help from third-party, negligence, and expression of emotion. The negligence was instead denoted as aggressive to give a better representation of nature regarding style. The participants responded to a Likert-type of a 5-point scale where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree. The reliability of every subscale in the perimeter of conflict management style in the culture group was computed with the alphas of Cronbach ranging between .72 and .91 as depicted in the table below.

Table 1: The Values of Cronbach alpha for Conflict Management Styles, Identity Scales and Self-Construal.

Conflict Style and Identity	Cronbach alpha
Integration	.82
Compromise	.74
Domination	.74
Oblige	.79
Avoidance	.83
Emotional	.80
Third-party	.89
Aggressive	.81
Ethnic identity	.84
Independent Self-Construal	.72
Interdependent self-Construal	.87

In the second section of the questionnaire, the participants answered questions related to self-construal. In this case, the participants responded using a Likert-type of 5-point scale with 1=strongly disagree and 5=strongly agree. The statements depicted in the questionnaire either supported interdependent self-construal or independent self-construal. The Cronbach's Alpha was also used for this case and depicted .87 for the interdependent self-construal and .77 for the independent self-construal.

For section 3 the participants provided a response for 6 items that quantified their ethnic identity in relation to conflict management. It was an open-ended questionnaire that focused on the ethnic label of the participants. The items in this section explored the ability of the individual to explore, and show commitment to the culture of an individual. The reliability of this used for this scale was confirmed to have a Cronbach's alpha of .85. All the survey questions used the English language with participants acknowledging the clarity of the items.

The first form of analysis included a summation of different measures such as means (*M*) and standard deviation (*SD*). The relationship between conflict management styles (independent variables) and ethical decision-making (dependent variable) was done using regression analysis and ANOVA (Analysis of variance). The procedures in ANOVA provided the regression analysis for the multiple-dependent variables that evaluated the influence of the various independent variables on the dependent variables. All the analysis was done using the SPSS.

Results

The table 2 below illustrates the respondents' characteristics in terms of demographics. Most of the participants were Arabs (73.73%) with a little of them categorized under mixed origins (3.81%). The percentage of the males used in the study was 71.61% while that of females was 28.39% with most of the participants (62.71%) falling between the age of 26 and 40 years. In regards to education, about 2.12% of the participants were from high schools, 22.03% were undergraduates, 68.64% were masters and, 7.20% were PhD. In terms of profession, most of the participants (42.8%) had been in the company under study for less than 1 year with only 13.98% had stayed in the same company for over a decade.

Table 2: Participants' Demographics (N=236)

Characteristic	N	% (percentage)
Sex		
Males	169	71.61
Females	67	28.39
Age Bracket		
<25	3	1.72
Between 26 and 40	9148	62.71
Between 41 and 55	61	25.85
>55	24	10.17
Highest Education level		
High school	5	2.12
Undergraduate	52	22.03
Masters	162	68.64s
Ph.D.	17	7.20
Managerial Experience		
Less than 1 year	101	42.80
Between 1 and 3 years	67	28.40
Between 3 and 5 years	31	13.14
Between 6 and 10 years	4	1.70
More than 10 years	33	13.98
Ethnicity		
Arab	174	73.73
Asian	6	2.54
African	29	12.29
White	18	7.63
Mixed	9	3.81
Other	0	0.00

RQ1: What is the main conflict management styles that Saudi Arabian managers use when making decisions?

In answering this question, a descriptive analysis of data was used to show how managers employ different conflict management styles in facilitating ethical decision-making. Descriptive statistics showed that the main conflict management style in the ethical decision-making process is oblige ($M = 3.55$, $SD = 1.073$) with a positive skew (1.151) and a negative kurtosis (-1.121). Compromise ($M = 3.40$, $SD = 0.999$), integration ($M = 3.35$, $SD = 1.035$), accommodation ($M = 3.32$, $SD = 1.264$), and aggressiveness ranked second, third, fourth, and fifth respectively as conflict management styles that managers employ in making ethical decision-making.

Table 3: Descriptive Statistics

	N	Mean	Std. Deviation	Variance	Skewness	Kurtosis		
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Accommodation	236	3.32	1.264	1.596	-.566	.158	-.813	.316
Aggressiveness	236	3.06	1.076	1.158	.141	.158	-.837	.316
Avoidance	236	2.82	1.096	1.202	.183	.158	-.574	.316
Compromise	236	3.40	.999	.999	-.644	.158	.023	.316
Dominance	236	3.19	1.099	1.208	-.027	.158	-1.103	.316
Emotional	236	3.11	1.021	1.043	-.223	.158	-.862	.316
Ethnicity	236	3.08	1.115	1.244	-.762	.158	-.790	.316
Integration	236	3.35	1.035	1.070	-.574	.158	-.111	.316
Oblige	236	3.55	1.073	1.151	.117	.158	-1.121	.316
Third Party	236	3.26	.830	.688	-.163	.158	-.709	.316
Valid N (listwise)	236							

Third party (M = 3.26, SD = 0.830), dominance (M = 3.19, SD = 1.099), emotional (M = 3.11, SD = 1.021), and ethnicity (M = 3.08, SD = 1.115) ranked sixth, seventh, eight, and ninth respectively as conflict management styles that managers used in ethical decision making. Avoidance (M = 2.82, SD = 1.096) was the least conflict management style employed by managers in ethical decision making.

RQ2: Is there a correlation between ethical identity and conflict management style used in decision-making?

Correlation analyses was performed to indicate whether there was a significant relationship between ethical identity and conflict management style in the process of ethical decision making (Table 4). Accommodation conflict management style and ethnic identity had a very strong positive relationship ($r = 0.947$, $p = 0.000$). Aggressive conflict management style and ethnic identity also showed a very strong positive relationship ($r = 0.920$, $p = 0.000$). The relationship between avoidance and ethnic identity was not only positive but also very strong ($r = 0.902$, $p = 0.000$). Compromise and ethnic identity had a very strong positive relationship ($r = 0.922$, $p = 0.000$) while dominance and ethnic identity had statistically significant positive relationship ($r = 0.939$, $p = 0.000$). Emotional aspect of conflict management and ethnic identity altogether had a very strong positive relationship ($r = 0.934$, $p = 0.000$). In similar manner, ethnicity ($r = 0.922$, $p = 0.000$), integration ($r = 0.924$, $p = 0.000$), oblige ($r = 0.857$, $p = 0.000$), and third party ($r = 0.875$, $p = 0.000$) had a very strong positive relationship with ethnic identity that is statistically significant ($p = 0.000$).

Table 4: Correlation between ethnic identity and conflict management style

		Ethnic Identity
Accommodation	Pearson Correlation	.947**
	Sig. (2-tailed)	.000
	N	236
Aggressiveness	Pearson Correlation	.920**
	Sig. (2-tailed)	.000
	N	236
Avoidance	Pearson Correlation	.902**
	Sig. (2-tailed)	.000
	N	236
Compromise	Pearson Correlation	.922**
	Sig. (2-tailed)	.000

	N	236
Dominance	Pearson Correlation	.939**
	Sig. (2-tailed)	.000
	N	236
Emotional	Pearson Correlation	.934**
	Sig. (2-tailed)	.000
	N	236
Ethnicity	Pearson Correlation	.922**
	Sig. (2-tailed)	.000
	N	236
Integration	Pearson Correlation	.924**
	Sig. (2-tailed)	.000
	N	236
Oblige	Pearson Correlation	.857**
	Sig. (2-tailed)	.000
	N	236
Third Party	Pearson Correlation	.875**
	Sig. (2-tailed)	.000
	N	236
Ethical Identity	Pearson Correlation	1
	Sig. (2-tailed)	
	N	236

RQ3: Can ethnic identity predict the conflict management styles that managers use?

The Table 5 below illustrates the strength of the relationship and the extent of influence of ethnic identity on conflict management style. The regression analysis revealed that ethnic identity had a very strong relationship with conflict management style ($R = 0.963$). R-square ($R^2 = 0.963$) showed that ethnic identity explained 92.7% of the variation in the conflict management style among managers in the ethical decision-making process.

Table 5: Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.963 ^a	.927	.927	.27227

a. Predictors: (Constant), Ethnic Identity

b. Dependent Variable: Conflict Management Style

An ANOVA table (Table 6) indicated the regression model employed in predicting the influence of ethnic identity on conflict management style in the ethical decision-making process is statistically significant, $F(1,234) = 2989.539$, $p = 0.000$.

Table 6: ANOVA^a (For predicting the influence of ethnic identity on conflict management style)

Model	Sum of Squares	df	Mean Square	F	Sig.	
1	Regression	221.612	1	221.612	2989.539	.000 ^b
	Residual	17.346	234	.074		
	Total	238.958	235			

a. Dependent Variable: Conflict Management Style

b. Predictors: (Constant), Ethnic Identity

Table of coefficients (Table 7) was used to depict that ethnic identity was a statistically significant predictor of conflict management style ($t = 54.677, p = 0.000$). The regression equation showed that a unit increase in ethnic identity resulted in 0.842 increases in conflict management style when other extraneous variables remained constant.

Table 7: Coefficients^a

Model		Unstandardized Coefficients		Standardized	t	Sig.
		B	Std. Error	Coefficients Beta		
1	(Constant)	.409	.054		7.531	.000
	Ethnic Identity	.842	.015	.963	54.677	.000

a. Dependent Variable: Conflict Management Style

The Regression Equation is that:

$$\text{Conflict management} = 0.842 \text{ ethnic identity} + 0.409$$

The regression model showed that conflict management styles, namely, third party, avoidance, ethnicity, oblige, dominance, compromise, emotional, accommodation, aggressiveness, and integration collectively explain 94% of the variation in ethical decision-making among managers ($R^2 = 0.940$).

Table 8: Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.970 ^a	.940	.937	.264

a. Predictors: (Constant), Third Party, Avoidance, Ethnicity, Oblige, Dominance, Compromise, Emotional, Accommodation, Aggressiveness, Integration

b. Dependent Variable: Ethical Decision-Making Process

The regression model was statistically significant in predicting the collective influence of the third party, avoidance, ethnicity, oblige, dominance, compromise, emotional, accommodation, aggressiveness, and integration on ethical decision-making, $F(10,225) = 352.970, p = 0.000$.

Table 9: ANOVA^a

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	245.997	10	24.600	352.970	.000 ^b
	Residual	15.681	225	.070		
	Total	261.678	235			

a. Dependent Variable: Ethical Decision-Making Process

b. Predictors: (Constant), Third Party, Avoidance, Ethnicity, Oblige, Dominance, Compromise, Emotional, Accommodation, Aggressiveness, Integration

Coefficients table showed that some styles of conflict management were statistically significant predictors while others were not statistically significant predictors. Aggressiveness, avoidance, compromise, dominance, ethnicity, oblige, and third party were statistically significant predictors of ethical decision making ($p < 0.05$). However, accommodation, emotional, and integration are statistically insignificant predictors of ethical decision making ($p > 0.05$).

Table 10: Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.508	.085		5.955	.000
Accommodation	.032	.058	.038	.551	.582
Aggressiveness	-.155	.067	-.158	-2.291	.023
Avoidance	.275	.055	.286	5.022	.000
Compromise	.412	.079	.390	5.208	.000
1 Dominance	.134	.064	.139	2.089	.038
Emotional	-.045	.071	-.043	-.628	.531
Ethnicity	.134	.061	.142	2.202	.029
Integration	-.058	.083	-.057	-.706	.481
Oblige	.503	.049	.511	10.327	.000
Third Party	-.304	.073	-.239	-4.157	.000

a. Dependent Variable: Ethical Decision-Making Process

The regression equation is that:

Ethical decision making = 0.032 accommodation – 0.155 aggressiveness + 0.275 avoidance + 0.412 compromise + 0.134 dominance – 0.045 emotional + 0.134 ethnicity – 0.058 integration + 0.503 oblige - 0.304 third party + 0.508. Correlation showed that ethical decision-making has a very strong positive relationship with conflict management style, which is statistically significant ($r = 0.948$, $p = 0.000$).

Table 11: Correlations

		Ethical Decision-Making Process	Conflict Management Style
Pearson Correlation	Ethical Decision-Making Process	1.000	.948
	Conflict Management Style	.948	1.000
Sig. (1-tailed)	Ethical Decision-Making Process	.	.000
	Conflict Management Style	.000	.
N	Ethical Decision-Making Process	236	236
	Conflict Management Style	236	236

The regression analysis indicated that conflict management style has a strong positive relationship with ethical decision-making ($R = 0.948$). Moreover, R-square shows that conflict management style accounts for 89.9% of the variation in ethical decision-making ($R^2 = 0.898$).

Table 12: Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.948 ^a	.899	.898	.337

a. Predictors: (Constant), Conflict Management Style

b. Dependent Variable: Ethical Decision-Making Process

The regression model for predicting the influence of conflict management style on ethical decision-making was statistically significant, $F(1,234) = 2072.220$, $p = 0.000$. This meant that the regression model was statistically relevant in predicting the relationship between conflict management style and ethical decision-making.

Table 13: ANOVA^a

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	235.127	1	235.127	2072.220	.000 ^b
Residual	26.551	234	.113		
Total	261.678	235			

a. Dependent Variable: Ethical Decision-Making Process

b. Predictors: (Constant), Conflict Management Style

The coefficients' table below showed that conflict management style was a statistically significant predictor of ethical decision-making among managers, $t = 45.522$, $p = 0.000$. The coefficients showed that a unit increase in the conflict management style resulted in 0.992 increases in ethical decision-making.

Table 14: Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	.430	.073		5.854	.000
Conflict Management Style	.992	.022	.948	45.522	.000

a. Dependent Variable: Ethical Decision-Making Process

Regression equation is that:

$$\text{Ethical decision making} = 0.992 \text{ conflict management style} + 0.430$$

Discussion

From the results, the purpose of the study manifests in two folds that involve examining the conflict management styles among the managers in Saudi Arabia and exploring the impact of conflict management style on ethical decision-making. The unmanaged conflict has chronic negative effects on organizational performance. The ability to manage conflict using the conflict management styles is still a challenge in the daily decision-making process and is influenced by both the environment and the individual.

The results of this study showed that managers tend to use oblige form of conflict management style which is win-lose approach although there were other modes almost in the same line with it such as compromising, integration, and third party. These results were in the same line with the findings of Moissoglou *et al.*, (2014). These researchers ranked conflict management styles beginning with oblige, accommodation, all the way down to competition. However, these findings contradicted those of Bankovskaya (2012) who revealed collaboration as the most popular strategy used but concurred with her studies that avoidance is the least used style.

The main point of concern is that the findings of the study supported the theory of Drucker (1960) that effective management styles serve as the principle of goal-oriented decision-making. The philosophy of managerial practices comprises several practices that can influence the process of decision-making (Toubiana & Yair, 2012). Managerial practices may at times involve going against the will of the workers

to realize a particular goal. Nevertheless, every practice should remain true to the ethical standards of the organization since lack of proper management as Johansen (2012) describes can always lead to conflict and insubordination of employees.

Ethnic identity was another aspect considered in the study and how it impacts ethical decision-making through conflict. To a significant level of over 92%, it was showed that ethnic identity impacted conflict management style which in the overall influenced the ability to indulge in ethical decision-making. Different ethnic groups perceive different interpretations regarding the attitude of the other person and cultural behaviour leading to the easy eruption of conflict in case of misunderstanding. The positive correlation found out in this study agreed with the findings of Wang (2015) found out that there is importance in considering the ethnic identity of an individual to manage conflict.

Conclusions and Recommendations

The first limitation of the study was the domination of male participants. Women in the Arabian countries have limited liberty to research and even if they were included, it was still hard to have a representative sample.

Secondly, conclusions were derived from the responses that the participants gave rather than studying their actual behaviours. Individual opinions could be a way of providing information regarding conflict management styles but there is no guarantee that such opinions match behaviour. It is therefore important to study communication patterns in groups particularly in Saudi Arabia where language seems to live independently and people barely use it as a way of expressing true feelings and observations.

Based on the findings it can be concluded that the study forms a crucial exploratory step towards understanding the various conflict management styles and how they impact ethical decision-making process among Saudi Arabians. The current study extends the findings of a previous research that managing conflicts effectively can lead to good relations in the workplace and enhance ethical decision-making. However, it adds to the notion of ethnic identity and how it relates to conflict management styles under the umbrella of decision-making. The study also calls for more research regarding how communication is executed in Arabian countries as there is a negative stereotyping towards Arabs. Hopefully enough, the study has provided some baseline foundation for the continued research in conflict management styles and how they influence decision-making from the perception of ethics in Saudi Arabia. In the context of the research's findings, it is worth recommending the need for designing and enforcing an educational program that can teach managers different conflict management styles and how they can be well managed to come up with an ethical decision. Along with this is the need to note that there is a need for Arabian researchers to include more women in their studies to balance the views of both gender in findings.

The future research should address the need for including women in studies as perfect representative samples by following the examples from Jordan, and Morocco. Also, future studies should focus on the ways of including conflict management styles in the current Arabian education system so that upcoming managers can get nourished with the skills in the right time.

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Impact of Organizational Culture on Job Satisfaction among the University Faculty Members – An Empirical Study

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Abstract

Organizational culture and job satisfaction are the very critical factor for any university. The purpose of the study was to find out prevailing organizational culture among the faculty members of the Universities and between Public and Private Universities, to understand the correlation between Organization culture and Job satisfaction and to suggests the remedies for improving the organizational culture and job satisfaction The present study was conducted on 368 faculty members of Indian private and government universities randomly drawn using questionnaire method. The results obtained indicates that the faculty members of both private and government universities were experiencing moderate level of OCTAPACE culture and also moderate level of job satisfaction and dominant culture components includes Openness and Risk taking, Confrontation, Pro-action, Collaboration and Experimentation. No differences were found between male and female faculty members on the dimensions of job satisfaction and organizational culture. It was further explored and found that there is significant positive correlation exists between organizational culture and job satisfaction.

Keywords: Openness and Risk Taking, Trust, Autonomy, Organizational Culture, Job Satisfaction

1. Introduction

1.1 Job Satisfaction

The job satisfaction of employees occupies the important place in the list of main concerns of human resource management department. The reason of this importance is twofold. On one side it helps in retaining the employees and on the other side it raises their performance level. The term 'job satisfaction' is quite frequently used for individual attitudes towards the specific aspects of total work situation. Since the time when the occupation of individuals became a socially significant phenomenon, social scientists focused their attention on the problem of job satisfaction. According to Hoppock (1935) job satisfaction is "any combination of psychological, physiological, and environmental circumstances that causes a person to say, "I am satisfied with my job." Schneider et al. (1975) defined job satisfaction "as a personal evaluation of conditions present in the job or outcomes that arise as a result of having job".

Further, they explain that job satisfaction has to do with individual' s perceptions and evaluation of his job and this perception is influenced by the person"s unique circumstances like needs, values and expectations. Locke (1976) defines job satisfaction as "a pleasurable or positive emotional state resulting from the appraisal of one"s job or job experience". Kerego and Muthupha (1997) described job satisfaction as feelings of employees about the environmental factors. Ivancevich et al. (1997) stated that job satisfaction is something due to which a worker feels that how well he/she is in an organization. Researchers link job satisfaction with many factors e.g. fairness of rewards, growth opportunities, participation in decision making, supervisory support and compensation etc.

A large number of researchers, however, link job satisfaction with organizational culture e.g. Jiang and Klein (2000), Chang and Lee (2007), and Mansoor and Tayib (2010) etc. A dissatisfied teacher cannot produce healthy and satisfied minds. Robbins (2001) suggested that at the organizational level, organizations with more satisfied employees tend to be more effective than organizations with less satisfied employees. In another research study the researcher noted that satisfied employees tend to be more productive, creative, and committed to their employers. Bhatti and Qureshi (2007) noted that job satisfaction leads to productivity through bringing high quality motivation and through enhancing working capabilities of employees.

1.2 Organization Culture:

According to John (1992), "Organizational culture has received extraordinary attention ever since the concept was proposed by American scholars in 1980's. By contrast with the management practice in Japanese companies, the concept of organizational culture was proposed and related theories were developed. The academia and managerial practitioners have reached the consensus that organizational culture is the core competency for an organization. It will impact effectiveness or performance of the individuals, the groups and the whole organization. There is no single definition for organizational culture. The topic has been studied from a variety of perspectives ranging from disciplines such as anthropology and sociology, to the applied disciplines of organizational behaviour, management science, and organizational commitment. The following definitions are views of authors from the applied sciences.

Disciplines and are more relevant to the scope of this research document. Afterwards, the publication of Organizational Climate and Culture, Schneider (1990) provided a thoughtful analysis and integration of the development of organizational culture theory and research. A decade after Pettigrew (1979) first introduced the concept of organizational culture to the literature, his conclusions in that book were, "The most serious cause for concern is the lack of empirical study of organization culture in the 1980's" Pettigrew, (1990). This article reports the results of such an empirical study examining an important cultural effect thought to influence organizations' productivity. Robbins (2003) postulated that culture, as a concept, has had a long and chequered history. In the last decade, it has been used by some organizational researchers and managers to indicate the climate and practices that organizations develop around their handling of people or to refer to the espoused values and credo of an organization. Schein (1999) defined culture as a pattern of shared basic assumptions that the group learned as it solved problems of external adaptation and internal integration that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems. Mullins (1999) defined organizational culture as the collection of traditions, values, beliefs, policies, and attitudes that constitute a pervasive context for everything one does and thinks in an organization. Aswathappa (2003) referred to culture as a complex whole which includes knowledge, belief, art, morals, law, custom, and other capabilities and habits acquired by man in a society. The OCTAPACE culture is characterized by the occurrence of openness, confrontation, trust, authenticity, pro-activity, autonomy, collaboration and experimentation, it deals with the extent to which these values are promoted in the organization (Pareek& Rao 1983).

Openness & Risk Taking: Employees feel free to express their ideas and the organization is willing to take risks and to experiment with new ideas and new ways of doing things.

Confrontation: Employees face the problems and work jointly with others concerned to find its solution. They face the issues openly without hiding them or avoiding them for fear of hurting each other.

Trust: The employees department and groups trust each other and can be relied upon to 'do' whatever they say they will do.

Authenticity: Authenticity is the value underlying trust. It is the willingness of a person to acknowledge the feelings he/she has, and to accept him/her as well as others who relate to him/her as persons.

Pro-action: Employees are action – oriented, willing to take initiative and to show a high degree of pro-activity. They anticipate the issues and act or respond to the needs of the future.

Autonomy: Autonomy is the willingness to use power without fear, and helping others to do the same. Employees have some freedom to act independently within the boundaries imposed by their role/job

Collaboration: Collaboration involves working together and using one another's strength for a common cause. Individuals, instead of solving their problems by themselves, share their concerns with one another and prepare strategies, work out plans of action, and implement them together.

Experimentation: Experimentation as a value emphasizes the importance given to innovation and trying out new ways of dealing with the problems in the organization.

2. Literature Review:

Zafar, S. & Vikramjeet, (2017) conducted a study on 526 faculty members of Public and Private higher educational institutions of India and reported moderate level of job satisfaction among them they also found that private educational institutions faculty members were more satisfied than their government higher educational counterparts.

Behzadi et al. (2012) found no significant relationship between organization culture & job satisfaction among physical education office staff of Mazandaran Province.

Khalid et. al. (2012) conducted a study on 108 faculty members to investigate the relationship between various facets of job satisfaction among university academicians in Punjab Province, Pakistan. Results of the study indicated that a pay differential does exist between private and public universities in Pakistan. Academicians in private sector universities were more satisfied with their pay, supervision, and promotional opportunities than the academicians of public university. On the other hand, academicians in public sector universities were found more satisfied with co-worker's behavior and job security.

Sabri et al (2011) conducted a research on 347 teachers to determine the effect of organizational culture on job satisfaction level of teachers of public and private sector higher education institutes and universities of Lahore which is second largest city of Pakistan and a hub of higher education. Supportive organizational culture may raise the level of job satisfaction of teachers and satisfied teachers may produce healthy, satisfied and creative minds. Empirical findings show that organizational culture is categorized into two components i.e. organizational culture related to managers and leaders (OCM) and organizational culture related to employees (OCE). In this study effect of both kinds of culture on job satisfaction is positive and significant.

Tsai (2011) studied 200 hospital nurses in Taiwan to find out Job satisfaction, organization Culture and leadership behavior among them. He found that there is positive significant relationship between organization culture and job satisfaction. He further found that job satisfaction level among nurses is high and they endorse the culture as positive.

Mansoor and Tayib (2010) in their study on indirect tax administration in Malaysia observed strong positive impact of organizational culture on the job satisfaction.

Bake and Nalla (2009) studied the relationship between organizational culture and job satisfaction among police officers working in various cities in two Midwestern states in United States . Data for the study was gathered from 669 respondents in five medium and large sized police organizations in two adjacent Midwestern States. More specifically, police officers' (supervisors and non-supervisors) perceptions about organizational factors of job satisfaction was examined and suggested that organizational characteristics are better predictors of job satisfaction than individual factors.

Aoms and Weathington (2008) in their study on teaching Fraternity of University of Tennessee at Chattanooga argued that the organization with strong and suitable culture positively affects not only the satisfaction of the employees but also the job commitment of the employees with the organization.

Chang and Lee (2007) in their research on business professionals in Taiwan emphasized over the group oriented culture in the organization for raising the employees' job satisfaction. However, they find a positive relationship between the culture of the organization and job satisfaction.

Chang and Lee (2007) in their research on business professionals in Taiwan emphasized over the group oriented culture in the organization for raising the employees' job satisfaction. However, they find a positive relationship between the culture of the organization and job satisfaction.

Lund (2003) made an empirical study of the impact of organizational culture types on job satisfaction in a survey of employed and contracted physicians in the American firms and found that “managing” organizational culture is an important building block for reinforcing positive physician attitudes and preferences which ultimately leads to their overall satisfaction.

Jiang and Klein (2000) in their research on 500 randomly selected Information system personnel from the roster of the American Institute for Technology Professionals (AITP) in the United States argued that supportive culture of the organization increases the satisfaction level of the employees and decreases the turnover ratios from the organization.

2.1 Objective of the Study

- To compare the prevailing organizational culture between public and private Universities
- To compare the level of Job satisfaction between Public and Private Universities
- To understand the correlation between Organization culture and Job satisfaction
- To suggest the remedies for improving the organizational culture and job satisfaction

3. Research Methodology

3.1 Sample

Faculty Members of various Public & Private Universities of India with more than two years of experience were used as a subject. The questionnaire was distributed among 410 faculty members in various public and private universities but only 385 filled responses were returned. After scrutiny of the filled questionnaire, 368 of them were used for the proposed study.

3.2 Procedure:

Faculty Members working in various public and private universities of India were selected as a sample keeping in mind the availability of the data, cost and distance for the data collection. Only faculties with more than two years of experience were taken in to consideration. The data were collected using survey method. Each of the respondents was contacted by the Researcher and the data was collected through questionnaire. They were asked to fill the questionnaire after going through carefully the given instructions on each scale separately. They were also assured of confidentiality of their responses.

3.3 Tools Used:

Organizational Culture: Parsec and Rao (1983) developed OCTAPACE profile consisting of 40 items instrument that gives the profile of organizational ethos in 8 values, were used in the study. The total value of an individual will vary between 40 – 200.

Job Satisfaction Scale: Scale on Job Satisfaction developed by Singh (1989) was used in the study. This questionnaire consists of 20 items that measures the degree of job satisfaction. Each item was rated on five point rating scale ranging from highly satisfied to highly dissatisfied with a weighted score of 5 to 1, the total score of an individual varies from 20-100.

3.4 Analysis Of The Data:

The collected data were tabulated as per the research design to meet out the objectives of the study and suitable statistical tools like Mean, Median, S.D., Correlation, t-test etc. were applied using SPSS 18.00 software.

3.5 Result And Discussion:

The present study was an exploratory research and mainly concerned to explore the kind and types of organizational culture, and job satisfaction among the Faculty Members of Public and Private Universities. Further efforts were made to find out the nature and relationship with the variables under investigation and demographic characteristics like gender and qualification etc. Based on the outcome of the statistical analysis, the obtained result was discussed in the light of literature review and other novel findings.

4. Results and Discussion

Table 1: Showing Mean, SD and T Value on the dimensions of Organizational Culture and Job Satisfaction among Faculty Members of Private and Government Universities.

DIMENSIONS	MEAN (Private University) N-229	SD	MEAN (Government University) N-139	SD	T Value
Openness & Risk Taking	14.65	2.46	14.25	2.70	1.42
Confrontation	14.38	2.49	14.01	2.43	1.44
Trust	13.32	2.56	13.39	2.22	.29
Authenticity	12.43	2.76	12.75	2.66	1.10
Pro- Action	15.34	2.48	14.08	2.79	4.37*
Autonomy	12.96	1.86	13.37	2.11	1.88
Collaboration	13.68	2.21	13.25	2.57	1.63
Experimentation	13.97	2.50	13.27	2.35	2.70**
Total OC	110.64	13.81	106.78	13.57	2.62**
Job Satisfaction	68.53	12.84	64.38	19.28	2.25**

It is evident from the Table 1 that faculty members of both type of Institutions are scoring high in the dimensions of Openness & Risk Taking, Confrontation & Proactively dimension Respectively Whereas the scores on dimensions Experimentation & Collaboration are High in case of Public/ Government Universities. In all other dimensions i.e Trust, Authenticity & Autonomy, the mean scores were found to be low for both the type of institutions. But if we compare both type of Institutions, The faculty members teaching in Private Universities were shown scoring high in Openness & Confrontation dimension. But the mean score in case of Pro activity dimension is very high for Private universities. This is possibly because *Pro action* dimension which means the level to which employees take initiative and are action oriented. The Private Institutions are known for their strategies & preparedness for facing all anticipated challenges. They keep on introducing new courses, conducting FDP's , Training & Placement activities for their students , establishing admission offices at various places and sending Faculty members on duty there months before the actual admission dates and preparing the teaching modules etc. accordingly. This High proactivity score also favours the opening up of many Private Universities in India which started up as small Institutions few years back. This shows that only those Institutions who are action oriented & will take new Initiatives, shall survive in future.

Openness i.e the extent to which an organization allows employees to express their opinions, ideas, feelings, and conducting new activities is found slightly more in Private Universities. The Public Universities have also scored high in this dimension which indicates that the faculty members can express their ideas without any fear of losing their jobs or any type of scolding by the management of the university. The main reason behind such expressiveness could be their Job Security, Financial stability & less Pressure. The faculty teaching in Public universities also scored high in *Confrontation* dimension i.e the level to which employees are empowered to take up challenges, solve problems, and confront similar situations. The Public University Faculty scored high in Collaboration & experimentation dimension which shows that in Public Universities faculty can work together supporting the principle of *Espirit de Corps*. These findings again reveal that a faculty member teaching in Public University feel more confident while taking up new initiatives. Such initiatives could be related to conducting university youth festivals, worker's participation in management decision-making , taking students on tours, field trips, excursions , confronting management or Government on issues of salary hike, working conditions, research grants etc. This result supports the findings of Bhalla and Nazneen (2013) in OCTAPACE study of retail employees in India, in which they found that the most dominant components of culture were confrontation, openness, experimentation, and pro-action. Also, Srimannarayana (2008) in their study reached to a conclusion that manufacturing sector scored a higher rank as compared to Service & IT sectors while measuring on OCTAPACE culture.

It is also clear from the Table that significant difference of Means were found on organizational culture and private institutions faculty members were shown experiencing better organizational culture than government institutions faculty members. Significant differences of means were also found on the dimensions of pro-action and experimentation and private institutions faculty members were shown experiencing high level of culture.

Significant difference of mean were also found on Job satisfaction dimension and surprisingly faculty members of private university institutions were shown high level of job satisfaction than their government institutions counterparts. During the interaction with the faculty members of the private institutions it was observed that majority of the faculty members working in the private institutions belongs to the same or nearby town and not willing to move to distant place where they may get better salary and work environment. Being local can be one of the biggest reasons of higher JS among faculty members as compared to JS of Public University faculty. When someone gets Federal/ Government Job in present era, due to multiple lifelong benefits, One doesn't hesitate to move at faraway place with family because Government Job & Benefits related to this kind of Job are very lucrative in nature. These findings match with study findings of a study conducted by Nazneen & Singh (2014) in which they found JS level of faculty teaching in Private Institutions on a bit higher side as compared to faculty teaching in Private Institution of U.P.

Table 2: Showing Mean, SD and T Value on the dimensions of Organizational Culture and Job Satisfaction among Male and Female Faculty Members

DIMENSIONS	MEAN (Male)N-174	SD	MEAN (Female)N-194	SD	T Value
Openness & Risk Taking	14.57	2.38	14.44	2.71	.45
Confrontation	14.49	2.31	14.01	2.59	1.87
Trust	13.65	2.21	13.08	2.59	2.26**
Authenticity	12.86	2.73	12.27	2.70	2.05**
Pro- Action	14.94	2.63	14.80	2.71	.49
Autonomy	13.17	1.92	13.06	2.01	.53
Collaboration	13.52	2.37	13.68	2.35	.02
Experimentation	13.68	2.67	13.73	2.26	.20
Total OC	110.41	13.19	108.09	14.32	1.61
Job Satisfaction	67.37	16.01	66.59	15.44	.48

It is clear from the Table 2 that both Male and Female faculty members have shown moderate level of organizational culture and job satisfaction. Authenticity, Autonomy and Trust were perceived by male and female faculty at low level. And the significant difference of means were found on the dimension of Trust and Authenticity and Male faculty members perceiving Trust and Authenticity greater than the female counterparts inspite of the fact that it is perceived as poor. No significant difference of means was found between Male and Female faculty members and the level remains moderate.

Table 3: Showing Mean, SD and T Value on the Dimensions of OC and Job Satisfaction Among Ph.D. and Non Ph.D. Faculty Members.

DIMENSIONS	MEAN (Ph.D) N-126	SD	MEAN (Non-Ph.D) N-242	SD	T Value
Openness & Risk Taking	14.71	2.55	14.39	2.56	1.13
Confrontation	14.43	2.41	14.14	2.50	1.07
Trust	13.60	2.28	13.21	2.50	1.50
Authenticity	13.02	2.59	12.31	2.76	2.43**
Pro- Action	14.71	2.73	14.94	2.64	0.77
Autonomy	13.80	1.79	12.76	1.96	5.09*
Collaboration	13.71	2.44	13.42	2.31	1.09
Experimentation	13.68	2.32	13.72	2.54	0.15
Total OC	109.75	14.73	108.89	13.64	0.55
Job Satisfaction	72.53	11.87	64.06	16.65	5.07*

If we look in to the Table 3 Faculty members with Ph.D. and Non Ph.D, degree were perceived moderate level of organizational culture. Openness and Risk Taking, Proaction and Confrontation were found to be high in the case of both Ph.D. degree and non Ph.D. degree holder faculty members. The significant difference of means were found on the dimension Authenticity and Autonomy and Ph.D. degree holder faculty members have shown higher level of perception of culture on these dimensions.

It was found that Ph.D. degree holder faculty members were shown moderately high level of job satisfaction while non Ph.D. degree holder faculty members shown moderate level of job Satisfaction. The difference between both the mean wer found to be significant at .01 level of significance. It was observed that faculty members working in the Universities with Ph.D degree were enjoying more salary and increments as per UGC/AICTE rules and were busy in research activities because they were given Ph.D. scholars and hence their need of research was being fulfilled . Their load of teaching and administrative tasks was lesser as they were justifying their salaries being a guide to research scholars. On the other side, the faculties without Ph.D. degree were under pressure of management, overburdened with lot of unnecessary committees and though most of them were also registered for Ph.D. degrees but not getting enough time to pursue their research. . Thus the faculty members with Ph.D. degree were showing Higher level of Job satisfaction as compared to faculty members without Ph.D. degree.. This finding supported the research conducted by Nazneen and Singh (2014).

Table 4: Showing Correlation Between Organizational Culture and Job Satisfaction Dimensions among the Faculty Members.

VAR.	JS	O	C	T	A	P	A	C	E	TOT OC
JS	1.000	.243*	.209*	.233*	.123	.189	.239*	.260*	.131	.244*

*: Significant at .01 level of significance

It is clear from the Table 4 that Job satisfaction were found to be positively and significantly correlated with the organizational culture components like openness and risk taking, confrontation, trust, autonomy and confrontation. Over all organizational culture and job satisfaction were found to be correlated significantly with job satisfaction means if the level of perception about the organizational culture will go up the level of job satisfaction of the faculty members of the universities will also go up.

4.1 Conclusion and Suggestions

On the basis of the above results and discussions it was concluded that the faculty members of Private As well As Government University were experiencing Moderate level of Job satisfaction and Organizational Culture. Significant differences of means were observed on the Pro-action and Experimentation and faculty members of private university were experiencing higher organizational culture than their government university counterparts. Significant differences were also observed between private and public university faculty and private university faculty were shown high level of job satisfaction. No differences were observed on the dimension of organizational culture and job satisfaction and both Male and Female faculty were shown moderate level of satisfaction with job and culture. No significant difference of means were observed between Ph.D. degree holder and Non Ph.D. degree holder faculty members and on organizational culture but significant differences were found on the dimension of job satisfaction level and faculty members with Ph.D. degree were having high satisfaction than non Ph.D. faculty members. Positive correlation were found between organizational culture and job satisfaction means if the level of perception of organizational culture will go up the level of job satisfaction will also go up.

Based on the above results it is suggested that to develop better organizational culture in universities, it is the responsibility of the top leadership to explore the missing OCTAPACE factors and try to implement positive policies and practices with the help of OD Interventions as well as OD practitioners. Job satisfaction level was found to be moderate. To increase the level of job satisfaction amongst university faculty a more comprehensive study including

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Impact of Prevailing HRM Practices on Job Satisfaction: A Comparative Study of Public and Private Higher Educational Institutions in India

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Abstract

A sound HRM system can be generated through the effective HRM practices. HRM practices refer to all activities that are directed towards the management of human resources and the employment of the resources for fulfillment of desired organizational objectives. Job satisfaction “as summation of employees feelings in four important areas namely, job, management, personal adjustment and social relations”. The present study was conducted on 526 faculty members randomly drawn of Government and Private affiliated higher educational institutions of India using questionnaire method. The results indicates that faculty member of government higher educational institutes has a moderate level of satisfaction with the overall HRM practices. Employees were more satisfied with training, teamwork and employee participation and satisfied to small extent with performance appraisal and compensations. The study also revealed that there is no significant difference between the government and private educational institution’s faculty scores on all HRM practices. A significant positive correlation has been obtained among the job satisfaction with the dimensions of the human resources management in both government and private higher educational institution’s faculty members.

Keywords: HRM practices, job satisfaction, training & development, higher educational institutions, performance appraisal, compensation

1. Introduction

Growth of the developing countries has been significantly positively correlated with the human capital, where educational institutions play an important role to build capable and educated societies. People of the nation write the success story of any country and education is only the success mantra to make the people ready to face the challenges of upcoming future expectation. In this current era of modernization where technology is challenge for technology itself, it is important to satisfy the needs of our employee to enhance organizational performance. To serve this purpose, organizations are focusing on work related behavior which is more critical for individual as well as organizational success. HRM practices are the approaches by which organization can enhance the job satisfaction among the employees. Present study is an attempt to understand the level of HRM practices and how these practices effect the job satisfaction among the faculty members of the public and private educational institutions.

1.1 Human Resource Management Practices

Managing people is much more difficult than managing other resources, where HRM plays a crucial role to bridge organizational and employee’s expectations. HRM is composed of the policies, practices, and systems that influence employees’ behavior, attitude, and performance. An effective HRM system can be generated through the effectual HRM practices. It refers to all activities that are directed towards the management of human resources and the employment of the resources for fulfillment of desired organizational objectives (Schuler & Jackson 1987). Koch and McGrath (1996) explored HRM practices to improve employee’s commitment, employee’s competency and creativity leads towards the attainment of organization objectives. Researchers identify different type of HRM practices in different sectors. Each researcher has their own view to implementation of practices as per the requirement. The applicability of practices depends upon the level of

employees; organization; industry and the culture. As Pfeffer (1994) initially, identified the following seven practices employment security, selective hiring, self-managed teams/team working, high compensation contingent on organizational performance, extensive training reduction in status difference and sharing information. Further, Redman and Matthews (1998) identify six HRM practices especially to service organizations to support quality strategies, i.e. Recruitment and selection, extensive remuneration systems, team working and flexible job design, training and learning, employee involvement and performance appraisals. Huselid (1995) studied eleven practices that are personnel selection, performance appraisal, incentive compensation, job design, empower of decision, information sharing, attitude assessment, labour management participation, recruitment efforts, employee training and promotion criteria.

1.2 Training and Development

According to Flippo, “*Training is the act of increasing the knowledge and skills of an employee for doing a particular job*”. Training involves enhancing and imparting the basic skills that are usually important to perform a specific job in the organization. The basic purpose of training is make employees more productive. It is a formal and systematic process of change in the behavior through learning, resulted from the series of educational programs, instruction modules and planned exercises (Armstrong 2001).

1.3 Team Work

A team is a group of people working together towards a common goal. Teams are characterized as “a set of two or more people dynamically, interdependently, and adaptively working towards the achievement of common and valued goal/objective/mission”, Salas et al. (1992). Tambe (1997), characterized team behavior as a process of sharing the goals they want to achieve, sharing knowledge, intention to execute the plan, sharing their capabilities and to monitor their own progress towards the team goal. Thus, team can be defined as a group of individual’s integrated functioning towards common mission or goal.

1.4 Performance Appraisal

According to Flippo, “*Performance Appraisal is the systematic, periodic and an impartial rating of an employee’s excellence in matters pertaining to his present job and his potential for a better job.*” Performance Appraisal includes, evaluating the employee’s performance in their jobs and comparing it with the standards, and further communicating the feedback to the employees. Armstrong (2001) defined as “*a strategic approach to delivering sustained success to organisations by improving the performance of people who work in them and developing the capabilities of teams and individual contributors*”

1.5 Compensation

Employee compensation is another major HRM practice to improve job satisfaction among the employees of an organization. Compensations policies and motivating reward system of an organization can influence the behavior of the employees and treated as indicators of the organization attitude and concern for employees. Luthans (1998) explain compensation not only to attain basic requirement of the employees, but are also helpful to fulfilling the higher level needs. Once a level of needs achieved next level of needs motivate people to achieve higher level of needs. Therefore compensation is considered as most significant variables for job satisfaction.

1.6 Employee Participation

Poole and Jenkins (1997) projected basic principles to achieve superior employee involvement in the organization. Employee participation with the help of work councils, management support to employee participation in work and decision making, trade unions, collective bargaining and to provide equal opportunities for employees to present views on development initiatives and other major issues. Employee participation improves the understanding of the objective of the organization and the strategies to achieve efficiently. Meyer and Allen (1991) found that employee participation in work and decision making is a significant positive **predictor** of job satisfaction and organizational commitment.

1.6 Job Satisfaction

Job satisfaction is frequently used as expressing individual attitude towards a specific job. Social scientists have shown a wide interest to find out the consequences and outcome of job satisfaction. Hence the dynamic nature of the job satisfaction attracted so many researcher and theorist for a sophisticated measurement and theoretical improvement pertaining to job satisfaction. Locke (1976) defined job satisfaction as “a pleasurable or positive emotional state resulting from an appraisal of one’s job or job experiences”. These are the positive responses to specific aspects of the job and play an important role in improving performance and enhancing employee commitment. Hop Pock (1995) defined employee satisfaction as “any combination of psychological,

physiological and environmental circumstances that causes the person truthfully to say I am satisfied with my job". Based on such conceptualization, Hulin and Judge (2003) explained job satisfaction as cognitive, affective and behavioral responses to an individual's job.

2. Review of Literature

Teachers are the back bone of any nation and play an important role in the nation building. Higher and technical education is a big challenge for the policy makers, thus it is important to have competent and effective teaching system. Thus, success and effectiveness of teaching system is depends upon the quality of its teachers. In this changing scenario of education, it will be interesting to bring out the relationship between HRM practices and job satisfaction.

Numbers of studies suggest that HRM practices have a significant influence on the job satisfaction. Nayak and Nayak (2014) conducted a research on 234 teachers, found that HRM practices like supervision, employee relationship, remuneration growth opportunities and work itself promotion have a significant impact on employee job satisfaction. Hinai and Bajracharya (2014) found in his study that remuneration and development, management support, students, colleagues, workload, and status of job were positively associated with job satisfaction. Work load was the most strongly associated with job satisfaction followed by the perception about colleagues, status of job, management support, and remuneration and development. Khan et al. (2012) found that male faculty members of the university are more satisfied than the female faculty member. HRM practices that are offered by the universities do not satisfy male and female equally. Female teachers are found more satisfied with HR practices than the male faculty members of universities. While comparing public and private universities it is found that faculty member of government universities teachers are more satisfied than private universities. It was also found that there was a direct relationship with the tenure of experience and job satisfaction.

Khalid et. al. (2012) conducted a study on 108 faculty members to investigate the relationship between various facets of job satisfaction among university academicians in Punjab Province, Pakistan. Results of the study indicated that a pay differential does exist between private and public universities in Pakistan. Academicians in private sector universities were more satisfied with their pay, supervision, and promotional opportunities than the academicians of public university. On the other hand, academicians in public sector universities were found more satisfied with co-worker's behavior and job security. Adeel et.al.(2011) investigated the influence of HR practices (compensation practices, employee performance evaluation practices, promotion practices, empowerment practices) in universities on job satisfaction. Result of study described that the teachers were satisfied with job itself, compensation practice and empowerment practice, whereas dissatisfied with promotion practice and performance evaluation practices. Teacher satisfaction is not predicted by these set of HR practices so there are some other factor which effect satisfaction.

The study conducted by Ch'ng et al, (2010) shows that management support, salary and promotion opportunities are significant in determining the Job Satisfaction level of College Teachers. Singh (2012) asserted that there is a significant difference in Job Satisfaction among college teachers with regard to gender in self financing institutions. Santhapparaj and Alam (2005) examined the relationships between pay, promotion, fringe benefits, working condition, support of research, support of teaching, gender and job satisfaction of 173 academic staff in private universities in Malaysia. The results indicated that pay, promotion, working condition and support of research have positive and significant effect on job satisfaction. On the other hand fringe benefits and support of teaching have negative effect. Romle (2006) conducted a study on Assistant Registrars working public institutions of higher studies in northern region of Malaysia to find out the relationship of management practices and job satisfaction. It was observed in the results those assistant registrars are satisfied with the HRM practices and have a positive influence on job satisfaction.

Chen et al., (2006) measured the job satisfaction of the 248 teachers in private university in China on the satisfaction determinants, namely organisation vision, respect, result feedback and motivation, management system, pay and benefits, and work environment. The analytical results showed that higher education employees focus on high salaries and fair promotion systems. Investigations of the job satisfaction of college teachers in Europe and America have produced similar results. Sseganga & Garrett (2005) measured the job satisfaction of academicians among the universities of Uganda by using nine general element of their work comprising research, teaching, remuneration, governance, opportunities for promotion, supervision, working environment co-worker's behavior and the job in general.

2.1 Objective of the Study

1. To study the level of human resource management practices and job satisfaction among the faculty members in the private and public educational institutions.
2. To examine the impact of human resource management practices on job satisfaction.

3. Research Methodology

The Investigator decided not to formulate any Hypothesis rather make the study as Exploratory in nature and hence concentrated on objective of the study.

As per the requirement of the research objectives, faculty members from government and self financed educational institutes with more than two years of experiences were used as population. The study was conducted on a sample of 546 faculty members out of which 341 faculty members were from self financed and 205 faculty members were from government educational institutes. But 20 questionnaires were rejected because of various reasons and at last 526 samples were used for the study.

Table 1. Frequency of respondent's type of institution

Type of Institute	Frequency
Government Educational Institute	194
Self Financed Institute	332
Total	526

Table 2. Biographical characteristics of the respondents

Government Institutions	Educational Institutions	Self Financed Institutions	Educational Institutions	Government Institutions	Educational Institutions	Self Financed Institutions	Educational Institutions
Male Faculty Members	Female Faculty Members	Male Faculty Members	Female Faculty Members	Low Experienced	high Experienced	Low Experienced	high Experienced
118	76	176	156	78	116	193	139

Faculty member with more than two years of experiences were taken in to consideration. The data were collected using survey method. Each of the respondents was personally contacted and the data was collected through questionnaire. A purposive random sampling were used to collect the data. Respondents were also provided with detailed instructions as to how the questionnaires were to be completed and returned. The rationale behind providing clear instructions and assuring confidentiality of information is based on the fact that this significantly reduces the likelihood of obtaining biased responses.

Qureshi, and Ramay (2006) scale comprised of 25 items, which contained questions on training, team work, performance appraisal, compensation, and employee participation was used to measure HRM Practices. Scale developed by Singh (1989) was used to measure job satisfaction. This scale consists of 20 items that measures the degree of job satisfaction. Each item was rated on five point rating scale ranging from highly satisfied to highly dissatisfied with a weighted score of 5 to 1, the total score of an individual varies from 20-100. The reliability and validity of the scale is within acceptable norms.

The collected data were tabulated as per the research design to meet out the objectives of the study and suitable statistical tools like Mean, Median, S.D., Correlation and Critical ration (t-Value) were calculated using SPSS.

4. Results and Discussion

Table 3. Mean and SD value of the dimensions of human resource management practices and job satisfaction of faculty members of government and self financed educational institution.

Components	Government Educational institution		Self-financed educational institution	
	Mean	S.D	Mean	S.D
Training	14.62	3.57	14.97	3.73
Performance Appraisal	14.25	3.76	14.62	3.69
Team Work	15.26	3.35	15.28	3.22
Employee Participation	13.93	3.44	14.42	3.43
Compensation	14.33	4.23	14.54	3.47
Total HRM	72.39	13.90	73.84	12.6
Job Satisfaction	69.54	11.79	73.13	9.46

It is observed from the table 3 that the faculty member of Government Educational institutes were showing satisfaction to the moderate extent with the overall HRM practices. Employees were more satisfied with training, teamwork and employee participation and satisfied to small extent with performance appraisal and compensations. It is clearly showed that Government Educational institutes offered policies to enhance Training, Teamwork and Employees Participation and moreover employees were also satisfied with these practices. Performance appraisal and compensations practices were not found satisfying among the Government Institute's employees. Contradictory to our belief that government sector is spending lot of money on training, teamwork and employee participation which further can say that the government is not logical in their endeavor. It is found in the study that the faculty member of self financed institutes were showing satisfaction to the moderate level with the overall HRM practices. Employees were more satisfied with team work. While faculty members were satisfied to small extent with Training, Employee participation, Performance appraisal and Compensations.

These results are supported by the finding of Majumder (2012) as HRM dimensions does not satisfy to the employees equally. Most of the employees are dissatisfied with compensation package followed by reward and motivation, career growth, training and development, management style, and job design and responsibilities. HRM practice compensation revealed as most dissatisfied factor among school teachers, hence teachers were not satisfy with their salaries, Steyn and van Wyk (1999) and Olivier and Venter's (2003). Grace and Khalsa (2003) concluded compensation as strong dominant factor for job satisfaction among the faculty members of higher education institution. While on the dimension of job satisfaction faculty members of Government and self financed educational institutes are showing moderately high level of job satisfaction again contradictory to our finding where job satisfaction is high.

Table 4. Mean and SD value of the dimensions of human resource management practices and job satisfaction of male faculty members of government and self financed educational institution

Components	Government Educational institution		Self-financed educational institution	
	Mean	S.D	Mean	S.D
Training	15.60	3.53	14.75	2.99
Performance Appraisal	14.95	2.96	14.78	3.60
Team Work	15.47	2.78	15.63	3.21
Employee Participation	16.25	2.90	13.39	3.04
Compensation	15.01	3.71	14.69	4.07
Total HRM	77.28	12.65	73.25	11.54
Job Satisfaction	73.74	9.51	70.77	11.39

Male faculty members of Government Educational institutes were showing high satisfaction with the overall HRM practices. Male faculty members were more satisfied with Training, Teamwork and Employee participation, where as they were satisfied to less extent with performance appraisal and compensations. In case of self financed Institutes, it is investigated that male faculty members were showing satisfaction to the moderate

extent with the overall HRM practices. Male faculty members were reported satisfied to small extent with training practices, performance appraisal, compensations practices and employee participation, where as they were satisfied to moderate extent with Team work.

Table 5. Mean and SD value of the dimensions of human resource management practices and job satisfaction of female faculty members of government and self financed educational institution

Components	Government Educational institution		Self-financed institution	educational
	Mean	S.D	Mean	S.D
Training	14.66	4.38	14.07	3.81
Performance Appraisal	13.57	3.64	13.82	4.31
Team Work	14.47	3.55	15.10	3.59
Employee Participation	15.03	3.27	12.73	3.43
Compensation	13.72	4.3	13.92	3.97
Total HRM	71.45	15.52	69.64	14.38
Job Satisfaction	69.39	12.04	68.69	11.48

It is observed from the results that female faculty members from the government institutes are less satisfied with training practices, performance appraisal practices, team work and compensations practices. Female faculty member of self financed Institutes were satisfied to below average or dissatisfied with the dimensions of HRM practices like performance appraisal, Employee participation and compensations. Bishay (1996) research supported the results that female teachers were satisfied to less extent with overall HRM practices. Female faculty member were less satisfied with compensation as compare to the male faculty member. Results of the study contradictory to the study of Perie and Baker (1997) reported high level of job satisfaction among female teachers than male teachers.

Table 6. Mean and SD value of the dimensions of human resource management practices and job satisfaction of less experienced faculty members of government and self financed educational institution

Components	Government Educational institution		Self-financed institution	educational
	Mean	S.D	Mean	S.D
Training	14.67	4.11	14.60	3.29
Performance Appraisal	13.96	3.3	14.38	3.96
Team Work	15.08	3.2	15.35	3.42
Employee Participation	15.66	3.04	13.09	3.31
Compensation	14.38	4.47	14.30	4.11
Total HRM	73.75	14.49	71.72	13.59
Job Satisfaction	71.05	11.12	68.81	12.05

It is cleared from the results that less experienced faculty members of Government Educational institutes were also less satisfied with Training, performance appraisal and compensations, it means faculty member are required changes in the training programs, faculty members also challenged the performance appraisal parameters to evaluate their performance. Teamwork and employee participation practices were found at moderate level, as they appreciate the initiative of team work and their participation in the decision making. Less experience faculty members of self financed Institutes were less satisfied with training practices with Training, performance appraisal, compensations and employee participation, and to the moderate extent with Team work. Results are in consistent with the study of Perie and Baker (1997) that young and less experienced school teachers working in public school shown high job satisfaction.

Table 7. Mean and SD value of the dimensions of human resource management practices and job satisfaction of less experienced faculty members of government and self financed educational institution

Components	Government Educational institution		Self-financed educational institution	
	Mean	S.D	Mean	S.D
Training	16.15	3.37	13.93	3.73
Performance Appraisal	15.14	3.20	14.17	4.03
Team Work	15.07	3.06	15.48	3.36
Employee Participation	15.96	3.20	13.06	3.05
Compensation	14.70	3.06	14.40	3.81
Total HRM	77.01	13.30	71.04	11.42
Job Satisfaction	73.64	10.00	72.68	8.99

It is cleared from the results that high experience faculty members of Government educational institutes were less satisfied with compensations and to the moderate extent with Training, performance appraisal, Teamwork and employee participation. High experienced faculty members on dimension training and compensations, indicating agreement to a small extent and to a moderate extent with performance appraisal, team work and employee participation.

Table 8. T-test analysis of the faculty members of self financed and government educational institutions on the dimensions of the human resources management practices and job satisfaction

Components	Sector	N	Mean	SD	T – test
Training	Govt	194	14.62	3.576	0.999
	Private	332	14.97	3.730	
Performance Appraisal	Govt	194	14.25	3.764	1.053
	Private	332	14.62	3.693	
Team Work	Govt	194	15.26	3.351	0.065
	Private	332	15.28	3.224	
Employee Participation	Govt	194	13.93	3.446	1.499
	Private	332	14.42	3.439	
Compensation	Govt	194	14.33	4.233	0.568
	Private	332	14.54	3.476	
Total HRM	Govt	194	72.39	13.909	1.224
	Private	332	73.84	12.660	
Job Satisfaction	Govt	194	69.54	11.790	3.383*
	Private	332	73.13	9.462	

In table 8, t-test analysis was conducted for the significant differences of human resources management practices and job satisfaction among the faculty members of self financed and government institutes. For the all dimensions and HRM as p values was observed more than 0.05. This signifies that there was no significant difference between the government and private faculty's scores on all HRM practices and job satisfaction.

Table 9. Showing the correlation between the HRM practices and job satisfaction among the faculty members of government and self financed educational institutions

Components	Job Satisfaction									
	Faculty Members		Male Faculty Members		Female Members		Faculty Low Experienced		High Experienced	
	Govt	Self Financed	Govt	Self Financed	Govt	Self Financed	Govt	Self Financed	Govt	Self Financed
Training	.430**	.119*	.220*	.050	.614**	.165*	.445**	.088	.359**	.300**
Performance Appraisal	.353**	.332**	.258**	.356**	.394**	.298**	.278**	.309**	.456**	.469**
Team Work	.256**	.310**	.206*	.332**	.257*	.280**	.135	.341**	.491**	.200
Employee Participation	.445**	.376**	.278**	.339**	.583**	.403**	.428**	.357**	.472**	.493**
Compensation	.366**	.534**	.230*	.483**	.469**	.584**	.320**	.527**	.490**	.600**
Total HRM	.460**	.472**	.299**	.476**	.578**	.461**	.408**	.444**	.541**	.655**

In case of government institutes, a significant positive correlation has obtained among the Job Satisfaction with the dimensions of the human resources management. It means job satisfaction is positively linked with HRM practices. Positive enhancement is observed in Job satisfaction with the increase efforts in the HRM dimensions. The analysis was in consistent with the Hasan et al. (2013) study showed that there was a significant positive relation between employee compensation and appraisal system with employee satisfaction. Human resource management practices are closely linked with job satisfaction. It is believed and proved by many researchers that effective implementation of human resource practices improve the level of job satisfaction positively. Edgar and Geare (2005) and Yu and Egri (2005), also found that human resource management practices has positive impact on job satisfaction. The result of the study also supported by study of Sarker and Afroze (2014) indicated that HRM practices have significant influence on job satisfaction. Uddin and Rahman (2014) supported the study as employee job satisfaction was comparatively more positively associated with promotional opportunity and benefits. In case of self financed institutes, significant positive correlation was found among the Job Satisfaction and the various dimensions of the human resources management practices. Compensation found to have positive impact on job satisfaction. It means with the increase in compensation practices or improved compensation practices will increase the level of job satisfaction among the faculty members.

5. Conclusion

On the bases of above finding it is concluded that faculty member of government educational institutes has a moderate level of satisfaction with the overall HRM practices. Employees were more satisfied with training, teamwork and employee participation and satisfied to small extent with performance appraisal and compensations. Faculty member of self financed institutes were also shown moderate level of satisfaction with the overall HRM practices. Employees were more satisfied with team work and satisfied to small extent with training, employee participation, performance appraisal and compensations. The study also revealed that there is no significant difference between the government and private educational institution's faculty scores on all HRM practices. A significant positive correlation has been obtained among the job satisfaction with the dimensions of the human resources management in both government and private educational institution's faculty members.

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IMPACT OF SAUDI ARABIA ECONOMIC CHANGES (OIL SHOCK) 2016 ON CONSUMER PURCHASING HABITS; WITH SPECIAL REFERENCE TO RETAIL SHOPPING IN KSA**Dr. Salah Abunar and Dr. Mohammad Zulfeequar Alam***

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ABSTRACT: *Consumer behaviour is a complex phenomenon, consisting of a set of decision-making processes, economic determinants and market incentives. The complexity of the buying processes of consumers may be largely linked to a sensation that's hard to predict and control. However, consumers are a primary source of income for business organisations, so knowing their behaviour has a great importance for the survival of business and market prosperity. For this, the researcher focuses primarily on highlighting the effects of the current economic recession (oil shock) of Saudi Arabia among the behaviour of consumers, in particular for household goods. An explorative research followed by descriptive research has been taken. Primary data has been obtained through a close-ended questionnaire, and it was collected using online Google form and the personal basis from the consumer of Saudi Arabia during January 2017 March 2017. Following receiving the data, it was examined with descriptive statistics. Chi2 test at P. Value 0.05, correlation coefficient has been utilised to check the validity and reliability of the hypothesis, and results were interpreted accordingly in the article. It was investigated that the majority of the respondents had a negative impact of the current economic crisis on the household purchase. Besides, it was also found that there was a variation in opinion among the respondents regarding the changes of their household consumption and expenses before and after the economic crisis (Oil shock).*

Keywords: *Consumer Behavior, Consumer Perception, Economic Crisis, Oil Shock, Household, Retailing, Saudi Arabia*

INTRODUCTION

With the growing globalization and new challenges in the retail, market have changed and brought in the competitive market scenario. Marketers are exploring new opportunities in the market industries day by day. Besides, the retail market in Saudi Arabia is no exception in getting new opportunities. The appearance of a vast amount of foreign residents contributes significantly to the Kingdom, giving the retail sector a major incentive for growth and increasing the purchasing power of local consumers. Conscious consumer retail market is now getting online, Facebook, Twitter and so on so far. Clients from the industries that come with online advertising now successfully attract and provide potential focus to customers. Marketers are trying to attract a buyer with attractive options and integrate market to appeal retailers as well as to attract consumers significantly. Furthermore, retailers are growing wider enough to respond to new forms of retail marketing and marketing based on preferential attitude, taste and consumer behavior. Now the beginning of new consumption patterns and local consumption tend to avail the opportunities that can give a big push to achieve the goals with good profit.

Since a decade of global trade is rolling to the economic recession in general and especially for KSA, which has been facing economic problems during the past three years due to the oil shock. As the country are facing enormous challenges to the expansion of their economic base (<https://www.bloomberg.com>, 2016). Since last two to three years, a slight impact on oil prices rang the bell to the country economy not to be only depended on oil only otherwise dependency on it will be the country in a deep recession. In other words, we can have an adverse impact on the status of the global recipe for market goods that stimulate some social and economic problems in the Kingdom. Because of this economic problem in the Kingdome retail sector has had a clear impact on it. However, inflation or recession can have an adverse impact on the retail sector. With the economic situation of sudden turmoil, consumers gradually lose interest in the purchase.

An Increasing in the market share during the recession is tough, because of every Riyal matters and saving money become the important part during this period for customers that leads them to use more discretion in making purchasing decisions. They keep withholding not to try new brands and trying to be stick to the brands on that they have trust. As a result, companies often face difficulty in putting their brands on the market during the recession. However, despite of these challenges, companies can succeed if they put their brands: taking into account the brand, product category and proper understanding of consumer expectations. Hence, the immediate objectives of the study are to understand the impact of the country economy deficit (Oil Shock Period) of the Saudi Arabian consumers as well, its impression on intentions of the purchase with a particular reference to retailing and household items in the region.

Scope of the Study

The area of this study covers retail sectors within the KSA. However, the study is especially focused on the household products retailers who trade their goods inside the Kingdome of Saudi Arab and to sell shortly.

The importance of the research

- This research will be helpful to some business groups in KSA.
- Another set of the interest group that will be profited from the verdicts of this analysis will be Government, the marketer in general and particularly retailers in KSA.
- The beneficiaries of this study is the national and global society especially in the area of similar field of research
- This study will be valuable to the researcher for further in depth study.

Objectives of the Study

- To explore and compare the household expenses of respondents before and after economy shock
- To investigate is there any changes in the consumption pattern of consumer due to the current economy situation after oil shock
- To understand the respondent's observant attitude before the product purchase in current economic condition

- To evaluate the respondent's opinion of their worrying tendency towards the current economic condition
- To assess the respondents' opinion about the changes in their buying situations after oil shock

LITERATURE REVIEW

The Consumer Behavior

Consumer behavior can be described as a process in which individuals or groups purchase tangible or intangible products to suit their needs or preferences (Perner, 2008). In another definition, consumer behavior refers to consumer buying who buy goods and services for personal consumption (Kotler & Armstrong, 2010) and "is a study of processes that occur when individuals or groups are selected, or experience to meet the needs and wishes" (Solomon, 2009). As noted by Mansour and Jalal (2011), the behavior of purchase usually has many forms of consumer choices can range from a wide variety of factors such as population interest and social and cultural data, such as purchasing behavior is determined by two key factors. Internal and external. Provided internal factors that determine consumer behavior for different segments of customers. In different words, it can be said that a unique set of characteristics of the client such as demographic, social, cultural, lifestyle can be described as determinants of purchasing. Moreover, it can be divided into internal factors that define consumer behavior in the following categories: (Ie, common sense, history, beliefs, and knowledge (Groucutt et al., 2004).

Moreover, some external factors can play a significant role in determining consumer behavior, such as promotion. Declaration of customer service, economic stability, market, and so on. One can infer strongly influenced by the overlay that the behavior of the designer is buying, and the consumer is highly conscious and buying external factors (Dawson et al., 2006), group (as you can see, the behavior mainly decided to buy internal factors), i.e., the principle of economy. , Status, social class, external effects, marketing. Promotion, advertising and the economic environment (Dawson et al., 2006). Arnold, Price, Znkham (2002), depending largely on the frequency of their occurrence, emotional involvement, and the complexity of decision-making and risk. These behaviors are called programmed buying behavior. In any case, the driving force behind these actions is consumer confidence. At the same time, the influence of internal and external factors (Chaudhry, 2006).

The Economic Crisis

The financial crisis is a set of unforeseen events that create results of which will affect the micro level corporate banking crises and global of-turkish-currency-and-banking-crisis-in-2000-and-2001. In other words, it can be defined as an economic crisis such as land swings beyond the limits of acceptable change in price or supply of any goods, services, and factors of the production market (Flatters and Willmott, 2009). The expansion of the crisis was to a decline in many industries and failure of large enterprises at the time of the global economic recession in countries such as the France, Germany, and United Kingdom, (Deutsche Welle, 2008). The performance of the multi-dimensional financial crisis has adverse effects on commercial and non-commercial consumers. Some of the main consequences of the current financial crisis on the consumer are job insecurity and unemployment. The decrease in

disposable income, Low savings rates, fewer chances of credit financing increasing consumption risk and rising prices of goods and services (Allen and Gale, 2007; Gramley, 2008).

Economic Crisis and its Effect on Consumption

The economic crisis may have a significant impact on consumer behavior. Also, income affects not only domestic consumption in the period of economic crisis often reduces consumption and gives priority to goods and products of the most important (Ang, 2001). It is often said that the economic crisis has had an adverse impact on the global economy. The credit crunch in the market can have a negative impact on businesses and households in the economy. Business interests in the economy, which must deal with low incomes and jobs in times of economic crisis. Some families begin to decline consumption and depend on others in the family in times of crisis to overcome the financial crisis (Fiszbein., et al. 2003).

Many studied had the relationship between the credit crunches and reduced in consumption at the macro level during the economic crisis. That indicates that during the period of the financial crisis, the overall level of consumption will be less that will lead to less disposable income and fewer employment opportunities that reduced revenue. Because of their high prices in a period of stagflation, families tend to choose less expensive products (Ang, 2001). The economic crisis is changing the buying patterns of people due to challenging and stressful situations (Lelia Voinea, Alina Filip, 2011). Regardless of the economic conditions, consumer awareness of the risks that affect the change in consumption patterns (Mansoor & Jalal, 2011). As the economic environment resulting from the crisis has changed, consumers have decreased confidence too in recent years (McGregor, 2011).

Mansoor & Jalal (2011), described changes in consumer behavior: when accept shopping behavior and have made a decision in the decision-making process or are limited. Economic concerns for consumers, trying to look for alternatives after the process of buying behavior has become seen in widespread. Amalia & Ionut (2009), reported in her report some facts that affect consumers who suffer from high unemployment, high inflation or freezing or lower wages and less purchasing power results. Also, media is one of the main factors of influence during this period. During the recession, high savings rates increased due to the fearing the loss of their jobs Amalia & Ionut (2009), point out that, like all people, they do not have the same view of the effects of the crisis. In another study of Flatters and Willmott (2009), people streamline their demands, save expenses; switching brands looking for cheaper price requirements than cut quality.

Krishna S (2016), Analyzed and examined the effects of the financial crisis on the purchasing behavior of consumers in the kingdom The following factors that have a direct impact on the labor uncertainty of consumer spending are included, the low level of savings, increased risk aversion and less disposable income. Because of these factors, limit consumers spend; especially they focus on important things. Therefore, Morris (2009) highlights the fact that disposable income is the driving force during the recession that restricts consumers' buying at a certain level. The economic crisis has serious effects on the behavior and attitudes of consumers (Zhigalova, 2012). Studies in different countries indicate that the financial crisis has high consumer social and economic impact. Different attitudes, expectations, and consumer buying patterns are affected by the crisis before the recession (Sharma & Sonwalkar, 2013).

Research in various countries has shown that recession has had a substantial impact on consumer and their purchase behavior. The article analyzes the results of research conducted in different countries in the recession to highlight the significant changes in the new purchasing behavior of consumers and make the drawing after the economic crisis (Lelia et al., 2011). Consumers should buy very carefully, they also focus on efficiency purchasing, and product quality, but do not expect customers to reduce regular consumption. Change behavior to buy good quality products with a relatively small price (Hawkins, 2008; Aliqah & Al-rfou 2010). Moreover, assistance consumption is the largest component of GDP. Also, had a significant impact on the pace of recovery of the economic crisis. During the first shock, consumers are turning to cheaper products and reducing overall consumer spending. Open credit lines, temporary decrease in the value of taxes and tax on private consumption added in some goods and future marketing campaigns through the Chambers of Commerce and non-governmental activities in activities affected by the increase in the specific use of the promotion (Mehmet K and Misra C., 2014).

Economic Crisis and Saudi Arabia

The Saudi economy continues to rely heavily on oil revenues to support the growth of foreign financial assets, more than 90 percent of the government and 80 percent of income from export earnings come from oil sales. The fall in oil prices has a direct negative impact on financial and external balances, is likely to slow growth in the final (Ahmed A Darwish et al., 2015). The Saudis are entering a period of extreme uncertainty, as the kingdom progresses ahead of the National Transition Plan and Vision 2030 announced by Deputy Prince Mohammed bin Salman in April. However, changes in the social and economic system of the Kingdom could lay the foundation for a similar disparity. The resulting political and social reforms undermine the demands of Saudi cohesion (<http://journal-neo.org>, 2016). The Kingdom faces enormous challenges in expanding its economic base. (<https://www.bloomberg.com>, 2016). Two years of the little impact of oiliness in most commodity-dependent countries pushed into a deep recession. In other words, the negative situation on the global commodity market could stimulate some social and economic problems in the kingdom. For example, Saudi Arabia, whose budget reached an unprecedented level of 15% of GDP deficit last year, the highest figure in 30 years since 1987 (<http://journal-neo.org>, 2016).

The economy of Saudi Arabia is relatively unique. It also, reveals one limits of analysis of Saudi Arabia regarding traditional scope, monetary, trade, and fiscal, macroeconomic policies. The heavy dependence on oil prices in the context of institutions to the constant commitment to maintaining the level of monetary policy creates problems that may require profound changes. Under the current configuration, Saudi Arabia has become "bankrupt" concerning the US dollar, especially if oil prices are not recovering significantly. Uncertainty, over in the future oil prices will be a difficult time for a country like Saudi Arabia, suffering from unrest on multiple fronts (Krishna S., 2016). In another study, the results of the survey showed that the impact of the global financial crisis initiative to the next decline in the system, take to reduce economic growth in exports for three years. (Hassan B. et al., 2013). Besides, the study found that most of the Arab countries that have raised the price of crude oil to finance their budgets are in great danger due to low oil prices. Risk management should be useful during a period of inactivity to prevent control or mitigation of risk. Moreover, an empirical study showed that consumers changed dramatically after the recession. The evidence also showed a stagnant visit affects the purchasing behavior of clients, especially in a Muslim country (Ghazal M. and Jha, S., (2015). The organized retail trade is to regulate with various factors, such as

changing social and economic income, the changing role of women, age factors, and the role of the dynamic banking system at the end of the day. (www.researchgate.net, 2017).

Research Gap

A research gap is described as a subject or field for that is missing or inadequate knowledge restricts the powers to give judgment for an interrogation. From the literature review, we found that economic crisis or financial crisis had a great impact on consumer behaviour and their attitude of shopping during the recession period. Although, many research has been undertaken to determine and measure the impact of economic crisis on consumer buying habits and their perceptions around the world and in the region. However, a very few research have been done to investigate the impact of economic crisis in this area, and even those research were related to the impact of economic crisis on consumer behaviour globally, and that was done before the oil shock of this country. Besides, especially we found that there is a very few research has been done to see the impact of the economic problem of Saudi Arabian consumer behaviour within near past and after Oil Shock of the country. Therefore, it shows there is a big call to identify and measure the impact of economic crisis on consumer buying habits and their perceptions on the current economic scenario that may arise after the Oil Shock. Consequently, the present study is an effort to this direction.

Research Hypothesis

Based on the literature review to ascertain the buying behaviors of consumers during the recession the following hypotheses were formed:

- ✓ **H₀₁**: There is a significant variation in consumer expenses during before and after the economy shock.
- ✓ **H₀₂**: There is a notable variation in opinion between genders regarding the worrying tendency for the current economic situation.
- ✓ **H₀₃**: There is no association between genders in the buying habits changes in quantity of branded products purchased due to the current economic condition.
- ✓ **H₀₄**: There is no relationship between job status and with the changes of buying habits in number of branded products purchased due to the current economic condition

METHODOLOGY OF RESEARCH

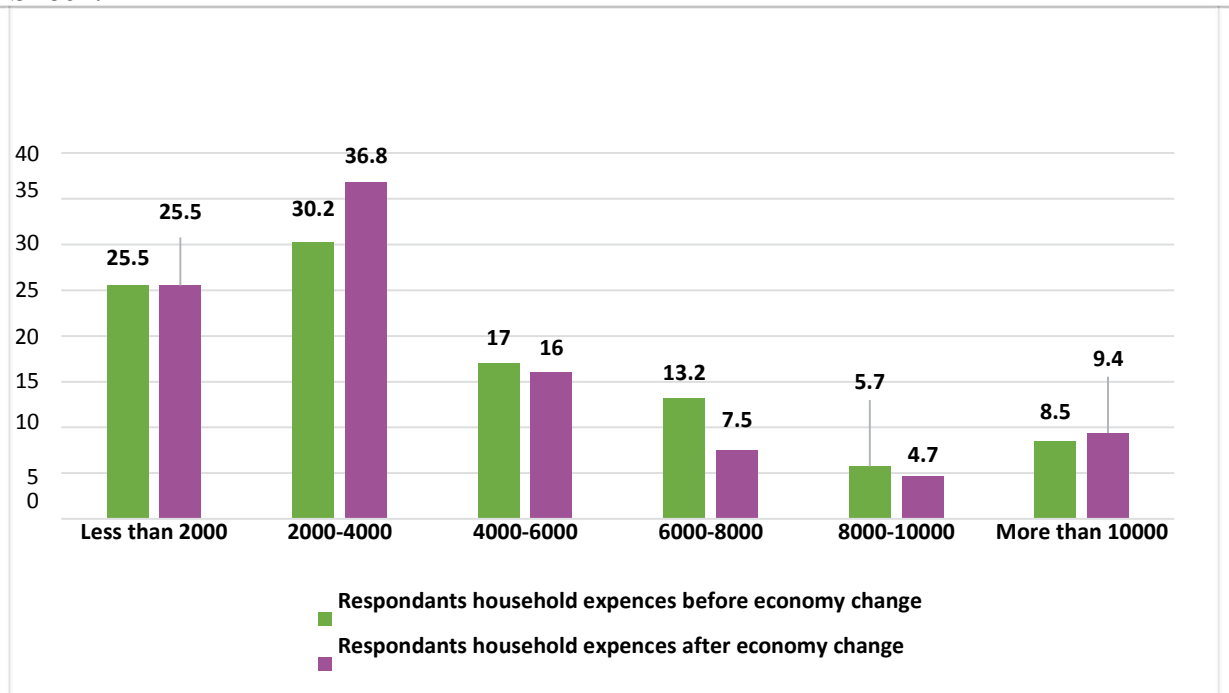
Present research work is descriptive in nature wherein a survey was conducted of 212 consumers in Saudi Arabia. The study has been done through secondary and primary data collection. Primary data were collected with a convenience sampling, close-ended structured questionnaire. For obtaining, the data Online Google form and the personal basis from the consumer during the January 2017 March 2017 were used for the investigation. Particular care has been given to reduce the error in the investigated result. The information was assessed with descriptive statistics. To check the validity of the hypothesis Chi² test and correlation coefficient has been utilized, and results were interpreted accordingly in the article.

RESULT ANALYSIS AND DISCUSSIONS**Table 1: Demographic Information Of Respondents.**

	Level	Counts	Proportion	p
1. Gender:	Female	52	0.245	< .001
	Male	160	0.755	< .001
2. Age:	26 to 35	78	0.368	< .001
	36 to 45	64	0.302	< .001
	46 -55	28	0.132	< .001
	56 and above	18	0.085	< .001
	Less than 25	24	0.113	< .001
3.Educational Level:	Graduate degree	92	0.434	<.063
	High School	10	0.047	< .001
	More than graduate	76	0.358	< .001
	Undergraduate degrees	34	0.160	< .001
4.Working Status:	Governmental employ	44	0.208	< .001
	Private employ	126	0.594	<.007
	Self-employed	8	0.038	< .001
	Student	26	0.123	< .001
	Unemployed	8	0.038	< .001
7. Nationality:	Non Saudi (Expatriate)	48	0.226	< .001
	Saudi	164	0.774	< .001
6.Monthly family income level (in S.R):	Less than 5,000	16	0.075	< .001
	11000-15000	52	0.245	< .001
	16000-20000	46	0.217	< .001
	21000-25000	44	0.208	< .001
	6,000-10000	24	0.113	< .001
	Above 25000	30	0.142	< .001
8.Region (Province):	Al Madinah Munawwarah	6	0.028	< .001
	Al Qassim	2	0.009	< .001
	Al Riyadh	8	0.038	< .001
	Al-baha	2	0.009	< .001
	Eastern Province	6	0.028	< .001
	Jeddah	36	0.170	< .001
	Jordanian	2	0.009	< .001
	Makkah	149	0.703	< .001

From the Table 1, the demographic information of the respondents can be seen. A percentage of 75.5% of the total sample (N=212) were male and the rest of the sample 24.5% were female. Majority 36.80% of the respondents belongs to the age group range 26-35 years followed by 36-45 age range 30.2%, between 46-55 ages range 13.2%, less than 25 age 11.3% and above 56 age were 8.5% respectively. In conclusion, about 80% of the respondents belong to the range between 26-55 years of the age group. Educational level of interviewees was most of them graduate degree 43% followed by above graduate degree 35.8%, holding undergraduate degree 16% and very few had high school passed 4.7%. Regarding the job status of the Respondents' it can also be seen in the table that majority 59.4% were private employed followed by government employed 20.8%, the student 12.3%, and the rest were unemployed 3.8% of the respondents. Furthermore, the table shows that the income levels of the participants; more than 80% of the participants belongs to the monthly family income range of higher than 11, 000/- SR and more. Less than 20% of the respondents belong to the regularly less than 11000 SR of their monthly family income. This sequence shows that the majority of the population belongs to the higher middle-income class of the society. As far as geographical location is concerned majority 87.3% belongs to the Makkah region followed by Al Riyadh 3.8%, Al Madinah Munawwarh, Eastern Province was 2.8% respectively of the sample size.

Figure: 1. Comparison of Respondent's Household Expenses, Before And After Economy Shock.

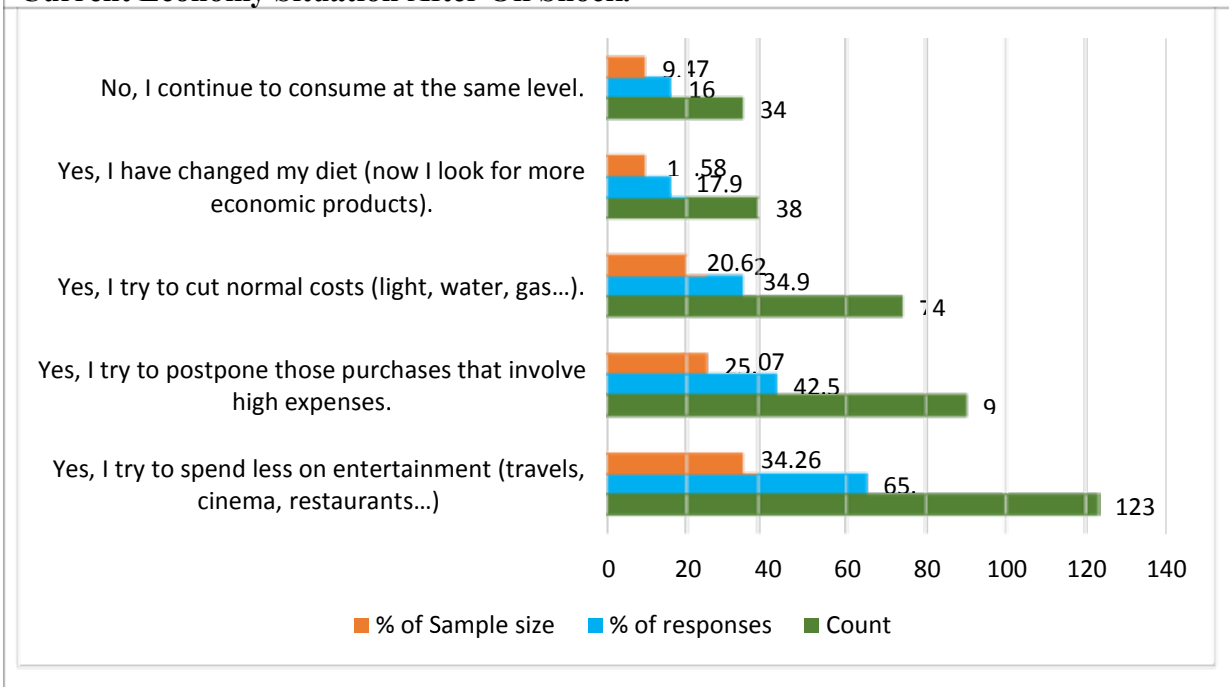


The correlation coefficient value of R is 0.94286 and the two-tailed value of P is 0.0048. By normal standards, the association between the two variables would be considered statistically significant.

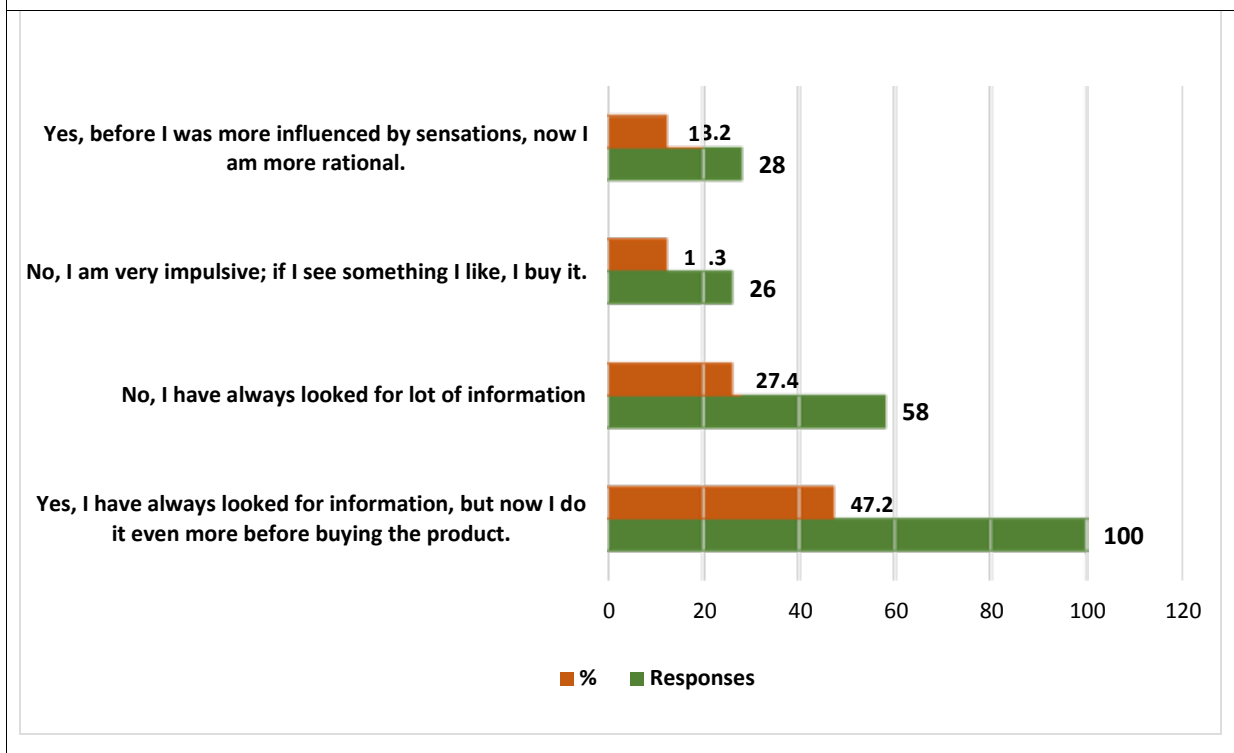
In a question, the respondents were asked to indicate the impact of the economic crisis had on their overall spending and consumption as well as how much they were spending before the oil shock and after it. Figure 1 shows the relevant details from the responses given. In the trend of expenses indicated that majority of the participant's one-fourth 25% of the respondents' asserted that there is no change in the family expenses before and after the economic shock those categories belongs to the less than 2000 SR per month. It can be noted that the ratio of this group are fulfilling the basic needs of the household that is necessary to spend in any circumstances and it is highly significant. About 29% of the respondents' claim that they have minimized the expenses due current economic situation as compare to before economic shock. It is commonly believed that a consumer would become more money minded when going through financial difficulties. The respondents' have minimized their expenses due to a current economic situation as their monthly payments were between 4000 SR to 10000 SR. It was noted that these groups were spending their disposable income not only in basic need but also they were buying shopping products when it needed, but after a crisis, they were more sensitive to save the money for future. It is exciting to note that there is a group of respondents' they stated they expend more during the crisis as compare to the expenses before the oil shock. That group belongs to the expending pattern of 2000-4000 SR and more than 10000 SR monthly expenses.

The group of respondents' that claim they expend more belongs to below the middle-income grope, and they are in the category of promotion prone consumer. Another group belongs to the higher middle-income group they spend monthly income more than 10000 SR the slight claim change in exceeding the expenses in the crisis period. This type of consumer not a price sensitive but they want to take the recession benefit as every seller selling branded and specialty product in discount, so they want to grab the interest even this is not the necessary for them. In conclusion, it can be said that the respondents' opinion about the impact of the economic shock on household expenses varied differently and it did not show the symmetry pattern. For H1; there is a significant variation in consumer expenditures during before and after the economy shock, calculated value of the correlation coefficient R is 0.94286, and the two-tailed value of P is 0.0048. By reasonable standards, the association between the two variables would be considered statistically strong significant relation between before and after the economic shock in the country. Therefore, the result is significant at $P \leq 0.05$. Hence null hypothesis is rejected, and alternative hypothesis will be accepted.

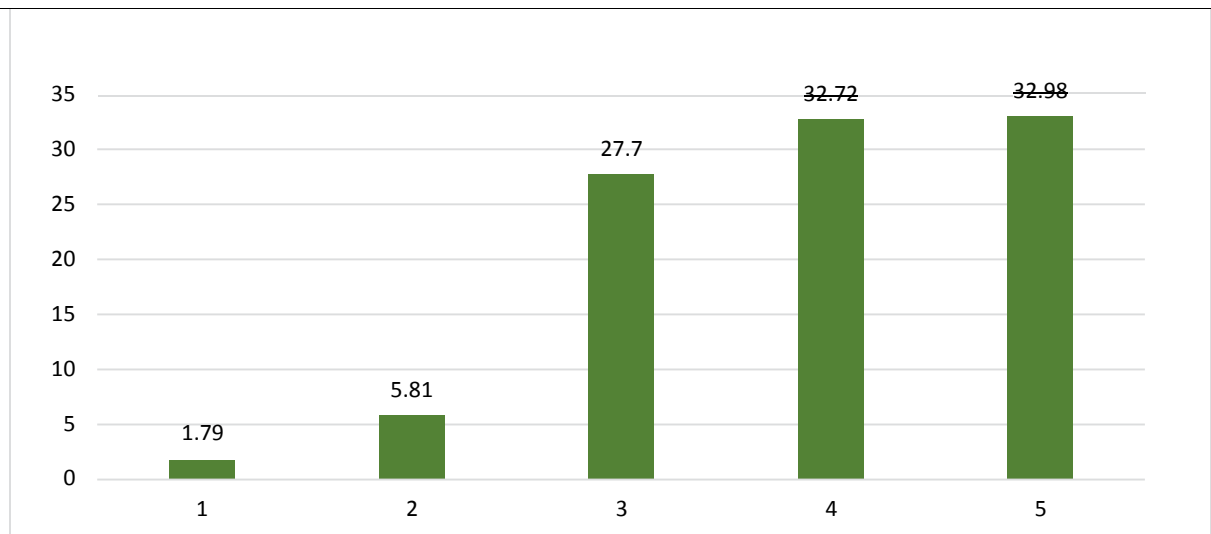
Figure: 2. Consumer Perceptions Regarding The changes in the consumption Due to Current Economy Situation After Oil Shock.



Respondents' were asked about the perception regarding the changes in the consumption due to the current economy situation. It can be revealed from the figure 2 that 34.26% of the respondents' tried to spend less on the entertainment such as travel, restaurants, etc. Followed by 25.07% of the interviewees' said yes I try to postpone those purchases that involve in high expenses, 20.62% of respondents' said yes I try to cut average costs and try to save the consumption of light water, etc. Besides, 10.59% of the interviewees' claimed that they had changed their diet before they were not concerned with expensive food and the quantity bought but after the economic crisis the look for economical food and not buying more than the need. They are more rational in the current situation but before they were more impulsive to buy. Only 9.47% of the consumer said that they are consuming at the same level. That category of users belongs to the less income group and in every economic situation; they have to expend that minimum level of living standard. It can be concluded from the result that a high majority of (90%) of the respondents'' have changed their consumption pattern due to current economic shock in a different way. It showed that they become more sensitive as they move from one level to another level of the hierarchy of demands as described by Maslow's hierarchy of needs. From the result, it is also concluded that marketers should understand the phenomena of consumption trend in economic crisis. Moreover, they should try to promote their product as per the product types that are covalence, shopping, and specialty products. They should give more attention in comparison to the commonly available product, to buying the product and the specialty product in increasing order.

Figure 3. Respondent Observant Attitude before the Product Purchase in Current Economic Condition

According to the results, 47.2% of the buyers were highly committed when looking for information before the product purchase in a current economic situation. In addition, they confessed that they had always looked for information, but it was extensive data search before deciding to buy in current economic conditions. The 27.4 % of respondents' confessed that they had always looked for information search before deciding to purchase a product. And 13.2 % respondents acknowledged being before more influenced by sensations before the economic crisis, but after the financial crisis, they become more rational consumer. 12.3% of respondents' claim that they are very impulsive and don't care about the situation what they like to buy. Thus, taking into analysis the model of Doyle & Stern (2006), we noticed that consumers had changed their buying behavior from more emotional and impulsive behavior to a more extensive decision-making behavior. Kotler and Armstrong (2010) affirmed that the evaluation of the alternatives process depended not only on the individual consumer but also on the specific buying situation, in this case, a reduction of income due to a crisis period. Nistorescu and Puiu (2009) affirmed that consumers compare the different products by price and quality in the evaluation process. Our empirical analysis supported these affirmations too. According to Delgado (2008), consumers are expected to be more rational and less impulsive when there is an economic downturn. This observation was also confirmed by our experimental study (See the Figure 3).

Figure 4. Respondent's Opinion of their Worrying Tendency towards the Current Economic Condition**Table 2. Opinion Between Genders Regarding The Worrying Tendency For The Current Economic Situation**

Gender:		Are you worried with your economic situation now?					Total
		1	2	3	4	5	
Female	Count	0.00	4.00	24.00	14.00	10.00	52.00
	% within row	0.0%	7.7%	46.2%	26.9%	19.2%	100.0%
Male	Count	6.00	18.00	46.00	48.00	42.00	160.00
	% within row	3.8%	11.3%	28.7%	30.0%	26.3%	100.0%
Total	Count	6.00	22.00	70.00	62.00	52.00	212.00

Chi-Squared Tests		
Value	df	p
X ² 6.944	4	0.139
N	212	

During the Respondents' were asked regarding the worrying tendency towards the current economic condition. The result shows that 65% of respondents' were worried about the present economic situation besides, 27.7 percentage of the interviewees' were in neutral in this regards, but very few percentage of respondents' about 7% indicated that people are not worried about the current situation. This result infers that the Respondents' are not concerned the high-income level of a consumer (See the Figure 4).

From the table 2. It can also conclude the worrying tendency between genders wise. Male respondents' are more worried than the female respondents,' and the majority of women respondents' (46%) were neutral level or no matters than the male (28%) about the current economic condition. From the result, it can be revealed that in Saudi Arab culture all the responsibility of household expenses and the management handled by male members, so it is evident that male respondents are more worried than the female respondents because of a majority of the female are not working so they not concerned about an economic crisis. We can conclude that during economic downturns unemployment rates increase so male members are more concerned about the current situations. Ho2: There is a notable variation in opinion between genders regarding the worrying tendency for the present economic conditions; the Chi-square independent test calculated p-value is 0.139 (Table 2). Therefore, the resulting valve is greater than the record value that is insignificant at $p \leq 0.05$. Therefore, it can be assumed that there is a considerable variation in opinion on worrying tendency gender wise related to the economic crisis, so the null hypothesis is accepted.

Figure 5. Respondents' Opinion About the Changes in their Buying habits after Oil Shock.

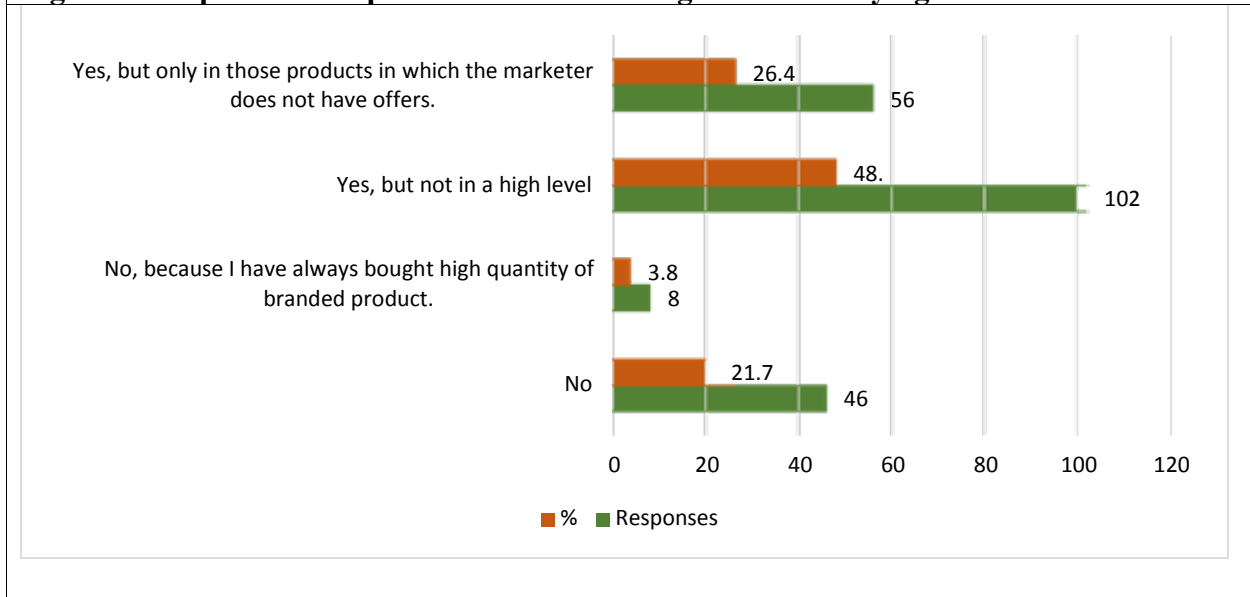


Table 3. Respondents' opinion about Buying Habits Changes In Quantity Of Branded Products Purchased Due To The Current Economic Condition Gender Wise

		Have you changed your buying habits in quantity of branded products purchased since the economic changes appeared? If yes, at what level?				
		No	No, because I have always bought high quantity of branded product.	Yes, but not in a high level	Yes, but only in those products in which the marketer does not have offers.	Total
Female	Count	0.00	4.00	30.00	18.00	52.00
	% within row	0.0 %	7.7 %	57.7 %	34.6 %	100.0 %
Male	Count	46.00	4.00	72.00	38.00	160.00
	% within row	28.7 %	2.5 %	45.0 %	23.8 %	100.0 %
Total	Count	46.00	8.00	102.00	56.00	212.00
	% within row	21.7 %	3.8 %	48.1 %	26.4 %	100.0 %

Chi-Squared Tests			
	Value	df	p
X ²	20.82	3	< .001
N	212		

Table 4. Respondents' opinion about Buying Habits Changes In Quantity Of Branded Products Purchased Due To The Current Economic Condition with Different Job Status.

		Have you changed your buying habits in quantity of branded products purchased since the economic changes appeared? If yes, at what level?				
		No	No, because I have always bought high quantity of branded product.	Yes, but not in a high level	Yes, but only in those products in which the marketer does not have offers.	Total
What is your current working situation?	Count	10.00	0.00	22.00	12.00	44.00

Governmental employed	% within row	22.7%	0.0%	50.0%	27.3%	100.0%
	Count	26.00	8.00	52.00	40.00	126.00
Private employed	% within row	20.6%	6.3%	41.3%	31.7%	100.0%
	Count	2.00	0.00	4.00	2.00	8.00
Self-employed	% within row	25.0%	0.0%	50.0%	25.0%	100.0%
	Count	8.00	0.00	16.00	2.00	26.00
Student	% within row	30.8%	0.0%	61.5%	7.7%	100.0%
	Count	0.00	0.00	8.00	0.00	8.00
Unemployed	% within row	0.0%	0.0%	100.0%	0.0%	100.0%
	Count	46.00	8.00	102.00	56.00	212.00
Total	% within row	21.7%	3.8%	48.1%	26.4%	100.0%
Chi-Squared Tests						
	Value	df	p			
X ²	21.96	12	0.038			
N	212					

From the Figure 5. It is analyzed the respondents' opinion about the changes in their buying habits after oil shock. In this regards the majority of those surveyed' 48.1% agreed that they had changed their habits of buying but not on high level. Followed by 26.4% claimed that they had changed the buying habits after oil shock but only in those products in which the marketer does not have offer and 21.7% of the respondents' indicated that they did not change the buying habit even in the economic crisis after oil shock in the region. Interesting to note that very few 3.8% of respondents' claimed that they did not change the purchasing habits because they are very loyal to buy the high quantity of branded product. From the result, it can be inferred that more than 70% of consumers have changed their buying habits due to the current economic condition, but they can continue the same purchasing habits if marketers provide the offer to the required product to them. So it is advised to the marketer if they want to get the responses of buying from the old customer in this down economic condition they should try to attract the customers through different types of promotions so the consumer can stay with them still in the worst situation. However, for the extreme brand loyal customers, it will not work that much, but they should also try to give some offers to make them happier to repeat buy.

The table 3 revealed the buying habits changes in the quantity of branded products purchased due to the current economic condition gender wise. The majority about 92% of female respondents' indicated that they had changed the buying habits in the present economic situation. 57.7% female consumer confirmed that they changed but not in a high level followed by 34.6% said they modified for that product not having the offer. Regarding the male consumer, 45% of them claim that they changed but not high level followed by no change, and 23.8% have changed the purchasing habits those products not having off and promotion so they shifted to the other options. Ho3: There is no association between genders in the buying habits changes in the quantity of branded products purchased in the current economic condition; the Chi-square independent test calculated p-value is $< .001$ (Table 3). Therefore, the result value is less than the table value that is significant at $p \leq 0.05$. Therefore, it can be assumed that there is an important relationship in buying habits with gender wise in the economic crisis period, so the null hypothesis is rejected.

Table 4 has Indicates the respondents' opinion about buying habits changes in the quantity of branded products purchased due to the current economic condition with different job status. Unemployed (100%) consumers have changed their buying habits due to the financial situation followed by Students 61%, self-employed 50% and privately employed 41.3%. Other than unemployed consumers, all the job status respondents' have been changed their buying habits almost on the same level that is about more than 75%. In conclusion, it can be stated that there is a high impact of the economic shock in the buying habits of consumers in the region and it has the great relation with the gender wise and job status wise. Through the strategic promotional methods, marketers can handle such situation in the short-term basis. It is also suggested that marketer should focus on natural product and running product than the specialty and high innovative product during the recession period. Ho4: There is no relationship between job status and with the changes of buying habits in some branded products purchased due to the current economic condition; the Chi-square independent test calculated p-value is $< .038$ (Table 4). Therefore, the result value is less than the table value that is significant at $p \leq 0.05$. Consequently, it can be concluded that there is a highly significant relationship in buying habits within job status in the economic crisis period, so the null hypothesis is rejected.

CONCLUSION

Saudi Arab is an among the Gulf countries that suffering oil shock problem which leads to an economic crisis and that, affects many aspects of business and human life, such as investments, spending, savings, consumption, etc. Triggered by the adverse economic conditions, the researcher tried to explore the current study focused on the impact of the current Oil shock situation and economic downfall on the spending and behavior of Saudi consumers. Specifically, the research was driven by the need to identify the impact of the current economic crisis (Oil shock) on consumer household spending in Saudi Arabia. The study identified unfriendly changes in the attitudes, habits, and perceptions of consumers. It was reported to influence negatively, approaches towards spending leads in less frequent purchases and money in the importance assigned to specific purchase drivers. Analytically, the study revealed that the crisis makes consumers more conservative regarding spending and to exercise higher control over their spending. Further, regarding purchasing practices and household shopping, the investigation show that the economic crisis has no influence on buying of necessary goods, while it leads to diminishing the spending for the goods such as clothes, luxurious assets, and electronics, however, though they consume less for entertainment. The investigation also

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reveals that the crisis makes consumers more price sensitive and discriminating buyer than the impulse purchase.

Overall, the study identified the customers were highly involved when looking for information on the product procurement in a current economic situation; also, they confessed that they have always looked for information but having increased their information search before deciding to buy a product in current economic conditions. Almost 65% of the respondents' indicate that they are worried about the present economic situation that happens after the oil shock in Saudi Arab. The result also concludes that the respondents those belong to the high-income level consumer are not concerned about it. It was also found that male respondents' are more worried than the female respondents about the economic crisis. The majority of those surveyed' 48.1% agreed that they had changed their habits of buying but not on the high level, besides, it was inferred that more than 70% of consumers had changed their buying habits due to the current economic condition. However, they could continue the same purchasing habits if marketers will provide the offer to the required product to them. The majority about 92% of female respondents indicate that they have changed the buying habits in the current economic situation. Hundred percent of Unemployed consumers have changed their buying habits due to the financial condition followed by Students 61%, self-employed 50% and privately employed 41.3%. It is suggested that through the strategic promotional methods marketers can handle the situation. It is also suggested that marketer should focus on regular product and running product than the specialty and high innovative product during the recession period. It is advised if the marketer wants to get the responses of repeat buying from the old customer in the current economic condition they should try to attract the customers through different types of promotions so a consumer can stay with them. However, for the extreme brand loyal customers, it will not work that much, but they should also try to give some offers to make them happier to repeat buy always. It is also concluded that marketers should understand the phenomena of consumption trend in economic crisis. Moreover, they should try to promote their product as per the product types that are the convenience, shopping, and specialty products. They should give more attention in comparison to the available product, to buying the product and the specialty product in increasing order.

Limitations of the Study

Although good effort has been made to put up for the study however the following factors have been unavoidable absent as a result of their critical limiting factors for this study:

- ✓ This study could not cover all products of retailing as only household goods retailing has been taken for the survey.
- ✓ Conducting the research to more households could have given additional information that would provide better results, ensuring very higher reliability at country level but due to the lack of time and resources it, could not be done as needed.
- ✓ There is a likely problem of inferring too widely based on a small sample size (N: 212 consumers only) which can cause limitations by affecting the assumption of homogeneity of variance.

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MARKETING STRATEGIES FOR THE PROMOTION OF E-COMMERCE IN SAUDI ARABIA

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ABSTRACT

E-commerce has depended on new calls for the marketing these days because of the changes in the associated behavior of consumer habits, and the way of purchase changed during the new millennium due to the technological innovation and the external communications methods of marketing. Due to fast increase in the attention of consumers in online marketing, it has become the ideal means of purchasing and the pattern of doing shop for the people in the world. In Saudi Arabia, the internet become the part of life now, and citizens are motivated to obtain their demands online, but the electronic procurement direction still did not keep the significant place of marketing in Saudi Arabia. The present study is to measure the e-commerce motivational factors and to identify the strategy for the promotion of electronic business in the region. For the study, a survey of 128 respondents of Saudi Arabian purchasers was conducted during the three months from September to November 2015. Data collection was carried out using a structured and close ended questionnaire. The received data were coded and analyzed with proper analytical tools. It was investigated that the majority of the respondents had involved in e-marketing as well as alternative one. Moreover, the timing of e-marketing significantly differed in opinion among the people, and discount offer were the most motivational factors to e-marketing by the people.

Keywords: *E-commerce, promotional strategy, e-marketing, Saudi Arabia*

1. INTRODUCTION

In the back history, a customer must go to physical markets to obtain necessities. It was the unique means to meet their demands. By the rapid evolution of technology, mixed styles of buying system brought many positive outcomes for consumers. Hence, various organizations have evolved purchasing through the e-payments to take recognition of this developing amendment concerning these distinct marketing practices. With the increasing use of the internet services consumer are ready to contribute toward online marketing in the Kingdom of Saudi Arabia. Approaching to the knowledge so many online retailers attempting to equip clients with the variety of online window-shopping adventures.

According to a study accompanied by the Arab Consulting Group in 2008, there were 48% of Internet users in Saudi Arabia to order commodities and services within their mobile phones. Based on the report as mentioned above, users of e-commerce in Saudi Arabia are supposed to be the representative of 3.5 million consumers. Aforementioned compares to 14.26% of the total state of the country.

Said Ronaldo Mouchawar, co-founder of Souq.com, one of the preeminent website for online purchasing in the Kingdom of Saudi Arabia, stated that Saudi Arabia is the largest and fastest growing e- market. We see a recorded turnover, which also indicates the potential for further growth. According to a review by MasterCard on the research of online purchasing had indicated that nearly half of the respondents of the study are making an online purchase bulk was happy with the online buying activity that shows a high degree of purchaser gratification amongst persons that make a buying on the Internet too.

The e-commerce also offers many tangible advantages. For example, the time buyer reduces with e-commerce techniques and people reach to the ultimate decisions quickly. Additionally, they spent less time- to solve billing and order deviations, consumers do enjoy buying online 24 hours a day, and finally,

e-commerce gives the consumer to increase the chances of buying alternative commodities as per their evoked set. Thus, online shopping is more environmental friendly as compare to traditional purchase clients desire the things with a click without hurdles.

2. OBJECTIVE OF THE STUDY:

The actual goals of the present analysis are to perceive the Saudi customers' purchasing selectivity and inclinations of using electronic commerce in the area. Be that as it may, the particular goals of the assessment are as per the following:

- To recognize the buying approaches of the respondents in KSA
- To ascertain the habit of buying through online
- To understand the factors that give advantage in e-marketing
- To explore the likable time through of e-shopping
- To discover the preferable sales promotional methods, motivate to e-marketing
- To determine the likable campaign medium for e purchasing
- To explore the attitudes of buyers towards sales offer with product and services
- To investigate the attitude of buyers regarding price of product charged by e-marketer

3. SCOPE OF THE STUDY

The sector of this analysis covers all enterprises and dealers inside the KSA. Though, the evaluation is for the most part centered around the retailers who exchange their items and orders through on the web or having the expectation to offer in future.

4. SIGNIFICANCE OF THE RESEARCH:

1. This evaluation will be useful to various business folds in Saudi Arabia.
2. Additional, arrangement of study gathering will be profited from the findings of this examination will be Government, merchant and especially retailers who approach ecommerce in Saudi Arabia.
3. This assessment will be useful for the analyst to do advance evaluation on the theme.

5. LITERATURE REVIEW:

The development of the electronic-commerce have reduced sales barriers that drive to generate possibilities for trade and comfortable to approach buyers globally immediately. Indeed, business science research presently directs particularly on electronic commerce (Griffith et al. 2006). Development of internet in the KSA has the enormous possibility to raise e-commerce because it lessens the charges of goods and services and opens the geographic borders to appeal consumers and traders collectively. The arrival of technology and the Internet has not only allowed people to buy online, however, further improve the economy and promoting global business through foreign trade worldwide (Al-Somali, et al. 2009).

It is showed in research done by Master card.com; forty six percent of Saudi Arabian purchasers access the internet for online spending is frequently achieved acceptance in Saudi Arabia (Shim, et al. 2001). The Internet technology results in online activities in which the activities of buying and paying for items through shopping sites anytime, anywhere and showed an effective scale growth these days (S. Muylle,

et al, 2004). In one study, the researchers noted the enormous possible contribution to electronic commerce in business performance and try to examine the essential qualities and characteristics related to the success of marketing aspects of the online store (Talal Maghrabi (2010)).

According to a report of euro-monitor, Internet is rising fast in the nation; presently stands at 60%, many retailers have searched to improve the online shopping experience for customers. It reviles that the customers of KSA, in particular, great earnings keen to expend through electronic deal. However, level of assurance in making online expenditures properly established. In practice experience for the consumers and the demographic characteristics also contributes the consumption. Satisfaction and allegiance significant in number the inhabitants, and improvement of the education, and increase the expectations and the civilization the rural areas in the countries be possible that the effective purchase plays two decisive roles of consumer behavior. (Berry, L.L. and Seiders, K. et al; (2002)

On the other side he the agreement is the evident worker's main discouragement consumed who the electronic commerce use, to the extent that the electronic commerce differ as per culture and value customer. (Asianzu, E&Maiga, G., 2012). Although the complexity and special and the agreement it the main workers which use on all electronic services perceived on, and the direction for the consumer, it is known that two other elements to forms essential: Nature for the Internet and the connected uses through the use of the electronic services. The electronic shopping accordingly workers perceived the confidence satisfaction and allegiance (Srinivansan, Anderson 2002)

Furthermore, the one results of the study showed that the Kingdom of Saudi Arabia in the late adopters of online shopping compared to developed countries. For some reason, and encourage consumers to shop online. The main thing is to save time, and (the price) and the best comfort. The second category of reasons for this: There is a wide range of products and services that are not available in the local market. The third category of grounds were for more options and easy to get on a comparison with a single click between different products. The study concludes that there are some goods and services to be online deal who book hotels and airline tickets, electronic equipment shopping (Delafrouz, et al, 2010).

One study showed an upper number of the Internet costs is happening in the music download sites, with 64% of respondents in Saudi Arabia prefer to buy music online instead of traditional outlets. Other broad categories include computer programs (57%), airlines tickets (50%) and products/services online gaming in a virtual world (48%). It is encouraging that the positive trends in online and mobile phone shopping in the Kingdom of Saudi Arabia. More consumers are going online to buy the technology related products, as well as day to day items and lifestyle product buying. MasterCard's' Research shows that today's tech-savvy shoppers are becoming more aware of the various online shopping options and becoming more pronounced in their decisions (Eid, Talal Maghrabi, 2010; Sandhu K S (2010). He also stressed the importance of factors also affect the success of online shopping quality assurance system, information quality, and punctual delivery, sales, and services. Also, A research study indicates the behavior of electronic purchasing practices recent years, which identify factors that influence the buying decisions of purchasing online (Sait, SM, at el; 2004; Pannavolu, K., (2002). Given the attributes shop online and is important in the online shop online design greatly influenced select settings and made the purchase and resale purchase decision processes. Be the use of the Internet in recent times is no longer limited to the media networks, but also expands treatment for consumer use in the global market (Delafrouz, et al, 2010).

In extension, customers have the flexibility, and the widest range of products; they can access a variety of information from different sources, compare prices and buy with their comfort, generate more openings intended for alteration of numerous supplier's and retailers to enter in the market. Consequently, it is through customer to shop online access to a wide range of products easily without customers' time and space limits (Brynjolfsson and Smith, 2000; Kushchu & Kuscu, 2004). It presents challenges customers to keep online retailers and to win. To achieve it is important for online retailers to understand, not only to

encourage consumers to buy online but also the factors that lead to the electronic purchases make them loyal (Alam M. Z. and S. Aasi, 2016).

For this purpose, it is suggested that e-commerce enhance the experience continue business correspondence work requires a significant impact on the organizations. E-business and buyer loyalty in Kingdom of Saudi Arabia strongly to customer satisfaction, but a lower demand from the trust of clients (Eid, M., 2011; Sandhu K S, 2010). As the consumer, uses of the shopping across the Internet, including the safety and the security and the comfort the treatments across the Internet, is an increase of occurrence expect consumed on the sites online for the purchase. Use of the devices witnessed the carried to making operations of the acquisition across the gradual Internet increase with nearly one of between all three individuals the samples point out to that them.

5.1. Research Gap:

Although, the abundance of investigation was done in this area but here is an ample space to define and analyze the strategy of electronic commerce that will generate the superior values for marketers to accomplish their marketing goals. Access to products and services worth more than that for the shopper, this is constantly advisable to sellers that they should understood the need of purchaser. Thus, existing study is an effort to achieve it. In addition to the contribution focuses about client's awareness for online purchasing. It is expected that this report will help for various economic aspects of online shopping to determine their business to expand. It is also useful to determine the criteria that marketers prefer online marketing from the traditional way of marketing.

6. RESEARCH METHODOLOGY:

The present study is to measure the e-commerce motivational factors and to identify the strategy for the promotion of e-business in the region. A convenience study has been carried off 128 consumers using electronic tools and personally (in Jeddah City, KSA) for the period of three months from September to November 2015. The close-ended survey was employed for the research. Particular attention has been practiced to overcome the non-response flow and the mistake appearing to this. Following this collected data were personally edited, coded and then summarized on excel file. Furthermore, the data were examined with proper statistics and outcome were discussed accordingly "*Alam M. Z. and S. Aasi, 2016*".

7. FINDINGS/ DISCUSSION:

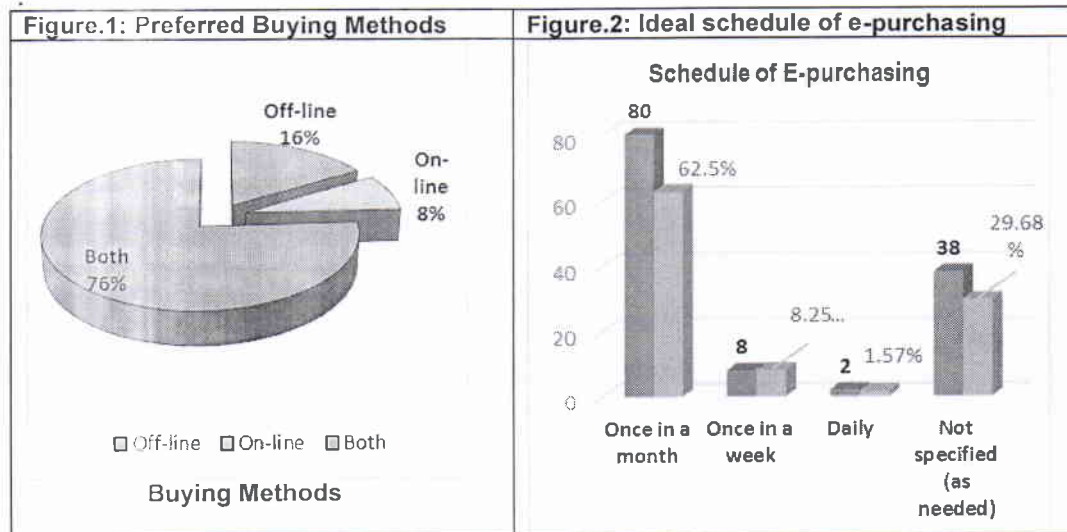
7.1. Demographic information:

Table1. Demographic information of respondents:			
Variables		Frequency	Percentage (%)
Gender	Male.	63	49
	Female.	65	51
	Less than 20.	12	9
Age	20 - 30	95	74
	30 – 40.	10	8
	40 and above.	11	9
Family Monthly Income	Less than 10,000 S.R.	106	83
	10,000 – 15,000 S.R.	7	5
	15,000 – 20,000 S.R.	5	4
	20,000 – 25,000 S.R.	4	3
	25,000 and above.	6	5
Profession	Student.	79	62
	Privet Sector worker.	21	16
	Governmental employee.	10	8
	Unemployed/ house wife.	13	10
	Business Man/Women.	5	4
Education level	Less than high school	6	5
	High School.	22	17
	Under graduate.	85	67
	Post-graduate and more	15	11
Total		128	100

The respondents were classified on the grounds demographic representatives such as sex, age, monthly income, education, and profession. The table.1, show that male and female are nearly uniformly interpreting the unit i.e. around 50% of both genders. We also obtain that 74% of the respondents remain below the age groups of 20-30 years.

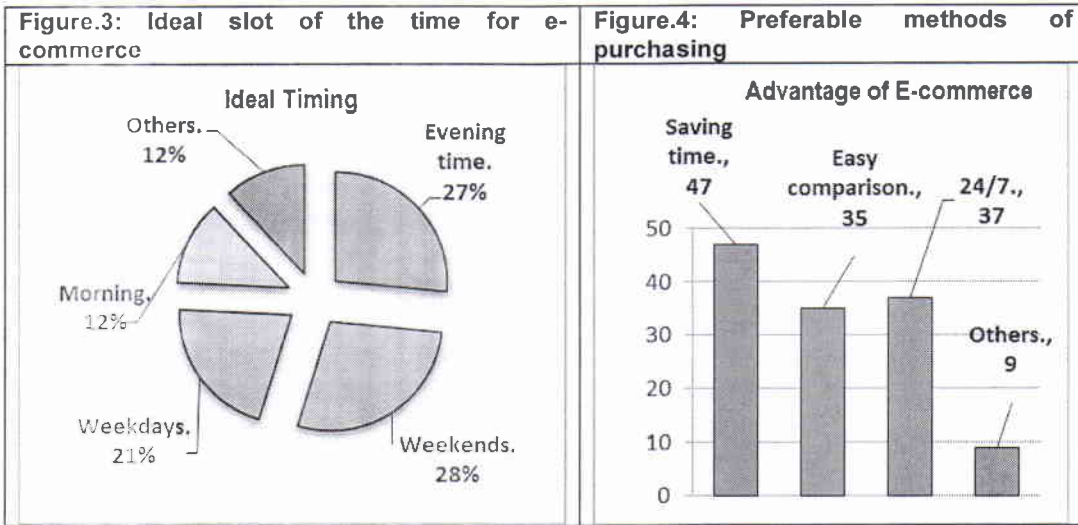
This age limit broadly matches the characterization of the youthful Saudi society. The range is extremely involved in the electronic commerce also. 83% of consumers have obtained their regular income within the group of less than 10,000/- SR., And profession wise adulthood were students (62%) continued by personally employed 16%, Government employee 8%, 4% businessmen/ businesswomen and unemployed/ housewife were 10% of the total unit size.

Further, the above table also showed that bulk of the customers having undergraduate degree i.e. 67% followed by high school 17%, postgraduate & more are 11% "Alam M. Z. and S. Aasi, 2016".



From the figure.1, it can be concluded that majority of respondents preferred classical and e-buying methods 76% followed by offline (16%) and online (8%). This result indicates that customer not only inclined only with e-purchasing but they mostly prefer to take the experience of both buying methods. It is depending on the types of goods and services they buying. Consumer/ shopping products and other services (like tickets, banking services etc.) are more acceptable through e-commerce.

Besides, majority of buyers was usually buying through online once in a month consequently not having specific schedule to e-purchasing, once in a week and daily involvement for buying had very insignificant response among the buyer. It is advising that marketers should give their promotion, additional opportunity to see their commercial on a monthly basis and normal regular pattern of communication will help to approach and attract to the consumer to be involved with e-marketing.



Regarding the ideal slot of the time for e-commerce experience, the majority of them agreed that the ideal and excellent time for involvement to do purchase were weekends (28%) followed by evening hours (27%) and weekdays (21%) respectively (Figure.3). Therefore, it is recommended to the e-traders that they should be aware of timing of rush hour and days so they can manage their websites and server speed of this slot properly and carefully so the consumer can shop easily without disrupting of the network failure. Besides of this, it was also analyzed that consumer chose e-shopping because it has many advantages to them.

Among the given choices, time saving (36.72%) was the major benefited factor with e-marketing experience followed by 24 hours/ seven days in a week services (28.91%), and product comparison (27.34%) were the major motivating factors to lure with it (Figure.4). From the result, it is assumed that e-commerce not only will be the attraction point to the e-traders but it will also help to the physical retailers to show their products and give the chance to know the consumer about their products through electronic commerce, and this will give the traders an age for their business.

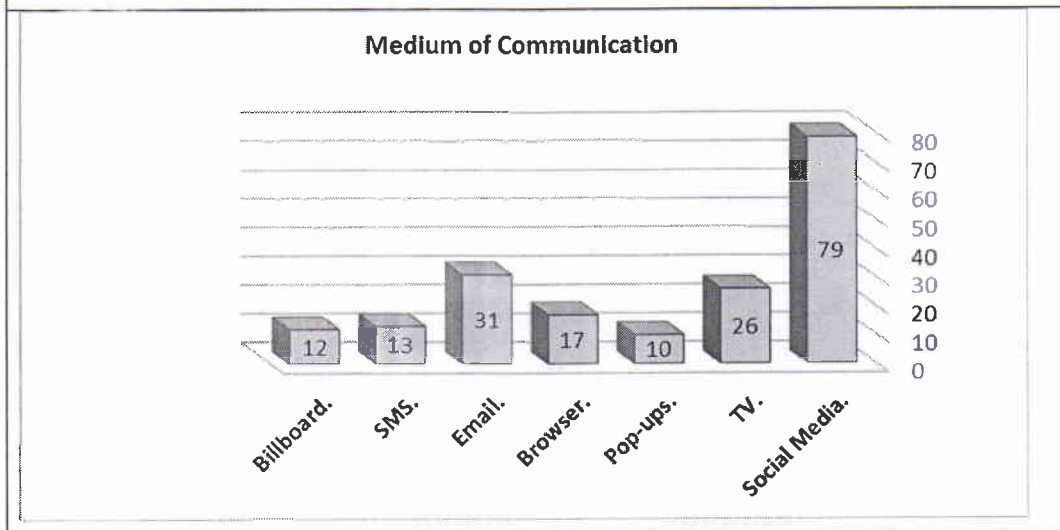
From the figure.5; it was noted that discounts (38.58%) were the most favored determinants for the consumer to lure and attract for e-shopping. After this free shipping (25.38%), other promotional offers (20.81%), coupons (9.14%) and warranty & guaranty (6.09%) with the product were the famous attraction and motivational factors for buying online respectively (See the figure.5).

In conclusion, to attract the shopper, E-traders must provide time to time financial, convenience and value-based incentive to consumers as this will give the many advantages to a trader, and by this way, they can manage better market share in their field of business.

Figure.5: Preferable promotional factors (cyber baits) that attract e-shopping

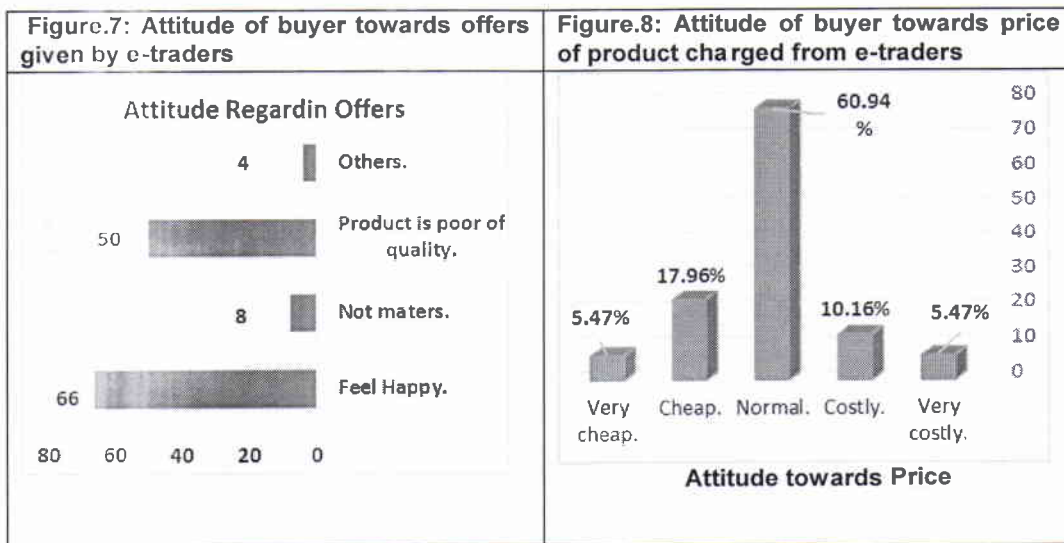


Figure.6: Preferable medium to promote e-business by the people



It can be shown from the Figure 6, that the most preferred medium of communication to promote the products were social media (48.89%), followed by emails communication (18.78%), television commercial (12.12%) and SMS/ billboard communication (7.5% each) preferred consecutively by the respondents.

Among that medium of communications, social media having a high significant impact on consumer mind as tools of communication, then emails and T.V commercial are preferable channels for them. Therefore, it is advised that to keep aware and make a better brand image of product promotion through social media will give an excellent opportunity to the marketer.



When the respondents were asked to provide their viewpoint towards their feelings on promotional offers provided by marketers, in this regard majority of them explained that they feel happy (51.56%) when they see the promotional offers for the products needed. However, a second majority of the respondent stated that it might appear the quality of the product poor (39.06%), especially when they see the offers every time with the same goods and services (Figure.7).

This result is an eye opener for the marketer. Moreover, it has been proposed that they should give the promotional offer for the products, which have high competition. Furthermore, it can be suggested that they should not give offer continuous for any brand that reveals the negative impact of product quality in consumer faith, and give discontinuous promotional offers when needed that show customers feel happy and give the quality of product image better.

At last from the Figure 8, it was revealed that consumer was satisfied with price charged by e-marketers, 60.94% of respondents felt neutral about pricing of product charged by e-shopping followed by 17.96% felt cheaper than classical shop, and very insignificant percentage (10.16%) of respondents affirmed that it was expensive. The result had an excellent image in customer perception about price imposed by e-traders; therefore, it is recommended that marketers should maintain this image and if they need to improve the quality of the product for that situation they have the room to increase product price relatively.

8. CONCLUSION AND RECOMMENDATIONS:

In conclusion, it can be inferred that the Saudi Arabia e-commerce is growing fast and having a great impact on e trading. With the rapid growth of e-commerce as many present vendors marketing their commodities or services within electronically, by this way they enhance the powerful medium to extend their business regionally and internationally.

Furthermore, this research finds the people are more familiar with buying methods so, most people buy from both online and offline, and they are around 97 (76%) of responders. Besides, who like online shopping have a real educational background, good income, educated so; they are familiar with the new technology. In addition, Consumer goods, shopping products, and other services (like tickets, banking services, etc.) are more acceptable through e-commerce by consumers. Besides this, the majority of

buyers usually buy through online once in a month consequently not having the specific schedule to e purchasing. So it is advised that marketers should give their promotion, additional opportunity to see their commercial on a monthly basis and standard regular pattern of communication will help to approach and attract to the consumer to be involved with e-marketing. Furthermore, the ideal slot of the time for e-commerce purchasing experience is weekends, followed by evening hours. Therefore, it is recommended to the e-traders that they should proper notice of timing of rush hour and days so they can manage their websites and server speed of this slot carefully so the consumer can shop with ease without disrupting of the network failure.

Besides, the study reveals that consumer chose e shopping because it has many advantages to them. Among the choices, timesaving, 24 hours/ seven days in week services and product comparison are the primary motivating factors to lure with it. From the result, it is believed that e-commerce will not be only the attraction point to the e-traders but it will also help to the physical retailers to show their products and give the chance to inform about their products through electronic commerce, and this will give the traders an age for their business.

It is noted that discounts are the most favored determinants for the consumer to lure and attract for e-shopping followed by free shipping, and other promotional offers, are the famous attraction and motivational factors for buying online respectively. It is recommended to e-traders that to attract the shopper, they must provide time-to-time financial, convenience and value-based incentive to consumers as this will give the many advantages to a trader, and by this way, they can manage better market share in their field of business.

Moreover, the most preferred medium of communication to promote the products are social media, followed by emails communication, television commercial and SMS by the consumer. Therefore, it is advised that to keep aware and make a better brand image of product promotion through social media will give an excellent opportunity to the marketer. Furthermore, when the respondents were asked to provide their viewpoint towards their feelings on promotional offers provided by marketers, the majority of them explained that they feel happy when they see the promotional offers for the products needed. However, a second majority of the respondent stated that it might appear the quality of the product not good, especially when they see the offers every time with the same goods and services. This result is an eye opener for the marketer.

Moreover, it is recommended that they should give the promotional offer for the products, which have high competition. It can also be suggested that they should not give offer continuous for any brand that reveals the negative impact of product quality in consumer faith, it is better to give discontinuous promotional offers when needed that will show customers feel happy and will give the product quality image better.

In the end, it is reported that majority of the consumers remain satisfied with the price charged by e-marketers, and very insignificant percentage of respondents affirmed that it is expensive. This indication has an excellent image in customer perception about price imposed by e-traders; therefore, it is recommended that marketers should maintain this image and if they need to improve the quality of the product for that situation, they have the room to increase product price proportionately.

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Organizational culture and job satisfaction: a study Of organized retail sector

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Key Words

Organized Retail Sector, Organizational Culture, Autonomy, Trust, Pro-Action, Job Satisfaction

Abstract

Organizational culture has been characterized as the “glue that holds organizations together”. Culture can support linkages between technology adoption and organizational growth; it can be a critical success factor in organization growth strategy and play a crucial role in determining the success or failure of organization. The term ‘job satisfaction’ is quite frequently used for individual attitudes towards the specific aspects of total work situation. The purpose of the study was to examine the level of Job Satisfaction and Organization Culture in organized retail sector. To examine the relationship between Organizational Culture and Job Satisfaction and to offer suitable suggestions to stake holders for improving the Job Satisfaction and make better Organizational Culture in retail sector. The present study was conducted on 436 employees of organized retail sectors randomly drawn using questionnaire method. The results obtained indicates that the employees were experiencing moderate level of OCTAPACE culture and also moderate level of job satisfaction and dominant culture components includes Openness and Risk taking, Confrontation, Pro-action, Collaboration and Experimentation. It was further explored and found that there is significant positive correlation exists between organizational culture and job satisfaction.

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1. Introduction

Organizational culture has been characterized as the “glue that holds organizations together”. Culture can support linkages between technology adoption and organizational growth; it can be a critical success factor in organization growth strategy and play a crucial role in determining the success or failure of organization. On a more micro level, researchers have found significant relationships between the “fit” of employees and the prevailing organizational culture and a number of important outcomes such as job commitment and turnover. There are many unanswered questions remain regarding the meaning and content of organizational culture, the methods by which it should be measured and, more fundamentally, the feasibility of cultural management and change, especially when attempting to operationalize specific organizational goals. While debates around these issues continue, culture has been accepted as a “fact of organizational life” by managers and has become an integral aspect of many organizational development programs. Culture is a communication process for creating, sending, storing and processing information that is viewed from three perspectives:

words, material things and behavior (Rothwell et al 1995). The OCTAPACE culture is characterized by the occurrence of openness, confrontation, trust, authenticity, pro-activity, autonomy, collaboration and experimentation, it deals with the extent to which these values are promoted in the organization. (Pareek & Rao 1988).

Openness & Risk Taking: Employees feel free to express their ideas and the organization is willing to take risks and to experiment with new ideas and new ways of doing things.

Confrontation: Employees face the problems and work jointly with others concerned to find its solution. They face the issues openly without hiding them or avoiding them for fear of hurting each other.

Trust: The employees department and groups trust each other and can be relied upon to 'do' whatever they say they will do.

Authenticity: Authenticity is the value underlying trust. It is the willingness of a person to acknowledge the feelings he/she has, and to accept him/her as well as others who relate to him/her as persons.

Pro-action: Employees are action - oriented, willing to take initiative and to show a high degree of pro-activity. They anticipate the issues and act or respond to the needs of the future.

Autonomy: Autonomy is the willingness to use power without fear, and helping others to do the same. Employees have some freedom to act independently within the boundaries imposed by their role/job.

Collaboration: Collaboration involves working together and using one another's strength for a common cause. Individuals, instead of solving their problems by themselves, share their concerns with one another and prepare strategies, work out plans of action, and implement them together.

Experimentation: Experimentation as a value emphasizes the importance given to innovation and trying out new ways of dealing with the problems in the organization.

Bullock (2003) described that the job satisfaction as "an attitude which result from balancing and summation of many specific likes and dislikes experienced in connection with the job". Peptone (1999) defined job satisfaction as summation of employees feelings in four important areas namely, job, management, personal adjustment and social relations. Hop Pock (1996) defined employee satisfaction as any combination of psychological, physiological and environmental circumstances that causes the person truthfully to say I am satisfied with my job.

The term 'job satisfaction' is quite frequently used for individual attitudes towards the specific aspects of total work situation. Since the time when the occupation of individuals became a socially significant phenomenon, social scientists focused their attention on the problem of job satisfaction. Inputs affect the outputs via employees' ability and motivation. Job satisfaction is an important aspect for any organizations. Many employers or superiors do not hesitate to know whether or not their employees or subordinates are satisfied with their jobs. Generally, there are four factors that influence the degree of job satisfaction, namely personality, values, work situation and social influence. A research by Karim (2008) reported six variables that significantly correlate with job satisfaction -affective commitment, job autonomy, job performance feedback, role conflict, role clarity and organizational tenure. The research also found that out of these six variables, only two have predictive relationship with job satisfaction: affective commitment and organizational tenure.

2. Review of literature

Nazneen et al (2014) conducted a study on 350 employees-218males & 132 Females drawn randomly from different retail organizations and result shows that the most dominant components of culture in organized retail sector is Confrontation, openness, experimentation and proactively. It is observed from the study that if we create a good culture for the employees, retail would be the best found destination for new graduates and even for the existing employees.

Saleh (2012) analyzed 62 employees of retail organizations in Malaysia to study level of the job satisfaction, organizational commitment, and turnover intention of employees. The findings suggested that the respondents were moderately satisfied with job satisfaction facets such as promotion, work itself, co-workers, and supervisors but were dissatisfied with salary. They also had moderate commitment level with considerably high intention to leave the organization.

Sabri et al (2011) conducted a research on 347 teachers to determine the effect of organizational culture on job satisfaction level of teachers of public and private sector higher education institutes and universities of Lahore which is second largest city of Pakistan and a hub of higher education. Supportive organizational culture may raise the level of job satisfaction of teachers and satisfied teachers may produce healthy, satisfied and creative minds. Empirical findings show that organizational culture is categorized into two components i.e. organizational culture related to managers and leaders (OCM) and organizational culture related to employees (OCE). In this study effect of both kinds of culture on job satisfaction is positive and significant

Tsai (2011) studied 200 hospital nurses in Taiwan to found out Job satisfaction, organization Culture and leadership behavior among them. He found that there is positive significant relationship between organization culture and job satisfaction. He further found that job satisfaction level among nurses is high and they endorse the culture as positive. Shah (2011) studied 215 faculty members to examine whether organizational culture affects the employee's job satisfaction of university faculty in Public Sector of Pakistan. Result indicated that organizational culture was negatively related to employees' job satisfaction. Thus, the study recommended that the efficiency of the faculty members of public sector universities in Pakistan need to be improved.

Bake and Nalla (2009) studied the relationship between organizational culture and job satisfaction among police officers working in various cities in two Midwestern states in United States. Data for the study was gathered from 669 respondents in five medium and large sized police organizations in two adjacent Midwestern States. More specifically, police officers' (supervisors and non-supervisors) perceptions about organizational factors of job satisfaction was examined and suggested that organizational characteristics are better predictors of job satisfaction than individual factors. Askari (2011) conducted a study to find any relationship between organizational culture and job stress of personnel in government departments at Ferozabad city and found that there is a meaningful and negative relationship between organizational culture and job stress and organizational culture is different between men and women.

Nazneen & Bhalla (2013) conducted a study on 218 male employees and 132 female employees of organized retail sectors and found that the employees of organized retail sectors having moderate level of job satisfaction. They also found that male and female both are showing same level of job satisfaction. They also found negative correlation with the entire dimension of organizational role stress and job satisfaction. Nazneen and Sayeed (2012) conducted a study on 215 faculty members of UP and Punjab and found that faculty members of Punjab are showing low level of job satisfaction than their UP counterparts. Singh & Dubey (2011) found that job satisfaction was negatively correlated with all the dimensions of organizational role stress among middle level executive. Organizational stress and organizational culture were also found to be negatively correlated among middle level executives and male and female staff of retail. Sector. Askari (2011) conducted a study to find any relationship between organizational culture and job stress of personnel in government departments at Ferozabad city and found that there is a meaningful and negative relationship between organizational culture and job satisfaction.

Muzainah et al (2010) found that determining a culture which is appropriate for all organizations is an impossible task because characteristics of organization, its external environment and situational constraints dictate different values, beliefs and behaviors within tax administrations of Malaysia and other developing countries. Pool (1999) studied the organizational role stressors and its impact on job performance in predicting outcome and results indicate that a constructive culture

will significantly reduce impact of role stress and thereby decreasing job stress, increasing job satisfaction and job commitment.

2.1 Hypothesis

We have not formulated any null or alternate hypothesis rather make our research exploratory in nature with following Objectives.....

- 1.) To examine the level of Job Satisfaction and Organization Culture in organized retail sector.
- 2.) To examine the relationship between Organizational Culture and Job Satisfaction.
- 3.) To offer suitable suggestions to stake holders for improving the Job Satisfaction and make better Organizational Culture in retail sector.

3. Research methodology

3.1 Sample

Employees working in the organized retail sectors with more than two years were taken as Sample and purposive random sampling technique were used to collect the data. Around 500 employees of various retail organizations were contacted in different cities of India and finally 463 employees of various designations, sex, and experience were used as sample.

3.2 Procedure

Retail employees from various designation level of different organized retail organizations located in various cities of India like Walmart India, Future Retail, Shoppers Stop, Reliance Retails and Spencer's were selected as a sample keeping in mind the availability of the data, cost and distance for the data collection. Only employees with more than two years of experiences were taken in to consideration. The data were collected using survey method. Each of the respondents was personally contacted in group by the investigator and the data was collected through questionnaire. They were asked to fill the questionnaire after going through carefully the given instructions on each scale separately. They were also assured of confidentiality of their responses.

3.3 Tools used

Job Satisfaction Scale: Scale on Job Satisfaction developed by Singh (1989) was used in the study. This questionnaire consists of 20 items that measures the degree of job satisfaction. Each item was rated on five point rating scale ranging from highly satisfied to highly dissatisfied with a weighted score of 5 to 1, the total score of an individual varies from 20-100.

Organizational Culture: Pareek and Rao (1983) developed OCTAPACE profile consisting of 40 items instrument that gives the profile of organizational ethos in 8 values, were used in the study. The total value of an individual will vary between 40 - 200. The reliability and validity of all scales are well within acceptable norms.

3.4 analysis of the data

The collected data were tabulated as per the research design to meet out the objectives of the study and suitable statistical tools like Mean, Median, S.D., Correlation, ANOVA and Critical ration (t-Value) were calculated using SPSS.

4. Result and discussion

Table 1: Showing Mean and SD Values on the Dimensions of Organizational Culture and Job Satisfaction (N = 463).

Components	Mean value	S.D.
Openness and Risk Taking	13.05	1.95
Confrontation	12.97	1.89
Trust	12.27	1.90
Authenticity	12.24	2.19
Pro -Action	12.78	2.82
Autonomy	12.53	2.08
Collaboration	12.99	2.34

Experimentation	12.84	2.19
Organization Culture	101.66	9.36
Job Satisfaction	61.08	14.15

It can be seen from the Table that OCTAPACE Culture in Organized retail sector of India were found to be at Moderate level and also the employees of organized retail sectors were shown moderate level of Job satisfaction. If we analyze further we can see that on the dimensions of Openness and Risk Taking means employees feels free to express their ideas and the organization is willing to take risks and to experiment new ideas and ways of doing, found to be at moderate level. Collaboration means working together as team and using strength of one another and sharing the problem and concerns with each other and making strategies to resolve those problems and issues together again found at moderate level. Confrontation means employees face the problems and work jointly irrespective of the task and without hurting the feelings and ego of each other and also allowed by the top managers to put their ideas and feelings without any fear also found at moderate level. Experimentation were also found to be at moderate level means there is no much importance given to innovation and trying out new ways in dealing with the problems. Pro-action means the employees are action oriented and willing to take initiatives and anticipate the act or response which may need in future were also found at moderate level.

It was further found that the employees of organized retail sector feels Culture of Trust, Authenticity and Autonomy very poor or at low level. It means the employees, departments and group does not relying and trusting each other while doing any assigned task of the organization and at the same time it was also found that the element of authenticity were also found to be very poor means it is a value underlying trust and it is the willingness of the employees to acknowledge the feelings he or she has and to accept him or her as well as others who relate to him as person in other words we can say that trust whatever we are showing is not authenticated and since there is no elements of Trust operating in this case there is no point of having authenticity culture. The culture of Autonomy were also found to be very low in organized retail sectors here the Autonomy is related with the willingness of the employees to use their power without fear and help others to do the same, in other words employees has given full freedom to their job effectively no boundaries has been imposed on them. This factor is very crucial in retail sector because if employees don't have the freedom or autonomy at work they will not be able to generate and implement new ideas which are needed for the success of retail sectors.

Job satisfaction of the employees of the organized retail sector was found as moderately satisfied and this may be attributed to moderate level of organizational culture.

Table 2: Showing Mean and CR Values of Male and Female Staff on the Dimensions of Organizational Culture and Job Satisfaction

Components	Mean- Male (N-299)	SD- Male (N-299)	Mean- FE (N-164)	SD- Male (N-164)	CR Value
Openness and Risk Taking	13.10	1.97	12.96	1.92	0.738
Confrontation	13.02	1.87	12.87	1.93	0.786
Trust	12.11	1.94	12.55	1.80	2.38**
Authenticity	12.22	2.16	12.27	2.26	0.267
Pro -Action	12.91	2.81	12.52	2.82	1.422
Autonomy	12.33	2.06	12.88	2.08	2.708**
Collaboration	13.04	2.49	12.91	2.04	0.563
Experimentation	12.84	2.13	12.85	2.31	0.067
Organization Culture	101.57	9.60	101.82	8.91	0.276
Job Satisfaction	61.08	14.15	60.68	13.87	0.298

** : Significant at .05 level of significance

It is clear from the Table that Male and Female staff of organized retail sector is experiencing moderate level of Organizational Culture. It is also observed that among Male staff the dominant culture components are Openness and Risk taking, Confrontation, Collaboration and Pro-action while in the case of Female staff the dominant components are Openness and Risk taking, Confrontation, Autonomy and Experimentation. The significant difference of mean were observed on the dimensions of trust and Autonomy between Male and Female staff and it can be seen that in both the cases Female staff are experiencing more Trust and Autonomy in the organization means female staff are trusting and relying each other in individual as well group capacity and willing to do whatever is needed for each other without considering any doubt on the integrity of the co workers. Surprisingly Female staff were shown higher level of Autonomy than Male counter parts and they using they power and authority in more effective way without having any constraint on utilizing those given powers and also not having any constraint in term of utilizing their power and position but the fact is it is only moderate level not at the higher side in both Trust as well as Autonomy components.

No significant difference of means was found on the dimensions of job satisfaction and both male and female employees of organized retail sectors are showing moderate level of job satisfaction.

Table 3: Showing Mean and CR Values of Managerial and Non Managerial Staff on the Dimensions of Organizational Culture and Job Satisfaction

Components	Mean-manual (n-160)	SD-manual (n-160)	Mean- non manual (n-188)	SD- non-manual (n-188)	CR value
Openness and Risk Taking	12.87	1.84	13.01	1.99	0.68
Confrontation	12.82	1.88	12.81	1.84	0.049
Trust	12.03	1.92	12.11	1.84	0.394
Authenticity	12.29	2.29	12.22	2.17	0.291
Pro -Action	12.32	2.89	12.74	2.70	1.392
Autonomy	12.56	2.03	12.59	2.11	0.134
Collaboration	12.71	2.35	13.14	2.25	1.734
Experimentation	12.54	2.06	13.03	2.31	2.091**
Organization Culture	100.14	10.25	101.64	8.13	1.633
Job Satisfaction	56.92	13.81	61.16	13.49	2.884**

** : Significant at .05 level of significance

As shown in the table that managerial and non managerial employees of the organized retails sectors were experiencing moderate level of organizational culture and no significant differences on organizational culture and their dimensions other than experimentation were found significant. Non managerial employees having greater experimentation than their counterparts mean they were given freedom to innovate new ideas and trying out new methods and techniques in resolving any issues or doing their normal routine work. While on the dimension of job satisfaction it was observed that both managerial and non managerial employees were having moderate level of job satisfaction. And a significant difference of mean was found between managerial and non managerial staff and non managerial employees were shown high level of job satisfaction than their counterparts.

Table 4: Showing Mean and CR Values of High and Low Experience Staff on the Dimensions of Organizational Culture and Job Satisfaction

components	mean high expr (n-133)	SD- high expr (n-133)	mean- low expr (n-330)	SD- low expr (n-330)	CR- value
Openness and Risk Taking	13.69	1.67	12.80	2.01	4.55*
Confrontation	13.53	1.76	12.74	1.90	4.11*

Trust	13.31	1.61	11.85	1.84	7.98*
Authenticity	12.17	2.14	12.27	2.21	0.449
Pro -Action	14.41	2.81	12.12	2.54	8.497*
Autonomy	12.35	1.64	12.60	2.22	1.190
Collaboration	13.02	2.59	12.98	2.23	0.138
Experimentation	13.32	1.64	12.65	2.35	3.011
Organization Culture	105.78	9.27	100.01	9.27	6.26*
Job Satisfaction	61.47	17.27	60.72	12.52	0.519

*: Significant at .01 level of significance

It is evident from the above Table that high experienced employees of organized retail sectors were experiencing moderately high level of organizational culture than the low experience employees who feel moderately low level of organizational culture supported the findings of Sayeed and Bhalla (2013). Significant difference of Mean was observed on the dimensions of Openness and Risk Taking, Confrontation, Trust, Pro-Action and total organizational culture. And in all the cases the high experienced employees are experiencing high level of Openness and Risk taking, Confrontation, Trust and Pro-action it means as the time passes in the organization employees feel comfortable and act and perceives the things accordingly. No significance of differences between means were found on the dimension of Authenticity, Autonomy, Collaboration and Experimentation dimension of organizational culture in spite of the fact that there is significant differences of means between high and low experience employees on total organizational culture. No significant of differences between means were observed on Job satisfaction between high and low experienced employees and the satisfaction level were found to be moderate.

Table 5: Showing Correlation between Organizational Culture and Job Satisfaction among Retail Employees (N 463).

OC	O	C	T	A	P	A	C	E	OCT
JS	.323*	.233*	.368*	.248*	.435*	.272*	.420*	.205*	.471*

*: Significant at .01 level of significance

It is evident from the above Table that all the eight dimension of organizational Culture are significantly (significant at .01 level of significance) and positively correlated with Job satisfaction. It means if we improve the level of perceived organizational culture the job satisfaction level of the employees will also go up and if the perceived organizational culture were found to be low it is expected that job satisfaction level of the employees will also be low. Here in this case both Organizational culture and job satisfaction were perceived as Moderate supporting the study of Bhalla and Nazneen (2014).

Table 5: ANOVA analysis in terms of their designation for the scores on the dimension of Organizational Culture and job satisfaction.

Components	Senior Level		Middle Level		Non Managerial		F - Test	p value
	MEAN N-160	SD	MEAN N-115	SD	MEAN N-188	SD		
Openness	12.87	1.843	13.01	1.996	13.39	2.007	2.508	0.083
Confrontation	12.83	1.879	12.81	1.843	13.42	1.942	4.423*	0.013
Trust	12.03	1.924	12.11	1.845	12.84	1.852	7.347*	0.001
Authenticity	12.29	2.286	12.22	2.172	12.20	2.112	0.066	0.937
Pro -action	12.32	2.889	12.74	2.703	13.46	2.786	5.576*	0.004
Autonomous	12.56	2.033	12.59	2.111	12.37	2.105	0.421	0.657
Collaboration	12.71	2.349	13.14	2.254	13.15	2.450	1.820	0.163

Experimentation	12.54	2.065	13.03	2.309	12.97	2.138	2.435	0.089
Organization Culture	100.14	10.24	101.64	8.130	103.81	9.596	5.227*	0.006
Job satisfaction	56.92	13.81	61.16	13.494	66.17	13.543	15.491*	0.000

*: Significant at .01 level of significance

ANOVA analysis was conducted for the significant difference between the scores on the dimensions of the organizational culture and job satisfaction among the employees of the retail sector categorized on the basis of their designation.

For the dimension *openness, authenticity, autonomous, collaboration* and *experimentation* as p values obtained were all greater than 0.05. This signifies that there was no significant difference between the employees categorized on basis of their designation, scores on the all dimension discussed above. For the dimension *confrontation* as $t = 4.423$, $p < 0.05$. This signifies that senior and middle level employees score i.e. 12.83 and 12.81 respectively was significantly lower than the scores of the sales representatives i.e. 13.42.

For the dimension *trust* as $t = 7.347$, $p < 0.05$. This signifies that senior and middle level employees score i.e. 12.03 and 12.11 respectively was significantly lower than the scores of the sales representatives i.e. 12.84. The dimension *pro-action* as $t = 5.576$, $p < 0.05$. This signifies that senior and middle level employees score i.e. 12.32 and 12.74 respectively was significantly lower than the scores of the sales representatives i.e. 13.46. For the *Organization Culture* as $t = 5.227$, $p < 0.05$. This signifies that senior and middle level employees score i.e. 100.14 and 101.64 respectively was significantly lower than the scores of the sales representatives i.e. 103.81. For the *Job Satisfactions* $t = 15.491$, $p < 0.05$. This signifies that senior and middle level employees score i.e. 56.92 and 61.16 respectively was significantly lower than the scores of the sales representatives i.e. 66.17.

5. Conclusions

It can be concluded on the basis of above result and discussions that employees of the organized retail sectors are experiencing moderate level of organizational culture and job satisfaction. The dominant OCTAPACE culture dimensions includes Openness and Risk Taking, Confrontation, Pro-action, Collaboration and Experimentation. No significant differences were found between Male and Female employees and both the genders are experiencing moderate level of organizational culture and job satisfaction. The significant difference were observed on the dimensions of job satisfaction between managerial and non managerial employees and non managerial employees are more satisfied than the managerial employees and no difference were found on the dimensions of organizational culture in the same case. It was further found that high experience employees are experiencing high level of organizational culture than low experience employees but no difference were observed on the dimension of job satisfaction level and both the group were having moderate level of job satisfaction. Significant positive correlation were found among the dimensions of OCTAPACE culture components and job satisfaction means if we improve the organizational culture the level of job satisfaction will also go up among the employees of organized retail sector.

5.1 Suggestions

To improve the organizational culture it is the responsibility of the Leadership to explore the missing OCTAPACE factors and try to use different OD techniques to improve the organizational culture. Job satisfaction level was also found to be moderate and to increase the level of job satisfaction a more elaborative study should be conducted to know the exact reason beside poor or moderate organizational culture and the intervention should be implemented accordingly as it is very important factor to make an employee efficient and organization effective.

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Sojourner Culture Shock: Assessing the Role of Exposure in Intrapersonal Identity Conflict

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Abstract

This research assesses the relationship between intercultural exposure variables—the length of time spent in the United States, the length of previous experience outside Saudi Arabia, the length of time studying English as a second language, and the frequency and nature of interactions with Americans—and intrapersonal identity conflict. To assess this relationship, the researcher conducted a survey of Saudi Arabian students studying in the United States, which collected information on exposure variables, as well as employing Leong and Ward's (2000) Ethno-Cultural Identity Conflict Scale (EICS). A Pearson correlation test was conducted to examine the relationship between the Saudi sojourners' intercultural exposure and their identity conflict scores to conclude that there is not a relationship between exposure and identity conflict.

Keywords: intrapersonal identity conflict, Saudi Arabian students, study abroad, acculturation

1. Introduction

There are a number of factors that determine how one will respond to a foreign culture. According to Furnham and Bochner (1982), there are three conditions that influence the duration and the extent of culture shock: 1) cultural differences, 2) individual differences, and 3) sojourner' experiences. Guirdham (1999) states that an individual's ability to survive culture shock is affected by "knowledge of the culture and its language, stereotypes of and attitudes towards people in the other culture, being able to suspend evaluation of other people's behavior and understanding the self as a cultural being" (p. 272). Ward (1996) claims that cross-cultural adaptation for sojourners is affected by additional factors, including knowledge about the host culture, the length of residence, the amount of interaction with the people from the host culture, previous experiences in a foreign country, and whatever cultural orientation programs exist. Worchell and Mitchell (1972) state that the learning process is directly connected to cultural readjustment.

This research assesses the relationship between intercultural exposure variables—the length of time spent in the United States, the length of previous experience outside Saudi Arabia, the length of time studying English as a second language, and the frequency and nature of interactions with Americans—and intrapersonal identity conflict. The intercultural background variables are hypothesized to impact how one will respond to American culture and thus his or her levels of intrapersonal identity conflict. To assess this relationship, the researcher conducted a survey of Saudi Arabian students studying in the United States, which collected information on length of previous experience abroad and time studying English, and details on prior interactions with Americans, as well as employing Leong and Ward's (2000) Ethno-Cultural Identity Conflict Scale (EICS).

Socialization is a human process (Herrmann, 2007). This study focuses on the exposure factors that are related to socialization as measured by intrapersonal conflict. Understanding this relationship, or even the meaning in the lack of relationship, is both of practical and theoretical significance. Theoretically, this study contributes to the study of international students and acculturation to their host cultures. Practically, the results of this study stand to advance relationships between Saudi Arabians and Americans. Understanding the role of exposure to American culture's relationship to intercultural identity conflict is a step towards identifying the sources of such conflicts through analytical frameworks. Understanding how cultural beliefs and values can hinder cooperative or advance beneficial interaction and to what extent, if any, exposure to the culture is related to acceptance of the culture is particularly important for civilizational fault lines, such as between the United States and Saudi Arabia (Huntington, 1996).

In 1996, Samuel P. Huntington postulated that future conflicts would revolve around civilizational cultural differences. This thesis was supported by the subsequent terrorist attacks of September 11, 2001. The events of this date changed the way that many Americans perceive Arabs and Muslims (Livengood & Stodolska, 2004). Furthermore, Saudi Arabia and Afghanistan were held most culpable for the attacks, which has had calamitous repercussions for relationships between individuals from these countries and Americans. Repercussions include both diplomatic consequences and emotional contempt, including toward Middle Eastern students studying in the United States (Livengood & Stodolska, 2004). This reaction not only impacts how Saudi Arabian students are viewed by Americans, but also how they perceive themselves, which ultimately impacts the ability of Saudi sojourners in the United States to successfully learn and socialize within the host culture. Thus, this study is built on the premise that intrapersonal identity conflicts—those which arise from personal conflict resulting from cultural clashes and the need to find oneself from within the competing demands of cultures—are related to exposure to the competing culture (Erikson, 1950; Leong & Ward, 2000). Within this study, American culture is viewed as the culture that is competing with Saudi Arabian culture for Saudi students studying abroad. Moreover, exposure is treated as a composite of the length of time spent in the United States, the length of previous experience outside Saudi Arabia, the length of time studying English as a second language, and the frequency and nature of interactions with Americans. These variables of exposure are considered to be part of the larger picture of acculturation.

This research employs a quantitative approach to measure participants' exposure to American culture and identity conflict. The study relies on Leong and Ward's EICS and a brief online questionnaire designed by the research to obtain data on exposure and conflict. The Statistical Package for the Social Sciences (SPSS) was used to analyze the data.

Although acculturation, identity conflict, and exposure have been researched in Western contexts, the Arabic and Muslim experience is absent within the literature. To date, there have not been any studies focusing on the intercultural exposure of Saudi sojourners or that relate exposure to identity conflict. There is a call in the literature (c.f., Leong & Ward, 2000; Ward, Stuart, & Kus, 2011) to use direct measures, such as the EICS, to examine the intrapersonal identity conflict among the Saudi student sojourners in the United States.

2. Literature Review

Identity conflict is of interests as it can hinder positive interactions among individuals, particularly those of different cultures (Slocum-Bradley, 2008). Individuals of differing cultures often experience challenges in engaging with others for fear of compromising their own culture and beliefs or for the possibility of offending another's culture. Thus, the fear of loss of personal identity can be anxiety-inducing, especially for minorities (Slocum-Bradley, 2008). Identity conflict arises when this fear becomes a mental struggle, causing hyper-awareness of one's own culture, such as language, food, religion, clothing, entertainment, and education. A psychological binary is developed in which either the individual's native or host culture is perceived as negative and the other as positive (Salhi, 2006).

Saudi and American cultures yield an ideal case for assessing identity conflict as the cultures are considerably different. Language, for instance, marks Saudis within the United States as the "other" (Said, 1977). The terrorist attacks of February 26, 1993 and September 11, 2001 have resulted in Arabic and Muslim appearing individuals to be perceived as terrorists (Livengood & Stodolska, 2004). Haas (2012) argues that Saudi sojourners may be viewed as an affront to Americans and, in particular, those speaking in Arabic may be perceived to view their own culture as superior to American culture.

These potential conflicts of acculturation are perceived to be able to be alleviated by cultural acclimation programs, such as orientations for Saudi students in the United States. Saudi sojourners come through the King Abdullah Scholarship Program (KASP). Originating in 2006, KASP has placed thousands of Saudi students abroad. Most of these students, however, have limited or no interaction with individuals of other cultures prior to their participation. This may further exacerbate cultural clashes as the students enter the full immersion of studying abroad (Law & Guo, 2010). This acculturation stress can then lead to identity conflict (Ward & Kennedy, 1999). It is therefore important, as is the emphasis of this study, to understand the factors associated with identity acculturation in order to ameliorate the dissonance caused by identity conflict.

While socialization is part of human nature (Habermas, 2003; Erikson, 1950), individuals often identify and socialize by race, social classes, familial lineages, and other anthropological constructs. Cultures often used these assessments to divide people into in-groups and out-groups (Brewer, 1999). Sojourners often exist as constituents of out-groups, relaying a sense of rejection or cultural tension. It is hypothesized within this research that exposure to American culture increased acceptance of and within the culture and decreases identity conflict.

Acceptance as result of shared membership occurs within a social structure (Tajefel & Turner, 1996). Status inequality, as explained by social identity theory, is the manifestation of in-group bias (Smith, 1991). Greene (1999) extends this concept to sojourner acceptance within host cultures.

As predicted by social identity theory, sojourners traditionally identify with individuals of their native culture more readily than they do with individuals of their host culture. It is human nature to gravitate towards like individuals. This also entails that in the United States, Saudi sojourners are more likely to interact with other Saudis than with Americans. As part of the Saudi sojourner in-group, individuals place emotional value and significance on the culture of this group as an antecedent of social identity (Rubin & Hewstone, 2004).

Acculturation theory can be applied to Saudi sojourner interaction with their American host culture (c.f., O'Guinn & Faber, 1985). Acculturation is the process by which immigrant gradually understand and adapt to their host culture. Lin and Yi (1997) find that Asian sojourners struggle with balancing acculturation and maintaining their host culture. Stereotypes are common obstacles to acculturation (Perna, 2009). Therefore, as previously discussed, the post-September 11, 2001 terrorist attacks stereotypes of Arabs and Muslims may prompt Saudi sojourners to be hyperaware of acculturation and acceptance. In Persons' (1987) three-stage model of acculturation—contact, acculturation, assimilation—individual of different cultures interact with each other to form accommodation needed to avoid intergroup conflict. Thus, Saudi sojourners must be exposed to American culture to prompt the adaptation to American language and social rituals. This is, in turn, theorized to limit the conflict between Saudi and American culture, reducing instances of xenophobia and aggression against Saudi sojourners.

3. Methods

The research question assessed within this study is: "Is there a relationship between the intercultural background variables (the length of time spent in the United States, the length of previous experiences outside Saudi Arabia, the length of time studying English as second language, and the frequency and nature of interactions with Americans) and intrapersonal identity conflict?" A Pearson Product Moment Coefficient of Correlation test was conducted to examine the relationship between the Saudi sojourners' intercultural backgrounds and their identity conflict scores.

The research uses a cross-sectional survey design to collect data on the target population, Saudis studying in the United States, at a single point in time. This design is appropriate for generalizing the results from a sample to the broader population of interest (c.f., Lankshear & Knobel, 2004). Thus, the researcher seeks to form conclusions regarding the relationship between exposure variables and identity conflict in Saudi sojourners and generalize these findings to international sojourners. Data were collected through a survey of Saudi Arabian students studying in the United States. This study was limited to the Saudi students in the United States of America who are involved in the King Abdullah's Scholarship Program and over 18 years old. This inclusion criterion provides a sampling frame of forty-five thousand individuals (Maati, 2011). All eligible individuals received the call for participants through the Saudis in the United States database. Potential participants received the IRB approved invitation explaining the study's purpose, the role of participants, ethical privacy considerations, and information about the researcher. A follow-up email was sent one week after the initial email was sent to encourage participation in the study. Based on the sampling frame of forty to fifty thousand, the appropriate sampling size was determined to be 381. After the first 381 responses were received, the survey was closed to further response. Of these responses, 210 respondents (55%) took the survey to completion.

The survey began with a Demographic Information Sheet (DIS) containing seven items to collect participants' information to extract predictor variables in this study. Those variables are 1) age, 2) sex, 3) location, 4) length of previous overseas experiences, 5) length of studying English as second language, 6) frequency of interaction with Americans, 7) length of time in the United States. Two items within DIS, require the respondents to identify themselves based on sex and location. The remaining five items prompt the respondents to provide continuous, numerical answers to collect data about their intercultural backgrounds and ages. Variables four through seven are the focus of this research.

3.1 Length of Residence

Is the duration for which each Saudi sojourner spends inside the United States. This variable is one of the four variables used to predict the intercultural background of the targeted population. In this study, participants were asked to indicate how long they had been in the United States using a numerical format. This variable was used as a continuous, independent variable without coding. Moreover, the interval-ratio was used as a level of measurement.

3.2 Length of Previous Overseas Experience

Is the duration for which each Saudi sojourner spent outside Saudi Arabia during his or her lifetime. This variable is one of the four variables used to predict the intercultural background of the targeted population. Participants were asked to say how long they had been outside Saudi Arabia using a numerical format. This variable was used as a continuous, independent variable without coding. The interval-ratio was used as a level of measurement. Data on the length of previous overseas experience was collected as the total number of years and months the respondent has been outside of Saudi Arabia, both as part of the current study abroad experience and prior trips abroad.

3.3 Length of Time Studying English as Second Language

The duration for which each Saudi sojourner spent learning English before studying at American universities. This variable is one of the four variables that were used to predict the intercultural background of the targeted population. Participants were asked by the researcher to indicate how long they spent studying English in Arabia using a numerical format. This variable was used as a continuous, independent variable without coding. Interval-ratio was used as a level of measurement. Data on the length of studying English was collected as the total number of years and months the respondent has studied English.

3.4 Frequency Interaction

The repeated communication of two or more individuals in the same society (Carpendale & Miller, 2004). Participants were asked to tell how many hours they interacted with Americans per day. This variable was used as a continuous, independent variable without coding. Interval-ratio was used as a level of measurement. Data on the frequency of interaction was collected as the total hours per day spent with Americans.

Intrapersonal identity conflict is the internal struggle relating to different aspects of one's identity. Such conflicts often engender insurmountable tensions, depression, and anxiety, as they are capable of yielding fractured identities (Leong & Ward, 2000). To measure the extent to which an individual is struggling with intrapersonal identity conflict, Leong and Ward (2000) developed the Ethno-cultural Identity Conflict Scale (EICS), a 20-statement instrument that asks respondents to rate their level of agreement using a five-point Likert scale from strongly disagree to strongly agree. The EICS provides scaled statements to assess subjective feelings of cultural contrast relating to the respondent's experience with intrapersonal identity conflict. In Leong and Ward's (2000) study of Chinese sojourners in Singapore (N=106), fourteen of the twenty statements were tested and confirmed to be predictors of identity conflict with a strong reliability (Cronbach's Alpha score of 0.80).

4. Results

Of the 186 respondents that completed both the DIS and EICS questions, 63.44% (n=118) were males, 35.48% (n=66) were female, and 1.08% (n=2) did not specify their sex. Regarding location, 38.17% (n=71) were attending schools in the South; 31.18% (n=58) were attending schools in the Northeast; 15.05% (n=28) were attending schools in the West; 14.52% (n=27) were attending schools in the Midwest, and 1.08% (n=2) did not specify their locations. Respondents were an average of 27 years old, with an age range from 19 to 55 years. The length of residency in the United States for the respondents per the EICS ranged from a few months to 27 years with a mean of 2.8 years and their length of studying English as a second language before coming to the United States ranged from 0 months to 10 years with a mean of 1.21 years. Additionally, the results show that the EICS respondents' overseas intercultural experiences ranged from 1 month to 43 years with a mean of 5 years, and their interactions with Americans varied from less than an hour to more than 12 hours per day with a mean of 4 hours per day. DIS variable frequencies and percentages are provided in Table 1.

Table 1. The characteristics of the participants as frequency and percentage

Characteristic		Frequency	Percentage
Sex	Male	135	64.30%
	Female	73	34.80%
	N/A	2	1.00%
Age	18-27	121	57.60%
	28-37	81	38.60%
	38-47	6	2.90%
	48-57	2	1.00%
Location	South	80	38.10%
	North-East	67	31.90%
	Mid-West	31	14.80%
	West	29	13.80%
	N/A	3	1.40%
Interaction with Americans	<1 hour per day	59	28.10%
	1-4 hours per day	76	36.20%
	5-8 hours per day	49	23.30%
	9-12 hours per day	16	7.60%
	>12 hours per day	8	3.80%
	N/A	2	1.00%
Length of Residency in USA	<1 year	14	6.70%
	1-3 years	115	54.80%
	4-6 years	64	30.50%
	7-10 years	14	6.70%
	>10 years	1	0.50%
	N/A	2	1.00%
Overseas Experience	<1 year	26	12.40%
	1-3 years	87	41.40%
	4-6 years	60	28.60%
	7-9 years	11	5.20%
	>9 years	21	10.00%
	N/A	5	2.40%
Length of Studying English	<1 year	84	40%
	1-3 years	111	52.90%
	4-6 years	6	2.90%
	>6 years	6	2.90%
	N/A	3	1.40%

EICS scores suggest that respondents are experiencing low to moderate levels of intrapersonal identity conflict. The statement average was 2.37 and the instrument average was 47.4. EICS instrument scores ranged from 23 to 84, with statement averages ranging from 1.15 to 4.20, expressing a range from no identity conflict to high identity conflict. Table 2 reflects the frequencies, means, medians, modes, and standard deviations for each statement on the EICS.

Table 2. EICS frequencies, means, median, mode, and standard deviations

No.	Survey item	n	M	Median	Mode	SD
1	No matter what the circumstances are, I have a clear sense of who I am	210	1.78	2	1	0.95
2	I have difficulties fitting into the wider society because of my cultural background	210	2.6	2	2	1.19
3	In general, I do not think that people from my ethnic group know the real me.	209	3.02	3	3	1.09
4	I sometimes do not know where I belong	209	2.24	2	1	1.26
5	I am an outsider in both my own ethnic group and the wider society	209	2.63	3	3	1.17
6	Because of my cultural heritage, I sometimes wonder who I really am	207	2.05	2	1	1.13
7	I experience conflict over my identity	207	2.32	2	1	1.17
8	I find it impossible to be part of both my cultural group and the wider society	209	2.39	2	2	1.17
9	I am uncertain about my values and beliefs	209	1.99	2	1	1.15
10	I have serious concerns about my identity	208	2.12	2	1	1.26
11	People tend to see me as I see myself	206	2.86	3	3	0.98
12	I do not know which culture I belong to	206	1.84	1	1	1.11
13	I find it hard to maintain my cultural values in everyday life	206	2.76	3	2	1.2
14	I sometimes question my cultural identity	205	2.59	2	2	1.21
15	I am confused about the different demands placed on me by family and other people	205	2.57	2	2	1.27
16	Sometimes I do not know myself	205	2.12	2	1	1.17
17	I find it easy to maintain my traditional culture and to be part of the larger society	204	2.65	2	2	1.14
18	I feel confident moving between cultures	205	2.37	2	2	1.11
19	I have difficulties fitting in with members of my ethnic group	206	2.59	3	2	1.14
20	I am sometimes confused about who I really am	205	2	2	1	1.2

4.1 Relationship between the Intercultural Background and Identity Conflict

The research question asks the following: Is there a relationship between the exposure variables (the length of time spent in the United States, the length of previous experiences outside Saudi Arabia, the length of time studying English as second language, and the frequency and nature of interactions with Americans) and interpersonal identity conflict? In order to answer this question, four Pearson's product-moment correlation tests were run individually to assess the relationship between the four intercultural background variables and the EICS scores (see Table 3). It was found that these relationships were not statistically significant, given that $r=-0.021$ and $p>0.05$ for the length of previous experiences outside Saudi Arabia, $r=-0.094$ and $p>0.05$ for the time spent in the United States, $r=-0.076$ and $p>0.05$ for the frequency interaction with Americans, and $r=-0.034$ and $p>0.05$ for the length of studying English as second language prior to arriving in the States. Table 3 summarizes the results of the Pearson correlation test of students' intercultural background with the EICS scores.

Table 3. Relationship between intercultural background variables and EICS scores

	Length of time spent in the United States	Length of previous experiences outside Saudi Arabia	Length of time studying English as second language prior to going to the U.S.	Frequency of interaction with the American people
Pearson correlation	-0.094	-0.021	-0.034	-0.076
Significance (2-tailed)	0.265	0.779	0.684	0.304

5. Discussion and Conclusion

The data presented within this research does not present a statistically significant relationship between any of the four variables of exposure and EICS scores based on Pearson product-moment correlation tests. However, the exposure variables demonstrate the degree of exposure to American culture. A majority of respondents spend less than four hours a day interacting with Americans (64.30%), have resided in the United States less than three years (61.50%), have spent less than years overseas (53.80%), and have studied English less than three years (92.90%). Despite this relatively limited exposure, especially in terms of language, the average level of intrapersonal identity conflict was 47.4 points, with an average per statement of 2.37. This EICS score suggests that Saudi students have low to moderate levels of intrapersonal identity conflict. More specifically, 8% of respondent strongly disagree that they exhibit identity conflict, 48.5% of respondents disagree that they exhibit identity conflict, 36.6% of respondents neither agree nor disagree, 6.9% of respondents agree that they are facing identity conflict, and no respondent strongly agreed that they exhibit identity conflict. Therefore, despite these relatively low levels of exposure, the majority of respondents do not feel that they are experiencing intrapersonal identity conflict. As so, this research fails to conclude that there is a relationship between intercultural exposure and intrapersonal identity conflict.

It is important to consider that acculturation is not merely the output of exposure. Exposure is one of many factors that impact acculturation and acculturation is one of many factors that impact identity conflict. Berry (2005) discusses acculturation strategies, including the constraints imposed by the host culture. Strategies, the author argues, rely on two fundamental questions: What is the value of maintain cultural heritage? What is the value of developing relationships with larger society of the host culture? If value is seen in developing in both areas, the individual will integrate. If value is not seen in either area, the individual will marginalize. If value is only seen in maintaining cultural heritage, the individual will separate. Finally, if value is only seen in developing relationships with the host culture, the individual will assimilate (Berry, 2005). Further research is needed to assess the relationship, if any, between patterns of integration, marginalization, separation, and assimilation amongst Saudi Arabian students studying in the United States.

It is important to note that although this research has not concluded a relationship between intercultural exposure and identity conflict that this lack of relationship is a finding in itself. Assessing this relationship was an important step towards developing a more robust understanding of the factors impacting acculturation and identity conflict. As Furnham and Bochner (1982) provide that sojourner's experiences, individual differences, and cultural differences are all factors that determine how one will respond to a foreign culture, this research has only touched on one of many factors that are to be considered in future research of Saudi sojourners. More specifically, this research has correlated exposure to identity shock to test Guirdham's (1999) statement that an individual's ability to survive culture shock is affected by "knowledge of the culture and its language, stereotypes of and attitudes towards people in the other culture, being able to suspend evaluation of other people's behavior and understanding the self as a cultural being" (p. 272). Although Ward (1996) and Guirdham (1999) have asserted that cross-cultural adaptation for sojourners is affected by factors of exposure, this research has failed to find a relationship. As this research included the factors listed by Ward (1996) to be factors of exposure, there is one variable that this research did not include: cultural orientation programs. Therefore, the next step of this research is to incorporate experiences with cultural orientation programs.

This research focuses on Saudi sojourners which have all come through the King Abdullah Scholarship Program (KASP). As potential conflicts of acculturation are perceived to be able to be alleviated by cultural acclimation programs, such as orientations for Saudi students in the United States, future research must consider both the nature of orientation and preparation, if any, provided by KASP and how this potentially differentiates the Saudi sojourner population from other sojourner students in the United States. With this in consideration, further research is also needed to assess differences between Saudi sojourners and sojourners of other nationalities and cultures.

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STAKEHOLDER ROLE IN SAFETY CULTURE AND SAFETY PERFORMANCE OF CONSTRUCTION: A CONCEPTUAL MODEL

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ABSTRACT: *Project management in the Saudi Arabian construction industry is an activity complicated by the current widespread lack of a mature organisational safety culture, which results in a high incidence of serious and fatal accidents, making it difficult to deliver project objectives. This article addresses this major problem. This research is therefore an attempt to verify the causal relationships and interactions between stakeholder involvement, safety culture, and safety performance in the construction industry, thus providing a better understanding, in turn, may improve safety. To achieve this objective, a conceptual model was developed to enable empirical research via responses to a questionnaire will distribute to construction organisations. The model provided in this study is a systematic approach to assess the safety culture of construction organisations and to guide them in self-assessments. The research contributes to the literature pertaining to assessments of stakeholder involvement and safety culture. Furthermore, it offers a valuable tool to government bodies and regulatory agencies for assessing their efforts in improving safety culture.*

KEYWORDS: Management, Policy, Safety Culture, Performance

INTRODUCTION

This study explores the extent to which stakeholders endorse a positive safety culture on construction projects. In recent years, stakeholder theory has become a commonly accepted management theory for framing an organisation's strategies, yet little is known about how stakeholders may influence the safety culture of a construction project. Even so, the stakeholders are expected to contribute to (Newcombe 2003; Smith, J & Love 2004), and influence, the development of that project (Chinyio & Olomolaiye 2009). Despite this expectation, there is still a large gap in the general conceptualisation of a safety culture in a construction project, due to both a lack of agreement on what 'safety' means and a lack of integration into accepted models of business operation.

The interaction between stakeholder theory and safety culture in balancing responsibilities and preventing injury or loss of life are obvious and significant. However, the types of interaction between the stakeholders, theories of relationships and safety culture that could provide a positive safety outcome are not very well developed in construction projects. No conceptual model has been produced to explain the relationships between stakeholder involvement and safety culture. This study addresses this shortcoming.

Safety culture, and safety performance in the construction industry, thus providing a greater understanding of their interaction which, in turn, will facilitate safety improvement. To achieve this outcome, a conceptual model was hypothesised and empirically will be tested by using information gathered via a questionnaire survey covering the main attributes of construction safety culture.

LITERATURE REVIEW

In preparation for the literature review, Cooper's (1988) Taxonomy of Literature Reviews was adopted to organise the review according to the research focus, goals, perspective, coverage, organisation and audience (Randolph 2009). The literature reviewed dealt with the three topics most important to this study – construction industries, workplace safety and stakeholder theory. The benefits of stakeholders' engagement in improving safety culture and reducing accident rates is examined by reviewing stakeholder theories and thinking. The review will demonstrate the influence of stakeholder theory on safety culture.

The construction industry

The construction industry plays a vital role in all countries, because it contributes significantly to the economic and social development of any nation. The ancient Egyptians were one of the earliest cultures to develop innovative construction techniques in order to build pyramids, temples, and obelisks. Also, just as we do today, they too had to supervise, mobilise, and feed a labour force.

The economic growth of a nation is often associated with the construction going on in the country, such as housing, industrial complexes, roads, bridges, buildings and other projects. Consequently, the success of construction projects is of particular importance to stakeholders and governments (Wibowo 2009). A study carried out in the Australian context has indicated that a 10% gain in the efficiency and productivity of the construction industry could lead to 2.5% gain in GDP (Stoeckel & Quirke 1992). This demonstrates the way in which a thriving, productive construction industry can influence any country's economic growth.

The construction industry involves many types of activities, and in terms of health and safety is considered unique by many researchers in terms of risk to life and limb. Construction industry conditions and organisation present a great challenge in terms of leadership, communication, and team integration, which all impact on health and safety.

Safety in the construction industry

Numerous definitions of safety are available in the literature; according to the Oxford Dictionaries safety is defined as 'the condition of being protected from or unlikely to cause danger, risk, or injury'. Also, British Standards Institution (2007, p. 3) defines occupational health and safety as 'conditions and factors that affect, or could affect, the health and safety of employees or other workers ..., visitors, or any other person in the workplace'.

Globally, the construction industry is labelled as one of the most dangerous sectors in terms of work safety, and occupational health and safety have become a major concern of both society and government (Choudhry, RM et al. 2008; Iain & Billy 2008; Phil 2010; Zou 2011). The likelihood of accidents is high, in spite of improvements over decades (The UK's Health and Safety Executive 2012). Construction in the 2011/12 data for the UK accounts for 22% of fatal injuries and 10% of reported major injuries throughout all industry, even though the construction industry accounts for only about 5% of the employees in Britain (The UK's Health and Safety Executive 2012). In Australia also, the construction industry records the highest number of fatal injuries of any industry: 17% of all compensated fatalities (Safe Work Australia 2013). In Europe, the construction industry has one of the worst workplace incident records, and around 47% of workers have indicated that they believe that their work affects their safety (EU-OSHA).

Providing a safe workplace is a global issue, and both developed and developing countries are attempting to solve the problem. In developed countries, new regulations and legislation have meant substantial improvement in the accident records. The UK's Health and Safety Executive (2012) reported that in the early 1990s the number of workers killed in the construction industry was around 125. By 1996/97 it was around 90, by 2005/06 around 60. For 2011/12 the fatal accident figure was 50.

Accident Causation

The reasons why accidents occur in the workplace, or anyplace, have been much investigated. It has been largely accepted that accidents are unplanned events which result in physical harm to people and property (Ridley & Channing 2008), but how and why accidents happen has produced different models of causation. The most widely known theories and models of accident causation are:

- the domino theory
- Leather's potential accident subject model
- project management accident model
- distractions theory
- Rasmussen's work behaviour model
- the Swiss cheese model
- the ConCA model.

Accidents in construction workplaces occur because of a failure of one or more indirect and/or direct factors, as summarised in Table 1. Accident causation models focus on management characteristics, human variables, and hazard aspects. Unfortunately, accident causation models are not interfaced with hazards identification and risk assessment, and there is a gap in our understanding of how risks become accidents (Khanzode et al. 2012).

Table 1 Summary of seven accident causation models

Accident causation model	The reason why accidents happen
The Domino Theory	Management loss control and a chain of loss event
Leather's Potential Accident Subject Model	Failure of management system, loss motivation, and inappropriate training and instruction which given by top management
Project Management Accident Model	Company policy failure, project management failure, site management failure, and individual failure
Distractions Theory	Distractions by hazards
Rasmussen's work behaviour model	Not comply with safety rules, hazards, and loss of control
The Swiss Cheese Model	Failures caused by management decisions
The ConCA Model	A failure in the interaction between worker and team work, workplace issues, and materials and equipment. Also it affected by the shaping factors and the originating influences

The big picture: Organisational and safety culture

Improving workplace safety usually concentrates on individual human failures and technical issues (Gadd, 2002). Most of major accidents, such as the meltdown at Chernobyl, the fire and explosion on the Piper Alpha or the grounding of the Exxon Valdez, all highlight the

contribution to major accidents of the organisation's procedures and policies. For example, when BP's Deepwater Horizon oil well spilled oil into the Gulf of Mexico in 2010, the judge ruling on the later litigation commented that BP had acted with 'conscious disregard of known risks' and that 'employees took risks that led to the largest environmental disaster in US history', because the company had allowed a reckless culture to dominate its decision-making capacity (Fisk & Feeley 2014).

According to Hofstede, GH (2001), culture is: transmitted and created content and patterns of values, ideas, and other symbolic meaningful systems as factors in the shaping of human behaviour and the artefacts produced through behaviour (Kroeber, & Parsons, 1958, p. 583). It is a shared mindset that distinguishes one group from another. Miraglia et al. (1999) point out that culture works as a template which shapes human behaviours in the form of values and practices; culture is learned and shared, and it is determined by contextual factors.

Organisational culture

An organisation's values, its objectives, and its resources must be congruent with one another. Turner and Pidgeon (2004) demonstrated that: part of the effectiveness of organisations lies in the way in which they are able to bring together a large number of people and imbue them for a sufficient time with a sufficient similarity of approach, outlook and priorities to enable them to achieve collective, sustained responses which would be impossible if a group of unorganized individuals were to face the same problem (Turner & Pidgeon, 2004, p.47). Cooper (2000) defines corporate culture as: ...to reflect shared behaviours, beliefs, attitudes and values regarding organizational goals, functions and procedures (Cooper, 2000, p.112).

Erez and Gati (2004) point out that the fit between organisational culture and management practices is critical and management behaviour tends to be constrained by an existing culture, which affects overall performance by influencing problem solving and decision making (Christensen & Gordon 1999). According to Deal and Kennedy (1982) certain cultural directions lead to strong and effective performances, while other directions result in failure. Clearly, there is evidence in the literature for the hypothesis that organisational culture and management practices influence the performance of construction projects.

Concepts of a safety culture

In the 1980s, researchers into the science of safety considered human error to be one of the sources of accidents, having already noted the dangers of the physical workplace in the technical phase and moved into the socio-technical phase (Reason, J 1993). At that time, it was agreed that the interaction between technical systems and various social situations caused accidents in the workplace. When analysing the accidents, it was in this context that researchers and practitioners considered social and organisational factors.

The term safety culture was introduced in an International Atomic Energy Agency (IAEA) report after their analysis of the nuclear accident at Chernobyl, Ukraine, in 1986 (Cooper, MD 2000; International Safety Advisory Group 1991). According to the agency (1992), a poor safety culture contributed to the disaster. The IAEA defines safety culture as: that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance (International Safety Advisory Group 1991, p. 1).

According to Flin (2007), the most widely accepted definition of safety culture was introduced

by Advisory Committee for the Safety of Nuclear Installations (ACSNI): The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures (ACSNI & HSC 1993, p. 23).

The concept of safety culture has increasingly become a part of academic literature, and the idea of working in a safe work environment is largely embedded in organisations in developed nations. The idea of safety culture and safety management are largely accepted by businesses (Cooper, MD 2000; Guldenmund, FW 2000). Cooper (1998) argues that the organisation's safety culture affects not only accident rates, but also quality, productivity, absenteeism, commitment, loyalty, work methods, and work satisfaction, while being a source of influence in determining outcomes (Cipolla et al. 2005), for better or worse.

Stakeholders and stakeholder theory

The main factors affecting safety in construction projects include the leaders of the company having a low awareness of the importance of safety in the workplace and the poor engagement among designers, architects, planners and coordinators of the projects (Tam et al. 2004).

Freeman's (1984) book is generally acknowledged to have brought stakeholder theory into the forefront of management literature, and his discussion of the history of the concept of stakeholders provides an overview of the various theories to which its early development is attributed. Then in 1988 and 1993, Evan and Freeman elaborated the stakeholder concept in editions of Beauchamp and Bowie's text *Ethical theory and business* by introducing two principles – the principle of corporate legitimacy, and the stakeholder fiduciary principle (Evan, William M & Freeman 1988/1993).

Stakeholder definitions. Stakeholders therefore are a group of individuals or a single person whose activities can affect, or are affected by, the organisation (Freeman 1984, 2010; Loebbaka & Lewis 2009). Stakeholders have the power to benefit or threaten an organisation (Gibson 2000), and influence an organisation's goals, activities, improvement and functions (Chinyio & Olomolaiye 2009).

Understanding and managing the complexities of business today is a challenge. Stakeholder theory has appeared as a new narrative to understand three interconnected problems related to organisations; the problem of how value is created, the problem of connecting ethics and capitalism, and the problem of managerial mindset (Parmar et al. 2010). According to Parmar et al. (2010) organisation executives pursue profit and care little for ethics. Since managerial activities have a broad impact on a range of people (Clement 2005), Parmar et al. (2010) suggest that academics and managers need to rethink the traditional ways of conceptualising the responsibilities of the firm.

Stakeholders in the construction industry include owners or clients, shareholders, project managers, employees, designers, contractors, subcontractors, suppliers, governments and legal authorities, insurance companies, competitors, customers and visitors (Newcombe 2003; Smith, J & Love 2004). At some point, each of these stakeholders has influence on the development of the project (Chinyio & Olomolaiye 2009). Much of the literature identifies primary and secondary stakeholders. Primary stakeholders are those who have a direct impact

upon an organisation and have formal or contractual relationships. Secondary stakeholders are various, and include those who are indirectly engaged in the organisation's activities, but are able to influence the organisation's decisions (Savage et al. 1991).

Safety Performance

Safety performance relates to how well the organisation manages its hazards (Reason, JT 1997). An organisation can increase its resistance and lower the risk of accidents by a positive safety performance, or decrease its resistance and increase the risk of accidents by a negative safety performance (Nevhage & Lindahl 2008). Edwards, JRD et al. (2013) view safety outcomes as representative of safety culture's interpretation within the organisation and a subset of organisational performance.



Figure 1 The conceptual model

The Research Problem

Since 1959, several theories of accident causation have evolved in an attempt to explain why accidents occur. The most widely known theories and models of accident causation are:

- the domino theory (Heinrich 1959)
- Leather's potential accident subject model (Leather 1987)
- project management accident model (Whittington et al. 1992)
- distractions theory (Hinze, JW 1996)
- Rasmussen's work behaviour model (Rasmussen et al. 1994)
- the Swiss Cheese model (Reason, JT 1997)
- the ConCA model (Haslam, R et al. 2005).

These researchers have variously determined that accidents occur in construction workplaces because of a failure of one or more indirect and/or direct factors; management characteristics, human variables, and hazard aspects.

In 1986, the concept of a poor safety culture was introduced as a contributing factor to the Chernobyl disaster. Since then, the idea of a safety culture has increasingly become a part of academic literature. Cooper (1998) argues that an organisation's safety culture influences not only accident rates, but also reflects quality, productivity, absenteeism, commitment, loyalty, work methods, and work satisfaction. Safety culture is often a factor in better outcomes (Cipolla et al. 2005). Thus, improving an organisation's safety culture is considered to be one way to improve safety performance and achieve better overall organisational performance (Fang et al. 2006).

Although the safety culture concept has been widely used for many decades by academics and practitioners, the actual nature of a safety culture is not precisely clear. According to Choudhry, R et al. (2007a), there is a major limitation to the concept of a safety culture since no accepted model of safety culture exists. This is due to both a lack of agreement, and the lack of its integration into general models of organisational culture (Edwards, JRD et al. 2013). Edwards, JRD et al. (2013) has pointed out, however, that there does exist a synthesised conceptualization of safety culture, which includes practices and activities, behaviours and attitudes, policies and procedures, and safety performance. This conceptualisation provides a useful starting point for discussion regarding the nature of safety culture, yet still needs a clear justification of its indicators and a conformity analysis to validate the model. Furthermore, safety outcome as safety performance needs more in-depth studies to distinguish between leading indicators and lagging indicators, in order to understand the effect of safety culture on those indicators. The current research presents a comprehensive conceptual model of safety culture to fill this gap.

According to Greenwood and Freeman (2011), stakeholder theory is important for a number of reasons. Firstly, it does not separate the logic of business from human or ethical logic, because all workers are stakeholders and as stakeholders are human beings. Secondly, in any business model, workers often form the core meaning of that model. Therefore, business models have been defined by stakeholder theory as “how an organization makes customers, suppliers, employees, communities and financiers better off, and how making one better off makes the others better off (Greenwood and Freeman 2011, p. 276)”, and defines the purpose, principles and the relationship of the organisation to society. Stakeholder theory suggests that this needs to be a shared process where workers are at the centre, and involved.

In the current research, stakeholder theory and thinking has been adopted and conceptualised with the safety culture model in order to understand the relationship between the stakeholder and safety culture in the construction industry, and discusses the usefulness of their interaction in finding a balance between responsibilities and the prevention of loss. The main aims of the research were to determine empirically the extent to which stakeholder involvement impacts on safety culture and safety performance, and the nature of this involvement, along with developing a model that could help to assess the extent of this involvement within the construction industry.

METHODOLOGY

The study will be conducted in stages. The lack of common empirical indicators and the absence of an appropriate model meant that it was necessary to begin the research with a review of the literature, and to obtain expert opinions prior to developing a research instrument and verifying the extracted indicators, as suggested by García-Valderrama and Mulero-Mendigorri (2005), as well as Jonker and Pennink (2010). Having completed these steps, a pilot test was then conducted to modify the questionnaire.

To achieve the above research objective, a conceptual model was hypothesised and empirically will be tested by using information gathered via a questionnaire covering the main attributes of construction safety culture. The questionnaire will administer within the construction industry to the three groups of organisations (small, medium, and large). The initial study determined a cross-sectional design to be the most appropriate method for the

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collection of data. Cross-sectional research is used to collect data on relevant variables simultaneously, which provides a snapshot of the variables (Busk 2005).

According to Busk (2005), the advantages of this method are that it fulfils multiple research requirements, such as collecting data on multiple variables, collecting data on behaviours and attitudes, and generating hypotheses for future study.

After data collecting, descriptive statistics, calculation of reliabilities, and checking of outliers and non-normality will be undertaken by employing the SPSS program. A confirmatory factor analysis and convergent and construct validities will be also undertaken by using AMOS. Lastly, the final results and model will be validated by using independent experts.

The procedure and applied methods used in the current research were considered appropriate in order to control biases, reduce error, and remove unwanted influence through statistical techniques and measurements, and to validate the research outcomes.

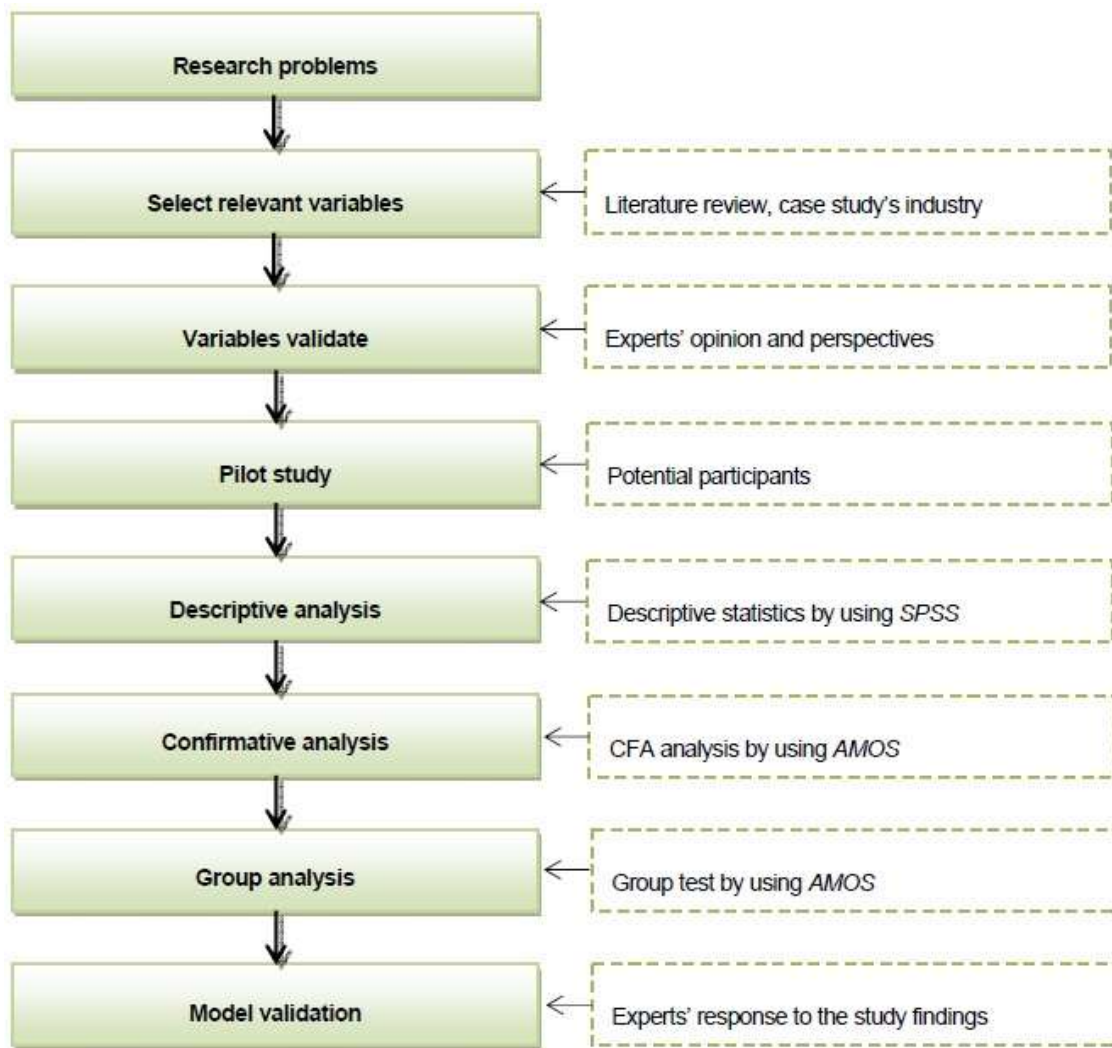


Figure 2 Research design for the current study

Figure 2 illustrates the procedure and methods used and will be used in the current research. In sum, these are:

- ☒ A comprehensive and critical review of relevant literature was conducted in order to develop the necessary research instruments.
- ☒ Formal interviews with safety experts will conduct to verify extracted variables.
- ☒ A pilot test will conduct to modify the questionnaire.
- ☒ Data will be collected.
- ☒ Descriptive statistics will be undertaken in this research by SPSS program.
- ☒ Confirmatory factor analysis will be also undertaken by using AMOS.
- ☒ Group analyses will be conduct by using AMOS.
- ☒ The final results and model will be validated by experts in construction projects after the data will be analysed.

Contribution to Knowledge

This study contributes to the theory and practice of stakeholder involvement, to aspects of safety culture, and to safety performance in the workplace as a first, empirically-determined step in raising standards in these areas. Despite the large number of studies having addressed the concept of safety culture and safety performance, only a limited amount of research has focused on stakeholder involvement and safety culture in the construction industry with particular reference to developing countries.

In the majority of existing studies, researchers have either replicated an already tested model in order to improve its adequacy, or developed a new model. To the best of the author's knowledge, none of the existing studies has explored the extent to which stakeholders promote a positive culture within the construction industry. This study examined the inter-cultural aspects of construction stakeholders' and senior management attitudes towards workplace health and safety within their industry, and then attempted to assess the influence and enforcement of the stakeholders on safety culture and safety performance. Therefore, this study adds to a growing body of empirical research related to construction safety culture in developing countries, and its relationship to the stakeholders in the industry. The most notable contribution of this study is in examining the relationships between stakeholders and safety culture dimensions with the objective of improving safety within the workplace. In addition, it opens up a future area of research into the clarification of these relationships, in particular by considering stakeholder theory in the context of construction safety culture and vice versa.

KEY Assumptions and Limitations

Despite the growing body of literature covering safety culture in the construction industry, it is still widely recognised that the empirical validation of stakeholder involvement in safety culture at senior management level is limited, and their contribution to safety performance is rarely studied. The interactions between the aims and objectives of senior management and what is actually being done in relation to safety performance appear to be ignored. This research is an attempt to verify the casual relationship and interaction between stakeholder involvement, safety culture, and safety performance in the construction industry, thus providing a greater understanding of their interaction which, in turn, will facilitate safety

performance improvement.

In the academic literature, these ways of elaborating stakeholder theory have been subject to significant debate. However, this research used stakeholder theory and thinking not to debate, but only to investigate the ways in which enforcement, influence, and participation can improve safety culture in construction projects.

A limitation of the study is that it focused on organisations within developing countries. Although the sample will be randomly selected, some restrictions will be applied. These restrictions will inevitably have influenced the results, which consequently may not be generalisable to other geographical areas.

SUMMARY

The main aims of this research were to determine empirically the extent to which stakeholder involvement impacts on safety culture and safety performance (leading indicators), the nature of this involvement, and to develop a model that could help to assess the specific nature of this involvement within the Saudi Arabian construction industry. Despite the large number of studies that have addressed the concept of safety culture and safety performance, only limited studies have focused on stakeholder involvement and safety culture in the construction industry with particular reference to developing countries. Therefore, the current study adds to a growing body of empirical research concerning construction safety culture in developing countries, and its relationship with its stakeholders.

A number of possible future research directions are offered in this section in relation to the findings presented above. Firstly, while this study focused on safety culture in the Saudi Arabian construction industry and to what extent stakeholders can influence that safety culture, there is an opportunity to replicate this study from the context of other developed or developing countries. Such an analysis would provide data to determine whether influence preferences may vary between different legal, religious, political, and cultural settings. Secondly, while the targeted participants were in senior positions to facilitate the capture of a macro-level perspective of stakeholders' involvement and safety culture, there remains an opportunity to carry out a comparison study between senior management and workers' perceptions, and capture the macro-level, as well as micro-level perspectives.

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THE BUYING PATTERN OF ENERGY DRINK AND ITS USE AMONG THE YOUNG GENERATION OF SAUDI ARABIA

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ABSTRACT: *Energy drink intake has to turn into a favorite exercise around the world, in particular among the younger generation. In Saudi Arabia, there are significant limitations in energy drinks – in abstract, tastes, advertising, the attention of sponsorship, are not permitted," however, it is not limited to the use of social media. The core purpose of this study is to investigate the consumption patterns of energy drinks among young people in Saudi Arabia even after partial restrictions on the promotion of energy drinks. This method of the research was used an exploratory approach in nature with the data collection through survey method (Maxim, 1999) were gathered from the respondents. A self-administered structured questionnaire was developed using survey monkey online services. After getting the responses, the data were edited, tabulated and analyzed using descriptive statistics (Frequency distribution) through the excel sheet and the result was explained accordingly. The result reveals that there is a trend of widespread use of energy drinks among young people, especially students in the age group 23-27 (72.10%). It also indicates that there is a high level of social acceptance of energy drink consumption in the region. The respondents showed a tendency towards buying decisions of it, but between the choice of brands, a certain degree of loyalty was shown. There is a call of some awareness program to increase the knowledge among the youth about the consumption of energy drinks and their effects on health.*

KEYWORDS: Energy Drinks, Power Drink, Consumer Behavior, Buying Pattern, Youth, Saudi Arabia,

INTRODUCTION

Beverage industry and perhaps broader and deeper base in the world in particular among the younger generation. Energy drinks are energy-enhancing products, which aim to increase mental or physical energy and improve alertness. In 1962, a Japanese pharmaceutical company, Taisho, launched Lipovitan D, one of the first energy drinks that still dominate the Japanese market. Lipovitan D contains B, taurine and ginseng vitamins, which are common elements of traditional energy drinks for the consumer with sustainable energy and reduce mental and physical fatigue (Taisho Pharmaceutical Co., Ltd., 2009). It has been confirmed viable energy drinks are to be applied in the beverage market, as shown by the combined consumption of morning, afternoon

and evening, not only for the consumer in general but also for those aged 18-34 in particular (Lal, 2007).

Energy drinks are in the functional beverage category, which also covers sports and food drinks (Datamonitor 2008A). Games juices are designed to be consumed before or during exercise to prevent dehydration, providing carbohydrates and salts usually contain caffeine (Coombes and Hamilton 2000). Energy drinks part covers a broad range of options, including ready-to-drink (RTD), clips, and in powder form. Globally, energy drinks account for 47.3% of the global market share of functional beverages, while in the United States they represent 62.6% (Datamonitor 2008a, 2008b). The remarkable growth of more than 240% in the US and abroad between 2004 and 2009 was particularly energy drinks (Mintel, 2009). In 2008, sales of the functional beverage industry worldwide reached 26900 million at a CAGR of 8.6% 2004-2008. Energy consumption having made a significant announcement for these drinks is easy and straightforward to easily access grocery supermarkets and supermarkets, which are acceptable and can reach all age groups of the population (Babu et al., 2008). It deserves considering that energy drinks are sold in more than 140 countries, and the other half of the consumers of these drinks consist of children, adolescents and young people (Seifert et al., 2011).

The rise in the expenditure of power drinks, promotion of these products and marketing across all channels of communication, including the Internet, may be intended to encourage adolescents to obtain benefits (Hendrick et al., 2006). It may also be increasingly popular because of sleep pattern. On the other hand, for students to take in the morning before going to school to increase vigilance and concentration (Yeomans et al., 2002; Kapner, 2004). In the marketing of these, energy drinks countries that provide instant energy, reduce fatigue and improve performance (Reissig et al., 2009). This data may encourage consumers to increase their consumption of energy drinks. About 51% of college students in the United States drink energy drinks more than once a month (Malinauskas et al. 2007) and the United Arab Emirates, and 92% of university students consume energy drinks (Jacob et al.).

Sportspersons are initially the main consumers of energy drinks companies. However, because the energy drinks market has grown rapidly and expanded, athletes are no longer the main target. Today, manufacturers of energy drinks are aimed at adolescents and young people (18-34 years) (Heckman et al., 2010). For example, 34% of young people aged 18-24 in the United States are energy drinkers such as attendees (O'Brien et al., 2008; Gallimberti et al., 2013). While athletes are the main goals of the energy market demands have shown that adolescents and young people aged, 16 to 35 became the main target (Babu et al., 2008); Miller, 2008; Bunting et al. 2013). Notwithstanding, up to one in three young people aged among the regular consumption of energy drinks (Goldman 2013). With easy access to energy, drinks between children and adolescents grow and sources of concern, especially in the UK.

"In Saudi Arabia, there are significant limitations in energy drinks – in abstract, tastes, advertising, the attention of sponsorship, are not permitted," however, it is not limited to the use of social media. According to the report of Euro Controller, despite restrictions, the Saudi Arabian market has continued to grow rapidly. "In the last five years, the energy drink market increased by 11% of the value of RCA", it is expected to grow this category is complex value terms of 9% of CAGR

during 2015-2020. The growth of this will fall lowest due to the prohibition of distribution in the years in the area next five years. (www.foodnavigator.com)

In addition to a partial prohibition of energy drink products in Saudi Arabia warns of "Significant Losses" In Industry because of new rules that have been prevented in selling energy drinks at sports clubs, government, health and educational institutes. This rule came after studying a partial prohibition from government side on the "negative effects of energy drinks" on health, a category that includes the main brands like Red Bull, Monster, Horse, and Bourne. Experts say that restrictions will have a significant impact on the lucrative Saudi Arabian market, which has one of the top ten ranks of energy drinks market in the World (Al Arabiya News). The consumer is the heart and king of any marketing effort in the modern marketing world. The consumer behavior is a process that allows the organization to understand how consumers choose, buy or sell goods, services, ideas or ideas that suit the needs and wishes to them (Kotler & Keller 2009). The organization should follow a detailed investigation into the fundamental processes of consumer behavior (perception, learning, attitudes, and motivation) to make appropriate marketing decisions. It also helps to understand the consumer behavior and the place to learn about effective techniques and strategies for sellers to achieve a significant competitive advantage in the market. In the modern and competitive world, people must make mental and physical rigor to survive successfully.

According to (Flynn, 1995), age is a vital demographic factor that affects decision-making on the process of purchasing, and it is easy to measure and use many social science theories. People of different ages have different needs, desires, and purchase of various goods and services throughout their lives (Flynn, 1995). Engel et al., 2008 indicated that consumer-purchasing behavior is directly related to the consumption of products and services resulting from the decision-making process before and after it. According to East et al. 2008; it is imperative to know the buying behavior of the consumer, and it has been the most common purchasing element of rational decision-making. Therefore, the main objective of this study is to investigate the patterns of consumption of energy drinks among young people and the use pattern, preferences and reasons for use after partial restrictions on the promotion of energy drinks in Saudi Arabia.

LITERATURE REVIEW

Energy drinks (ED) carbonated beverages, which usually contain large amounts/concentrations of caffeine (Babu et al., 2008; Reissig et al., 2009; Roussos et al., 2009). Several studies have agreed that the effects of these drinks provide greater stamina, maintain vigilance and mood, improve reaction time, concentration, memory, cognitive performance and drive drowsiness reduction during long periods of conduction. These effects may be related, firstly, to the presence of caffeine or synergies with other ingredients such as taurine and glucuronolactone (Heckman et al., 2010; Ballisteri et al., 2010; Van et al., 2008; Alford et al., 2011 and Mets et al., 2011). According to the American College of Health Association, 71% of university students surveyed reported the lack of sleep and were not comfortable for at least five days of the past seven weeks (Mets et al., 2011). Lack of sleep to choose cognitive tasks, at least, it is hard for college students with sleep difficulties to get the highest repetition of stress (Mets et al., 2011; Bigard, 2010). There are also many studies examined the relationship between energy drink consumption and behavioral problems. The

results of a recent survey concluded that increased consumption of energy drinks was linked with an increase in risk captivating behavior (Miller 2008).

Marketing of these drinks have positive effects always; marketer does not take into account the adverse consequences. May be important, especially intake of excessive amounts of caffeine, which can lead to psychosis or mania (Rottlaender et al., 2015) hyperactivity, aggressive and uncontrolled pulse, arrhythmia, acute coronary syndrome, and even sudden death (Bigard, 2010; and Lloret, J., 2011). Although, some studies had considered the physiological effects of energy drinks with active ingredients such as caffeine, taurine, glucuronolactone. Also, its implications in the long-term are not well known (Reissig et al. 2009; Pennay and Lubman, 2012; Van et al., 2008; Alford et al., 2011). However, scientific literature indicates the incidence of adverse effects and deaths associated with excessive consumption of these drinks (Gunja and Brownm 2012; Iyaduraj and Chung 2007, Rottlaender et al., 2015; Schoffi et al., 2011; Avci et al., 2013 and Rotstein et al.,2013). Many countries and regions have developed guidelines to regulate, distribution, and sale of energy containing significant amounts of beverages product containing caffeine (Thomson and Schiess, 2011; and Breda et al., 2014). Consumption of energy drinks is a specific problem. In current years, there has been an improvement in the use of power drink in teenagers and youngsters in developed countries (Pomeranz et al., 2013; Alsunni, 2011). Moreover, therefore the adversarial impacts and consequences of these age groups are matters. In addition to large amounts of energy drinks contain steroids, especially caffeine, causing both physiological and behavioral changes that particularly affect the heart and blood vessels systems (Marczinski and Fillmore 2014; Bašková et al., 2016; Jessica et al., 2017). Furthermore, In another study, it was also revealed the impact of energy drink use with other unhealthy habits such as alcohol, drug abuse, smoking. Moreover, the risk of sexual violence in adolescents and young people (Azagba et al., 2014, Larson et al., 2015). In 2014, after finding the adverse effects of energy drinks through various studies, the government banned on advertising of health drink such as Red Bull required to implement health warnings on the product labeled. Producers are also outlawed from sponsoring any social or cultural event. In the context of trade exhibitions, and a ban on energy drinks in restaurants, cafes, schools, health centers and public and private sports. However, consumers continue to consume these products despite health warnings on these products (www.euromonitor.com, 2015).

In one study indicated that the Red Bull Energy Drink is a "functional drink" designed to enhance physical and mental performance and "fit for consumption during the sport while driving and recreational activities" (Van 2008).). While Monster Energy provides a huge "massive double injection of huge energy drink from our killer energy brew, it provides the usual buzz twice of an energy drink" (Heckman et al., 2010). Energy drinks are soft drinks, marketing in raising energy levels and alert or encouraging interest (Torpy & Livingston, 2012). Since the Red Bull began in Austria in 1987, the global market for energy drinks has grown steadily, but continues to expand (Reissig et al., 2009; Burrows et al., 2013). It is expected that the market absorbs energy and sports drinks will reach 1.8 billion pounds in 2016, an increase of 95% compared with 2008-estimated (Mintal, 2011). Besides, the volume of energy drinks consumed is expected to exceed 6400 million liters in the same year as mentioned by Canadean, 2012.

This beverage market introduced in Europe, Asia, and dietary supplements for energy developers in the 60s has expanded its use to become one of the most dynamic and fastest growing sectors of the beverage industry (Heckman et al., 2010; and Zenith International, 2012). In the US, the energy drink industry has shown that this upward trend until 2018 is expected to continue steady annual growth in 2008-2013 (Institute of Food Technologists (IFT) 2014). There are hundreds of different brands in the market with attractive packaging designs and colors. That are readily available in supermarkets, and other stores without any restrictions of any kind (Jasák, and Szente, 2012). One of the marketing strategies is to introduce artistic names, highlighting their benefits and motivating the characteristics of [Zenith International, 2012; and Research and Markets 2014]. Prakash, 2011 study indicated that most respondents are satisfied with all other factors, except for the price, quality, taste, and flavor. The study suggests that it is not an inevitable part of the manufacturers to offer drinks at the most competitive prices needed, but at the same time, must see that the quality does not deteriorate nor standards.

According to the studied energy drinks market for young people, marketing efforts is especially attractive to college students (Ballistreri and Corradi, 2008). Although, players were initially the main consumers of energy drinks. However, with the growing market of energy drinks and the expansion of many niche markets, athletes are not the main target. Today, most energy drinks that are directed to teens and young adults aged 18-34 because of the lifestyle of this generation to trigger publicity for these products (Lal 2007). The attraction of energy drinks is clearly, shown between the new generations is 34% of the elderly Aged 18 to 24 regular energy users (O'Brien et al., 2008; Mintel, 2011)). The further study also supports that often marketing of energy drinks targeting young people (Harris and Munsell, 2015, Pomeranz et al., 2013) and youth aged 18-34 are the main target group. However, there is concern about the potential risks of consumption of adverse effects of energy on the health of consumers, especially young people, due to the high frequency of caffeine, sugar and other ingredients (Harris and Munsell, 2015, Pomeranz et al., 2013, Reissig et al., 2009). On the other hand, it was said that about 30% of students who use energy drinks, more than 40% reported daily use of regular soft drinks and about 20% reported daily use of soda diet. Special links between energy drinks and substance usage are much stronger than those who differ from regular soda or food and material use. The study found that energy drinks of adolescents showed energy and a larger amount of energy drinks increased the risk of health it is worth mentioning that this study does not prove a causal relationship between behaviors (Yvonne et al., 2014).

According to the study in Saudi Arabian consumer, most students did not recommend (86.2%) consumption of energy drinks; however, 52.2% of them drink it. It was suggested that the health education program educates students on the composition of energy drinks and their health effects. The legislation is needed to ensure that the exact ingredients of these beverages are printed on posters and that adolescents regulate the use of these beverages (Alugmany et al. 2011). Besides one study in the region revealed that there was a high prevalence of energy drinks among students in Saudi Arabia who participated in the study, most of these students do not have accurate information about the ingredients of the product information or potential adverse health effects. This study also supports the above mention research that there is a need to develop stronger labels on energy drinks so that consumers can know the exact amount of each item. Furthermore, there is also a need for prospective studies to determine whether formal educational training can affect

the understanding of food drinks and energy adverse side effects of these beverages and among college students (Aljaloud, 2015).

As revealed by the researcher that Saudi Arabia was one of the top ten countries to consume energy drinks. Among the limited studies, the study of girls in high school in the western region showed that 52.2% of women tried to consume energy drinks (Alugmany et al., 2013). In a study found that about 46% respondents were drinking energy drinks, while 54% of them never drink energy drinks in Saudi Arabia. Among those who drink energy drinks, 37% of them started with it in primary school, 64% of them drink energy daily, and 44% were taken two or more per day. Behind not eating energy drinks are reasons to believe they are unhealthy beverages (about two-thirds are not the user of energy drink). Also, another study suggests people start drinking energy drinks in about 16 years and found that men consume more energy drinks than women in Gulf region too. The results of this review suggested several recommendations for policy formulation, implementation, education and public research that could help official has to decision-making and to achieve the goal of using safe to the energy drinks. (Layla et al. (2016). Moreover, a study revealed that every year, new energy drinks are available in Saudi Arabia. These energy drinks are very popular among university students (Aljaloud (2014)). With a global approach to the energy drinks market of about \$ 15 billion, the overall consumption of energy drinks has increased accordingly, especially among university students. High consumption rates in this population are mainly due to increased concentration on carbonated soft drinks (Kim et al., 2015). Favorite power beverages such as Red Bull, Power Horse, Bison, Red Code, Boom Boom and Blue Horse. Also, the analysis revealed in this study that students used different energy drinks for several purposes in Saudi Arabia (Aljaloud, 2013). However, many of them did not familiarize from where to gather reliable information about harmful effects of it.

Research Gap:

From the above literature, it can be denoted that although there is much research on the power drink in global level as well as regional, however, most of them are in the area of health-related and policy making but very few of them has been examined on consumption patterns of users in Saudi Arabia. Therefore, this research aims to understand the pattern of energy drink use among the young people in Saudi Arabia and the direction associated with buying habits of them.

RESEARCH METHODOLOGY

The future of marketing organization depends on the foundation of the consumer preference. The aim of marketing is too graceful and satisfy target customer has needs and wants perceptions, preferences, and shopping and buying behavior. For the study of consumers' consuming patterns and preferences on energy drinks, the selected brands (such as Bison, Boom, Shark, Bugzy, and XL energy drink brand of energy drinks) available in the market were taken into consideration. The aim of this investigation is to identify consumer response for the energy drink products amongst the young generation of Jeddah City, Kingdome of Saudi Arabia (under the age of 35 year's old user). This paper will perform research using a quantitative approach, with the survey as a data collection method (Maxim, 1999). The primary and secondary data were utilized for the study. With the popularity of the Internet, online surveys have been adopted to collect data in social sciences for years (Wimmer & Dominick, 2006). The survey data were gathered from the

respondents through structured questionnaire that was developed using survey monkey online services. The link to this survey was distributed electronically using WhatsApp and other social media services to the 125 respondents of selected old group among the residents of the city during the month of July to August 2016. For the analysis, only 104 respondents' responses (Yusuf N. et al., 2016) were examined and remaining of it were rejected due to some errors were found in the replies that were not appropriate for the study. Secondary data were gathered from various books, journals, and websites for the purpose. After getting the responses, the data were edited, tabulated and analyzed using descriptive statistics (Frequency distribution) through the excel sheet and the result was explained accordingly.

Objectives of the Study:

The primary aims of the research are to determine the consumption patterns of consumer and their likability among the selected available brands of energy drink in the region. Mainly the study aims at the following:

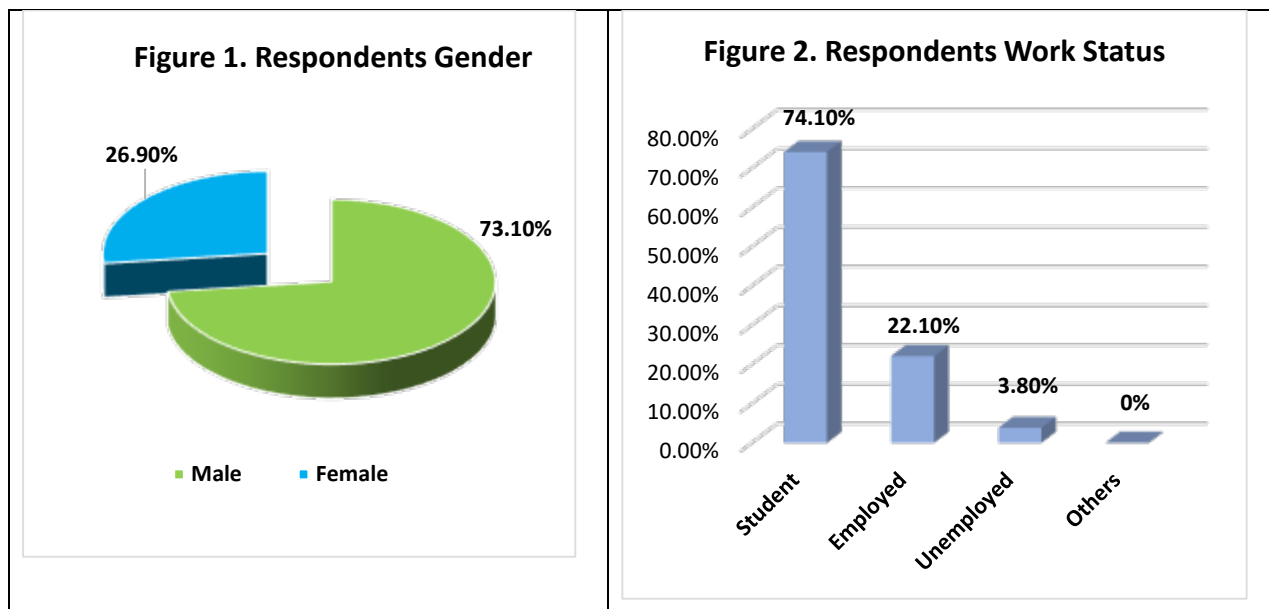
- To explore the most important factor influence consumers to buy the energy drink.
- To know the consumption pattern in quantity (Cans) of energy drink usually customer drinks in a week.
- To discover the highly favorable energy drink brand in the area.
- To assess the most available brand of energy drink in the area.
- To determine the brand of energy drink that producing good taste.
- To evaluate the energy drink product that having a high brand image in the region.

Limitations of the Study

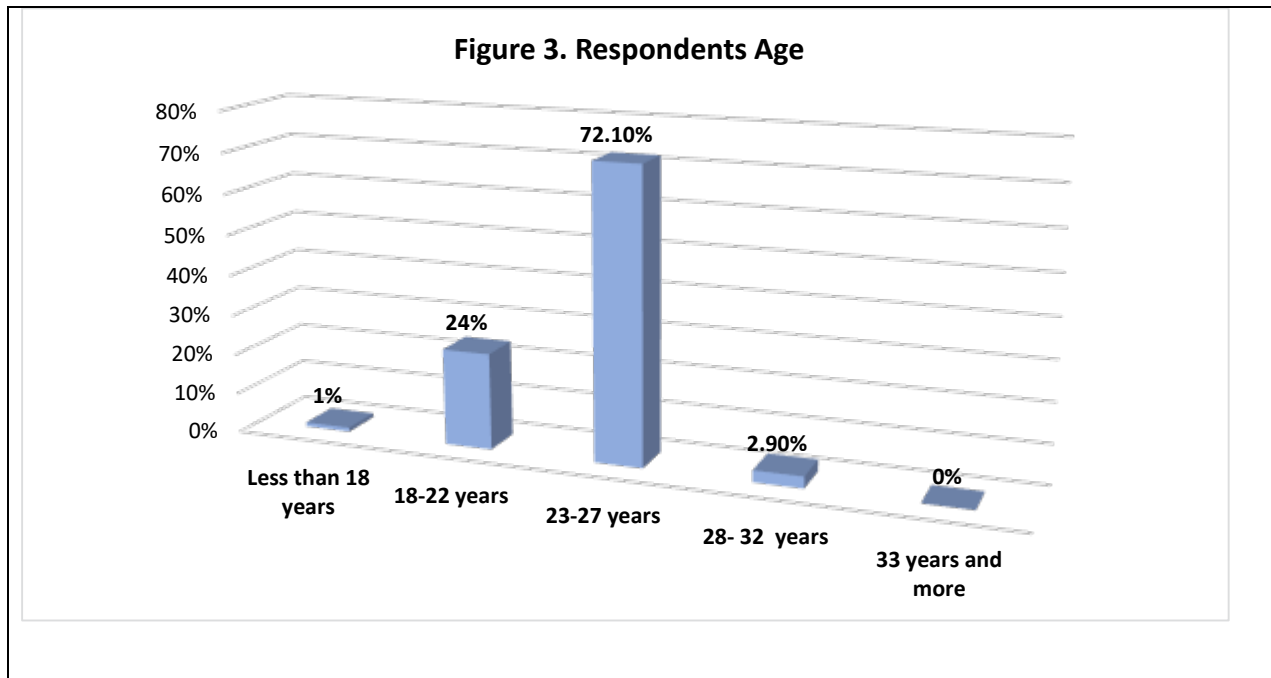
Although real effort has been made to put up for the study, however, the following factors have been unavoidable absent because of their critical limiting factors for this study:

- The study is limited to the Jeddah city only.
- Another limitation of the research is related to the small number of participants, as this may prevent generalizability of research findings.
- The results of the study cannot be universal due to geodemographic differences.
- Even though many numbers of energy drink brands are available in the market, but merely a few of them were measured for the study.

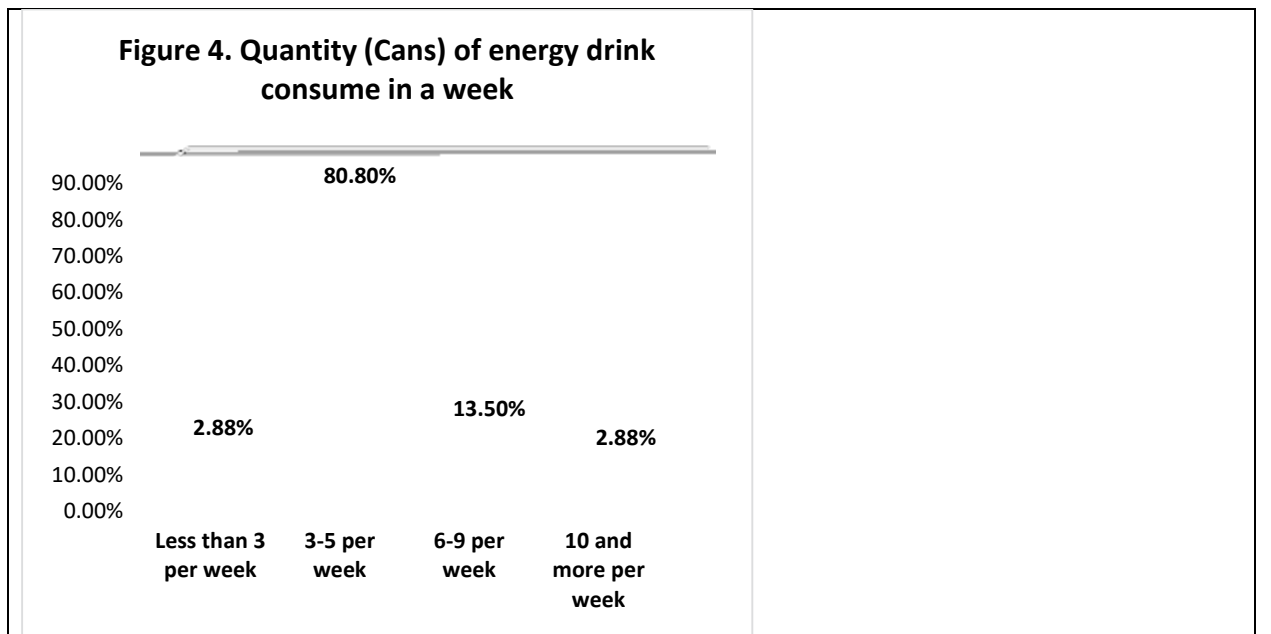
RESULT FINDINGS



The respondents were classified here on the basis demographic factors such as gender, age, and their work status. From the above figure 1 & 2, it can be seen that 73.10% (76 respondents of the sample) were male and 26.90% (28 respondents) female representing the sample size. The majority of respondents were students followed by employed and unemployed respectively 74.10%, 22.10% and 3.80% of the total sample size.

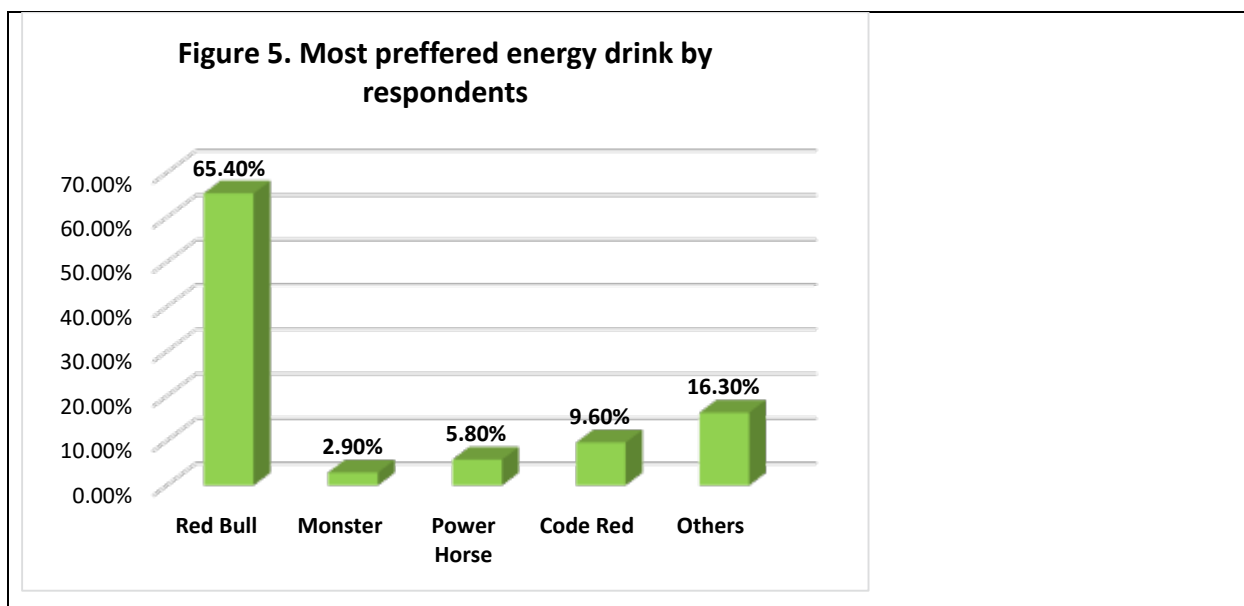


The above figure 3 asserting the age range of 23 to 27 years (75 of Respondents) are in the highest majority of the interviewees. After that 18 to 22 years of age range (25 of those interviewed), 28-32 years of range (3 respondents) and less than 18 years were only one respondent belongs to the total sample size were considered to study.

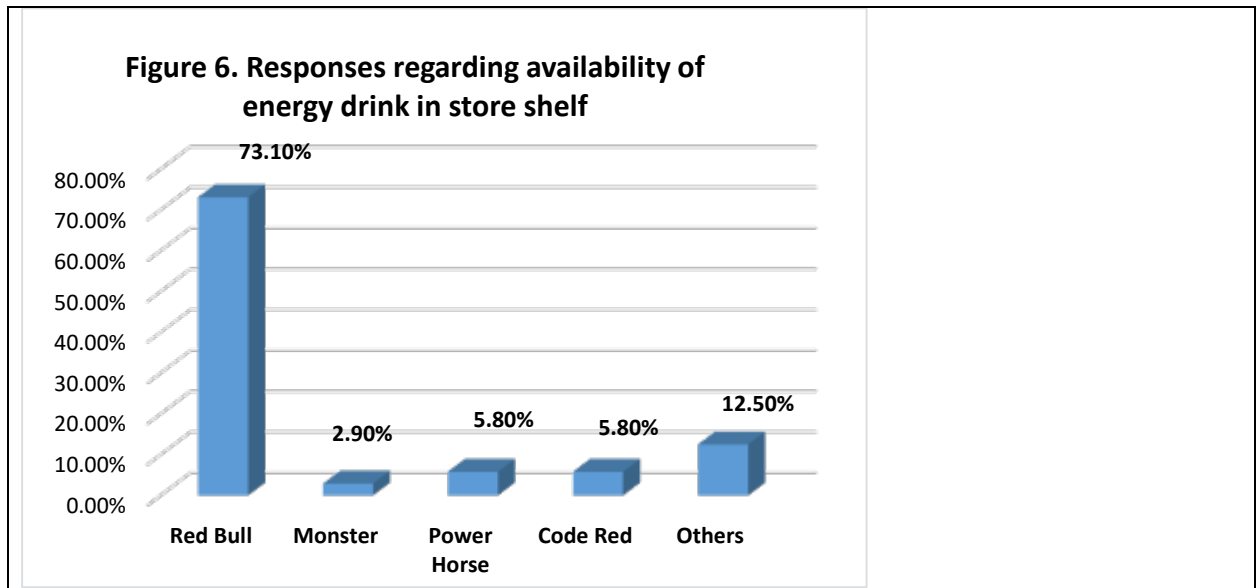


Results on the activities of consuming energy drinks varied among the respondents. The majority (80.80%) of them stated they are consuming the energy drink between three to five cans quantity

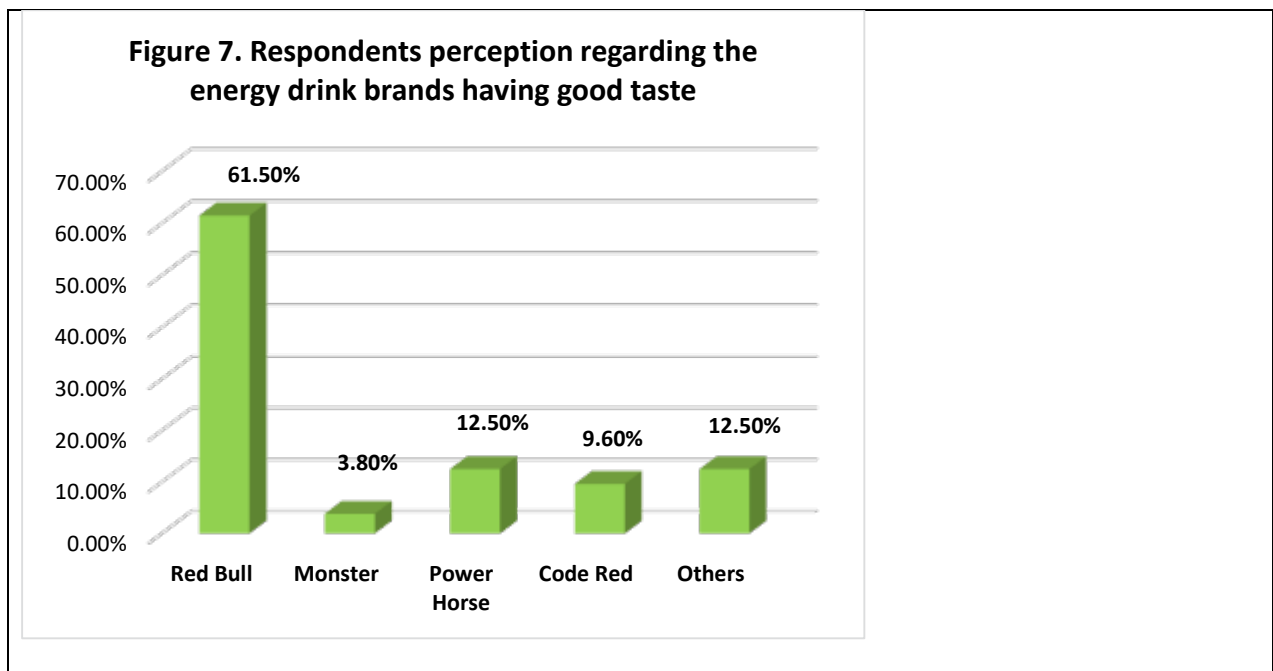
in a week followed by the consumption rate between six to nine cans per week (13.50% of consumers). Moreover, consumption of an energy drink less than 3 and 10 or more cans per week were (2.88% each) both were representing in the same manners. The respondent's differences were due to the differences occurring between regular users who consume energy drinks on a daily basis and occasional users who might use 1–2 or 2–3 cans per week. This finding also supports the conclusion by (Alsunni et al., 2011; O'Brien et al., 2008; Mintel, 2011). However, these results call for raising awareness among the youth on the safe consumption of energy drink units/ cans per week and its consequences of excessive consumption of energy drinks on the health of consumer in the area.

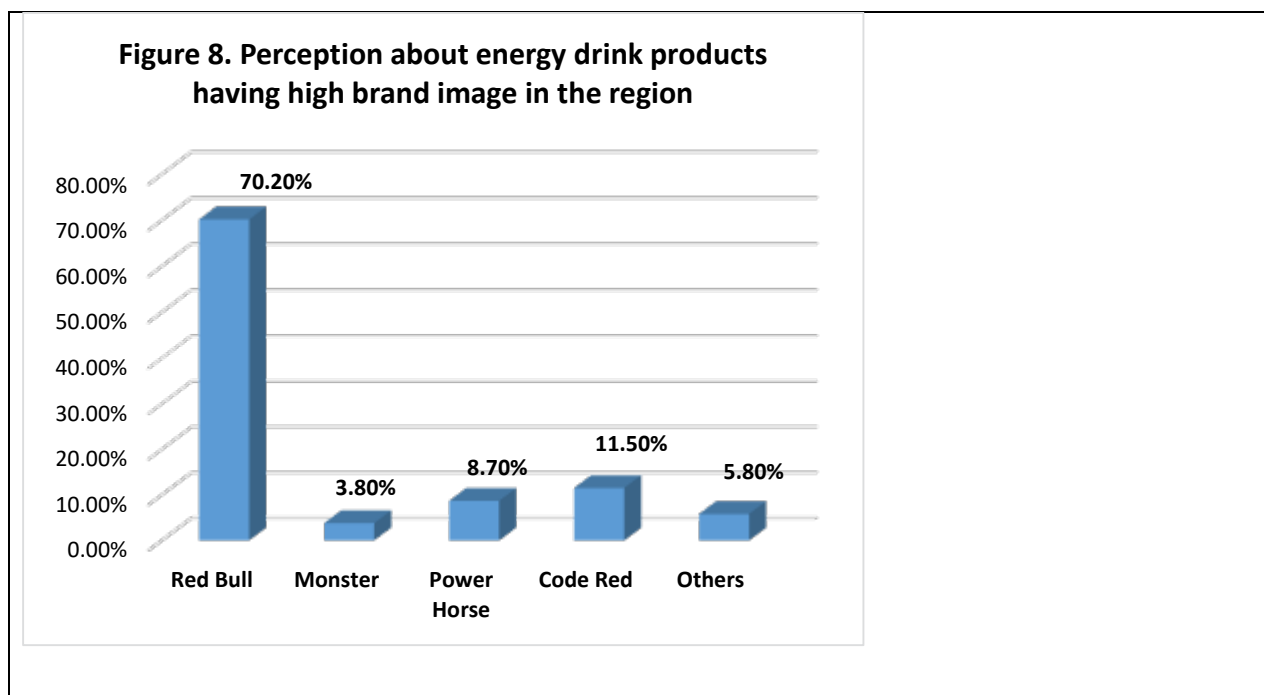


From the figure 5. it can be revealed that the highest majority of respondents (65.40%) preferred Red Bull energy drink among the other brands available in the market. Followed by other brands 16.30% (such as Bison, Boom, Shark, Bugzy, and XL energy drink brand), Code Red 9.60%, Power Horse 5.80% and Monster 2.90% respectively. It shows that Red Bull marketing strategy is having very high impact on consumers mind. Also, they are strategic to sell their product and to give more value to the product in the consumer's mind. As discussed in the literature since 2014 in Saudi Arabia there is a partial ban on the promotion of energy drink although having this situation Red Bull having a strong age in the market. The other sellers of the same field should learn the strategy through using competitive intelligence study to be a good marketer and to gain the value from consumers.



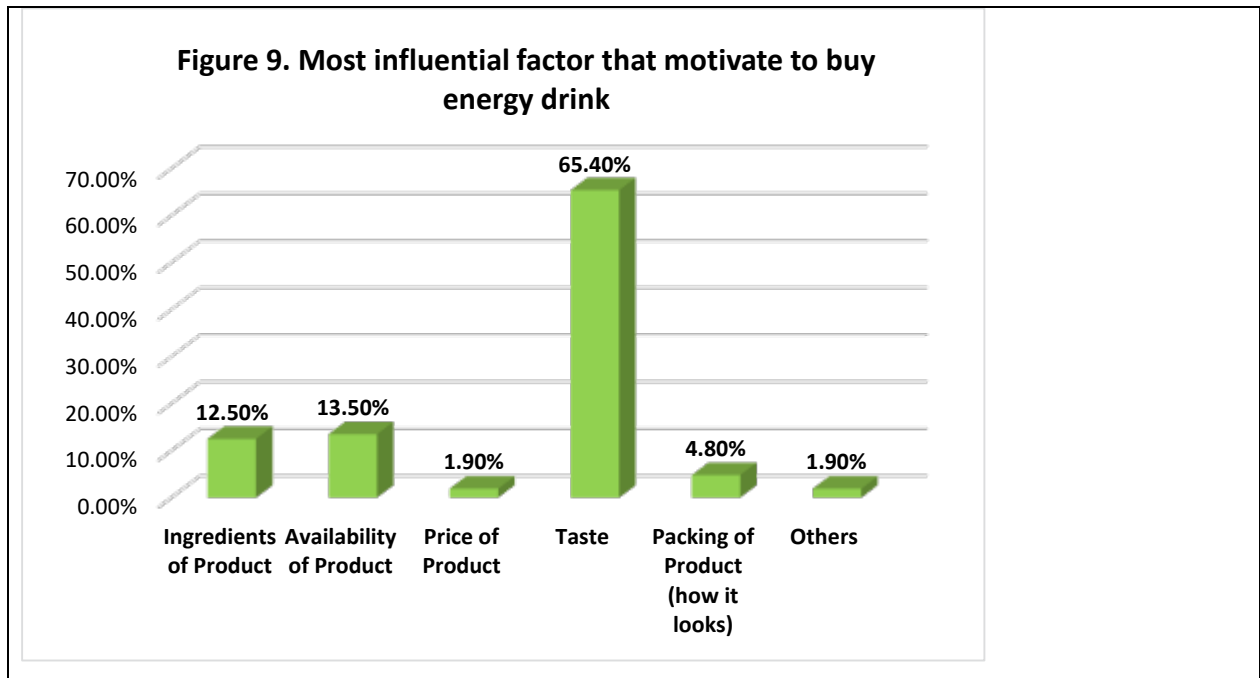
The majority of the respondents (73.10%) are reported that Red Bull energy drink stock was always available on the store shelf whenever it required. Others category (such as Bison, Boom, Shark, Bugzy, and XL energy drink brand) 12.50%, Power Horse & Code Red (5.80% each), and Monster (2.90%) availability were found on the stock shelf as perceived by the consumers. It indicates that the Red Bull distribution strategy is unyielding as compare to the followers of the marketer who are targeting the same segment of consumer. Among the given brands Monster availability in store shelf was reported penniless following Power Horse and Code Red that means these company should look to correct the distribution problems of their products in the region (As shown in Figure 6).





The question was asked to know the perception regarding the brand of energy drink that having the right taste. The majority (61.50%) of respondents (64 of sample size) reported that as per the taste of the energy drink Red Bull has the excellent taste. Followed by the others category of the product (such as Bison, Boom, Shark, Bugzy, and XL energy drink brand) & Power Horse (12.50% each), Code Red (9.60%) and Monster (3.80%) respectively (See the Figure 7).

The highest majority of the respondents (70.20%) have selected the “Red Bull” for having the great brand image among the given energy drink options. Followed by Code Red (11.50%), Power Horse (8.70%), Others brand (such as Bison, Boom, Shark, Bugzy, and XL energy drink brand, 5.80%) and Monster (3.80%) respectively in the consumer's eyes. It shows that again Red Bull having the great value and their brand images in the market. This picture will give the company to gain more benefit and to establish other related product in the market. The Red Bull should try to maintain this picture, and it is advisable to the marketers of this field that they try to improve their image in consumers mind through utilizing better marketing strategies to be a good marketer in this area (See the Figure 8).



The result indicates that most influential factors to buy the energy drink product of selected brand were a taste of the product (65.40%), availability of the product (13.50%). Moreover, ingredients of the product (12.50%) packing of the product (4.80%) and price of the product & Other factors (1.90% each) were in this order. This result gives the direction to the marketers of this field to be a good and leader of the market. They should consider the taste of the product as a high critical factor to attract and sale of energy drink to the consumers then the availability of the product, its ingredients and packing shall also be considered an important factor to lure the customer to buy their product. Adoption of this advice will be a great chance to gain more market share and good impact of their marketing strategy to the targeted consumers (See the figure 9).

DISCUSSION AND CONCLUSION

All people, young and old, like health drinks. They use healthy beverages, refreshments to relax, and energy. Health drinks have become an integral part of their lives. It is necessary and must ensure that these efforts are combined among different stakeholders. The conclusions of the research direct to an assortment of policy guidance, enforcement, general learning and study that can help formulate strategies and arrange to achieve the goal of the safe use of energy drinks.

The survey result suggests that taking energy drinks; there is a trend and widespread use of energy drinks among young people, especially students in the age group 23-27 (72.10%), 22 years 24%, indicating that 96% of young people are very likely to drink this in Saudi Arabia. In this sense, the drive to stimulate consumption with age should be a cause for concern. This figure is alarming because this high demand by the consumer is after a partial ban on advertising and selling some places as mentioned in the country. This result also supports the previous study (Harris and Munsell, 2015, Pomeranz et al., 2013).

The results of the survey and the trends of participants indicate a high level of social acceptance of energy drink consumption about 94% of young people drank this 3-9 packs per week and was 80% among them within 3-5 packs consumed per week. This result suggests that consumers now have a more severe dose than previous study (Alsunni et al., O'Brien et al., 2008; Mintel, 2011). The of positive attitudes of consumers regarding the energy drink, in particular, this may be because besides being widely marketed and adverse effects did not occur immediately but became apparent only after an extended period. According to the marked, increase in consumption the largest attractiveness in groups of young people. In this context, consumption should be considered as a crucial cycle, and this situation requires proper attention because of the potential effects of the negative impact of energy drinks on health (Rottlaender, 2015; Azagba et al., 2014, Larson et al., 2015).

On the other hand, there is now a partial ban on advertising, sales of energy drinks and some public and indoor places. It is prohibited now to sell energy drinks in restaurants and cafeterias in government facilities. As well as Education places, health services institutes, sports and public and private clubs. Although alternative advertising, such as social networks, focuses primarily on youth campaigns, this may cause the widespread use of energy drinks among them. Moreover, the seller only with this health warning about the use of rare labels once reported in details about the potential health effects, which led to a conscience risk of inadequacy among the general public (Mets et al., 2011). It can contribute the awareness of adverse health effects of energy drink and provide advice and discussions with schools and universities, in collaboration with government agencies and non-governmental organizations. Also, discussion of the proposed legislation to regulate some of the components (especially caffeine), and the detail description of packaging, distribution, and sale of energy drinks should be started (Pomeranz et al., 2013).

In this study, the Red Bull is the most favorite among the energy drink consumers, and the product available in the store in Saudi Arabia. Red Bull list is at the top to maintain its product available for the consumers. Red Bull acceptance rate is very high as the delicious and tasty energy drink product among the consumer. This brand also has the highest brand image among young consumers as compare to other brands in the market serving in the same field. The most influential factor in the purchase of this product is the taste of the product in this study, so it is a clear image of the brand and this is among the best for all the marketing of energy drinks in the region. As for manufacturers, they should be aware that consumers are the focal point in any commercial project. Here is the need to know that the consumer is one of the main determinants or decisive force in the market. Therefore, the marketer should understand about what consumers are very sensitive to the reaction expect from it exactly. There is advice on the urgent need for manufacturers to offer healthy energy drinks at competitive prices, but also has to see that quality or level is not deteriorated and should not affect the health of innocent consumers.

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The Cross-Cultural Experiences of Saudi Sojourners in the United States: A Study of Intrapersonal Identity Conflict

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The Cross-Cultural Experiences of Saudi Sojourners in the United States: A Study of Intrapersonal Identity Conflict

Abstract

What are the cross-cultural experiences of Saudi sojourners studying in the United States that lead to intrapersonal identity conflict? Sojourner identity conflict is a foundational issue in culture shock and can promote or limit positive relationships between Saudi and American students. It is important to study Saudi sojourners' cultural backgrounds and the factors that inhibit or promote assimilation into their host culture to ensure the success of cultural exchange through providing data needed to learn how to best ameliorate the dissonance caused by identity conflict. By employing a phenomenological approach, this research provides findings relating to acculturation strategies of sojourners to analyze these processes and their impact on intrapersonal identity conflict. Key themes are discussed in the areas of: perceptions of the United States, study experiences, living experiences, successful versus unsuccessful coping strategies, extent of social support networks, perceptions of the United States and its people, and perceptions of those of the opposing sex.

Key Words: Identity conflict, Sojourners, Saudi students, Cross-Cultural Experiences

1. Introduction

Sojourner identity conflict is a foundational issue in cultural shock that inhibits the opportunity for cooperative, beneficial, and harmonious relationships between Saudi and American students. By employing interviews, study respondents provide detailed

information about how they had, to varying degrees, struggled with culture shock and acculturation, in addition to trying to stay focused on their studies.

The central research question for this proposed study is, “What are the cross-cultural experiences of Saudi sojourners studying in the United States that lead to intrapersonal identity conflict?” This question is of both theoretical and practical importance as addressing it advances the literature on the socialization and cultural implications of studying abroad, specifically relating to interpersonal identity conflict, but also stands to improve relationships between students and their respective host cultures. Intrapersonal conflict—the internal struggle of one’s own identity—is theorized to arise from clashing cultures, which cause individuals to overcome competing demands (Erikson, 1950; Leong and Ward, 2000). This study assesses the competing demands experienced by Saudi Arabian students as they adapt to American culture. These students resist or accept their host culture to varying degrees. This research uses a qualitative approach to present the experiences of participants’ interpersonal identity conflict using a phenomenological design.

Identity conflict impacts interactions between individuals on different cultures (Slocum-Bradley, 2008). Individuals of different cultures often find it challenging to engage with individuals of other cultures without fear of losing their own culture or acting in a manner offensive to the opposing culture (Slocum-Bradley, 2008). The result is often that such interactions are anxiety inducing and result in intrapersonal identity conflict (Salhi, 2006; Slocum-Bradley, 2008).

Given the striking differences between Saudi and American culture (e.g., different primary languages, religiosity, political culture, and gender dynamics), the case of Saudi sojourners studying in the United States is exemplar for advancing the research on intrapersonal identity conflict and sojourners. Saudi sojourners are predisposed to potential cultural clashes with their hosts (Huntington, 1996; Haas, 2012; Said, 1977; Ward and Kennedy, 1999). This predisposition was only exacerbated by the World Trade Center bombings of February 26, 1993 and September 11, 2001. At current, the research on multi-culturally based conflict is scarce (Rosinski, 2003), but even more so for Saudi sojourners (Shaw 2010).

The King Abdullah Scholarship Program (KASP) began in 2006. Since its inception, thousands of Saudi students have travelled to the United States to received American higher education and experience American culture. It is important to study Saudi sojourners' cultural backgrounds and the factors that inhibit or promote assimilation into their host culture to ensure the success of KASP through providing data needed to learn how to best ameliorate the dissonance caused by identity conflict.

This study begins with the premise that not individuals experience socialization in the same manner and thus, not all individuals experience intrapersonal identity conflict in the same manner (Erikson, 1950; Habernas, 2003). However, by virtue of intergroup relations being formed by homophily, it is also expected that there will be commonalities amongst the interviews based on shared identity (Brewer, 1999; Tajifel and Turner, 1996; Triandafyllidou, 1998). This observation, which is supported by social identity theory

the issue of identity conflicts as experienced by Saudi student sojourners through hearing their diverse stories.

According to Creswell (2007), the phenomenologist focuses on describing what all participants have in common as they experience the same phenomenon. Campbell (2011) states that such methodology will: 1) identify the shared experience of the Saudi sojourners, 2) locate the collective nature of their experience, 3) identify experiences that are common among numerous participants, 4) locate the core of their experiences, and 5) investigate how they experience the phenomenon. The phenomenological approach is designed to let subjects 'speak for themselves' rather than to allow the research to be guided by an overarching conceptual design. "Phenomenology is concerned with the study of experience from the perspective of the individual, 'bracketing' taken for granted assumptions and usual ways of perceiving. Epistemologically, phenomenological approaches are based in a paradigm of personal knowledge and subjectivity, and emphasize the importance of personal perspective and interpretation" (Lester 1999, p. 1). When studying subjects from the Saudi Arabia in an American context it is particularly important to let the participants speak for themselves given the extent to which persons from Middle Eastern cultures have been objectified and essentialized in the past.

A wide variety of cultural texts and cultural artifacts are drawn upon to analyze the experiences of the participants, making discourse analysis less appropriate. Although verbal responses will be important, other sources of information are drawn upon (including non-verbal texts such as clothing, artistic media, music, and other naturalistic observations of the culture). In fact, one of the guiding assumptions of the research is the need to

transcend the purely verbal to paint a full picture of the culture. The focus is likewise broader than with narrative research, which focuses upon how human beings tell their stories—although the how's and why's of the individual's story-telling are important, the broader lens of phenomenology will also allow the researchers to incorporate objective data into this holistic study of a multifaceted phenomenon.

Finally, intuitive inquiry is inappropriate given the extent to which it emphasizes the subjective experiences of the researcher. Intuitive inquiry is defined as “an epistemology of the heart that joins intuition to intellectual precision in a hermeneutical process of interpretation...informed by feminist theory, heuristic inquiry, hermeneutics” (Blake, 2012). Once again, rather than emphasizing the researcher in this inquiry and the researcher's biases and assumptions (or attempting to access the researcher's intuitive ‘heart’), the focus will be upon the lived experiences of the participants in a broader fashion. It is their words and perceptions that will be chronicled and examined, rather than a more self-reflexive emphasis on the perspective of the researcher.

2.2. Research and interview questions. The central research question for this study is “What are the cross-cultural experiences of Saudi sojourners who have been studying in the United States that lead to intrapersonal identity conflict?” Interview questions designed to provide meaningful information to addressing this question include the following:

- Explain your past and current experiences of living in Saudi and American societies with as much detail as you can.
- Please describe how cultural differences as manifested in Saudi Arabia and the United States affect your identity?

- Please list and explain which strategies you utilize or have utilized to balance your cultural identities.
- What are the positive and negative aspects you have found in American culture that made you question your Saudi identity?
- Discuss your current thoughts about living in the United States.
- Before coming to the United States, what were your thoughts about the United States?
- Please describe how living in the United States can affect your reintegration in Saudi society.
- How do you believe you can improve Saudi Arabia's future?

2.3. Sampling. This study employs a judgment sampling approach. Marshall (1996) defines judgment sampling as a non-random sample that selects participants based on the researcher's "practical knowledge of the research area, the available literature, and evidence from the study itself" (p. 523). Using this form of sampling can give more accurate results as compared with other sampling approaches. According to Marshall (1996), researchers usually use this type of sampling if they want to study subjects who have specific experiences or have special expertise in order to present a critical case sample or key informant sample. A satisfactorily representative and targeted sample was used for two main reasons: 1) the researcher has a practical knowledge of the study's context and 2) the researcher wants to connect his research with participants who have the special qualifications indicated. The selection of the sample included different samples from a number of subgroups, such as sex, age, and location, in order to give equal representation for those subgroups.

2.4. The sample. After setting the inclusion criteria, potential participants were contacted. This researcher contacted an acquaintance to be both a participant in this study and act as a key informant. After completing the preliminary forms, the informant, a Saudi sojourner studying in the United States, agreed to participate in the study as well. The key informant met all the criteria for inclusion. Creswell (2007) claims that phenomenological design calls for the researcher to “interview from five to 25 individuals who have all experienced the phenomenon” (p. 61).

2.5. Data collection. The data collection method was a semi-structured tape-recorded interview. In a qualitative study, the researcher is the primary instrument for collecting data (Creswell, 2006; Marshall and Rossman, 1999). Furthermore, interviews are one of the most appropriate methods in collecting complex social interaction and human behaviors data (Miller and Crabtree, 2004). Kvale (1996) states that the purpose of selecting the interview format is to “obtain a qualitative description of the life world of the subjects with respect to their interpretation of meaning” (p. 124). By using semi-structured interviews, participants had the opportunity to generate new ideas about the topic through a process of self-reflection.

The interview questions were based on two core topics: 1) the participants’ hidden social, educational, and cultural difficulties in their host culture(s) and 2) the varied experiences of the participants in dealing with identity conflicts, which arose during their acculturation in the United States. Each participant shared thoughts and experiences about those two main topics.

Open-ended questions were asked throughout the interviews. According to Daymon and Holloway (2002), open-ended questions can be used to engage participants fully and naturally in conversation with the researcher. Berg and Lune (2011) support that claim by stating that open-ended questions can guide the interview to reveal experiences without forcing a participant into one direction.

Participants were asked to read the questionnaire and sign ethical consideration agreements, such as consent to be recorded. Prior to each interview, the participants were informed about the purpose of the study, the estimated time the interview would take, and the process of the interview. A sixty to eighty minute interview was enough to gather sufficient information. Interviewees were contacted via phone or email in order to confirm their willingness to participate. If the participant was located within the geographical region of the researcher, then the interviews took place at the interviewees' homes in order to make them feel comfortable, with the exception that if the participant would feel more comfortable somewhere else, then different arrangements were made. If the participant was not in the same region as the researcher, then Skype software was used. The call was recorded using Call Graph, software designed to record Skype calls. In the Skype interview the video option was used so that each person could see the other. However, in some cases the researcher did not use the video option if the quality of the participant's Internet connection affected the quality of the transmission. Skype was used for two main reasons: 1) Skype is free to all users and 2) it is routinely used by Saudi students to call their families and friends in Saudi Arabia and is therefore a mode of communication comfortably used by such students. Each interview was recorded and transcribed immediately after the interview and then analyzed by using the appropriate data analysis software. The

transcribed data was reviewed several times in order to ensure its accuracy (Creswell, 2006).

Mauthenr, et al. (2002) states “qualitative research relies upon gate keepers as a route of initial access to participants” (p. 55). The key informant acted as the gatekeeper by providing the names of the students currently studying in the United States. Engaging the key informant and the participants was not a problem since this researcher and the key informant share the same background as the participants. This was an advantage because it was easy to share and understand the needs, language, goals, and desires of the participants.

2.6. Data analysis. This study used Moustakas’ (1994) approach to phenomenological data analysis (revised from the Van Kaam method). Analyzing phenomenological data begins with horizontalization (Moustakas, 1994). For horizontalization the transcribed data was read several times until it became familiar. For the first reading, a comprehensive understanding of the participants’ responses was sought. Next the transcribed data was read for the second time using note taking along with memos of short phrases, ideas, or key concepts that could offer knowledge and insight. Then the transcribed data was reread in order to discover any deeper meanings (Creswell, 2007). Any overlapping, repetitive, and vague expressions that did not contain reflections of the Saudi sojourners students’ experiences of identity conflict were removed from the final transcription (Moustakas, 1994, p. 121).

The next step in analyzing the data was generating clusters and themes of meaning (Moustakas, 1994). After this researcher became fully familiar with the data, the data was

analyzed and coded by developing themes, interpreting and describing them in detail, and then placing them in categories. Open coding was used in order to avoid forcing the data to be a part of a fixed coding scheme. The codes were examined in order to assess each code in a related theme or category and then those themes were used to write both textural and structural descriptions. The textural description provided an account of what each participant experienced. The structural description indicated how the contextual environment in the United States affected or re-shaped the participants' identities. The last step in analyzing the data was providing a composite description of the meaning and essences in order to represent the targeted population as a whole.

2.7. Validity. A number of researchers (Maxwell, 1996; Kvale, 1996; Hammersley, 1998; Silverman, 2001) suggest that the consideration of validity with qualitative research is important as a tool to evaluate the research's quality. Maxwell (1996) defines validity in qualitative research as "the credibility of description, conclusion, explanation, interpretation, or other sort of account" (p. 87). These criteria were used to examine validity in order to decrease and limit the subjectivity issues.

To ensure dependable quality of the data in this study, the researcher dealt with the validity issues in the following ways. First, as a current Saudi student sojourner in the United States since 2006, the researcher has a good understanding of the study context and, therefore, he is more likely to present a convincing explanation of the Saudi student sojourners' perspective. It is expected that he is more likely to be seen by the participants as a member of their group, one that can be trusted more than an outside researcher (Daymon and Holloway, 2002). Second, comprehension of the collected data was achieved by submitting

it to the participants for their reactions. This strategy enabled the researcher to “provide feedback to participants, enables [the researcher] to check the [participants’] reaction to the data and findings, and helps to gauge their response to your interpretation of the data” (Daymon and Holloway, 2002, p. 95). Third, the researcher employed an ongoing peer review strategy by allowing his colleagues to discuss his analysis and interpretation of the collected data. According to Daymon and Holloway (2002), this strategy helps the researcher to detect bias and receive alternative explanations. Finally, this study provided rich descriptions about the processes, contexts, and participants in the current research. This enabled a view of the comprehensive setting (Daymon and Holloway, 2002).

3. Findings

This section details the participants’ opinions as revealed through the research questions. Moustakas’ (1994) methodology was applied in this study to collect the responses of the Saudi sojourners. The interviews were successfully carried out per the methodology, which is described in the previous section. The key themes identified when applying Moustakas’ (1994) methodology include the following: perceptions of the United States, study experiences, living experiences, successful versus unsuccessful coping strategies, extent of social support networks, perceptions of the United States and its people, and perceptions of those of the opposing sex. To comply with Moustakas’ (1994) methodology, this researcher collected all the data for examination and treated the data as having equal weights. All the pieces of information had an equal value at this stage, which complies with horizontalization. Next, in the reduction stage, this researcher transformed the collected interview responses into alphabetical, ordered and simplified forms. At this stage, themes were identified from the vast amount of data. For the clustering of the data, the un-

supervised data items were clustered into meaningful groups. Sub-themes also emerged. Validation was satisfied with an in-depth, semi structured format, which allowed this researcher to easily distinguish similarities and differences among respondents' answers, while also being flexible enough to allow further exploration. A short description was given to describe the identified themes, including what they aimed to assess. The themes were structurally arranged to highlight the frequency of responses given to each theme. The next section describes the coding and theme identification stages in detail based on the above process.

3.1. Participant Demographics. Age, sex, and educational qualifications were important criteria in selecting the participants so as to acquire a cohort that could most comprehensively answer the research questions. The participants' demographics are listed in the following table:

Table 1: Interviewee Demographics

Sex	Age	Location (State)
Female	24	California
Male	25	Pennsylvania
Male	49	Florida
Female	26	Pennsylvania
Female	27	Florida
Male	39	Florida
Male	38	New York
Female	26	Oklahoma

3.2. Horizontalization and Coding. According to Moustakas (1994), the coding of data includes three main stages, including, namely, open, axial and selective coding. This researcher constructed the categories and subcategories during the coding process, which were then sorted during the open coding stage to support the categorization of emerging themes.

To identify relevant themes, this researcher first analyzed the data to highlight words that were repeated and based on those words, themes were identified. Word repetition was analyzed informally by investigating the text and noting the words that were used most frequently by respondents during the interviews. Second, the data was comparatively analyzed, which helped in identifying differences and similarities in each individual's responses. Third, the data was evaluated to present any analogies that would represent thoughts of participants. Based on those analogies, themes were highlighted. Last, a contrast approach was used to look methodically at words and phrases that could be indicative of meaningful conceptual relationships. This was accomplished by extracting words and phrases such as "because," "since," and "as a result," which helped in identifying factors that made it difficult for students to adjust in new culture. This researcher thoroughly analyzed the content of the interviews, which were conducted with students, their parents, and teachers. The data was then categorized according to factors pertaining to school life, home life, and community life. This assisted in analyzing the data more effectively and separately evaluating the responses of each individual. The researcher was able to uncover the challenges that the four students faced and may continue to face in their school and home lives. This also helped with assessing the various approaches

adopted by their parents and teachers in overcoming these challenges, which have resulted from cultural differences.

3.3. Interview Transcripts and Coding. The researcher adopted an open coding methodology, which required the constant comparison of the responses emerging from the interviews and then making abstractions. This was accomplished by bearing in mind that every response indicates an underlying top-level concept. This was the reason that the transcripts were re-read and coded to a conceptual code. The codes were sorted and resorted to illustrate conceptual patterns about the cultural identity of the sojourners. During the coding process, the researcher employed self-inquiry to assess which categories the emerging responses best illustrate and what similarities or difference exist among them.

From the transcripts, the key points were determined and coded. The significant points from the unique identities were labeled for comparison to the rest of the interview transcripts. “Unique identities” refers to the fact that each respondent was his or her own autonomous person answering various questions, without noticeable pressure or coercion to respond in certain manners. This researcher then analyzed the codes and grouped those that were linked to the common themes followed by the patterns that resulted from this grouping to determine the most frequently found concepts. The emerging ideas were then regrouped into a higher commonality order (subcategories) that were regrouped further into the highest order of commonality (major categories).

Table 2: Major and Sub-Categories

Major Categories	Sub-Categories
Perception of the United States before leaving Saudi Arabia	Ideas about “positive perception,” “negative perception,” and “neutral perception”
Study experience	Notions about “language barriers,” “feeling of embarrassment and inadequacy”
Living experience	Perceptions around “missing culture and family life,” “extent to which prejudice and racism was experienced,” “independent living,” “culture shock”
Personal strengths and primary motivators	Ideas regarding “primary motivators to succeed” and “personal strength”
Social support networks/ Processes	Notions highlighting aspects of “support from professors,” “religion,” “family,” and “other Saudi Arabian international students”
Understanding of United States and its people after spending time in the host culture	Perceptions about “safety and freedom”
Cross sexual relationships	Perceptions about the “opposite sex”

4. Textural Description

4.1. Perception of the United States. Saudi sojourners' perceptions about the United States before and after studying in the United States were mixed and at times included negative, positive, or neutral perceptions. After studying in the United States, respondents overall reported viewing the country positively. Such an overall respondent-reported positive perception is consistent with the literature pertaining to international students as provided by the National Association for Foreign Student Affairs' (NAFSA) 2007 meta-analytic publication. According to that work, students and non-students in many countries consider higher education in the United States to be preeminent. A study by Constantine et al.'s (2005) found that the participants thought that the USA would offer international students increased opportunities for personal and academic success. In the same manner, Bornshtein (1987) found that common reasons for which students apply to study in the United States include the educational resources and the advances in technology in learning and development. In one of the studies in the NAFSA publication (2007), international students held four, negative, pre-entrance perceptions of American students and attaining

interact with their relatives subsequent to the terrorist attacks. For some other participants, the collective perception was not as negative as in the previous example. Conversely, they considered the United States to be a great country and as the one with different and developed public spheres of interaction such as business, education, technology and many more. Participant 7 believes that:

United States has the best people in all of those different sectors. I didn't have any negative thoughts or stereotypes about the United States and I still hold the same position today. This student thinks that media has played an important role in developing various stereotypes about Americans that Americans and non-Americans begin to believe. Subsequent to seeing movies, for instance, they also believe that it is dangerous to go out by themselves due to high crime rates. However, this phenomenon did not apply to the interviewed participants of this study. In contrast, what they found was that Americans do not care about what others think, and they respect the personal space of others.

Participant 6 thinks that:

They think what they feel and they don't think twice usually. They don't lie and they hate the lies and they gone believe anything that I would say even if I told them that there are a green man in the front of my door... they are not stupid but they are just a simple people without that much of complication.

Like their relatives, most of the students were afraid of how Americans would treat them in a post-9/11 world. Some of them thought that they might be viewed as and treated as

terrorists. This was their biggest fear, but when they arrived to the United States, they felt that people treated them fairly, which completely changed their views of Americans.

However, it should be noted that Participant 1's greatest concern was Hijab. She was afraid that people would treat her as a terrorist, but her fear abated when she received a great amount of support from her peers and professors. Nevertheless, the students also relayed less positive views. For example, Participant 3 indicated that the American students with whom he interacted in class were self-centered. The participant mentioned an instance in which a classmate asked him to give him class notes, which the participant agreed to do. However, when the participant asked for the student to reciprocate, he refused.

Ultimately, Saudi students return to their native country with high hopes for the future. They believe that they will be able to utilize their newly learned skills and accumulated knowledge in Saudi Arabia for its betterment. However, they expressed a realization that there may be issues in implementing what they have learned in the United States due to various Saudi cultural and religious restrictions. The students think that the Saudi government needs to give international students the opportunities to make a difference in Saudi Arabia. Participant 8 noted that, "If we speak about changing the Saudi traditions I believe that I and other students can make a big different in reshaping the Saudi culture when we go back to Saudi Arabia."

4.2. Study Experience. The participants provided detailed responses during their interviews about their overall living and study experiences in the United States. The outcome of this study shows that one of the significant academic challenges for the Saudi sojourners relates to the ability to use the English language proficiently. One of the main

personal challenges as experienced by the Saudi Arabian sojourners while living in the United States was homesickness. The participants reported that they were negatively affected by being away from their family members and homes, places where they could always find support. However, this study did not find any participants reporting verbal insults. For the Saudi students, the lifestyle of people in the United States is totally different than that which exists in Saudi Arabia, which could have been a source of verbal insults. However, this was not found to be the case. Some of the students indicated that they like how older generations in the United States teach younger generations to pursue interest of passion. The participants especially appreciated how Americans are not afraid to freely express themselves.

Some participants noted the opportunity and freedom to experience new things as a main positive aspect of U.S. society. For example, Participant 2 stated the following:

What I like here in the United States the most is the older generation here teach the younger generation to do whatever they believe and encouraging them to do what they like because they believe that doing what the individual wants will add something to the society not what your family or your society wants to do in your future. What makes America a great country is that everyone here is doing what she wants or like.

For others, as already noted, Americans' ability to freely express themselves seemed to be a welcome tradition; one that is deeply rooted in the United States' history and philosophical origins. However, some participants noted that there is no real connection among Americans like there is in Saudi Arabia, Fortunately, however, that has not affected some of the participants' senses of self (identity) because they have very strong connections

with their families and other social supports in Saudi Arabia.

Students appeared to marry this sense of connection with countrymen with a desire and even need to make the country better by using skills and knowledge acquired in the States. Students indicated that they think there are countless resources in Saudi Arabia that are not used wisely. Participant 4 noted the following: “The Human resources are the main key for any successful so we have to take care of all students who are going back and take advantage of their knowledge and ability.”

The participants believe that Saudi Arabian society can be improved by advancing education and technological efforts. They also believe that accomplishing this could prove difficult due to the country’s more traditional and social, rather than business-related, societal framework. The students noted that Saudi society could be improved if there was more of an easing of tradition in order to allow for progress in education, the economy, and technological advances. The participants think that the Saudi government-sponsored foreign scholarship program will have a positive, cumulative, impact on the future of Saudi Arabia. International students, specifically Saudi students in this case, can bring many benefits to Saudi Arabia.

Participant 1 indicated the following:

When I came from the Saudi Arabia I started attending an English center. That language center has a good environment for me because I found in that center a lot of other Saudi students along with many other international students. That environment made me feel comfortable. I believe that if I didn't go to that center my life would be

totally different here in the States because the University life or the academic life is different than starting in a language center. Attending the language center helped me to learn how to interact with different people. I was really not good in making conversation in English. The Language center helped me a lot. Before that I felt like an alien because I just had some basic academic vocabulary that related to my field but it was hard for me to interact with people on the street and the language center helped me a lot to overcome that issue.

Similar to the language as being an aspect of culture issue, some of the participants continued to be afraid of losing their identities. For example, Participant 4 articulated the following:

I don't like the illegal or the taboo interaction between people here. I am afraid about my kids to take this form the American culture and I am trying to protect them against such thing. Also the family relationships here in the United States are so poor unlike the Saudi Arabia. American people are so friendly but when it comes to family they have really bad behaviors toward their family members. Other than that, I found many good things in the American culture including the tolerance between people and that thing can't be found in Saudi Arabia. For example, my neighbors here in the States are coming from much different culture background such as Indian, Chinese, Asians and they have a good relationship toward each other. This thing, I couldn't find it in Saudi Arabia.

This response highlights this fear of acculturation, which as noted in the above response, specifically a fear that participants' children could be corrupted in American society

because of the relaxed interpersonal behaviors, e.g. relations between sexes, if participants were to remain in the U.S. post-study. In the United States, these deconstructed taboos further demonstrate how Saudi and American societies are drastically different. When participants were in Saudi Arabia, they were living normal lives by their standards; they sought employment and opportunities to support their families in accordance with the family-centric nature of Saudi society. But when they came to the States, they began to appreciate how culturally different the United States is in comparison to Saudi Arabia. Instead of just studying in the States, they were able to recalibrate their worldviews in addition to acquiring the skills and knowledge needed to better help their families in Saudi Arabia.

4.3. Living Experience. Most of the participants' experiences were similar since they all lived the lives, albeit temporary, of foreign students in the United States. As noted in the previous sub-section, they believe that Saudi culture is conservative and more family-oriented when compared to the U.S. However, some of the students like living in the country because of that clear difference. Arguably, such a difference allows students to have new and transformative experiences. Similar to what was highlighted in the previous sub-section about corruption, the respondents think that Saudi Arabia is more misleading and corrupt when compared to the United States and therefore, it is much easier to live in the United States. The students feel more empowered in the States, something that was articulated by Participant 7 in the following statement:

Living in the United States is much easier than living in Saudi Arabia as I can, for example, finish all my things here in the United States by Internet or phone without knowing anyone to help me finishing my things.

Moreover, participants also agreed that the United States appears to be better than Saudi Arabia with respect to law and order as judged from a justice rather than punitive framework. One participant noted: “I prefer to live in a clear and a very strict system because no one will respect a system unless it is very strict and this one of the things that we don't have in Saudi Arabia.” However, such a perception may be just that, rather than an accurate assessment of American jurisprudence since the sojourners’ experiences with the criminal justice system was limited or altogether non-existent. For instance, Participant 6 provided a quite grounded view of sojourners’ cultural identities and perhaps consequent perceptions, which actually contradicts the more life-changing testimonies provided by other respondents, by noting the following:

OK, I will be honest with you, many Saudi Students here are just hanging out with other Saudi students so they didn't really break the circle as they keeping speak in Arabic all the time and do all the thing that they were doing in Saudi Arabia because they didn't give them the chance to interact with the American culture or the American people. I feel that they didn't communicate as much as they should with the American people and that why if you asked them a question about their knowledge or immersion about the Americans they would not be able to answer you in a good and fair way. Actually and to be honest with you, until now I didn't meet a Saudi girl that are willing to hang out with other American girls... I think that they are not courage enough to interact and know the Americans more.

Moving on, the students believe that although studying in United States can be highly beneficial, upon arriving to the U.S., they immediately encountered an environment that was immensely different from their homeland and native culture. Beyond their initial

culture shock, they also faced language challenges stemming from the fact that Arabic is their first language. Due to the fact that Arabic and English are such different languages, the students faced a formidable language barrier that made it more difficult for them to effectively and confidently navigate the educational and social spheres in their learning environments. Moreover, the nature and extent of cultural diversity in the country also served as a challenge.

The participants indicated that their perceptions in some respects began to shift closer to those of Americans during their stays, arguably because they were, in fact, living American lives vicariously, which was both challenging and beneficial. Ultimately, their experiences in the United States were transformative and helped them to learn a lot about themselves, other people, and the United States. A significant revelation of this study was that the participants also now believe that their living and study experiences in the United States have made them more tolerant and open-minded. The participants reported that studying in the United States positively affected their concept of values and education by helping them learn new skills and by becoming more knowledgeable of other cultures. Overall, the sojourners' experiences from studying in the United States were generally positive and satisfying and they will recommend studying in the U.S. to friends.

All of the participants in the study stated that they have come to better understand American culture as a result of their time in the U.S. Principally, the students indicated that they perceive the United States to be a rather safe and free country, which is enjoyed by Americans. They found America to be safer than what they actually expected. Moreover, they indicated that Americans are kind and friendly, supportive as evidenced by peer,

professor, and friend relationships, and that such relations helped the students with overcoming culture shock. These perceptions were developed over time.

Feeling isolated is a major challenge that foreign students often have to overcome. Students may find it difficult to make friends and socialize with others with different cultural backgrounds. However, gradually, if they widen their area of interaction and leave their comfort zones, they can cope with such a challenge. Most of the Saudi sojourners in the United States display their adapted identities with only a few people, including close relatives, but when they deal with others in Saudi society, they feel embarrassed to express themselves. There have been many Saudi students who returned home and accepted the changes in their personalities and their American experiences. Unfortunately, however, a problem arises when they respect their right to alter themselves but fail to recognize the rights of others to do the same. It can be said that being in the United States affected the identity of the sojourners in a good way. They feel that they are stronger now. They always knew their rights and what should be done and what should not be done, but now they can more confidently express their feelings. They can do whatever they want without caring about what other people say about them or what they want them to do. This is, of course, the biggest change in their personalities and identities. Most of the participants believe that such change is a good thing and a source of pride. They hope that when they return to Saudi Arabia, they will bring those good things that American culture taught them.

The students indicated that the Saudi students experienced culture shock as a result of being faced with stark differences in language, communication styles, food options, and lifestyles. The culture shock can be manifested physiologically or psychologically, and it

was emphasized that a student needs to acculturate to adapt to studying in the United States. Most of the students believe that they belong to the American culture more than they belong to the Saudi culture because the individual rights-oriented nature of the United States allows for greater introspection and new and sometimes controversial experiences and ultimately, personal growth. Per the qualitative data it is clear that the students are willing to improve Saudi society by sharing their American learning experiences. They are willing to test traditions and religion and promote freedom of speech and expression in their society. All these goals will be difficult to implement in their entirety, and the history of reactions of those in Saudi society to similar endeavors cannot be encouraging. Despite this, the students believe that Saudi Arabia has a bright future. The students love being in Saudi Arabia. They also, however, noted that they love the American political system, so they think they will try to bring some aspects from the American culture to Saudi Arabia when they return. While in the United States, male Saudi students respected women and treated them fairly and when they return to Saudi Arabia, they could likely replicate that behavior. They have started realizing that male mistreatment of women in Saudi Arabia is a cultural rather than religious phenomenon. Many Muslim men in the States do not subjugate women, which could be an eye-opening revelation. Although the students are largely open-minded, there are some students who have remained conservative, and do not interact much with Americans, choosing to finish their studies in relative social isolation.

4.4. *Personal Strength and Primary Motivators.* The data also dealt with successful coping strategies and personal strengths that the Saudi students used and brought with them to assist them with completing their studies in the United States. Moreover, within this area, two main ideas emerged: personal strength as demonstrated by successful coping

strategies and sources of primary motivation to do well in the United States. It should be noted that, when the participants discussed their personal strengths and motivators, it was difficult to distinguish between the successful strategies they employed, which were part of their personal strength arsenals, from the strengths that they gained during their stays. The study participants reported being concerned about disappointing their families and their country if they were to have studied in the U.S. but returned to Saudi Arabia with little to show for their time in the States. Consequently, this fear of disappointing their families and country became a primary source of motivation to do well with their studies.

The interviewed students endeavored to cope with the challenges presented to them while studying in the United States by utilizing different (coping) strategies. The most commonly mentioned strategies included the following: focusing on the collective goal of going to the States (to study), learning English, watching Hollywood movies, accepting American culture, reading books, interacting with Americans, using technology to build friendships with Americans, and ultimately, overcoming culture shock. Primarily, the students attended workshops at local language centers to overcome their language barriers and consequently, become more able to acculturate themselves albeit temporarily in the United States. Watching movies aided students with learning about the United States – their new environment – as well as the particular cities in which they resided. The students became technologically savvy by using and becoming proficient with a variety of technologies. This was something that was not possible for most people in Saudi Arabia due to the relative scarcity of many new and expensive forms of technology. The support services that the Saudi students received from their professors, families, and through their faith, sufficiently insulated them from having any acute mental health issues related to the

potentially traumatic experience of being a foreigner in another land.

4.5. Support Process. As just mentioned, the student sojourners may have had relatively few individuals in their social support networks in the United States, but those individuals were sufficient sources of support nonetheless. One of the participants declined to pursue professional counseling to discuss academic or personal issues. This lack of interest in seeking professional help is consistent with the literature about cultural norms regarding support systems among international students. Overall, professional counseling services are not accepted as much in Middle Eastern cultures as they are in Western cultures. This phenomenon is likely because counseling as practiced in the West tends to employ a client and individual-centered approach for problem solving than that which exists in Middle Eastern cultures where there is an emphasis on communal problem solving. Furthermore, in the Middle East, there is an expectation that people are supposed to turn to their families, ethno-religious social resources and friends when they need help instead of utilizing professional (mental health or social work) services. Many in the Middle East consider asking for help outside the family to be a cultural affront and therefore, an offense worthy of social stigma.

Although the students did not report establishing any warm relations with their professors, they did, however, report that their professors cared about them and encouraged them to ask for additional support if needed. The students also reported that these non-familial relationships with the peers and friends complemented their educational endeavors and ensured that they were insulated from culture shock. By engaging in these intercultural exchanges, the students learned how to effectively communicate with people from differing

cultural, philosophical, and ethno-religious backgrounds, thus increasing their tolerance for others. The students learned from these cultural differences and tried to positively express themselves in new and sometimes tradition-bending ways, which served to further transform their individual identities. The students overcame, with varying degrees of success, culture shock by setting goals, reading books, engaging in productive tasks and increasing their interactions with the locals as already mentioned. Most of the participants tried to be themselves while also learning about American culture. They increased their interactions with locals and tried to communicate with their professors and peers on a regular basis. For example, Participant 2 articulated the following:

The good thing about the American people is that they will break the ice for you. For example, the first day that I came to Florida I found many neighbors welcoming me and greeting me, who made me feel accepted by them and they want to know more about me. Other thing is when I interact with the professors in my university, most of them accepted me as an international student and they are very understanding people and they don't judge me even if I did some mistakes because they knew that this is not my original culture and they knew that English is not my first language and that made me feel more comfortable.

Consequently, some students started to feel strange about their previous, as well as new cultural and religious identities. Their experiences led them to points where they were no longer “Other,” yet they were still different. They seemed to no longer be sojourners simply in another country but also among dichotomous cultural realms. In keeping with such monumental changes, some students – those who did not change as much as others – had

mixed opinions about students who had undergone considerable changes. Although two of the participants reported that they are still afraid of what their cultural transitions will bring when they return to Saudi Arabia, they noted nevertheless being willing to effect positive change in their country.

4.6. Understanding of United States and its People. The Saudi students did not report having any issues with beginning their studies in the United States. Social support from those in similar ethnic communities also helped the sojourners because they all had experienced similar situations, so they were able to empathize with each other. In contrast to this, and per most of the participants, the stereotypical media representation of Arabs and Muslims initially did not make it easy for participants to feel emotionally safe even if they wanted to speak with professionals. However, ordinary Americans were found to be considerably understanding and supportive; individuals who respect cultural differences. Therefore, there were mixed signals. Ultimately, however, the study participants did not feel unwelcome during their stays in the United States. The students sought employment to help them learn more about the working environment in United States, and to also facilitate improvement in their English skills – part of a sophisticated and insightful strategy to maximize their intercultural learning.

For participant 7, experiencing a less restrictive society was a major change. He noted that he will be more comfortable with and courageous to interact with the opposite sex. Participant 7 articulated the following:

I learned that people here have the right to express their thought and to think about what is right and what is wrong for them and I will use the same thing when I go back

to Saudi Arabia I will start speak freely and loudly. I don't have the fear anymore and I will critique anything that I don't like here... For example, I was talking to someone in Saudi Arabia about how bad throwing stuff when you are driving from the car's window and how bad that the Saudi police didn't give a fine for such act and I told him you can't do this when you are in my car. So I started by myself by teaching myself that I can't throw stuff from the window and then I started convince other people about or at least making them follow my rules when they inside my car. Many Saudi people think I am overreacting about those things but they can't push me back and I will keep doing what I believe is right for me.

The above statement highlights small gestures that can effect positive change in Saudi society. Overall, the students note that they have learnt a lot about that which can be implemented in Saudi Arabia to improve its society. But even these positive aspects fail to take into account the challenge that lingers from cultural differences that cannot be overcome so easily and so quickly such as understanding differences in humor. The fact is that, while some students find growth and positive change in addition to a lack of unresolved identity conflicts, others either experience identity troubles or are too much part of their culture to acculturate and conversely, experience cultural confusion and a sense of being an outsider. Participant 6 noted that:

Sometime Americans laugh on jokes that I don't laugh on because I don't understand what the funny thing about that joke is but because that is there culture so they understand each other jokes very well. So now I feel like I am foreign person in Saudi Arabia as well here in United States. I become an outsider in both culture and that is

really hard for me because I can't find a place that I belong to.

In contrast to the above, Participant 5 indicated that she has changed in great part because she is more confident and unlikely to care about how people appraise her value, especially if that appraisal is negative. She noted the following:

Before coming to the United States I was caring about how people see me and I was trying to get permission from my parents before doing anything but when I came to the United States I found that people here don't care about what other people thinks about them and I loved this idea and adapt it as I believe on it now.

This demonstrates that at least some of the students are willing to do what they are supposed to do, have firm heads on their shoulders, and not care about how society views them. This is one of the more serious, enlightened, and promising pieces of qualitative data.

4.7. Cross sex relationships. The students identified numerous ways in which culture affects relations between people of the opposite sex. Per Saudi culture and society, opposite sex relations are affected by various socioeconomic, religious, and familial factors. Relations between members of the opposite sex can be limited or even strained because students prioritize family over academics and social relationships. This dynamic continues even in new settings, specifically, in this case, when the students studied in the United States. For instance, students often miss classes to speak to their parents due to the time difference or leave the country for family events for extended periods.

For women, coming to the United States is an especially transformative event. By coming to the States, they are permitted to become more independent, have more freedom, feel

more responsible, have new experiences, have the freedom to interact with females as well as males, and simply, be more confident in who they are as individuals rather than components of a family and group-centric society as is the case in Saudi Arabia. Interactions with men, in particular, are more liberated. In Saudi Arabia, females and males do not communicate as freely as that which occurs in the United States. This is due to a number of cultural reasons, which by comparison seem to allow a culture of female subjugation. In the United States, female, Saudi students were able to learn about the conceptualization of female rights as an aspect of universal human rights in a way that is consistent with Islam.

One of the participants identified the issue of communication between the sexes as one of the main differences between the two cultures. She noted that there is a big difference in how males and females communicate in Saudi Arabia compared to in the United States. Per the data, it is clear the male, Saudi students learned to respect women more and treat them fairly, which are behaviors that they plan to replicate upon their return to Saudi Arabia. The female students are now trying to use media presentations to educate Saudi women that they can be true to Islam and Saudi culture and still be respected and pursue their own passions. One female respondent noted the following:

As a woman, if I want to ask a man in United States about anything he will be free to help me and give all the information that I want and that is something hard in Saudi Arabia. Another example, in Saudi Arabia if I was walking in the street and I smiled to a man that would be a big problem or no one can accept that but in the United States that is completely different as here it is OK say to any man on the street

something like good morning or how are you and move on... that it. When I was that one of our biggest problems was that issue. So I was trying to apply the Saudi culture into my life here in the United States and that didn't work at all.

5. Conclusion

This interview data facilitated the research knowledge of the cultural identity based on which it can be said that cultural identity is an important factor that can have a significant impact on reentry and readjustment of sojourns. The students who have retained the identities of their home countries will readjust into Saudi culture more easily on return than those who feel closer to the host country culture. Based on the results it can be said that not all the students necessarily assume the host country culture identities, but they retain at least some of their Saudi identities while abroad. The result show that keeping the identity intact into a new society is one of the main challenged which the Saudi students come across during their stay in the United States. More freedom of choice, and great social benefits awe the students, but they also know that their own culture is rich and more family oriented as compared to U.S.A. this where they suffer identity conflict. United states compel them to break their comfort zone because it is one of the ways in which cultural shock can be coped with, however during this process, there is pressure on the student to remember their culture, values and beliefs. Although there are some students who remain conservative in mingling into the U.S society or interacting with the people it is also hoped by these students that keeping their own values, they can bring the knowledge and learning back to Saudi Arabia.

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**THE EFFECTIVENESS OF MOBILE MARKETING AND BRAND RECOGNITION
IN SAUDI ARABIA: A LITERATURE REVIEW**

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Abstract

Information Technology sector is indeed very rapidly growing within KSA. Sales of internet and computers are highest in the country as compared to other nations in the region. Saudi Arabia is the second big market for the mobile phone in the Middle East. The country has specific rules and regulations to regulate and monitor the working of the mobile phone operators in the market. Saudi Telecom market also has grown tremendously over the past 4-5 years, and this is due to the result of the liberalization of the society and its thinking. This article describes the existing knowledge of how mobile marketing can increase value for consumers and retailers in the region. Mobile marketing and its activities are shown to be both an extension of consumers' shopping behaviours in Saudi Arabia. The article focuses on to know how mobile marketing creates value for consumers and retailers, enabling research that is more precise and development of managerial theories and tools while presenting both managers and academics with increased understanding of mobile purchasing and its value outcomes for retailers. For this study, an exploratory research has been taken, also more than hundreds of related articles have been reviewed, and outcome of this has been discussed.

Keywords: Mobile Market, value creation, mobile marketing, Saudi Arabia

I. INTRODUCTION

The subject of mobile marketing within Saudi Arabia has received increased attention in recent years, due to the growing potential which is represented by the country's consumer market. Indeed, the mobile market within Saudi Arabia is currently the largest within the countries which comprise the Gulf Cooperation Council (GCC) regarding its service revenue and its



number of subscribers (Yaici, 2013). It has 38.8 million active mobile users with a 132 per cent mobile penetration rate, resulting in a total of SAR 47 billion ion service revenue (Whitfield, 2012). The high level of mobile phone ownership within the country makes it ripe for the application of mobile marketing methods, although closer research suggests that there is fragmentation in this market, which may pose challenges for mobile marketers. In particular, the mobile base among consumers is split, consisting of 33 million smartphones and 24 million non-smartphones, with statistics suggesting that the number of non-smartphones will decline to approximately 11 million towards the end of 2016 (Yaici, 2013). Consequently, the mobile market is likely to become more homogeneous in the future, with the number of installed smartphones among the Saudi Arabian population reaching 40 million at the end of 2013 and approaching 55 million towards the end of 2016 (Whitfield, 2012). This increase in smartphone subscribers is representative of 16 per cent CAGR from 2011 to 2016. Statistics suggest that mobile marketing is highly effective in general at engaging customers, although few of these statistics have focused in particular on the impact that mobile marketing has on brand awareness. Smartphones are now growing an essential part of the lives of Saudi people (Alotaibi, 2015). The market remains significantly underexploited, with the levels of mobile marketing in the country being considerably lower than in the developed West (Euromonitor International, 2013). There is also less literature on the topic in the region compared to more developed regions, doing research targeting the area significant in this regard.

The objective of this research is to explain existing information on how mobile marketing can increase advantage for buyers and retailers. Power for customers is assumed to drive choice, use, and loyalty to retailers' firm and mobile marketing applications, etc. Also, the main research seeks to address the issue by asking, "To what extent is mobile marketing effective in Saudi Arabia, considering strengthening brand awareness in comparison to other forms of marketing?" Here mobile marketing is defined as "the distribution of any promotional or advertising messages to customers through wireless networks" (Heiki and Matti, 2005, p. 198). As These factors, create the foundation of competitiveness for retailers with cultural differences (Porter, 1985). The article will proceed as follows: the methodology of the literature search is represented followed by the literature review. Next, the findings of the review are considered. Finally, conclusions, managerial implications and implications for further research are conferred.

1.2. Objectives of Study

The main aims of the suggested research are to:

- To explore the information about mobile marketing and brand awareness
- To understand the forms of non-mobile marketing and brand awareness
- To determine the extent to which the specific cultural characteristics of Saudi Arabian consumers may affect the relationship between mobile marketing and brand awareness
- To formulate recommendations as to how the effectiveness of mobile marketing in Saudi Arabia can be increased to improve influence on the strength of brand awareness



II. METHODOLOGY OF STUDY

The subjective nature of the research question has led the researcher to utilize a phenomenological research philosophy, although the researcher wishes to adopt the best practices of a qualitative approach (Saunders et al., 2009). This was selected as it prioritizes the interpretation that different parties place on the research topic, and therefore is particularly useful in gaining a holistic perspective (Fisher & Stenner, 2011). Furthermore, as Saunders et al. (2009) explained, while the qualitative research provides a framework for existing theoretical constructs to be modified or expanded according to conceptual demands, aspects, and variables. The researcher assumes the perspective and feedback will lead to legitimately relevant and potentially useful recommendations regarding approaches to beneficial mobile marketing strategies.

It is suggested in research best practices that a study with such theoretical aims towards conceptual constructs be undertaken using a qualitative research design (Thomas, 2010). As mentioned, this qualitative approach considers the case of Saudi Arabia. The study was firstly approached through undertaking a more thorough review of more than hundreds literature about mobile marketing, its effectiveness and the use, and effectiveness, as well as mobile marketing in Saudi Arabia. Once the background literature review has been undertaken, then a quantitative study will be explored further. This instrument is believed to be effective as it allows targeted information to be recorded across a broad cross-section within a shorter period, compared to the other commonly used instrument (interviews) (Yin, 2008).

The literature review had been taken by selecting a series of keywords and key terms and then utilizing the keywords mentioned and key terms to search the relevant bibliographic databases to locate relevant research into this specific subject area. It aimed to elucidate the impact that forms of non-mobile marketing have on the strength of brand awareness, to provide a point of contrast to the findings of the primary research. The researcher suggested that a brainstorming or mind mapping process be used to determine the keywords and key terms that to be utilized, as a method such as this would allow all relevant keywords and key terms to be identified (Buzan, 2009). The relevant bibliographic databases that be searched include Science Direct, Emerald Insight, and Web of Science, along with the online portals of journal publishers such as Taylor and Francis, Wiley and Oxford Journals. Once the keywords, key terms, and the bibliographic databases had been selected, the keywords and key terms were entered into the databases. This allows all the relevant research papers to be identified, with those that are deemed most being selected and then used to build the literature review and then constructed using the information in these research papers.

Regarding the data analysis, the selected literature has been read thoroughly, and any relevant sections of the investigation found related to the topic have been saved for inclusion in the review of the literature. The literature review then is constructed using the information, that is utilized from other sources being cited and referenced correctly in-text too (or "intending to") avoiding plagiarism. The method used for this literature study is the Systematic Literature Review in which extensive literature study has been done to investigate the mobile market in the past and to analyze the current trend in the domain and how culture affects the mobile marketing.



III. REVIEW OF LITERATURE

3.1.1. Hofstede's cultural framework

One of the conceptual frameworks, which will be utilized in the proposed thesis, is Hofstede's framework of national culture. As argued by Kolb (2013), one of the key factors, which determine the effectiveness of marketing strategies, is the cultural characteristics of the consumer and given the difference, which exists between the Saudi Arabian cultural context and the Western context. Considering several studies outlined by Kolb (2013), it was decided that it would be necessary to examine these cultural differences within a formal framework. These communicational norms are affected by the interpersonal communicational styles of people and include both verbal and non-verbal cues (Gudykunst and Ting-Toomey, 1998).

Geert Hofstede finds the cultural difference across different countries. The study of the different cultures developed four-dimensional model for the intra-country cultural domain. Though he developed the fifth element into the model as well, the four fundamental elements have received more value and importance in the business circles. The culture of any country can be ranked in following dimensions according to Hofstede:

3.1.2. Power Distance Index

This dimension focuses on influence/wealth/power inequalities among people within a culture. Those countries who are ranked high on this dimension show some hidden system of caste that by large differentiate among the poor and rich as well as among the disadvantaged and privileged people within the country. Poor get poorer, are not able to improve their condition, and hence are blocked at different levels by the wealthy and powerful people.

3.1.3. Individualism

At the individualistic level, it can be observed that there are loose ties among the individuals within a group. Every individual looks after his/her desires. Moreover, form a shape of extended families who become protective for the family and the bonds among them. For example, the German culture is considered as individualistic while Guatemala is considered as the high collectivistic culture.

3.1.4. Masculinity

This dimension mainly focuses on the extent by which some society stresses the nature or achievement. Masculinity is a trait, which emphasizes genders' role, differentiation, wealth acquisition, and ambition. Different cultures give different importance to the role of the male regarding their ambition and achievement. Those cultures are having a high score of masculinity, are those who pay more importance to male workers at the workplace as compared to working women.

3.1.5. Uncertainty Avoidance

It focuses on the adaptability of any culture to changes and how it copes with the uncertainty. The emphasis is to what extent a culture feel threatened or anxious about the ambiguities. Risk taking and uncertainty tolerance different among the various societies and cultures. Those



cultures where this index is high, this shows that entrepreneur activities are mostly widespread across the country.

3.1.6. Long Term Orientation

This dimension highlights the differences between the East and West. It focuses on the degree a society embraces or ignores the forward-thinking ambition. Higher on this dimension means society is committed in its long-term commitments with its tradition and respects it.

3.1.7. Applying the Hofstede Model to Saudi Arabian Culture

The Hofstede analysis to Saudi Arabia is almost similar to any other Arab country. The Muslim trust show business a substantial role in the lives of people in these societies. Large Power Distance is 80 and Uncertainty Avoidance is 68 for countries in Arabic region. Saudi culture is more likely to openly follow the caste system, which does not help in the upward movement of the citizens. People there is quite a rule oriented with the regulations and laws of the country and have proper control which helps in avoidance of the uncertainty. However, there is a huge difference in the wealth and power distribution, and this trend is growing still in the culture. There is high uncertainty avoidance index in the country, which is recorded as 68 shows that the culture has a low tolerance for the uncertainty.

There is a subtle and rigid hierarchy in the society having a little scope, especially for the people to avoid the designated roles as well as status in their lives. People also accept these roles as part of the cultural heritage. Masculinity score in the country is though not very high than average as compared to the world. There are extensive rules and etiquettes in the business meeting both among men also among men and women. Males due to religious obligations to avoid most of the hostile acts give women there. Individualism score in the country is similar to what has been observed among the developing nations of the world, which show that Saudi culture is very communistic having a long desire of maintaining the traditional tribal as well as family loyalties. This shows why the country is long-term oriented culture actually (Joshi, 2014). The proposed thesis will utilize Hofstede's framework to focus in particular on the difference in communicational styles between the two cultures. An example of the difference in communicational styles can be gauged from the existing literature that divides the verbal communications into two categories - verbal personal and oral contextual, where the *personal* style is person-centred (such as 'I'), and *contextual* style is role-centred or identity-centred (such as 'Japanese or Taiwanese'). These communication norms vary according to cultural dimensions such as power distance, uncertainty avoidance, individualism/collectivism as highlighted by Hofstede (2001). For instance, verbal personal style of communication is used in individualistic cultures with low power distance (such as the UK and the US), whereas contextual communication style is more prevalent in culture with higher power distance and collectivism orientation such as Saudi Arabia, Japan, etc. Furthermore, the distinction can be made among elegant, exacting and succinct communicational styles. Cultures with moderate to high uncertainty avoidance prefer elaborate communications that are comprised of rich and expressive messages. "Arab cultures, for example, show this refined style of verbal communication, using metaphors, long arrays of adjectives, flowery expressions, and proverbs. Low-context cultures of weak uncertainty avoidance...tend to use the exacting style. The short



style is found in high-context cultures” (Marieke, 2013, p. 166). Based on cultural dimensions and communicational norms, Gudykunst and Ting-Toomey (1998) have categorized various countries in clusters that prefer similar communications styles, as seen in Figure 1.

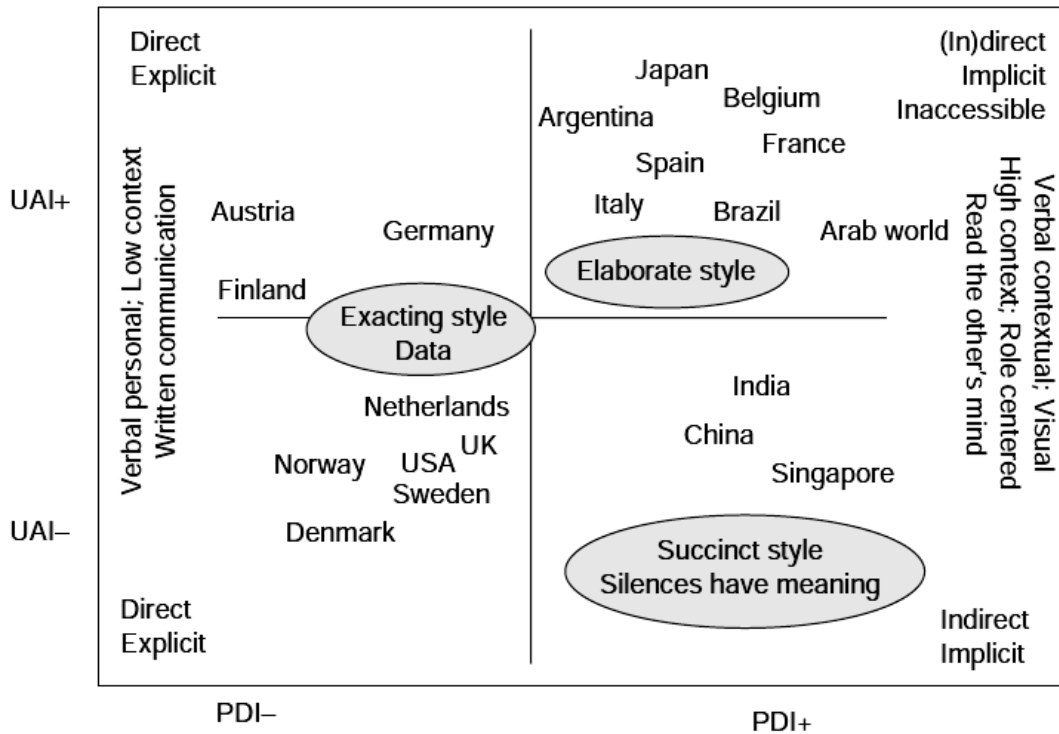


Figure 1: Interpersonal Communicational Styles

Countries in the left two quadrants with lower power distance and exacting style of communications prefer written communications such as email over phone communications, and in these cultures, the sender of information is responsible for the effective communicational message. On the contrary, in collectivist societies such as those in Asia, children are trained to understand the mind-set and messages from their elders, so, the responsibility of effective communication falls on the receiver. Lack of understanding of these cultural influences in marketing communications can result in a marketing and communications disaster, so, to avoid such situations, this study is conducted within the context of the Arab world, as there is a general lack of studies on Arab world on mobile marketing and communications.

Furthermore, as previously mentioned that the variables of interest, in this research, include informativeness, perceived usefulness, perceptions about the entertainment value, and the personalization of the mobile marketing. So, these variables will be explored and validated through the conceptual model (see Figure 2) to assess the effectiveness of the mobile marketing and advertising in Saudi Arabia. The following section discusses essential concepts in brand awareness.

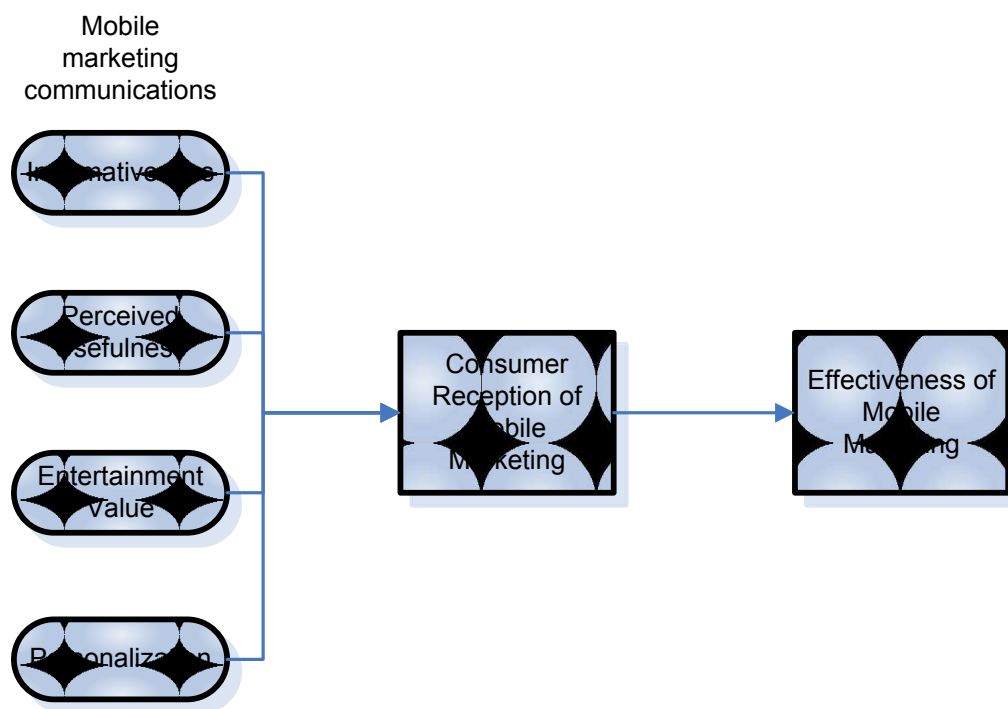


Figure 2: Conceptual Model

3.2.1. Brand Awareness

The proposed thesis will also utilize a conceptual framework to measure the different components of brand awareness, which exist. This will then be used within the research methodology to determine the precise manner in which mobile marketing may affect various elements of brand awareness. Specifically, the conceptual framework is based upon the six branding blocks, which were developed by (R. Anam, 2014); the extent to which mobile marketing contributes to each of these six components will be used to evaluate its overall success at contributing to brand awareness.

3.2.2. BRAND salience

This describes the extent to which a customer notices a brand when he or she is in the position to purchase. This is believed to be related to some factors, such as the strength of the brand of the client association, the extent to which the brand is perceived to be relevant to the customer, and the number of times that the advertising message is seen by the client (Sankaranarayanan, 2012).

3.2.3. Brand performance

This describes the quality of experience which customers have the product, and particularly to the extent to which both their functional needs are met and the type of experience, which they have concerning the economic, aesthetic and utilitarian characteristics of the product (Joshi,



2014). It, therefore, refers to customer attitudes concerning different features of the product, including its primary characteristics, its style and design, the service provided and its pricing.

3.2.4. Brand imagery

This refers to the values and personality, which is, associated with the brand, in particular, the psychological and social needs of customers are such that the product's characteristics are commonly linked to personal characteristics such as excitement, sophistication, and competence (Joshi, 2014). It also can refer to attitudes that the customers have concerning the way that the product is used and purchased, for example, it may be that the clients will experience specific emotions concerning the purchasing channel, which is associated with a particular brand (Joshi, 2014).

3.2.5. Brand judgments

This refers to the judgments made by customers concerning the imagery and performance of the product; it focuses in particular on their opinions considering the product's quality, its credibility, the extent to which they felt that the product's brand was personally relevant to them, and also their opinions of how the brand performed when compared to others on the market (S.-C. Chong, 2013).

3.2.6. Brand feelings

This concerns the feelings, which are experienced by the customers concerning the brand; in particular, as highlighted by (Joshi, 2014), it refers to the security, warmth, self-respect and social approval, which are experienced by the customer concerning the brand.

3.2.7. Brand resonance

This relates to the psychological bond, which customers have with the brand, and the level of their personal identification (Flynn, 2012). The way in which this is tangibly measured usually encompasses an analysis of the emotional terms which are used by customers in referring to the brand, the extent to which the purchase of the product results in an active sense of engagement (such as the degree to which the product encourages brand evangelism), and the level of behavioural loyalty that the customer has as measured in terms of the number of repeat purchases which are carried out (Joshi, 2014).

3.3. What is mobile marketing?

The term 'mobile marketing' covers a variety of different forms, and ways, of advertising via mobile, wireless, devices, such as smartphones, including SMS marketing, push notifications, in-game or in-app marketing, the use of QR codes, and location-based advertising, amongst others (Mengshoel, 2013). SMS messages are one of the main sources of mobile marketing, as they are read within a few minutes and, as such, represent a convertible method of marketing to customers. Research suggests, however, that 'spam' (the receiving of text messages containing advertising that the mobile user has to pay to receive), is unpopular amongst millennial consumers (Zabadi, 2012).



Mobile marketing is one of the 'buzz' concepts in marketing as cell phones are now ubiquitous and people have come to depend on, and rely, on their smartphones (Alotaibi, 2015). The fact that people have an experiential relationship with their mobile devices means that advertising via these mobile devices enables companies to establish an effective bond with the customer (Andrews et al., 2012). As Ting et al. (2011) note, many smartphone users are dependent on their smartphones which mean that, if mobile marketing is promoted in a way that is acceptable to smartphone users, mobile marketing could be very effective regarding building trust and brand loyalty amongst customers. The dependency on smartphones is, therefore, a factor that works to the advantages of companies using mobile marketing: it means that smartphone users are, essentially a captive audience that exists in a world heavily influenced by social media (Suki, 2013). If brands can market via social media, across a variety of mobile marketing platforms, then mobile marketing could be a potentially very powerful way for brands to build trust and loyalty amongst their customers (Ting et al., 2011).

Persaud and Azhar (2012) discuss the fact that, despite the experiential relationship certain users have with their mobile devices, the degree to which smartphone users are ready and prepared for mobile marketing differs across user types. Undertaking an online survey of smartphone users, Persaud and Azhar (2012) aimed to determine the variables that affect how smartphone users respond to, and with, mobile marketing campaigns. The research found that several key variables impact how consumers interact with mobile marketing, including their shopping style, their level of trust in the particular brand and the value they perceive from the advertising presented to them by the company (Persaud and Azhar, 2012). This means that, as with traditional, non-mobile marketing, marketers need to think carefully about how to use mobile marketing as a tool to build value and to establish relationships with their actual, and potential, customers. Mobile marketing, for example, could be very useful regarding building relationships, encouraging high levels of conversion and building customer loyalty towards a brand (Persaud and Azhar, 2012). It is important to note that marketers are hoping to use mobile marketing as a tool to build relationships with customers. Marketers must listen to their clients and engage in dialogue with them, that helps build trust in the brand; simply bombarding actual and potential customers with mobile-based marketing will be ineffective in generating brand loyalty and trust in the brand (Persaud and Azhar, 2012).

3.3.1. The Effect of Mobile Marketing on Brand Awareness

An assessment of the works proposes that there are only a limited number of studies which have addressed the impact that mobile marketing has on brand awareness. One such study was conducted by Smutkupt, Krairit, and Khang (2012) and focuses on the impact of SMS advertising on the perceptions that consumers have on brand awareness within the Thai hospitality industry. The study, which utilized structural equation modeling for the testing of the research hypotheses, found that SMS marketing had a statistically significant positive effect on perceived equality and brand awareness. In particular, it found that types of mobile marketing which contained messages, which were interactive, personalized and general in nature, are especially effective for the building of brand awareness, while messages which were personalized and general in nature had a positive influence on customers' perceived quality of a brand.



Further statistics suggest that mobile marketing is highly effective in general at engaging customers, although few of these statistics have focused in particular on the impact that mobile marketing has on brand awareness. In particular, (R. Anam, 2014) argues that the response rates which are generated by mobile marketing are higher when applied to certain demographic groups, namely, certain ethnic groups, young people, and women. This demonstrated by the fact that mobile marketing campaigns frequently generate response rates of up to 20 percent when compared to between 3 and 5 percent for static banner ads (S.-C. Chong, 2013). Further empirical studies suggest that there are some factors, which determine the effectiveness of mobile marketing regarding achieving high response rates, which are not applicable to other marketing channels. In particular, (Sankaranarayanan, 2012) argues that the most important utilitarian benefit which results in consumers responding to mobile marketing efforts is credibility, with a smaller emphasis being placed on issues such as content relevance or information (Rau et al., 2011). However, (R. Anam, 2014) demonstrated that while it does not seem to have as significant an impact on response rates, the quality and reliability of the content strongly impacted the loyalty of consumers to marketing.

Also, one study reported that the emotional values which consumers attached to mobile marketing were more important among younger and less experienced consumers. While older and more educated users were significantly more likely to place importance on the utilitarian values which belonged to a product in determining their likelihood of response (Mengshoel, 2013). In particular, younger consumers are more likely to respond to mobile marketing if it is perceived to be entertaining. This is determined by the way in which it is consumed, in other words, if it is consumed in between other activities the design of the mobile marketing campaign, and the ease of use of mobile shopping (Mengshoel, 2013).

3.3.2. The Effectiveness of Mobile Marketing in Saudi Arabia

As Whitfield (2012) noted, the Saudi Arabian market for smartphones is highly matured and saturated, with there being two active SIM cards per capita; this means that smartphones are ubiquitous in Saudi Arabia. This also means that mobile marketing could, potentially, be very effective across Saudi Arabia. Lobo and Elaluf-Calderwood (2012) discussed the use of mobile technologies, such as smartphones, in Saudi Arabia, finding that female Saudi Arabians, in particular, have variable opinions, and behaviors, in response to the issues that smartphones present to privacy. It was found that some users, especially female users, have issues with their privacy being invaded, and have issues with being allowed to access certain information via their smartphones (Lobo and Elaluf-Calderwood, 2012). Consequently, mobile marketing is not easy to implement in Saudi Arabia, and not necessarily as effective as it is in other countries, with other types of users, given the premium that is placed on privacy or the general distrust of invasions of privacy. These findings are balanced, however, by the findings from research undertaken by (Alotaibi, 2015). It suggests that there has been an increase in consumerism in Arabic civilizations, particularly in Saudi Arabia, and that, with this increase in consumerism, there has been some degree of opening up to marketing techniques and mobile marketing in particular. As stated, the massive wealth of Saudi Arabia has led to many luxury brands flooding into the Saudi Arabian market, with consumerism being rife in Saudi Arabia because of the convergence of great wealth and the influx of luxury brands to the Saudi Arabian market.



Saudi Arabia has the largest as well as the fastest growing market for the telecommunication products and the services. There is a state entity by the name of Communications and Information Technology Commission (CITC), which is responsible for the issuing of the license especially to the private sector operators in the mobile industry. This entity encourages competition among the different operators within the industry by issuing different new mobiles and licenses.

The introduction of television and Internet-based advertising has meant that consumerism has become a norm across Saudi Arabia, with smartphone usage being as ubiquitous in certain sectors of Saudi Arabian society as it is in the West. Mobile marketing, therefore, has the potential to be as successful in Saudi Arabia, brands, as it has proved to be in the West (Alotaibi, 2015). What needs to be taken into consideration by marketers proposing the use of mobile marketing in Saudi Arabia, however, is the issue of privacy and the fact that not all users will respond to such mobile marketing in a positive manner, given the highly private nature of some users' relationships with their smartphone. Anything that interferes with this privacy is likely to be rejected outright (Lobo and Elaluf-Calderwood, 2012). As this research suggests, then, smartphone usage and acceptance of mobile marketing are highly influenced by culture (Wells et al., 2012; Megdadi and Nusair, 2012).

IV. DISCUSSION AND CONCLUSION

The review of the research, which has been conducted in this chapter, reveals that there is a significant gap in the literature. This is because very few of the studies, which examine the effectiveness of mobile marketing, have focused in particular on the impact that it has on brand awareness. Indeed, the majority of studies seem to be focused primarily on issues such as the success of mobile marketing in eliciting high customer response rates (Sankaranarayanan, 2012). Saudi Arabia is becoming more open for accommodating mobile marketing, Government is taking particular interest in the telecommunication industry also, and the government is considering telecommunication as the next fastest growing industry after oil. Furthermore, there are very limited studies which have focused on the issue of mobile marketing within Saudi Arabia in particular which represents a significant gap in the literature given that Saudi Arabia currently represents the largest cell phone market in the GCC (Euromonitor International, 2013).

There is a lack of studies measuring the relative consequence worth of free promotion. In general, the lack of relevant results calculating effects of mobile marketing compared to retailers other investment opportunities remains problematic, as evidenced by the improved relative output value of mobile marketing. In the review, it was found that the major factors driving mobile marketing adoption and implementation in organizations. effectivenessTo assess the efficiency and effectiveness of mobile advertising practices, more empirically concerned with the investigation is needed to found relevant metrics of mobile marketing, for example, to align mobile marketing investments with overall results.

Finally, most of the studies conducted into mobile marketing have failed to consider the impact of issues such as the age and sex of consumers in the effectiveness of mobile marketing (Mengshoel, 2013). These problems are talked within the proposed thesis, which will be further utilized and recommended to take quantitative research to see the cause and effect of mobile



marketing, brand awareness within customers of different demographic groups within Saudi Arabia. The studied works provide an inadequate input to evidence that customer perceived value of mobile marketing inflated retailers' outcome value, and that mobile marketing increased relative value for retailers and consumers. Several key areas calling for further research have emerged. These are mobile device shopping, the relative outcome value of mobile marketing, mobile marketing value creation, and mobile marketing metrics.

V. LIMITATIONS TO THE RESEARCH

It is significant to highlight the fact that there are time limitations to the research, which may restrict the extent to which the findings of the investigation. The key limitation of the research is the reliance on that it is purely qualitative, and the literature is not very much available in the region to get the proper result.

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RESEARCH ARTICLE

The Impact of Accounting Information Reliability and Compatibility on Users Decisions (A Field Study in Jordanian Construction Companies)

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Abstract

This study aims to identify accounting information reliance and compatibility and their effects in decision making in Jordanian construction companies. A Questionnaire is designed and 49 surveys were distributed on the most related category, which consisted of accountants and executive managers working in shareholding construction companies in Jordan, only 45 questionnaires were returned taking into consideration that the total of construction shareholding companies in Jordan is 49 companies. The SPSS program is used through descriptive analysis statistics to analyze data and test the study's hypothesis. The repetitive distributions and the individual opinion percentages were identified studying each sample separately. The probable average was also identified depending on the 5 points Likert standard. The normative deviation was used to measure and identify the dispersion of responses for each question in the survey and comparing them with the rest. The study resulted in coming up with essential findings that accounting systems play an important role in supporting the construction companies' activities in decision making.

Keywords: *Reliability, compatibility, construction, decision making, information system*

Introduction

Technology and information era has impose many changes on various areas of life, many countries of the world raced to keep up with this development, everyone is trying to find the best and easiest ways to keep up with this progress.

As a result of the prominent role played by construction companies in the investment life of any country, this cannot be performed properly only if appropriate technology and information on the sector were available to perform all its functions to the fullest such as taking wise decisions in managing its resources and activities.

Accounting provides for the construction companies' management accounting information that would help them in providing the necessary information to choose between different decisions'

alternatives to achieve higher profits and maintain its financial resources.

Accounting information system have vital role in supporting the activities of construction companies, which aim to make profits. Accountants use in their work a huge quantity of information, so that information system or IT considered as one of the important areas that the accountants should be familiar with, because of its rapid and changeable growth, and so the contemporary accountant contributes in making decisions by providing the management with the necessary information to take a short or long term decisions, and in order to provide management with these information, the accountant should be aware of the organizational structure of the construction company, making him fully aware of what the departments and

different sections need of specific information that help them to take effective decisions.

Focusing on a decision as it is the final opinion which a man takes among a various alternative views about a particular matter and the decision passes in two phases that are: Decision Making and Decision Taking.

The function of decision making depends on the availability of accounting and non-accounting information. Accounting information especially the financial and cost information ones are considered the prime motive for the construction companies' management to carry out the functions of making investment decisions.

Therefore, the basis of the study represents in studying the effectiveness of accounting systems used in construction companies on its decision making function.

Significance of the Study

This study deals with construction companies in Jordan, where these companies are considered the most important investment projects in Jordan.

The significance of this study represented in showing and analyzing the role of the prepared accounting information and its benefits through the accounting system applicable in construction companies in Jordan to carry out the function of decision making in the Jordanian construction companies, where the information has an active role in taking decisions and that the failure of that information to make its role, leads to reduce the efficiency of that information and its effectiveness and impact in the decision making.

Thus, the construction companies are considered an important motive in the national investment and finance projects, through their facilitating the exchange of goods and services held by those companies.

Objectives of the Study

- Show the extent of the importance and effectiveness of accounting information

systems to participate in decision making process in the Jordanian construction companies.

- Show the degree of using and adopting the construction company management of the accounting information in making investment decision in the company.
- Provide a range of suggestions and recommendations that contribute in increasing the effectiveness of using accounting systems in decision taking in construction companies.

Problem of the Study

This study attempts to analyze the effectiveness of accounting information systems in construction companies in the process of decision taking stages, despite the great importance of this information, it is the basis upon which the company build its decisions, but the construction companies cannot take advantage of this accounting information properly, which helps it in taking better decisions that help in its development.

From this point we can formulate the problem of the study as follows:

To what extent accounting information systems can be effective in decision taking in the construction companies?

Hypotheses of the Study

- **H0:** The management in the construction companies doesn't use the accounting information in making decisions.
- **H0:** There is no significance for the reliance of accounting information in the construction companies.
- **H0:** There is no significance for the compatibility of accounting information in the construction companies.

Literature Review

Alsharayri [1] The study aimed at identifying the evaluation of accounting information systems performance used in the Jordanian private hospitals. In order to achieve the objectives of the study, a questionnaire has designed and developed for the purpose of data collection. Descriptive statistical methods were used to determine the views of employees in

Jordanian private hospitals who use accounting systems. The study reached the following conclusions: The cost of modern equipment is very high. Using modern programs help individuals to get the job done quickly. Employees are unable to keep pace with human development in accounting systems.

Grande et al. [2] research provided value added in accounting literature given the scarcity of works dealing with the relationship between the application and use of AIS and performance and productivity indicators in SMEs in Spain.

Badescu and Garces-Ayerbe [3] proposes to analyze the impact of investments in Information Technologies (ITs) on the productivity of Spanish firms. The results obtained reveal that the sensitivity of labor productivity to changes in technological capital intensity is positive and significant when firm-specific effects are corrected.

Azleen Ilias [4] measured the level of satisfaction among the end-users of computerized accounting system (CAS) in private companies. She determines the relationship of five factors (content, accuracy, format, ease of use, timeliness) that influence satisfactory level among the end users toward the CAS. Further, this paper examines critical factors in EUCS (content, accuracy, format, ease of use, timeliness) that contributes most to satisfaction. The research was conducted using a set of questionnaire to 269 private companies' staffs that using computerized accounting system (CAS). This study is analyzed with reliability analysis, correlation analysis and Standardized Regression Weight (using Structural Equation Modelling technique). The empirical results can provide support for the Doll and Torkzadeh model (1988), which related to the factors contributing endusers' satisfaction toward accounting system.

Ismail and King [5] focused on measuring the alignment of Accounting Information Systems (AIS) requirements with AIS capacity and then investigating whether this AIS alignment is linked to firm performance. The results indicated that a significant proportion of Malaysian SMEs

had achieved high AIS alignment. Furthermore, the group of SMEs with high AIS alignment had achieved better organizational performance than firms with low AIS alignment. The findings provided evidence of the importance of AIS alignment and deepened current understanding of the requirements for accounting information and the use of IT as an important information processing mechanism. More importantly, it opens up possibilities for further study of AIS alignment in SMEs, both in Malaysia and on a global basis.

Noor et al [6] investigated the status of computer-based accounting systems (CBAS) adoption among small and medium manufacturing firms (SMEs) in the northern region of Peninsular Malaysia. Results show that over ninety percent of the firms have adopted CBAS. The adoption of CBAS, however, is still at the beginning stage as majority of the firms only adopted CBAS in the last six years or less and the depth of the CBAS system adopted is behind that of industrialized countries. The results showed that years of adoption are positively correlated with the overall quality of the CBAS adopted. Further investigations on the relationships between CBAS use items and factors that were expected to affect CBAS use indicate that the maturity stage of CBAS adoption was significantly positively correlated with age of business. However, the results did not find evidence supporting previous research that argued age and size of the firms as well as the type of ownership influence the adoption of CBAS.

İlhan , Veyis [7] argued that advancements in information technology (IT) have enabled companies to use computers to carry out their activities that were previously performed manually. Accounting systems that were previously performed manually can now be performed with the help of computers. Therefore, improvements in the information technology have facilitated the use of cost and management accounting procedures. On the other hand, most of the companies have started to apply just-in-time (JIT) production system as a tool to become competitive. Companies applying JIT production system aim at minimizing all inventory levels and delivering the goods

and services to customers on time. In this sense, use of IT has also helped companies apply JIT production system more effectively. The aim of this paper is to identify how improvements in IT have influenced accounting systems

Grand [8] highlighted the importance of using the devices and computer networks to provide the information required for auditing and use it as a tool for auditing, also the need to understand the automated information systems and understand the purpose of these systems, this study focused on the need to keep up with information technology in update or change programs, the study found the need that the auditor will keep up with the developments in the company's environment in general and information technology in particular to use it in the field of audit, that it must respond to the modern changes in the field of communication networks and electronic commerce that improve the operations of the audit.

Alqtany [9] "The Impact of Using Accounting Information on Management Performance in the Public Industrial Shareholding Companies in Jordan". This study aimed to analyze the role of the accounting system in producing accounting information that is appropriate and have quality to meet the management needs in the public industrial shareholding companies in Jordan, and show the relationship between the level the quality of accounting information and its impact on the administrative performance in the field of planning, control and decision making areas. The study examined the importance, problem and previous studies and handled accounting as a system of information in industrial public shareholding companies in Jordan from different aspects, and looked at information accounting and its impact on management functions.

Anderson [10] "Using Electronic Data Interchange (EDI) to Improve the Efficiency of Accounting Transactions". The study applied regression method on a sample data from US office furniture manufacturers' entities sector using electronic exchange data systems, the study proved morally that

entities applied to these systems characterized by reducing the time of executing and processing of orders (strong significant correlation between the quality of these systems and the speed and accuracy of implementation of orders), As the evidence of this reduction is clearer for the orders and more complex commands with a significant decline to execute commands without errors, providing more effective reverse feeding systems and achieve greater accuracy in fulfilling the orders. But what weaken this study, that it dealt with the impact of electronic dimension of operations on some of the areas of cost accounting, without evaluating the effects of the practice of electronic commerce on the electronic financial accounting information systems and their properties and it also considered that the (EDI) systems are unlocked internal systems that do not include electronic commerce.

Rauplice [11] "Development of a Model for Evaluating the Effectiveness of Accounting Information System". This study aimed to explore models and methods of effective accounting information systems and the possibilities of their use and developing an advanced model to assess the effectiveness of these systems of economic, social and technical aspects, this study adopted the practical study in a narrow field, and on the comparison and logical analysis and multi-criteria analysis methods. The study concluded that the accounting information systems' properties have different importance and can be expressed in quantity and quality standards, and the success of its use depends on the correct choice of the components of the system, and it also found a sophisticated model to assess the effectiveness of accounting information systems that enjoy the openness and clarity of the determinants and the possibility of its use in all phases of the development life cycle of the system (Choice-Apply-Exploitation) and evaluating the mixed indicators (quantity- quality) of the accounting systems effectiveness.

The Methodology of Study

The researcher will use in this study a descriptive analytical method in analyzing the study data, which will be used descriptive approach in covering the

theoretical aspect of the study and use the analytical method in covering the practical side of this study.

We will rely on two types of sources to collect data that are:

Secondary Sources: Books and studies concerned with the issue of accounting information systems and their effectiveness in construction companies in the decision-making process.

Primary Sources: Information and data that is provided by the questionnaire designed to demonstrate the effectiveness of using accounting information systems in construction companies in decision-making.

Population and Study Sample

The study population consisted of all public shareholding construction companies in Jordan, consists of 49 companies, a random sample of 49 accountants and executive director of construction workers in the public shareholding companies in Jordan have been selected.

The Used Statistical Methods

We will use the following statistical methods:

- Using a descriptive and analytical statistics by using statistical analysis program (SPSS) to extract data redundancy, standard deviations and arithmetic mean and test hypotheses curve analysis (T).
- Determine the weighted average with weights that have been identified for the adoption of a five-point Likert scale, according to this scale, if the arithmetic mean value $3 <$, it means that the factor is important, and if the $3 >$, it means that the factor is not important.

Construction and Real Estate in Jordan

Jordan has witnessed through the last 5 years a large constructional development that leads to increase in real estate (lands and houses) transactions and spending money on lands and houses.

This unprecedented movement in real estate (lands and houses) transactions is more active among other economic sectors, which lead many Jordanian and Arab investors to invest in this sector and increase the interest in it.

Generally; Jordan-especially Amman- has witnessed unprecedented prosperity in real estate transactions, where the amount of investment in real estate through the last 5 years was (10) billions Jordanian Dinar, which has a great impact to push the process of economic development and reinforce sustainable development in the kingdom. Real estate market distinguished by its direct impact on boosting and developing other Jordanian economic sectors especially real estate sector that provides labor working opportunities, and creates remarkable activity for all supporting services such as: Iron, Cement, Wood, Glass, Aluminum markets, Sanitary ware and others, in addition to developing infrastructure sectors and different investment and housing projects.

Despite of this notable activity for real estate market in Jordan, but it faces many obstacles that hinder its development in the required manner such as:

- Increase in the prices of basic material of construction (Iron, Cement and labor wages) and others.
- Not granting working licenses for foreign labors in construction sector, which lead to increase in labor wages.
- Jordanian labor disinclined working in construction sector, especially general or technical work.

It is worth mentioning that the Department of Land and Survey is considered the official party that supervises the processes of buying, selling and conveyancing, where the Department registers these transactions to insure the legitimacy and equity of the real estate that is approved by the in force regulations, in addition to its duty in collecting treasury equity of taxes and fines resulted from these transactions.

The most important reasons that contributed in developing Jordanian real estate's market:

Many Jordanian and Arab experts in economic and investors relate the increase in real estate market to many reasons such as:

- The events of September 11, 2001 in the USA, that made many Arab and Jordanian expatriates search for a secure place for their investments.
- The continuous increase in oil prices, which lead to the provision of liquidity in Arab Gulf countries.
- Instability of the political conditions in the area, specifically (Palestine and Iraq), in addition to the continuous threats to Syria and Iran, which lead the people of these countries search for a secure place for their investments.
- Many large Arab and local real estates' companies oriented to invest in this sector.
- The existence of a safe investment environment and distinguished infrastructure in Jordan, which lead many Arab and Jordanian expatriates to invest their money in Jordan especially in the real estate market because it is one of the most safe and profitable sector.
- The immigrations of thousands of Iraqi families especially the wealthy ones that took Jordan as its investment and commercial activities.
- The amendments that emerged on landlords and tenants ordinance about not allowing the tenants to stay in the real estate after the determination of a lease, which makes this subject more appealing for those in lease market.
- A relatively decrease in interests' prices on residential loans, and the increase in expatriates' transfers in addition to the

increase in the residential apartments lease rates [12]

Statistical Analysis

In this part we will achieve the practical objective of the study, in order to know the effectiveness of using accounting information systems for decision making in real estates, through distributing a questionnaire to accountants and executive managers working in construction companies in Jordan, where the number of these companies was 49. The questionnaires were distributed and 45 were retrieved, in addition 3 questionnaires were excluded because of not answering all questions, the number of questionnaires used in the analysis is 42 as a percentage of 84%.

• Used Statistical Methods

○ Statistical Analysis Program (SPSS) was used in extracting data such as: repetition values, standard deviations, and arithmetic means and test the study hypothesis.

• Cronbach's Alpha Test for Credibility (Reliability)

Cronbach's Alpha test aims to achieve the internal consistency of the measuring tool as one of the indicators of its consistency, where the measure depends on the extent of internal consistency and the degree of reliability of the questions of the questionnaire, table No. (1) shows Cronbach's Alpha test values and their significant:

Table 1: Cronbach's Alpha test values and their significant (Tchaw, 1990)

Cronbach's Alpha Value	Its Significant
Less than 60%	Weak Reliability
Between (61%-70%)	Accepted Reliability
Between (71%-80%)	Good Reliability
Larger than (81%)	Excellent Reliability

Alpha's value for this study was (78.6%) which means that the reliability related to it is good, table No. (2) shows the result of

Cronbach's Alpha test and its significant, therefore we can circulate the results on study community.

Table 2: Cronbach's Alpha Credibility Test for Study

Cronbach's Alpha Value of Study Variation	Its Significant
78.6%	Good Reliability

Gender: Table No. "3" shows the distribution of the sample's individuals according to gender

Study Sample Characteristics

Table 3: Gender

Gender	Repetition	Percentage
Male	26	61.9%
Female	16	38.1%

We notice from the previous table that the Male percentage is (61.9%) of the sample's individuals, and the Female percentage is (38.1%). This indicates that the higher percentage of those who work in the

accounting field and make decisions is form males.

Scientific Specialization

Table No. "4" shows the distribution of the sample's individuals according to the Scientific Specialization

Table 4: Scientific Specialization

Scientific Specialization	Repetition	Percentage
Accounting	14	33.3%
Management Information Systems	11	26.2%
Economy	7	16.7%
Other	10	23.8%

It is cleared from the previous table that the higher percentage is for those with Accounting Specialization with a percentage of (33.3%), and then those who have a certificate in Management Information Systems with a percentage of (26.2%), after that those who have certificates in other specializations with a percentage of (23.8%), and finally those who have a certificate in

economy with a percentage of (16.7%). These percentages indicate the connection of the workers' specializations with their work.

Scientific Qualification

Table No. 5 refers to the distribution of the sample's individuals according to the scientific qualification

Table 5: Scientific Qualification

Scientific Qualification	Repetition	Percentage
High School	1	2.4%
Diploma Certificate	7	16.7%
Bachelor's Degree	28	66.7%
Higher Education	6	14.3%

We notice from the previous table that those who have Bachelor's Degree constitute the higher percentage of the individuals of the sample of (66.7%), and then those who have Diploma Certificate with a percentage of (16.7%), after that those with Higher Education with a percentage of (2.4%). It is cleared from these percentages that the

large one is for those who hold Bachelor's Degree.

Job Title

Table No. 6 refers to the distribution of the sample's individuals according to the job title

Table 6: Job Title

Job Title	Repetition	Percentage
Accountant	16	38.1%
Executive Manager	6	14.3%
Head of Accounting Department	4	9.5%
Other	16	38.1%

We notice from the previous table that those who work as accountants and other have the same percentage of (38.1%), and then came those who work as Executive managers with

a percentage of (14.3%), and the least percentage was for those who work as Head of Accounting Department with (9.5%).

The Department where the Employee Works

Table No. 7 indicates the department where every individual of the sample works

Table 7: The department where the employee works

The department where the employee works	Repetition	Percentage
Accounting	21	50%
Personnel	3	7.1%
General Management	13	31%
Other	5	11.9%

The previous table shows that the higher percentage is for those who are working in Accounting Department with a percentage of (50%); that means that half of the individuals in the sample work in Accounting Department, the second percentage goes for those who are working in General Management Department with (31%), after that those who are working in

un-mentioned departments with a percentage of (11.9%), and finally those who are working in Personnel Department with a percentage of (7.1%).

Years of Work Experience

Table No. 8 indicates the distribution of the sample's individual according to the employee's work experience

Table 8: Work experience years

Years of Work Experience	Repetition	Percentage
Less than 5 years	18	42.9%
From 5-10 years	15	35.7%
From 10-15 years	8	19%
More than 15	1	2.4%

The previous table shows that the higher percentage is for those who have an experience less than 5 years with a percentage of (42.9%), then those who have 5-10 years of experience with a percentage of

(35.7%), after that those who have 10-15 years of experience with a percentage of (19%) and finally the less percentage was for those who have more experience with a percentage of (2.4%)

Study Sample Results

Table 9: First Part: The following questions related to using accounting information prepared in decision making:

Question	Average	Standard Deviation
01- Do you think that accounting information is important in decision making in the company?	4.74	0.544
02- The accounting information is provided for the higher departments periodically.	4.05	0.987
03- The accounting information is characterized by objectivity in the company.	4.00	0.796
04- The accounting information must be provided at the lead time in order to benefit from when making decision.	4.60	0.587
05. Will the accounting information be able to make decision making more effective?	4.48	0.634
06. The management makes plans to benefit from accounting information in future company's prediction.	3.76	0.983
07. Accounting information is prepared according to accounting rules, basics and standards.	4.50	0.634

As the given values to measure the significance of the paragraphs range between 1-5 in their higher limit, then the paragraph that has an Arithmetic Mean

larger than 3 is an important paragraph, while the paragraph that has an Arithmetic

Mean less than 3 is relatively neutral or insignificant. It is clear from the previous table that all paragraphs related to the first hypothesis is important (positive) because

its Arithmetic mean is larger than 3, as well as the Standard Deviation indicates that the variation size is small in sample's answers.

Table 10: Second Part: The following questions related to the significant of reliability of accounting information in real estate:

Question	Average	Standard Deviation
08- Does the electronic accounting systems outcomes applied in the company distinguished by reliability?	4.05	0.795
09- The information that is prepared by accounting information system is characterized by comprehensiveness.	4.12	0.889
10- The necessary accounting data is transferred to accounting outcomes (reports) that are characterized by accuracy.	4.40	0.798
11- The accounting information must characterize by reliability to be adopted.	4.74	0.497

It is clear from the values of the previous table that all the paragraphs related to the second hypothesis are important, since all the Arithmetic Means of the paragraphs are

larger than 3, and the values of Standard Deviation indicates that the variation size is small in sample's answers.

Table 11: Third Part: The following questions related to the significant of the compatibility of accounting information in real estates.

Question	Average	Standard Deviation
12- Accounting information is distinguished with compatibility in the company.	4.24	0.656
13- Data is inserted by using computer according to documents in company.	4.26	0.661
14- Accounting data is being dealt with by using specialized accounting programs.	4.29	864.0
15- Do you think that the working accountants in the company are highly efficient and bear responsibility?	4.19	0.671
16- Does the company do its role in encouraging accountants to increase their efficiency through providing encouraging incentives and others?	3.57	1.151
17- Does the number of working accountants in the company is adequate?	3.76	1.008

It is clear from the previous table that all values of the Arithmetic Mean is larger than 3 and this indicates that the paragraphs related to the third hypothesis are important, the table also explains that the values of Standard Deviation indicates that the variation size is small in sample's answers.

Test of Hypothesis

The null hypothesis is accepted if the calculated value was less than the spreadsheet value that is extracted from the

statistical tables, or if Alpha value (sig.) was larger than (0.05) which is the approved value in humanitarian studies, and it is rejected if the value was larger than spreadsheet value, or if Alpha value (sig.) was less than (0.05).

First Hypothesis

(H₀): The management in construction companies doesn't use accounting information in decision making.

Table 12: Results of first hypothesis

Trust Degree	Hypothetical Statistical Significance Level	Spreadsheet T	Calculated T	Sig. (Alpha)	Result
0.95	0.05	1.943	31.188	0.00	rejection

The researcher has used T- Test, and found from the readings of the computer results as in the previous table that the value of (Calculated T=31.188) is larger than its spreadsheet value, therefore (Alpha) value is less than (0.05). According to the decision rule, the null hypothesis will be rejected (Ho) and the alternative hypothesis (Ha) will be

accepted, that means that there is a statistical relation between using accounting information and decision making in real estates.

Second Hypothesis: (Ho): It isn't significant to rely on accounting information in construction companies.

Table 13: Results of second hypothesis

Trust Degree	Hypothetical Statistical Significance Level	Spreadsheet T	Calculated T	Sig. (Alpha)	Result
0.95	0.05	2.353	27.578	0.00	rejection

The researcher has used T- Test, and found from the readings of the computer results as in the previous table that the value of (Calculated T=27.578) is larger than its spreadsheet value, therefore (Alpha) value is less than (0.05). According to the decision rule, the null hypothesis will be rejected (Ho) and the alternative hypothesis (Ha) will be

accepted, that means that there is a significant to rely on accounting information in construction companies.

Third Hypothesis

(Ho): There isn't any significant of the compatibility of accounting information in construction companies.

Table 14: Results of Third Hypothesis

Trust Degree	Hypothetical Statistical Significance Level	Spreadsheet T	Calculated T	Sig. (Alpha)	Result
0.95	0.05	2.015	26.040	0.00	rejection

The researcher has used T- Test, and found from the readings of the computer results as in the previous table that the value of (Calculated T=26.040) is larger than its spreadsheet value, therefore (Alpha) value is less than (0.05). According to the decision rule, the null hypothesis will be rejected (Ho) and the alternative hypothesis (Ha) will be accepted, that means that there is a significant of the compatibility of accounting information in construction companies [13].

• The study has shown the importance of the compatibility of accounting information in construction companies.

Recommendations

Results & Recommendations

- The study has shown that there is a statistical relation between using accounting information system and decision making in construction companies.
- The study has shown the importance of using accounting information in construction companies.

- It is necessary for the accountant to have an adequate practical and professional experience that qualified him to provide an optimal evaluation for accounting information systems through a training process.
- It is necessary for the accounting information to have a high compatibility and reliability because this affects the ability of the company in decision making.
- It is necessary for accounting reports to have a high accuracy for company's ability to put future plans.
- The necessary to provide accounting information to the higher departments periodically in order to benefit from in decision making.
- The necessary to prepare accounting information according to accounting criteria, rules and basics.

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The Impact of Employee Branding on Workplace Conflict

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Abstract

This paper focuses on the practice of employee branding within private sector, that is, the ability private companies and organizations enjoy in order to recruit those employees who are better suited to the environment and psychology of the company. Employee branding will be analyzed specifically in the context of work conflict situations. It aims not just at the quality of the employee, but also at the qualities a good employer should possess. The paper also discusses how, through this branding process, employees come to know where they best fit within the company, enabling them to pursue the position that best suits their abilities. These forms of employee branding are analyzed in relation to varying influential factors from both inside and outside companies, such as economical and functional benefits, chances of advancing from within the hierarchical structure, and the environment and atmosphere within a given company. Motivation of employees by their employers is also discussed. The paper will also present the different dimensions of brand equity, that is, the ability for a company to enhance its marketability, such as brand loyalty, brand awareness, brand association, and perceived quality of products; the employer's attractiveness, given their economic incentives and other factors; the employers' attributes, such as empowerment, training and development, corporate culture, career prospect, compensation, and brand name; and finally, other factors that attract a potential employee to a specific company. The method followed is the result of data collected during the past two decades.

Keywords: *Employee Branding, Motivation, Career Prospects, Position Advancement, Company's Atmosphere.*

Introduction

Competition in both domestic and international markets has immensely increased. In order to keep up with the fast pace in these changing and challenging environments, companies tend to do whatever they can to make them stand out as giant competitors. One practice, employee branding in the context of the private sector of organizations is discussed in detail in this paper. Various forms of employee branding are elaborated upon, and the relationship of these types of employee branding forms to the varying and influential factors both inside and outside the company is examined. Employers and their role in motivating the employees is also discussed, leading to some suggested concrete solutions for the conflicts arising in the organizations.

Employee branding is defined as enabling companies and organizations to recruit those employees who are better suited to the environment and psychology of the company (Mossevelde, 2017). This paper only addresses the private sector because most often it is the private sector complaining about needing more suitable employees; the government already has a tough screening phase for potential employees. Some characteristics of good employees that are suitable for many workplaces are also discussed.

Modern markets are rife with uncountable options in every field, and for an employee to retain their position in such a situation is certainly a strenuous task requiring a lot of struggle and exertion. This hard work, if done in a smart way, can reduce the pressure on the workers and is capable of bringing about some really wondrous results. Employee branding is undoubtedly one of the best options available to any company, but it is also important to note that this process has a lot to do with the welfare and benefit of the employees as well (Nigelwright.com, 2017). Through this process the employees come to know where they fit in the company, thus enabling them to pursue the career or the job that best suits them. The theme of less exertion and more output applies to the individuals as well. After having been rejected from a job the individual comes to know exactly what they need to do. This enables them to make his passion his profession, which results in less struggle and bears more fruit.

Things can be different to ideas mentioned above but those only will be exceptions or aberrations. It almost always happens that the employee is not suited to job, since the employee has been assigned without careful eligibility testing and screening. Consequently, the worst results are not confined to that individual but prevail throughout the entire organization, thus drastically affecting the company's efficiency and making it lag behind others.

Literature Review

Employers' Branding Process

This process consists of multiple techniques or strategies that are applied by employers to attract potential employees to their firm (Miles and Mangold, 2008). The process involves using techniques that make potential employees aware of the company while at the same time influencing the potential employee's perceptions of the company in such a way that he/she is attracted to that particular company. An integral part of the employer's branding process is setting apart their particular firm from other companies by specifically identifying and highlighting certain unique features of their company, its environment, and other exclusive perks that can only be accessed at that particular firm.

This a process in which the company has to create an image to market to a particular audience, the audience being prospective employees. This image must not be a false one; rather, it should reflect the actual essence of what it is like to work at the company so that once individuals actually come to the company, they get what they were promised in the first place. For instance, Google is a perfect example of this. Google promises a stimulating and exciting atmosphere for its employees, and that is exactly what it delivers. Similarly, successful companies are those who apply employee branding in an efficient manner in order to ensure that their employees have a positive impression of their firm; and this in turn gives a boost to organizational effectiveness.

Lastly, to sum up the employee branding process, it is basically the benefits that employers give to their employees. These benefits may fall into different domains, for instance economic benefits correspond to better wages, raises and rewards, whereas psychological rewards relate to moral support, cordial relations and respect. Other benefits may include functional benefits that allow the employee to advance their career.

The entire employee branding process should be carefully mapped by including extrinsic as well as intrinsic rewards.

Brand Equity Dimensions

Brand equity is linked to brand marketing; once the idea of brand equity is coupled with the brand, the brand has the ability to substantially enhance its marketability. Brand equity is defined by four dimensions, which are brand awareness, brand loyalty, brand associations, and perceived quality. Each of these dimensions is integral for a brand to be successful. According to Lee and Leh (2011), the importance of each dimension is as follows:

1) **Brand Loyalty**

This is related to how loyal a customer is to a particular brand. This attachment can occur on two distinct levels. The first level of attachment corresponds to the customer buying a particular brand repeatedly. The second level of attachment is preferring a particular brand over the other brands and keeping the particular brand as the customer's first choice regardless of the price. To accomplish this, certain aspects of the branding process should be enhanced so that the brand loyalty can be maximized.

2) **Brand Awareness**

Brand equity is very dependent on brand awareness. It may be defined as the customer's inclination towards a certain brand because of being able to remember and identify the brand. Brand awareness is very important as it is the principal factor that actually influences the customer's perception and makes him/her buy a specific brand. It is also closely linked to loyalty, and if a customer has sufficient brand awareness it is very likely that they will also have brand loyalty. Awareness of the brand is imperative, as it is the awareness of a brand that allows the buyer to choose between different brands. Certain elements should be crafted so that the brand could be remembered by triggering only certain stimuli.

3) **Brand Association**

Only after a customer has adequate brand awareness can he/she have some brand association. A customer develops some associations with the brand after using the brand's products over time. These associations could be memories linked to the brand, its products' performance, or any other personal reactions that an individual has linked to the specific brand. For instance, any attachment to a product of a particular brand may be due to the durability of the brand, or other attributes or features of that brand. Some particular aspects of the brand may have nothing to do with the actual performance of the brand but rather to the symbolic representation of the brand. For instance, a customer may buy a particular brand's clothes because wearing that brand signifies a distinct social status.

4) **Perceived Quality**

This is the customer's opinion regarding the quality of product of a specific brand as compared to products from other brands. It is how the customer rates a particular brand; it is this judgment that allows the customer to make a conscious decision while choosing between different brands. In a nutshell, if a brand has very high perceived quality, it is very likely that a customer will buy that brand. Any brand that is perceived as being of high quality will be favored by the customer. This perception must be tackled carefully.

Employer Attractiveness

This may be defined as the possible advantages and perks that a prospective employee sees in working for a specific employer. An employer can be deemed as more attractive if they promise to give enough monetary and non-monetary incentives to their employees. Potential employees may have specific requirements in terms of the features that they may be looking for in a workplace; the employer can only attract talented individuals by catering these individuals' needs in the workplace and by offering them the kind of atmosphere that they desire. For instance, as mentioned before, Google is perfect example of this. Google not only offers employees the freedom to voice their ideas and opinions, but also provides them a place where they can work on projects they feel passionate about, in a friendly, fun environment, while still allowing them to deal with challenging problems (Berthon, Ewing, and Hah, 2015)

There are different aspects of employer attractiveness. The first aspect is interest value, and this is basically how attractive the work seems to a prospective employee. If a potential employee sees that he/she will have a chance to work in a challenging environment, participate in big projects and be able to use to create novel products, the potential employee's interest in the company will definitely increase. Another aspect is that of the social value. If the potential employee believes that he/she will be respected by managers, co-workers and subordinates and will have cordial relations with everyone, then the company's attractiveness will be augmented.

Other aspects of employer attractiveness include economic and development value, where the prospective employee judges whether he/she will be able to grow in his/her career at that particular firm and whether or not he/she will be awarded according his/her work with attractive salaries, bonuses et cetera. All of the above mentioned aspects are part of an employer attractiveness scale, and to attract talented individuals to a firm, an employer must rate well on this scale. (Berthon, Ewing, and Hah, 2015)

Employer Attributes

There are multiple attributes that an employer should possess in order to run their company properly. According to Chhabra and Sharma (2014), these attributes include:

- 1) **Employee Empowerment:** This involves giving the employees a certain amount of authority so they can make some decisions by themselves without supervision.
- 2) **Training and Development:** The organization must offer training to new employees in order to get them acquainted with the organization's procedures, policies and systems.
- 3) **Corporate Culture:** This relates to the practices used by the company, and the values, beliefs and behaviors of employees and managers that guide them on a day-to-day basis in dealing with each other and the overall business.
- 4) **Career Prospects and Growth:** This relates to career development at a particular firm. It corresponds to how well a company allows an individual to enhance his/her skills, knowledge, and experience.
- 5) **Brand Name:** The brand name carries a symbolic value. It is a representative of the worth of the company, which automatically translates to the worth of the employees of the company as well.
- 6) **Compensation:** This is related to how well a company compensates its employees. Compensation includes various benefits that are given to the employee, including, disability benefits, and benefits given in the case of injury or illness on duty.
- 7) **Other Miscellaneous Attributes:** These may include various attributes of the employer, such as the employer allowing flexible work schedules, rewarding good performance, and providing various incentives and bonuses to motivate employees.

Attributes' Attractiveness

According to Herzberg's (1959) two factor theory, the motivation that an employee or prospective employee will have to work at a particular company will come from either the job itself, or from the rewards that the job offers. The *hygiene factors* mentioned above correspond to the features of the job itself, for instance salary, supervisor, colleagues, company policies etc. The other type factors are referred to as *motivation factors*, which include recognition, respect, achievement etc. These motivation factors cater to the growth needs of an individual.

Based on this theory, if the employer's attributes are attractive enough, in that both hygiene and motivation factors are catered to, then the individual will be more likely to work for the employer. For instance, if the employee feels that a particular organization will give him/her a certain degree of empowerment, and he/she will have a say in decisions and his/her opinions/ideas will be heard and acknowledged, then he/she is more likely to be inclined to work for that organization. Similarly, if a company has a proper training department, an employee will not be hesitant to apply to such a company, knowing that if he/she has any inadequacy in their skills the training department would assist him/her to obtain the needed skills. So this attribute is certainly an attraction for a prospective employee.

Also, if a company has established a proper corporate culture, individuals who want to become a part of this culture will be motivated to join that company. In other words, if the attributes that a company possesses act as a source of motivation for potential employees, then the company will be attractive enough to make those same individuals accept employment at that specific company (Jones, et al., 2001).

Attractiveness Factors

There are several factors that affect an individual's attraction to work at a particular company (Ahmad, 2012). First, the company's brand name, mentioned before as one the attributes of the company, is a major factor. Potential employees are more likely to work at a well-known company; for instance, an individual is more likely to work for a big name like Apple rather than Dell, even though Dell might be great place to work. Because Apple is such a well-known firm, it will definitely create a bias for the potential employee while making a decision.

Other factors may be personal reasons, and associations with a particular brand or company. For instance, if an individual has friends who have worked at particular company, and those people have good opinions about the company, then it is more likely that the individual will be attracted to that company.

Likewise, while choosing between companies, a prospective employee may prefer a company because it is located close to where the employee lives. This could influence a potential employee's decision and make one company more attractive than others. Other factors may include salary and various other aspects, depending on the individual and the company that the individual might be considering for employment (Ahmad, 2012).

Methodology

Workplace conflict is defined as a state of discord between people working in an organization. It is usually caused by discrepancies in what is expected and the actual values and interests between the working family of an organization or a company. The purpose of this research is to study the impact of employee branding on the workplace conflict. Employee branding is similar to employer branding but it is focused on aligning the behavior of the employees according to the image the company or organization wants to project.

The methodology followed in this research is based on data collected during the past two decades. Data from different companies in the private sector of the region was collected. The two decades of data is a considerable amount, and allows the reviewer (us) to completely analyze the process and ensure that the results obtained at the end of the study are meaningful. After the required data was collected, it was arranged and classified to infer meaningful information. The data was analyzed and the discrepancies were identified so that solutions and the required improvements could be suggested.

Discussion and Analysis

A detailed literature review was carried out to study the existing research on the topic and develop a basic understanding of the various parameters and factors involved in the study. Employee branding has become the single most important factor in getting the best performance out of the employees. Subsequent research has continued to highlight the importance of employee branding. There is considerable literature available, which testifies the importance of employee branding. Employee branding is going to be a significant practice in human resource management techniques (Backhaus & Tikoo, 2004). The significance of employee branding has also been realized by the government sector all across the world (Parkes and Maguire, 2009). Employee branding influences different aspects of an organization, including motivation and productivity (Hong, et al., 1995), competitiveness among workers (Miles and Mangold, 2008) and effects of corporate social performance (Turban & Greening 1997; Albinger & Freeman, 2000).

Spread Positive Emotions

Establishing the perfect brand culture has become very important for companies who want to compete in the international market. In a global and tech savvy world, maintaining perfect standards not only for the customers but also for the employees has gained enormous importance. Employees prefer to work in healthy environments, and therefore if companies want to hire the best possible talent available in the market the recruitment department must be able to present positive aspects of their organization. Employee branding has also gained importance from a marketing point of view. Employee branding is a tactic for displaying a working environment through its employees who not only interact with other employees within the organization but also with external stakeholders. The process of employee branding involves the training of employees, and in the process, they are given considerable attention. This process spreads positive emotions within the working environment. The employees feel self-satisfaction as they are given special attention. They feel entitled and start owning the organization, thus creating a positive impact. According to Maslow's Theory of Needs, self-actualization is one of the primary needs of a working individual which when met has major impacts on not only the individual's behavior but also on the organization itself. This positivity reciprocates and creates a positive atmosphere within the organization. It also creates a positive impact on the national and international market and leads towards socio- and economic development of the organization. According to Maslow's Theory of Needs, a healthy work environment is one of the primary needs of a working individual. Therefore, by spreading emotions the employer can actually benefit from the work of a satisfied and content employee.

Taking New Risks

Within an organization, the best way to move forward is by taking bold decisions involving risks. In any organization, that wants to be competitive, it is necessary to take measures to ensure that every opportunity is exploited and risks are taken that could help their growth. Some people tend to play things safe; they follow the safe standards and procedures established and stick to them, not experimenting with different ideas. Such organizations stagnate at a certain level and do not develop to their full potential. At times, taking risks can prove costly with organizations suffering losses on different scales. Bold decisions and

risks should not just be taken randomly; rather, the structural aspect of the organization should be kept in check and all necessary calculations should be made to justify the decision. For example, a company should not expand the market for its products if it does not have the manufacturing processes and workforce to support it. Making such a decision would inevitably lead to failure. The employee branding process is an example of how companies in the modern day are moving forward not only to attract consumers but also to attract a talented workforce. This has enabled organizations to expand their set-ups and reach out to the global market.

Supportive Learning in the Workplace

A well-structured organization places significant emphasis on learning in the workplace. While employee branding is a modern marketing and development technique, one of its key aspects is learning. Employee branding is an extensive process which ultimately aims to strength the organization's position in the international market while enhancing internal organizational effectiveness. Employee branding programs include regular job training, training in customer service or customer interactions, corporate orientation, and education about the corporate brand. Teaching and training are the core aspects of employee branding programs; they teach the employee to adapt their behavior to represent the organization's policies. Employees should know that to prosper they should be involved in active learning, which is well supported by the organization to which they render their services.

It also teaches employees marketing behaviors, and how to interact and attract employees, all of which can be extremely beneficial to the particular individual as well. Apart from employee branding teaching programs, an organization, in general, should be able to provide a learning platform for its occupants. The environment should be able to support learning and development. Such an atmosphere encourages employees to join a particular organization. The distinctive difference between a national and a multinational company is the existence of such learning programs within an organization. Young employees in particular intend to join companies that offer such opportunities. Such opportunities are necessary should be shaped by the organization so that employees stay motivated and they provide their best energy, aligning well with organizational goals.

Solution

The discord that arises in organizations due to differences in opinions, approaches and methods of completing tasks can lead to conflicts of different scales within an organization. For the healthy growth of the organization, it is pivotal to eradicate all such conflicts. Conflicts hinder organizational productivity and deviate the employees' behavior from actual goals to their own personal needs. Various studies have shown that some percentage of conflict is good for organizations as it leads to positive synergy, but once the conflict level crosses a certain threshold it becomes hazardous for the company. Therefore, it is important that a department is formed within an organization to deal with such conflicts and that the proper means of tackling such issues should be employed in organizations.

It is important to lay the foundation and define the basics so that differences of opinion between employees can only lead to healthy and constructive arguments from which the organization can benefit. Employee branding has had a significant impact on handling conflicts within organizations. Employee branding creates a sense of responsibility among the employees. Employees start owning the organization and develop a sense of giving back to the organization. They respect the policies and the procedures developed by the organization to carry out different tasks in a specified manner. The difference between what the employer expects and what the employer actually gets from the employee diminishes as the employee is trained and branded in such a way as to fulfill all the desired requirements. While trying to avoid conflicts within an organization, it is important for the employer to understand and value the emotions of an

employee. When an employee has an emotional reaction to an organizational dispute, he or she indulges in thinking about the situation and starts to contemplate the possible outcomes. This can take the individual's mind off important things leading to a drop in their overall performance. In a state where there is a possibility or probability for a conflict to develop, the employer or the senior official should display leadership and should try to refrain from indulging in long and pointless debates and arguments. The employer should be flexible in his/her approach and should be able to analyze both sides of the picture before passing judgments. Whenever a conflict arises the best approach is to identify the basic cause of the conflict. Occasionally, a conflict is a manifestation of a deeper issue either at the employee level or the management level. Therefore, it is extremely important to identify the issue and eradicate it completely. One of the best methods of keeping things together in an organization is by using a regular feedback system. The feedback system should developed such a way that each and every individual within the organization should be held accountable for their actions. Even the highest corporate and organizational positions should be held accountable. This develops a sense of responsibility in the employees as well as those holding higher posts to do things in a manner that is most beneficial to the organization. The employee branding process has had a considerable impact on the conflicts within an organization as discussed above; however, the other methods for resolving issues should also be considered equally important.

Conclusion

As much as the best of the employee is needed in the workplace, a similar criterion is needed for the employer. Good employees cannot work as subordinates to an inexperienced or less appealing employer. So the qualities and characteristics of the employer should be those that empower employees, and retain and strongly uphold the corporate culture, along with having positive perspectives for the employees. these are all essential attributes that serve as the competitive advantages of the companies those which have such employers (Chamberlain, 2017).

Moreover, the brand name of the company is a beacon of attraction and appeal for potential employees. A big company means higher privilege. so employees generally leave no stone unturned to get a place in such organizations. Employees do not always find it comfortable in every environment because there are always conflicts when more two or more people work together. Therefore, it has been found through careful surveys that many factors can play a pivotal role in nullifying conflicts in the workplace. Some of these methods include the inculcation of positive emotions in the employees, and enabling them to take new risks. This will lead the employees to discern the undiscovered part of themselves, thus proving beneficial for both the employee and the company (Jonze and George, 2009).

It is absolutely essential to eradicate all sorts of organizational conflicts in order for the goals of companies to be achieved. Leadership needs to play a decisive role when conflicts will arise in an organization. Leadership works as the binding force between all the members of an organization. In order to make the company or organization stay intact it is important to have sound and sensible leadership. Identification of the cause of a problem can also prove immensely helpful.

In short, it is not one or the other part that defines the success and progress of the company; rather, the entire organization and the whole company starting from the employer, including the leadership and ending with the employees needs to remain intact, like one integral unit. That will certainly bring success to the organization. Everything needs to be kept in a delicate balance and order to assure that no hindrance or obstacles block the company from achieving its organizational goals. Employee branding has brought to light the explicit, important and significant perspectives that need to be kept in mind for employers as well as employee.

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The Impact of Information Technology on Human Resource Management in Saudi Arabia

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Abstract: Notwithstanding to specify that, leaders presently have fully understood the power of information technology (IT) tools for achieving business targets. The utilization of IT tools not only help in fulfilling the defined company goals but also advance the work forms. No one can deny the noteworthy impact and the significant role that information technology plays in all sciences and fields recently, Information technology has caused today no boundaries and distance world, affecting everything beginning from our day-by-day life to the environment by surprising degree. Trends and consequences of the contemporary studies constantly confirm contribution of the IT tools in Human Resources (HR) area i.e. to achieve allocated HR undertakings by utilizing the fountain of IT capacities. The researcher developed a questionnaire to examine study hypothesis using a population of officials in HR Departments for several companies in KSA for the study. The researcher distributed 100 questionnaires and about 95 out of the 100 questionnaires were responded to and used for analysis. Finally, depending on statistical analysis, a significant relation of IT systems application on HR sector growth was developed. The researcher, therefore, recommends making use of Information technology administration in all sizes of KSA firms, establishments, and associations in the future.

Keywords: Information Technology, Human Resources Management, Organization Structure, human resource, Company's Goals, Recruiting, Idea Management, Efficiency of Employees Performance.

INTRODUCTION

There is no underestimation in regards to the significance and impact of Human Resources administration by any means. In the recent past, Human Resource administration, as well as its needs, are turning into the focal point of every business consideration in each association [1]. Human Resources assume an essential part in every vital choice. Human Resources managers, therefore, request the more key position of their area of expertise inside the association with expectation to get to the quintessence of the issue on oversight, motivation and increase in the performance of an organization. Moreover the work on attracting workers, achieving rehabilitation, training, developing employees' skills and creating favorable regulatory conditions in terms of quantity and quality to extract the best of their potential and encourage them to make the maximum amount of effort and tender [2].

With this in mind, the importance of human resources management stems from that is that it concerns an organization personnel, which constitutes the primary lifeguard of any effective association for being the fundamental fountain of generation [3]. The administration has therefore evolved rapidly over years from a conventional management interested within files

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and personnel to become a management strategy using human resources information systems to guarantee the effective change of the workforce. It is through this that it accomplishes the association's objectives through precise, appropriate quantity, timely and flexible access in planning and organizing the authoritative procedures for employees and for HR division to play out its distinctive exercises and practices [4].

Additionally, to get the information characterized by precision, appropriate quantity, at the ideal time and adaptability, reducing work errors, raising employee's performance rates, lessening work blunders, raising worker's execution rates, giving employees better approaches to work [5]. The diminishing cost of working execution of completed transactions quickly, conquering the hindrances of work, staying up to date with late improvements in working strategies, mitigating the daily pressures of work, lessening staff mistakes, and finally, improving decision-making process [6].

PROBLEM STATEMENT

Human resource information systems (HRIS) usage permits the human resource (HR) professional to become a noticeably key player in the recent past [7]. With both increasing efficacy and rationality, HRIS is being utilized widely in associations of all sizes. Regardless of this, who thinks about the present use whether incongruities exist between organizations of various sizes, or about the impact HRIS has on the general professional standing of the HR professional [8]. Among the private sector organizations where this technique is applied and public sector which suffers from the lack of modern techniques in work flow development. Using the old methods in carrying out their work processes [9]. We, therefore, developed and administered a survey through held structured interviews to evaluate and compare the aspects of utilization, and to present a taxonomy that provides a framework for academic discussion, and a correlation between the companies that use HRIS and those that do not use it.

We further determined whether HRIS usage was strategic, a perceived value-add for the organization and its effect on professional standing for HR professionals and employees as well [10]. A comparison of these findings was done with those of other professions already using the MIS in private sector. Our results showed that, on average, few differences exist between small and large company usage. Additionally, we found that the professional standing of HR professionals has been improved by the particular utilization of HRIS for strategic collaborating [11].

The researcher, therefore, tried to address this problem through the following attached survey Questions, for example, but not limited to the following points:

- Whether the public sector organization uses any type of the human resources information system (HRIS) as private sector organization.
- Whether applying this technique in Human Resource meet the organization expectations in several aspects like achieving employees' satisfaction, or helping effectively in decision-making, and whether it achieved more flexibility in work transactions?
- Does it help in saving time, effort and cost to the organization?

Significance of the Study

Regarding the fact that can't be denied, developing techniques that HR sectors follow nowadays for carrying out its work flow is no more effective due to the globalization and the fast rhythm of life, which acquires processes to be done faster and more precise [12]. Information technology possesses a significant role in our society nowadays. According to research done recently, a high percentage of KSA governmental organizations suffer from being unqualified for preparing professional work results compared to those in private sector [13]. However, they have adequate knowledge in their specialization but they suffer from lack of technologies and methods that might facilitate their performance by 100%. This affects their workflow negatively due to lack of proficiency in addition to the existence of many mistakes that occurred by human personnel [14].

KSA's public sector of communication, however, exerts strenuous efforts in providing all possible potentials for addressing this significant issue and supporting all governmental organizations and institutions in order to be well qualified for managing their workflow in the best way. Another point to be mentioned involves applying such technology which requires the availability of providing enough training courses for employees in all organizations especially in public sector [15]. Focusing on using (specialized software designed specifically for HR departments) in addition to training courses for developing employees' skills in both operating systems Windows/Android, Microsoft Office to be able to increase employees' proficiency in dealing with software instead of using the traditional methods of recording and saving data on one side [16]. More mistakes could also happen due to lack of computers software proficiency on the other side [17]. This study therefore at investigating the both public and private organizations in Saudi society to qualify them by the market requirements from early stages to achieve better results rather than suffering in later stages.

The importance of the research comes through the following:

1. Acknowledging the possibility of applying human resources information system in organizations in KSA and its impact in increasing the efficiency of employees' performance.
2. Knowing the importance of human resource information system in improving and developing methods and procedures for human resources management in order to be qualified for competing with other organizations follow this technique.
3. Activating human resources management style, and directing the performance of human forward better levels.
4. Informing the organizations on the importance of human resource information system and its impact on the implementation of administrative functions in public organizations by increasing the employees' efficiency and thus improve the organization's efficiency.
5. Bringing out the importance of applying information technology systems in all sizes of organizations, and activities in KSA on one hand, and the integration between the information technology and human resources role in improving the performance of these organizations on the other hand.

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6. Paying attention to the role of information technology in human resources that helps in adapting right decisions for competitiveness in the global market.

Objectives of the Study

This study aims to:

1. Identify the influence of information technology on the organizations' performance in KSA.
2. Understand the implications of information technology in the development of the human resources.
3. Understand the role that information technology in the development of decision-making processes by the human resources and the impact it has on performance.
4. Getting precise results about how far adapting information technology systems in human resources would contribute positively in employees' satisfaction.

Study Limitations

Actually it is worthy to pay our attention to some limitations we faced while preparing this research. These challenges include:

1. Difficulty in gathering complete questionnaires due to unresponsive participants who failed to respond to all the questions we used in our survey.
2. Challenge of applying such techniques as an experiment in some public organizations due to laws and regulations issued by public sector that needs many procedures to be issue a decree for applying such techniques and methods to take place due to the privacy of such data. It was therefore difficult to apply such techniques in our research without acquiring official letters from the decision makers in the Saudi government, which considered as an obstacle, hinders our path. Thus, we relied on private sectors organizations that applied this method compared by other public organizations that did not apply it in our research paper.

Study Definitions

Human Resource Information System (HRIS): It stands for human resource information system or human resource management system (HRMS), which is an intersection of human resources and information technology through HR software [18]. This allows HR activities and processes to occur electronically.

LITERATURE REVIEW

With the growth of organizations due to the increase of competitiveness and volume of work, there is need to regulate the production, and control of the mechanisms of action even more [19]. Attention is increased to human resources management in more holistic manner. The functions of the management thus expanded as well as a human resources management from a strategic perspective to ensure the policies compatible with its objectives were given the first priority is the most important management's activities [20].

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The work of the human resource management intersect with other departments to ensure the workforce focus on doing the work assigned to them to increase productivity Hassled, [21]. The administration thus offers an important value added for the organization guaranteeing them excellence in their work compared to other competitors. The limits of resources should be characterized with one another in a manner of human resources management to achieve competitiveness feature, which is one of the most important success factors.

Generally, Human Resources Management activities cover all stages of the individual existence in any organization in production, activities starting from the pre-employment stage and ending with the end of individual's relationship with the organization [22].

The Human Resources Information System is considered as a system designed to carry out the functions of human resource management in the framework of the organization's operations [23]. It primarily seeks to provide information needed by managers to make decisions concerning the effective and efficient use of human resources and increase the level of its performance with the aim to lead its role to the achievement of organizational goals.

Another key point to be mentioned, Human Resources Information System is one of the main pillars prevailing in the process of decision-making in the various administrative levels [24]. In addition, it is a part of an effective management information system. Therefore, implementation, development, and maintenance information systems for Human Resource Management became one of the most important business process [25]. Where managers and organizations in this context are faced with new challenges, HR managers in any organization facilitates the affairs that are necessary for the proper use and provision of appropriate information [26]. Especially for doing affairs of Such as recruitment, staff training in order to create a healthy environment for staff to achieve the organization's goals.

O'Brien [27] defined Human Resource Information System as a set of systems that support the activities of human resources management, such as the selection, appointment, and evaluation of performance. According to Laudon & Laudon [28], HRIS is a set of systems that perpetuate personnel records, develop their skills, measure their performance, training them, and development of professions and compensation. Neo et al. [29] further defines it as a set of software and computers used for data entry, maintenance, modernization, and the use of human resources information in order to provide beneficiaries and staff working in various fields, and managers to assist in strategic decisions making and avoid legal disputes and evaluation of policies, practices and support daily operations of the organization. These three definitions by scholars are based on based on previous definitions.

Whereas, the human resources information system is defined as organized procedures for collection, storage and retrieval of the correct and effective data regarding human resources and individuals' activities, and their characteristics in any organization to support the efficiency and effectiveness of human resources management in the completion of activities related to the human resources Management at all administrative levels of the organization [30]. The findings from a research by Abu [31] pointed out that human resources are based on

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information technology system as an important tool with a significant role in the achievements of organizational goals in big companies focusing on strategic partnership.

Some HR professionals can be unsuccessful to adopt technology in business although they know HR technology [32]. With a specific end goal to be an essential player in associations and add value for organizations, HR experts must comprehend the business strategies. According to Al Farooq [33]. Human Resources Information System correlated positively with the efficiency of the performance of employees, and there are correlations positive relations between each of the (accurate of human resources information, comprehensiveness of human resources information, the flexibility of human resources information, timely human resources information) and the efficiency of the performance of employees.

The competencies of HR professionals in business do not necessitate the ability to do all the business functions but the ability to understand the businesses [34]. However, Al Rohan [35] mentioned that human resource information systems have become a catalyst for main changes in the structure, operations and organization's management as a result of its ability to improve productivity, reduce costs, improve decision-making, strengthen relationships with customers, and develop new applications of strategies to raise organizational performance.

Another point overlooked by O'Brien [36] pointed out that there is a growing trend for organizations to adopt a human resources information system for use in processing vast amount of data related to human resources, and also to make the right decisions based on whether it provides appropriate information in terms of accuracy, timing, and flexibility. These systems are mainly directed to support human resource management through the following:

1. Planning to meet the needs of an organization workforce.
2. Developing Employee's competences and abilities.
3. Monitoring the programs and policies of individuals.

As a researcher, applying information technology systems on HR sectors in different organizations in KSA whether governmental or private sectors will deeply contribute in achieving significant development in HR work cycle and workflow inside any organization or institution. That reflects a great consideration of taking a significant step to show people how to boost KSA management development methods. Furthermore, it leads to the achievement of accuracy and speed of performance, transparency, and integrity in system design. It also results in extensive use of information and timely use of both internet and intranet. Such outcomes as a development activity, developing staff skills, improving human relations in the workplace and the ability of employee participation increases the motivation as well as the creation of favorable conditions for employees, educating, and empowering of executives required skills and continuous monitoring and evaluation of work plans [37].

METHODOLOGY

Both descriptive and analytical approach is used in this study to understand the relationship and the impact of human resources information systems on the efficiency of employees'

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performance as well as theoretical research and studies. A questionnaire was used for the purpose of managers and specialists view on a number of variables and assumptions used in this study based on statistical methods and the relations and differences in accordance with the fundamental variables of the study, designed primarily to try to answer the research questions.

The researcher used a technique based on books as a reference, and a survey questionnaire that drew out lines of the best ways of upgrading techniques in applying information technology to HR departments both in KSA public and private sectors. The sample population of this research included 100 HR managers and specialists with a wide experience in best ways that pay the society attention to interact with this new method and technique effectively.

Moreover, the researcher chose 100 managers and specialists to measure the results of applying information technology on HR departments both in KSA public and private sectors, and the impact on our study on every level within an organization. The volunteer should show full willingness to take part in the study and had to inform the researcher in case of changing his mind. The researcher later would start to collect figures and Statistics given by volunteers regarding their answers after applying this experiment on their organizations and companies one by one to estimate the benefit they have got in terms of applying information technology in HR departments and problems they faced during their application process.

The researcher used survey in this research to help in acquiring all needed information on HR departments to prove the necessity of new techniques and methodologies in achieving better way for better performance and workflow inside any organization and how this will improve from employees' abilities and capabilities, and turn them into the productive layer in our society by overcoming the challenges they may come across during their operations. By the end of this questionnaire, the researcher then wrote down the best ways obtained from the answers submitted in the survey to improve organizations HR productivity by applying better techniques in the best way to achieve the best results in record time.

The data used for this study was related to HR managers and specialists who answered a distributed questionnaire during the period 15/July - 18/Aug/2017. This methodology is supported by many researchers in this field. The objective was to investigate whether information technology plays an essential role in human resource development and whether it has a direct impact in improving the performance of KSA organizations' workflow. The population of this study is composed of officials in HR Department of different organizations, both in governmental and private in KSA.

The primary data collected for the study was conducted to clarify the phenomenon throughout the collection of data as follows: structured orientation with some HR managers and specialists to complete and clarify the problem addressed by the study, and a questionnaire was designed and contained general information about the respondents. It also included an independent variable human resources information system, and the dependent variable being the employees' performance efficiency in the private sector organizations surveyed. As data included in the study were obtained from both organizations in governmental and private sectors by the questionnaire designed to examine the hypothesis of study.

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The researcher used weights assigned for approval including: (5) Strong Agree (4) Agree (3) Neutral (2) Disagree (1) Strong Disagree. The study relied on specific criteria in the interpretation of the degree of approval depending on the values of arithmetic means. The secondary data were obtained by reviewing the research articles, books, and literatures related to the study.

In the light of problem and objectives of the study, the researcher presented the following model reflecting on the independent variable HRIS. It also reflects the dependent variable employees' performance efficiency after applying HRIS in some private sector organization compared to other governmental organizations that do not apply this technique. Our research, therefore, sought to answer these questions according to our survey. The answers were obtained from volunteers with the aim to know the best results that could be achieved in knowing the impact of applying information technology techniques in both private and public sectors organizations in KSA.

The volunteers in this research also played an essential role in our research experiment with their free will. They were informed of the advantages of this research and also informed of the time needed for this experiment in parallel with tools and techniques required to be used. Furthermore, the answers of the volunteers were completely locked in drawers as a way to show respect and keep them anonymous, right to privacy.

Research Questions and hypothesis

1. What are the impacts of human resources information system on the efficiency of the employees' performance in both public and private organizations under study?
2. Is there any significance to the output of human resources information system in public and private organizations under study?
3. Does the development of human resources information system contribute to the increase in the efficiency of the employees' performance and satisfaction as well in both public and private organizations under study?

Ho1: There exists a relationship between human resources information system and the employees' performance efficiency in the private sector organizations under study.

Ho2: There is an impact of human resources information system on the employees' performance efficiency in the private sector organizations under study.

Results

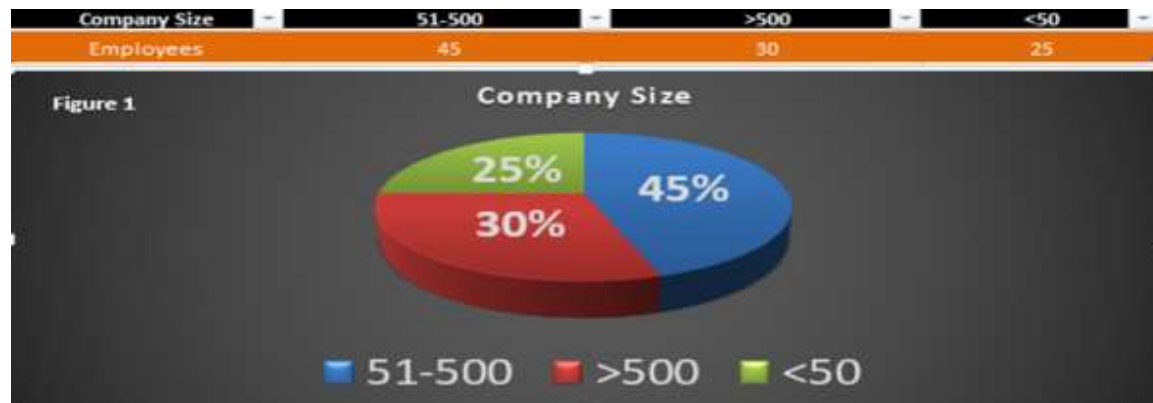


Fig. 1: Responds from employees in large, medium and small companies

The Figure (1) above shows that medium companies occupy about 45% with employees range from 51 to 500. Large companies, on the other hand, occupy about 30% from the questionnaire with employees exceeding 500. Small firms, however, occupies only 25% of our survey with employees of less than 50 persons. All of them gave their opinions by answering in our questionnaire covering all assumptions of applying HRIS in their companies whether public or private sector.

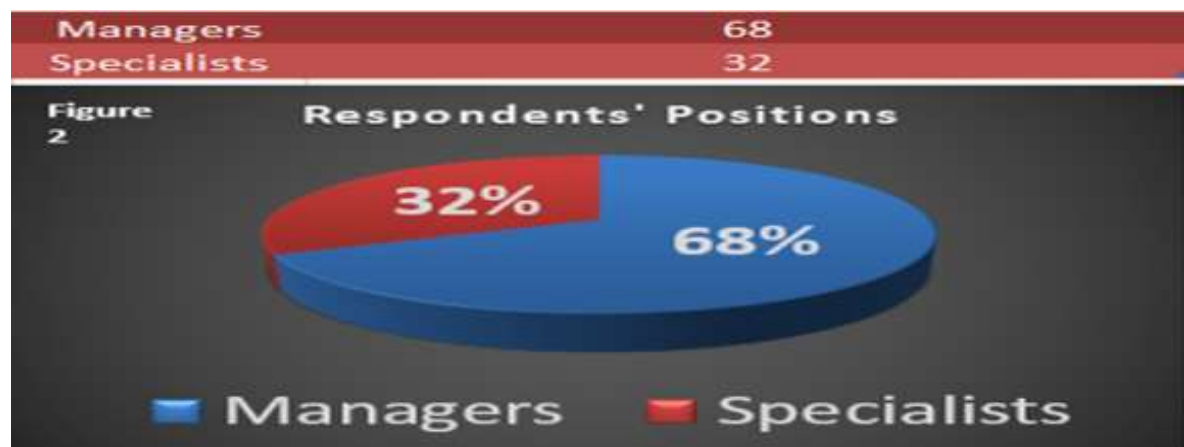


Fig. 2: Responses from Managers and Specialists

The respondents in the management department gave a 68% while the remaining 32% of respondents are specialists. There are however 5 respondents out of the total who failed to provide their responses by filling the survey questionnaire. The research, therefore, did not count them in the results as they are not matching the specifications to be taken into consideration in calculating our questionnaire result.

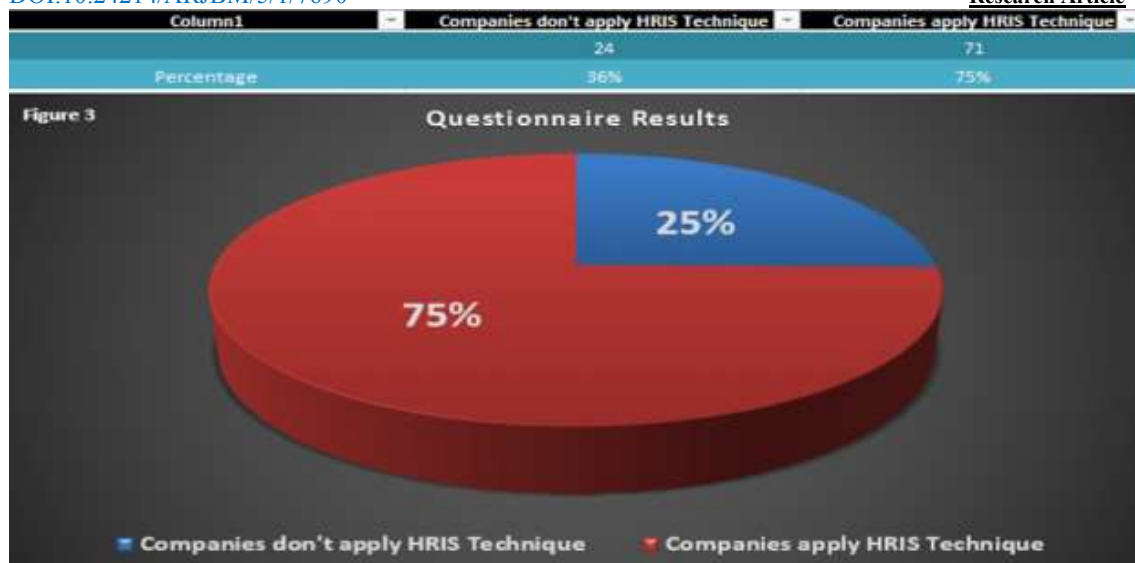


Fig. 3: Companies applying HRIS Technique and those that do not

The Figure 3 above shows the result of the questionnaire. The results were that below 25% refers to companies do not make use of the HRIS technique in their human resource department. This was deduced from the negative answers received by the respondents regarding achieving development in any of HR variables (employees satisfaction, lessening the of cost, money, and effort, meets the company expectations...etc.). On the other hand, however, more than 75% of respondents from those who work in companies that apply HRIS technique have achieved much better results with more than 50% difference.

- **First hypothesis Ho1:** There exist some correlation between Human Resources Information System and employees' performance efficiency in private sector organizations. That apply HRIS technique.
- **Second hypothesis Ho2:** There is a statistically significant impact at the level of the management control on the job performance efficiency in private sector organizations. That apply HRIS technique.

The study results showed that human resource information technology and the development of human resources has a positive impact on private sector organizations that apply HRIS technique. The results also indicate that there is a positive correlation between human resources development and the outstanding performance in private sector organizations that apply HRIS technique represented in the employees' satisfaction accomplishment and organization's growth.

The Human Resource Information System is employed with the aim to achieve the efficiency and effectiveness of performance in the field of human resources planning. It works to assign the administrative process in the three administrative levels through the following:

1. Support employment decisions in the organizations and determining the career path for staff in the organization.
2. Support planning process of the training needs and programs for staff development.

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3. Help in the management of property and scientific talent available to the organization

The study also proved the significant impact of HRIS on the employees' performance efficiency. Where Organization's efficiency is connected to its human resources efficiently, and that efficiency must be refined with the information technology and the use of means and methods that support the technology, so as to lead to effective decision-making, creativity, new ways of production, inventions, developmental research for an organization.

As it was clear from questionnaire answers that it helped in achieving the following:

1. Assist in providing an effective work force within the organization.
2. Lead to increased administrative channels of communication between the various departments.
3. Help in achieving effective control of the operational processes and reduce the size of the administrative Regulations.
4. Help in saving time to senior management and a full-time to more important business.

DISCUSSIONS AND RECOMMENDATIONS

During the research, it was evident that while some of the outputs of the HRIS are available, some of them are not practiced in those organizations. Considering that the information systems in the human resource department were characterized in terms of production of accurate information, proper quantity, timeliness, and flexibility in various degrees, many of the respondents had little information or knowledge regarding the availability of the system in their organization. In organizations where the respondents knew of the presence of the system in the human resources department, their response was clear that the presence and use of the system in the public sector improved the performance of the employees significantly. This implies that there is a strong positive relation between the Human Resources Information Systems and employees' performance efficacy. The use of the system in the human resource department, therefore, has a positive impact on the employees' performance efficiency with various degrees.

A number of recommendations were made with regards to implementing and making use of the HRIS in the human resource departments across organizations. One of the recommendations is that the human resources information systems should be made available in all public and private sector organizations to achieve maximum benefit from it. Additionally, and to be able to benefit from the system, organizations should ensure effective application of all the functions of human resources information systems extensively to get information used by public sector organizations in the implementation of functions that contribute positively to the development and improvement operations [38]. Furthermore, the employees should be informed of the presence and importance of the Human Resource Information Systems in improving the employees' performance efficiency. This can be done by training the employees in the organizations to deal with human resources information systems so that they feel they are ways to help them improve their performance. This will be reflected on improving the employees' performance efficiency in public sector organizations.

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Another component of the HRIS system beneficial to an organization is using the system to create a comprehensive data and information base and making them available for employees. By doing this, the performance of the employees will be reflected positively in terms of their efficiency. There is also the need to make a continuous improvement and development of the human resources information systems through the technological developments. Organizations further need to avoid the existence of difficulties impeding in the transition to the use of human resources information systems which is represented in the lack of trust and the relationship between departmental directors and the officials of Human Resource Management [39].

To be able to fully implement and utilize the benefits of the system across the organization, there is need to avoid those aspects that stand about the construction of the computerized human resources information system, and following the conventional methods. These aspects include:

1. Failure to determine the targets of human resources information system accurately.
2. Lack of effective participation of the management of human resources in the construction and design of the information system.
3. Weak integration between the sub-systems of the human resources information system.
4. The existence of the complex relationships and interlocking system leading to multiple reports.
5. Inadequate support by top management.
6. Reliance on commissions to design the system and follow-up.
7. The use of complex technology is often difficult to human resources management staff to use and operate.
8. Laxity in control before and during the process of construction and design human resources information system.
9. Resistance of workers to enter the human resources information system.
10. Non-study the cost of assisting programs used accurately.

Considering these aspects in mind, further recommendations with regards to the system can be made. Obstacles limiting the activation of the application of e-governance, for instance, need to be removed. Organizations should develop a comprehensive recruitment plan with the aim to attracting only qualified personnel specialized in e-governance. Organizations both in private and public sector further needs to develop and follow the work environment enactment regulations that support e-governance. Another rudimental component that will affect the success of the system in organizations involves the provision of incentives and growth opportunities to employees in line with the application of e-governance. Institutions should also allocate adequate budget for the implementation of e-governance and reliable communication service.

CONCLUSION

The impact and the relationship between human resources information systems on the employees' performance efficiency in public sector organizations are the theoretical

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foundations of this study [40]. The theoretical foundations were used to establish the impact of human resources information systems on each employees' performance efficiency indicators in private sector organizations. The experimental validation of the model applied on a sample of (100) managers and specialists showed that there exist positive impacts and a strong positive relationship between resources information systems on employees' performance efficiency in public sector organizations.

The results of the study confirmed the outcome of previous studies that established the existence of positive impacts of human resources information systems on the employees' performance efficiency. Previous studies have examined the impact of human resources information systems on the employees' performance efficiency [41]. The results showed that private sector organizations with human resources information systems are able to improve the quality of staff performance, reduce work errors, raise employee performance rates and reduce the time of implementation processes. The system can further give the staff new ways of working that reduce the cost of labor in the private sector organization, rapid implementation of completed transactions and non-delay of the transaction. It further contributes to overcoming obstacles at work, keeping pace with modern developments of working methods, alleviating the daily pressures of work, leading to reduce staff errors and helping to improve decision-making process [42].

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The Relationship between Elastic Money Growth and Prices in Countries with the Largest Money Stock: An Econometric Review

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ABSTRACT

The main objective of this paper is to examine the relationship between money expansion and inflation rates and asset price fluctuations across countries charged with highest money creation. The U.S.A, India, China and Japan reported with highest money stock in the world are studied for about 55 years. This research considers the monthly data of M2, the consumer price index, stock index values and real estate values in the stated countries. Johansen's Cointegration test indicates that a long term equilibrium relationship is seen between money supply and inflation rates and money supply and asset prices in all the four countries except India where money supply is not significantly cointegrated with the asset prices. Granger causality test results offer no definite inference, in China and Japan causality is mostly not established between the variables, however in the U.S.A and India significant causal relationship is seen.

Keywords: Causality, Co-integration, Money Supply, Inflation, Asset Prices, Stock Indices, Real Estate Indices

JEL Classifications: C3, E300

1. INTRODUCTION

This paper is an attempt to validate quantitatively the theory of instability of elastic money. A stance that elastic nature of fiat money is mainly responsible for inflation and Asset Price fluctuations is maintained and tested via Granger causality tests and Johansen's Co-integration Tests. Four countries namely Japan, the U.S.A, India and China, due to their leading money supply figures, have been selected to carry out this analysis. The study period is almost 55 years for all the countries except China, for which the data could not be found beyond 16 years. This research is not attempting to prove or disprove the Keynesian or Monetarist assertions towards the phenomenon of inflation. Our stance is to validate the fact that inflation which is said to eat up the value of fiat money, is only and only caused by the increased supply of it. Secondly, the Monetary impulses in the form of loose money supply put pressure on asset prices like stock and real estate prices which do not reflect the investor preferences but the easy money that has found its way into such markets. Therefore, this research would test the causality

and co-integration between money supply growth and inflation and asset prices.

The empirical analysis of the relationship between money supply and prices, and money supply and asset prices has received much attention in the past few decades. Most of the studies conducted, attempt to validate or refute the quantity theory of money. As price stability has remained one of the overriding objectives of the monetary policy, many scholars have attempted to approach the money price relationship to ascertain whether the objective is achieved or not. This empirical study will embrace the approach of validating the ill effects of fiat money systems in terms of deterioration of people's purchasing power and the creation of asset price bubbles.

2. LITERATURE REVIEW

Not many studies are conducted to investigate the causality between money supply and prices for a sample of countries that have higher money growth, however many researches have been conducted to study the individual countries for the same.

The single country analyses of similar studies have yielded the mixed results. For example, Dave and Rami (2008) studied the causality between money supply and price level in India for the time period 1953-2005 using monthly data. The results show that the money is endogenous and it is partially determined by the price level. Similarly the results also show that the monetary policy in India with respect to the money supply only have limited impact on the inflation, and main reason behind the increase in the rate of inflation in India is due to increase in the money supply.

Ma and Sun (2004) investigated the relationship between the money and price relationship in China. By using the Granger causality test, the authors tried to examine two aspects of the price level, namely the inflation and deflation. The empirical study suggested that the money in China was endogenous during the period of inflation.

Emerson (2006) examined the validity of the quantity theory of money in case of the United States from 1959 to 2004. The main aim of this study was to find out the relationship between prices, money, interest and output in the long run. The long term relationship among the variables was studied via co-integration analysis using the Johansen test and the Augmented Dickey Fuller (ADF) unit root test was employed to test for the stationarity. The results showed that price levels in the United States are affected by the money supply; however no long term association between money and prices is seen.

Katrin et al. (2008), studied prices and inflation in Japan in various time horizons and determined that the causality runs from money to the prices.

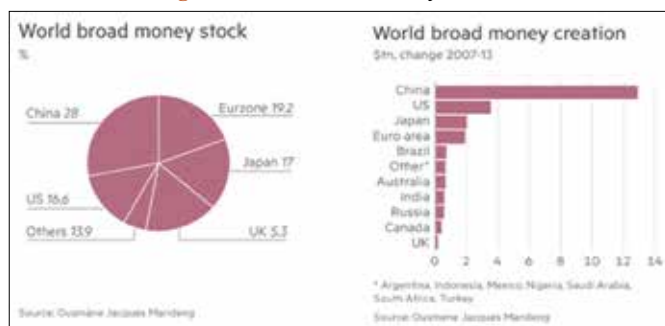
Sharma et al. (2008) in their study in India examined the causality between prices, output and money in India. Using the bivariate methodology to test the Granger causality between prices level, money supply and output (using frequency domain), the authors concluded that there is money-output trade-off in the short run however in the long run money supply have impact on the price level but not on the output.

Diaz and Kirkby (2013) examined the quantity theory of money in case of United States for the period 1960-2009. The results show that the quantity theory of money holds in the long run during the 1960-2009 which means that the money supply in United States has long run impact on the price level. However in the short run the relationship does not hold during the study period.

Gerlach (1995) tried to test the quantity theory of money using the long run averaged data across various countries. This paper was aimed at finding the relationship between the long run average inflation, real income growth and the money growth. The study concluded that the findings of a one to one relationship of inflation and money growth is sensitive with respect to the inclusion of the data from some countries which have very high rate of inflation.

Studies related to the relationship between increase in the money supply and asset prices, show mixed results. Arif et al. (2012)'s study aimed to test the linkage between money supply, liquidity,

Figure 1: World broad money statistics



share price and interest rate on quarterly data from 1968 to 2011. The results show that the changes in the money supply have positive effect on the liquidity and this result is in line with the existing theory. The authors also extend the liquidity equation to the price of the assets where the results show that the changes in the liquidity also have positive effect on the prices of the shares controlling for the earning effect.

Yao et al. (2011)'s study was based on China between June 2005 and September 2010 and the authors examined the effect of the monetary policy on the asset prices using the monthly data. Using the Johansen co-integration method based on Granger causality and the vectors autoregressive (VAR), the results showed that monetary policies in China have little impact on the asset prices in the short run.

Other studies of this nature have been carried out in countries like Malaysia, Pakistan, Nigeria and Australia, showing either the causality or long-term equilibrium relationship between Money supply growth and asset prices.

3. DATA AND METHODOLOGY

This study examines the causality and long-term relationship in terms of cointegration between money supply and general prices, money supply and asset prices. The countries selected to test this causality are the United States of America, Japan, China and India. The reason this research has selected the U.S.A, China and Japan is that these stand as world's largest economies and their Central Banks are charged with chasing high money supply growth. As reported by the Financial Times (2015), China's broad money supply within 2007-2013 has outgrown the rest of the world. Johnson (2015) in Financial Times as indicated in the Figure 1, listed countries in accordance to their broad money creation, China, United States and Japan topped the list. These countries even contribute in major proportions to the world broad money stock, Johnson (2015 FT). India, though not as advanced in money creation as other three, still tops the list of emerging economies with very high money growth. It is thought to be intriguing to explore the causal relation between money supply and prices in these countries where money supply has been continuously on the rise. Additionally like the United States and Japan, China's surge in money supply is seen to fuel bubbles in its real estate and stock markets. With this pre-consideration, the research aims at uncovering rather validating the ill effects of increased fiat money

supply on prices in general (the purchasing power of the common man) and on asset prices in the U.S.A, Japan, China and India.

The monthly data of broad money indicator M2 is collected for the United States of America, Japan, China and India. The price is taken as monthly consumer price index (CPI) data for these countries. The stock indices and real estate indices are taken as proxies for stock prices and property prices respectively. Monthly average values of Dow Jones Industrial Index, Nikkei 225, Shanghai stock exchange composite index and Sensex have been acquired for the U.S.A, Japan, China and India respectively. Monthly averages of S and P home price Index are taken as proxy for property values in the U.S.A. For Japan, India and China, property total return indices have been taken as proxies for property prices.

4. MODEL BUILDING

ADF test: Causality tests of Granger assume that the time series involved in the analysis are stationary. Therefore, tests of stationarity should precede tests of causality (Gujarati, 2004. p. 794) to rule out any possibility of Spurious, or nonsense regression, which is likely to distort the meaningfulness of the results obtained. In order to test for the stationarity, each time series acquired will go through ADF test. As in all we have 4 time series for each country i.e., monthly money supply, CPI, stock index values and property index values. All the 16 time series collected should pass through the ADF test to test for the unit root.

y_t is a random walk (with no constant and linear trend):

$$\Delta y_t = \delta y_t - 1 + \sum_i^n \alpha_i \Delta y_t - i + u_t \quad (1)$$

y_t is a random walk with drift (With constant):

$$\Delta y_t = \beta 1 + \delta y_t - 1 + \sum_i^n \alpha_i \Delta y_t - i + u_t \quad (2)$$

y_t is a random walk with drift around a stochastic trend (With constant and linear trend):

$$\Delta y_t = \beta 1 + \beta 2t + \delta y_t - 1 + \sum_i^n \alpha_i \Delta y_t - i + u_t \quad (3)$$

Where t is the time or trend variable and u_t is a pure white noise error term and where $\Delta y_{t-1} = (y_{t-1} - y_{t-2})$, $\Delta y_{t-2} = (y_{t-2} - y_{t-3})$, etc. The number of lagged difference terms to include is often determined empirically. In ADF we test whether $\delta = 0$. In each case, the null hypothesis is that $\delta = 0$; that is, there is a unit root-the time series is nonstationary. The alternative hypothesis is that $\delta < 0$; that is, the time series is stationary. The unit root test is conducted for all the four time series (money supply, CPI, stock index values and property index values) in each country under consideration. The lag length is taken in accordance to the Schwarz Information Criterion given automatically in the E-views unit root test.

4.1. Granger Causality Test

Correlation may not always refer to causation in any meaningful sense of that word. Granger (1969) approached the problem of whether x causes y by seeing how much of y is explainable by

the past values of y and if adding lagged values of x improved the explanation then x is said to help in predicting the values of y , hence x is said to Granger Cause y . This is ascertained by the statistically significant value of the co-efficient of lagged x . The method of Granger Causality measures the precedence and information content but may not validate causality in a sense the word is commonly used. Is it Y that “causes” the X ($Y \rightarrow X$) or is it the X that causes Y ($X \rightarrow Y$), where the arrow points to the direction of causality. The Granger causality test assumes that the information relevant to the prediction of the respective variables, Y and X is contained solely in the time series data on these variables. The Granger causality models are typically put in terms of Bivariate regressions of the form,

$$y_t = \alpha_0 + \sum_i^n \alpha_i y_{t-i} + \sum_i^n \beta_i x_t + \epsilon_t \quad (4)$$

$$x_t = \alpha_0 + \sum_i^n \alpha_i x_{t-i} + \sum_i^n \beta_i y_{t-i} + u_t \quad (5)$$

This research conducts the Granger causality test between the first differenced forms of “money supply and CPI,” “money supply and stock index values” and “money supply and property index values” in all the four countries i.e., China, India, Japan and the U.S. This test will reveal whether it is the money supply that causes the changes in general prices and asset prices or Vice-Versa.

$$\ln MS_t = \alpha_0 + \sum_i^n \alpha_i \ln MS_{t-i} + \sum_i^n \beta_i \ln CPI_{t-i} + \epsilon_t \quad (6)$$

$$\ln MS_t = \alpha_0 + \sum_i^n \alpha_i \ln MS_{t-i} + \sum_i^n \beta_i \ln SP_{t-i} + \epsilon_t \quad (7)$$

$$\ln MS_t = \alpha_0 + \sum_i^n \alpha_i \ln MS_{t-i} + \sum_i^n \beta_i \ln RE_{t-i} + \epsilon_t \quad (8)$$

Where $\ln MS$ stands for natural logarithmic values of money supply, $\ln CPI$ for natural logarithmic values of CPI, $\ln SP$ for natural logarithmic values of stock prices and $\ln RE$ for natural logarithmic values of real estate prices. Akaike Information Criterion is used for the optimal Lag length selection.

4.2. Johansen's Cointegration Test

The Johansen test is precisely a multivariate generalization of the augmented Dickey-Fuller test. The generalization calls for examination of linear combinations of variables for unit roots. The Johansen test and estimation strategy (maximum likelihood) makes it possible to estimate all cointegrating vectors when there are more than two variables. If there are three variables each with unit roots, there are at most two cointegrating vectors. More generally, if there are n variables which all have unit roots, there are at most $n-1$ cointegrating vectors. The Johansen test provides estimates of all cointegrating vectors. Though Johansen Test is used widely for multivariate cointegration testing, the author has used it to test the cointegration of only two variables.

The cointegration method characterizes the existence of a long-run relationship. According to Johansen (1988), a p -dimensional VAR of order k (VAR [k]) can be specified as follows:

$$Z_t = d + \Pi_1 Z_{t-1} + \dots + \Pi_k Z_{t-k} + \omega_t \quad (t = 1, \dots, T) \quad (9)$$

$$\Delta Z_t = d + \Pi k Z_t - k + \sum_{i=1}^{k-1} (\theta \Delta Z_t - i) + \omega t \quad (10)$$

Here Δ is the first difference operator, Π and θ are p-by-p matrices of unknown parameters and ωt is a Gaussian error term. The impact matrix Π could contain the long-run information about the relationship between money supply and CPI or money supply and stock index values or money supply and property index returns.

A full column rank of the matrix Π implies that all variables in the Z_t are stationary. When the matrix has zero column rank, the expression is a first differenced VAR involving no long-run elements. If, however, the rank of Π is intermediate meaning that $0 < \text{rank}(\Pi) = r < p$, there will be r cointegrating vectors that make the linear combinations of Z_t become stationary or integrated.

This study performs two Johansen cointegration tests. First, the maximum likelihood estimation procedure that provides a likelihood ratio test, called a Trace test, which evaluates the null hypothesis of, at most, r cointegrating vectors versus the general null of p cointegrating vectors. A second, likelihood ratio test is the maximum Eigenvalue test, which evaluates the null hypothesis of r cointegrating vectors against the alternative of $(r + 1)$ cointegrating vectors (Johansen 1991).

5. ESTIMATION RESULTS

The results of ADF test show the order of integration. The following table gives the summarized results of ADF for all the time series in the select four countries (Tables 1-4).

The ADF results for all four countries in summary show that the data mostly becomes stationary after first differencing. Therefore, in order to conduct the Granger Causality Test the first differenced time-series for all variables has been generated.

5.1. Granger Causality Results

Pair-Wise Granger Causality Test requires an optimal lag length to establish the causality between the variables. The results obtained are very much sensitive to the lag length criterion used. We have used VAR lag order selection criteria (VAR) to arrive at the optimal lag length. In order to determine the significant lag values, VAR uses five different criteria viz.

1. LR: Sequential modified LR test statistic (each test at 5% level)
2. FPE: Final prediction error
3. AIC: Akaike information criterion
4. SC: Schwarz information criterion
5. HQ: Hannan-Quinn information criterion.

This test depends democratically on final prediction error, Akaike information criterion and Schwarz information criterion for the lag length selection.

The all countries summary of Bivariate Granger causality test provided in Table 5 gives an overall picture of causality between various variables in all the four countries. In Japan we see that

money supply does not Granger cause CPI and property returns index. However significant causality can be seen running from money supply to Nikkei 225 and reverse from Nikkei 225 to the money supply. In the U.S.A a bivariate causality is seen running between money supply and CPI and money supply and Dow Jones industrial index. We do not see money supply in the U.S.A Granger causing S and P home price index, however interestingly reverse causation is significantly established. In India the results are little different, a bivariate Granger causality running between money supply and CPI is seen, with no significant causality between money supply and Sensex stock index. Money supply in India however is Granger causing property total returns with no feedback present. The Granger causality test results for China show that money supply does not Granger cause CPI, stock index returns or property returns. The reverse causality is also not present. China is the only country where no short term bivariate causality could be established between money supply and CPI, stock index and property index (Table 6).

Evident from the results given above, the long term cointegration between money supply and CPI is established by both trace test and Max-Eigen test in all the four countries. For Japan we can see that the null hypothesis is rejected in case of cointegration between money supply and CPI and money supply and property returns, however we do not have enough evidence to reject the null hypothesis of no cointegrating vector in case of Money Supply and Nikkei 225. Therefore significant long term association can be inferred between money supply and CPI, money supply and property index in Japan. In case of the United States of America the Null hypothesis of “no cointegrating vector” and of “at most one cointegrating vector” are rejected, indicating the presence of 2 cointegrating equations at 5% significance level. Therefore we can infer that there is a strong long-term relationship between money supply and CPI, Money Supply and DJIA and money supply and S and P home price index in the U.S.A. Rejection of the null hypothesis means that there is significant long-term association between the variables. For India, we can conclude that there are two cointegrating equations at 5% level signifying a strong long-term relationship between money supply and CPI in India. But we are not able to reject the Null hypotheses for the cointegration between “money supply and Sensex” and “money supply and property returns,” therefore we conclude that there is no long-term association between the same. In case of China, there are two cointegrating equations with respect to “money supply and CPI” and “money supply and Shanghai Composite Stock Index,” which indicates that these variables show strong long-term association. The cointegration between money supply and property returns show that there is one cointegrating equation at 5% level of significance. Money supply in China is cointegrated with CPI, stock index and property index returns.

6. CONCLUSION

This study has investigated empirically how the elastic nature of fiat money is mainly responsible for inflation and asset price fluctuations. Granger causality tests and Johansen's cointegration tests were used on four countries namely, Japan, the U.S.A, India and China, due to

Table 1: ADF test results - Japan

Exogenous	Level			First difference		
	Intercept	Intercept and trend	None	Intercept	Intercept and trend	None
Money supply						
t-statistics	1.936141	-2.32588	2.975386	-3.6244*	-4.3813*	-1.8237
Critical values at 5%	-2.86533	-3.41606	-1.94126	-2.86533	-3.41606	-1.9412
P	0.9999	0.4188	0.9994	0.0055	0.0025	0.0650
CPI						
t-statistics	-1.5861	-0.8143	1.0426	-3.2612*	-3.5350*	-2.2210*
Critical values at 5%	-2.8654	-3.4161	-1.9412	-2.8654	-3.4161	-1.9412
P	0.4892	0.9627	0.9225	0.0171	0.0365	0.0255
Nikkei (SI)						
t-statistics	-1.55683	-1.84416	-0.44178	-20.299*	-20.287*	-20.295*
Critical values at 5%	-2.8652	-3.4159	-1.9412	-2.8652	-3.4159	-1.9412
P	0.5042	0.6822	0.5232	0.0000	0.0000	0.0000
Property index TOT						
t-statistics	-1.83155	-2.10421	0.002385	-17.274*	-17.252*	-17.2583*
Critical values at 5%	-2.8687	-3.4214	-1.9416	-2.8687	-3.4214	-1.9416
P	0.3649	0.5413	0.6828	0.0000	0.0000	0.0000

The significance level is outrightly mentioned at 5% and the P values are given for both Augmented Dickey Fuller Test and Granger Causality. For Johansen's Cointegration the significance value cant be gotten from Eviews, however the test statistics are easily indicated to be significant at 5% level

Table 2: ADF test results - USA

Exogenous	Level			First difference		
	Intercept	Intercept and trend	None	Intercept	Intercept and trend	None
Money supply						
t-statistics	8.937182	5.213527	10.04840	-1.4613	-7.9331*	-0.4191
Critical values at 5%	-2.86558	-3.41644	-1.94129	-2.86568	-3.41645	-1.9413
P	1.0000	1.0000	1.0000	0.5528	0.0000	0.5321
CPI						
t-statistics	2.61980	-4.07949	8.912788	-14.662*	-15.098*	-2.1097*
Critical values at 5%	-2.86556	-3.41643	-1.94128	-2.8655	-3.4164	-1.9412
P	1.0000	0.0070	1.0000	0.0000	0.0000	0.0336
DJII (SI)						
t-statistics	1.27601	-1.203953	2.562123	-26.093*	-26.235*	-25.9006*
Critical values at 5%	-2.86555	-3.416410	-1.94128	-2.86556	-3.41642	-1.941288
P	0.9986	0.9082	0.9977	0.0000	0.0000	0.0000
S and P home price index						
t-statistics	-1.44195	-2.962981	0.207156	-3.0197*	-3.0271	-2.8866*
Critical values at 5%	-2.86970	-3.422903	-1.94174	-2.8697	-3.4229	1.941745
P	0.5619	0.1443	0.7459	0.0341	0.1263	0.0039

The significance level is outrightly mentioned at 5% and the P values are given for both Augmented Dickey Fuller Test and Granger Causality. For Johansen's Cointegration the significance value cant be gotten from Eviews, however the test statistics are easily indicated to be significant at 5% level

Table 3: ADF test results - India

Exogenous	Level			First difference		
	Intercept	Intercept and trend	None	Intercept	Intercept and trend	None
Money supply						
t-statistics	1.755837	-3.83931	4.266890	-3.3472*	-4.3996*	-0.6153*
Critical values at 5%	-2.86566	-3.41659	-1.94130	-2.865643	-3.416590	-1.941298
P	0.9997	0.0151	1.0000	0.0133	0.0023	0.4507
CPI						
t-statistics	-0.065465	-3.967964	2.854666	-4.5585*	-4.5495*	-2.5196*
Critical values at 5%	-2.865536	-3.416382	-1.941285	-2.865536	-3.416382	-1.941285
P	0.9510	0.0101	0.9991	0.0002	0.0013	0.0115
SENSEX (SI)						
t-statistics	-1.358891	-2.015876	2.833932	-19.2668*	-19.2817*	-18.8896*
Critical values at 5%	-2.867859	-3.420022	-1.941542	-2.867874	-3.420045	-1.941543
P	0.6030	0.5906	0.9990	0.0000	0.0000	0.0000
Property index TOT						
t-statistics	-1.787658	-2.275410	0.748856	-9.3823*	-9.3227*	-9.3544*
Critical values at 5%	-2.897223	-3.465548	-1.944811	-2.8976	-3.4662	-1.9448
P	0.3841	0.4421	0.8741	0.0000	0.0000	0.0000

The significance level is outrightly mentioned at 5% and the P values are given for both Augmented Dickey Fuller Test and Granger Causality. For Johansen's Cointegration the significance value cant be gotten from Eviews, however the test statistics are easily indicated to be significant at 5% level

Table 4: ADF test results - China

Exogenous	Level			First difference		
	Intercept	Intercept and trend	None	Intercept	Intercept and trend	None
Money supply						
t-statistics	2.376635	-0.073039	2.281838	-0.92193	-3.739973	0.504057
Critical values at 5%	-2.876595	-3.433651	-1.94250	-2.87659	-3.433651	-1.94250
P	1.0000	0.9950	0.9948	0.7796	0.0220	0.8235
CPI						
t-statistics	-2.649670	-2.848468	-1.330267	-5.830830	-5.860826	-5.837643
Critical values at 5%	-2.877186	-3.434569	-1.942574	-2.877186	-3.434569	-1.942574
P	0.0850	0.1821	0.1694	0.0000	0.0000	0.0000
S SECI (SI)						
t-statistics	-2.71044	-2.985782	-0.305484	-7.70088	-7.68563	-7.71232
Critical values at 5%	-2.87560	-3.432115	-1.942383	-2.87560	-3.43211	-1.94239
P	0.0740	0.1388	0.5747	0.0000	0.0000	0.0000
Property index TOT						
t-statistics	-2.51264	-2.279695	-1.55852	-12.1551	-12.1983	-12.1197
Critical values at 5%	-2.88505	-3.446765	-1.94344	-2.88524	-3.44707	-1.94347
P	0.1149	0.4414	0.1116	0.0000	0.0000	0.0000

H_0 : The variable has a unit root. *Denotes the rejection of the unit root null hypothesis for the 5% significance. The choice of optimum lag for the ADF test was decided on the basis of minimizing the Schwarz information criterion

Table 5: All countries summary of Granger causality tests

Null hypothesis	Observe	F-statistics	P	Reject/do not reject
Japan				
Money supply does not Granger cause CPI	712	0.46905	0.8956	Do not reject
CPI does not Granger cause money supply	712	1.01924	0.4227	Do not reject
Money supply does not Granger cause NIKKEI 225	717	3.09132	0.0007	Reject
NIKKEI 225 does not Granger cause money supply	717	3.65836	9.E-05	Reject
Money supply does not Granger cause property index	231	0.53324	0.5874	Do not reject
Property index does not granger cause money supply	231	0.54084	0.5830	Do not reject
The U.S.A				
Money supply does not Granger cause CPI	673	2.06533	0.0252	Reject
CPI does not Granger cause money supply	673	7.14182	1.E-10	Reject
Money supply does not Granger cause DJII	673	4.22307	1.E-05	Reject
DJII does not Granger cause money supply	673	5.31898	1.E-07	Reject
Money supply does not Granger cause S and P home	336	1.42191	0.1692	Do not reject
S and P home does not Granger cause money supply	336	2.10498	0.0238	Reject
India				
Money supply does not Granger cause CPI	672	6.75567	5.E-10	Reject
CPI does not Granger cause money supply	672	6.32566	3.E-09	Reject
Money supply does not Granger cause Sensex	410	1.01739	0.4069	Do not reject
Sensex does not Granger cause money supply	410	0.85368	0.5124	Do not reject
Money supply does not Granger cause property values	49	3.94843	0.0265	Reject
Property values does not Granger cause money supply	49	1.15322	0.3250	Do not reject
China				
Money supply does not Granger cause CPI	185	0.21831	0.9943	Do not reject
CPI does not Granger cause money supply	185	0.85732	0.5745	Do not reject
Money supply does not Granger cause shanghai comp	192	0.85383	0.5777	Do not reject
Shanghai comp does not Granger cause money supply	192	1.82105	0.0602	Do not reject
Money supply does not Granger cause property returns index	106	1.07676	0.3881	Do not reject
Property returns index does not Granger cause money supply	106	0.37080	0.9461	Do not reject

their leading money supply figures. This multi-country analysis of the influence of elastic money supply on CPI and asset price yields varied yet interesting results. The Johansen's Cointegration test results in Japan show that there is significant long-term relationship between money supply - CPI and money supply - property returns.

Index, however no Granger causality is seen running between these variables. Interestingly money supply and Nikkei stock index are not cointegrated significantly, yet show significant bivariate Granger causality. In the U.S.A money supply is strongly cointegrated with CPI, stock index and property index values,

showing a strong long term association between these variables. Money supply in the U.S.A seems to be influencing heavily the inflation rates and asset prices. The Granger causality results also validate a causality running from money supply to CPI and to Dow Jones Industrial Index with the feedback. Money supply in the U.S.A is not Granger causing the S and P home price index returns; however the reverse causality is significantly established.

The empirical analysis in case of India shows strong cointegration between money supply and CPI, but does not validate the same between money supply and Sensex and money supply and property

Table 6: Johansen's cointegration test results

H_0	H_1	Eigenvalue	Trace statistics	5% critical value	Max-Eigen statistics	5% critical value	VAR
Japan							
MS-CPI							
$r=0$	$r=1$	0.020763	17.75772**	15.49471	14.93923**	14.26460	2
$r \leq 2$	$r=2$	0.003951	2.818492	3.841466	2.818492	3.841466	2
MS-Nikkei 225							
$r=0$	$r=1$	0.014822	12.64133	15.49471	10.70691	14.26460	2
$r \leq 2$	$r=2$	0.002694	1.934415	3.841466	1.934415	3.841466	2
MS-property returns							
$r=0$	$r=1$	0.055627	21.80974**	15.49471	21.57744**	14.26460	2
$r \leq 2$	$r=2$	0.000616	0.232302	3.841466	0.232302	3.841466	2
U.S.A							
MS-CPI							
$r=0$	$r=1$	0.047138	38.07332**	15.49471	32.49589**	14.26460	2
$r \leq 2$	$r=2$	0.008253	5.577422**	3.841466	5.577422**	3.841466	2
MS-DJII							
$r=0$	$r=1$	0.032385	28.89446**	15.49471	22.15591**	14.26460	2
$r \leq 2$	$r=2$	0.009963	6.738545**	3.841466	6.738545**	3.841466	2
MS-S and P home price index							
$r=0$	$r=1$	0.055613	25.79843**	15.49471	19.22559**	14.26460	2
$r \leq 2$	$r=2$	0.019372	6.572846**	3.841466	6.572846**	3.841466	2
India							
MS-CPI							
$r=0$	$r=1$	0.027403	24.67689**	15.49471	18.67208**	14.26460	2
$r \leq 2$	$r=2$	0.008896	6.004812**	3.841466	6.004812**	3.841466	2
MS - Sensex							
$r=0$	$r=1$	0.024315	10.72664	15.49471	10.09240	14.26460	2
$r \leq 2$	$r=2$	0.001546	0.634237	3.841466	0.634237	3.841466	2
MS - property tot returns index							
$r=0$	$r=1$	0.185984	12.20993	15.49471	10.08301	14.26460	2
$r \leq 2$	$r=2$	0.042478	2.126922	3.841466	2.126922	3.841466	2
China							
MS-CPI							
$r=0$	$r=1$	0.149270	34.38442**	15.49471	29.90710**	14.26460	2
$r \leq 2$	$r=2$	0.023911	4.477324**	3.841466	4.477324**	3.841466	2
MS - Shanghai composite index							
$r=0$	$r=1$	0.120250	33.19868**	15.49471	24.59849**	14.26460	2
$r \leq 2$	$r=2$	0.043804	8.600195**	3.841466	8.600195**	3.841466	2
MS - property tot returns index							
$r=0$	$r=1$	0.209286	28.26455**	15.49471	24.89082**	14.26460	2
$r \leq 2$	$r=2$	0.031327	3.373738	3.841466	3.373738	3.841466	2

VAR is order of the variance. **denotes statistically significant at the 5% level. H0 and H1 denote the null and alternative hypothesis respectively and r denotes the number of cointegrating vectors

returns. The money supply in India is Granger causing the CPI with the feedback. No causality is seen between money supply and Sensex; however significant causality is inferred from money supply to property returns without the feedback. Money supply in India seems to be significantly causing the inflation rates and property returns, but not the stock index returns. for China cointegration tests show that money supply is strongly cointegrated with all the three variables. Therefore long term strong relationship can be assumed between money supply and CPI and money supply and asset prices in China. The Granger causality results in China show no causality what so ever running from money supply to CPI and asset prices. Over all, in all the four countries money supply seems to have significant long term influence on price levels and asset prices.

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6

The Impact of Internship on Youth Employment: Case University of Business and Technology, Saudi Arabia

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Abstract

This paper study the effect of internship program on female Youth employment, by analyzing the employers evaluation forms, for undergraduate students from University of business and technology in Saudi Arabia, Jeddah. While most previous studies examined the relation between internship and College performance and the impact of internships from students perspective to see how satisfied they are with their knowledge and skills in the real work environment, and if this improves their GPA level. This study investigate the impact of internship on intern's employment to find out the most important non-academic skills from employer's perspective. Interns in this study from two Colleges: College of Business and administration (CBA) and Jeddah College of advertising (JCA), with different majors and they conducted the internship in their last semester as a university requirement for graduation.

Keywords: Internship, Unemployment, Youth development, skills, Business

Introduction

Youth unemployment is among the most important problems most countries is facing. As youth population is increasing in Saudi Arabia, which is a leading country in the Middle East, this raises the risk toward unemployment among young people, Saudi workforce need development in the skills and knowledge required in the private sector labor market (Bagader, 2011).The private sector expected to offer good percentage of jobs to face youth unemployment. Recent date released by the General Authority of Statistics (GAS) shows that the percentage of unemployment rate for Saudi Female

between the age of (20-24) years old of 11.3% in the third quarter 2016, taking in consideration that most of them still studying to obtain a degree, Although the education development has been among the main concerns in Saudi Arabia for the past few decades, but one of the most important challenges is training youth and provide them the support to transit from classroom to real work environment, This support must include the skills required and the supervision from both the academic supervisors who represents the educational institutes and the employers. Alzu'be, 2012 in his study of the need of Saudi labor market mentioned the training as important way to develop Saudi graduates. One of training method is the internship. Internship or coop training which is a training program for undergraduate or postgraduate students usually for 3 to 6 months, paid or unpaid without formal contract, it could be full time or part time. It allows students to integrate classroom education with experience based learning (Jerice Hanson, 1984). (The European youth Forum, 2009) distinguished between two forms of Internships: 1-Internship as part of a formal education program. 2- Internship that takes place outside formal education (David Lain and others). So there are three parties involved in the internship, the students, Universities or educational institutes and the employers. Interns should improve their non-academic skills through the internships programs (Robert I Leman, 2013), For example: time management, problem solving, team working skills and other skills, the intern's personal traits also determine how likely students gain the benefits from the internship. On the other hand employers (firms) get better opportunities in recruitment having the chance to scan the intern's ability in certain job or position (Zhao, 2006), and the time to decide the suitable job for the trainee, and to get free help in the high seasons, or cheap labor (Coco, 2000).

Universities and educational institutions also getting the advantage of good reputation and connection with the society and companies ,getting the feedback about their students level and skills ,which enable them to improve the curriculums.

In Saudi Arabia some universities and colleges applying the internship or coop training as part of their curriculum, University of Business and technology is one of them despite that it is consider new University as it has been established in 2002 started as Business College and develop to University with different majors: Business, engineering and advertising and the female campus offers business and advertising only. This study includes only female students and investigated the effects of Internship on the opportunity to get job placement and the employers evaluation and the most important skills ,the results should help to improve the Internship program design and implication and hopefully to develop University programs. And on the other hand it should add insight to face Youth unemployment through well structured internships.

Literature Review:

In (1988) Taylor, defined Internships as "structured and career-relevant work experiences obtained by students prior to graduation from an academic program"(p. 393). The importance of internship has been noticed in many recent researches and in USA over 94% of Colleges of business offer some type of Internship to their students (Weible, 2009). Students with internship found more likely to persist to graduation versus those who did not participate in internship (Walker, 2011). Internship should improve college performance, students with internship, score better GPA than non-interns. (Knouse and others, 1999) .Researches also examined the effects of internship on increasing job opportunities in specific fields for example accounting major (Rigsby and others ,2013) studied the relation between participation in an accounting internship and job opportunities, the study found that employing firms placing students with internship in a better position than non-interns. Another study focused on employability skills of international accounting students from employer perspective found that the most skill developed among interns was team working while 40% of employers indicated that it is hard to determine if the intern ready to work place and to solve unusual problems (Jackling and Reccardo, 2015). Internship could be a method to curriculum innovation an example on accounting degree program (Bayerlein, 2015).

From students perspective most studies found that students place great value on Internship experience in Business education (Hergert, 2009), in 2011, Moghaddam found that students believe that business internship is an effective way to provide them with business education and to prepare them for their future job. Being ready for the work place environment leading to discuss the skills required or the employability skills ,A study about the skills required for a success career in agri-marketing and the important of internship experience (William,2003) found the the most important employability skills are communication skills and Ethics. In Arab world we found a study in Yemen evaluated a Youth internship program and indicated that students with internship had double work experience and 73% increase income and better employment outcomes (Mckenzie and others, 2016).In UAE University a study examined the impact of the Internship of accounting students on their academic performance and the results found that internship students perform better in the accounting classes than those without internship. (Ebeid, 2004)

Also Internship and training programs has been a subject of researches in Europe and other countries for example in Greek an empirical study examined the student point of view about internship and what skills they gained from internship and what is the benefits of their experience (Mihail,2006).

In Malaysia (Maelah and others, 2014) studied the benefits students may gain from internship from perspective of students and found that both University and employers, believed that students benefits from internship and gain the skills required for work place. Skills gained from internship is an important factor to study and to develop, Companies started to focus on the internship program and provide better opportunities for students with internship such as better started salary and full time jobs (Gault,2010). Recent study investigated the different between paid and unpaid internship and how it effects job satisfaction and career development (Rogers, 2013).

Canadian HR reporter (Shelly, 2016) mentioned that preparing youth to success in their careers require training and that internships provide and offer youth an opportunity to gain real work experience and strengthen their professional development, which will increase their future job opportunities. For example (Nestle) increased internship recently by 25 percent.

After reviewing the previous studied, the benefits and criteria of internship should be considered in preparing internship programs, if educational institute providing interns with high performance level, it will gain reputation and connection with the companies in the labor market and may also get financial support. And in order to measure the success of these programs we need the employer's feedback.

Questions raises such as:

- How internship impact the first job opportunity for female students?
- Which skills most important for employers?

Communication skills, Computer skills, Character traits, measures the satisfaction of the employers and academic supervisors and usually included in evaluations instrument (Verney and others, 2009).

- Are they prepared enter to the job market after the internship experience?

This paper seeks to answer these questions through analyzing the employer's evaluation and from interviews with career centers supervisors.

Methodology:

The subject in this study consisted of 120 evaluation forms for Female students from the University of Business and Technology in Saudi Arabia. From 6 departments: Marketing, Accounting, Finance, supply chain, Human Resources and Advertising. Those students completed the Internship program in 2016 as part of the graduation requirements, which is considered a 6 credits course per semester. The program designed to offers the students the opportunity to

apply and test their academic knowledge and education, acquire skills and experience. It is considered an academic degree requirement for all majors. Duration of the Internship is 16 weeks. 12 weeks field experience and 4 weeks report writing and research presentation.

During the 16 weeks academic supervisor assigned to each student to follow on weekly base, On the other hand business supervisor should follow the interns and evaluate them. Also career center supervisor arrange for the students the training place and continue observing the Internship program. By the end of the Internship business supervisor evaluate the student's performance by filling evaluation form consisting of eight performance factors and the evaluation total grade from 120.

The evaluation also contains assessment concentrated on the Knowledge and the professional skills of the intern. The three parts of the evaluation use a scale to rate the intern ranges from Excellent to weak and also including not at all. The values correspond to the ratings used in this study as follow: 1-Excellent, 2- Fair,3-weak,4-not at all. So there is three categories to analyze:

- 1- The Knowledge category included five questions about: the basic concepts, ability to apply knowledge, IT skills, ability to apply IT skills and ethical aspect.
- 2- The performance included eight questions about: the attendance, interpersonal skills, knowledge related to the major, professional skills, achievement, compliance with instruction, motivation, and English communication skills.
- 3- The professional skills category included 12 questions about: team working, interpersonal skills, presentation, write communication, ethical responsibility, problem solving, creativity, English language, business etiquette, commitment, motivation and accuracy. In their study (Verny&others,2009) used similar evaluation instrument, Their sample includes employers, Alumni and faculty.

In addition to the above categories, there is a question to employers: Do they think UBT students (interns) ready to work in different area related to their major? and the answer scale: 1- yes, 2- No, 3- Maybe, 4-other, In analyzing the evaluation the answer to this question used as a measure to indicate the employers satisfaction which may lead to future job opportunity and to investigate which skills are most important from the employers perspective. However we only considered YES or NO, to get more accurate results.

The question of the study is which skills are most important to obtain employer satisfactions. The total of the complete evaluations was 80 from the 120.This lead to Two Hypothesis:

- H0:** there is no relation between intern's skills and the employer's satisfaction (null).
- H1:** there is a positive and significant relation between skills level included in the three parts (Knowledge, professional skills and achievement) and between the employers opinion, That is mean if these skills increase the employers satisfaction will increase and they will consider her ready to work.

In order to test these hypothesis t- test applied using SPSS statistic data program.

Applying the t-test for each category in the evaluation forms, Started by the first category the Knowledge, Most significant factors: knowledge of the basic concepts and terminologies, perform tasks and analyze situation ability based to the education knowledge, Ethical aspects related to profession, Thus there is significant relation between these aspects and the employer satisfaction, another non-parametric test used to support the findings and shows the same results. So we can reject the Null hypothesis. (Table1.2)

From Table 1.1 below the most significant skill is the ability to perform tasks and analyze situation.

Table 1.1 Knowledge

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	basic concepts,terminologies,strategies & do you think CBA students prepared to job	80	.302	.006
Pair 2	perform tasks and analyze situation based to the education knowledge & do you think CBA students prepared to job	80	.335	.002
Pair 3	IT & do you think CBA students prepared to job	80	.203	.072
Pair 4	apply IT skills & do you think CBA students prepared to job	80	.227	.043
Pair 5	ethical aspects related to profession & do you think CBA students prepared to job	80	.262	.019

Table 1.2

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of basic concepts, terminologies, strategies is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.029	Reject the null hypothesis.
2	The distribution of perform tasks and analyze situation based to the education knowledge is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.030	Reject the null hypothesis.
3	The distribution of IT is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.160	Retain the null hypothesis.
4	The distribution of apply IT skills is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.187	Retain the null hypothesis.
5	The distribution of ethical aspects related to profession is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.023	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

In the second category of the evaluation (the professional skills), the most significant skills found: team work, the problem solving, the interpersonal skills, presentation skills, creativity, the written communication, commitment and accuracy. as shown in Table.2.1 and Table 2.2.

This results compatible with previous studies which considered the communication skill and problem solving among the most important non-academic skills required in the job market. (Lerman, 2013). And that Internship improve personal skills (Knouse, 1999).

The career center supervisor also mentioned that employers looking for skills like presentation skills and creativity and highly appreciate interns who have these skills. For example that advertising companies looking for creative and new ideas and got the benefit of the fresh graduate interns as they have the opportunity and the intention to prove their ability to gain the job.

Table 2.1. Professional Skills

		Paired Samples Correlations		
		N	Correlation	Sig.
Pair 1	team work & do you think CBA students prepared to job	80	.493	.000
Pair 2	interpersonal skills & do you think CBA students prepared to job	80	.384	.000
Pair 3	presentation and speaking skills & do you think CBA students prepared to job	80	.417	.000
Pair 4	written communication & do you think CBA students prepared to job	80	.355	.001
Pair 5	ethical responsibility & do you think CBA students prepared to job	80	.209	.063
Pair 6	problem solving and analytical skills & do you think CBA students prepared to job	80	.366	.001
Pair 7	creativity & do you think CBA students prepared to job	80	.376	.001
Pair 8	English language & do you think CBA students prepared to job	80	.100	.378
Pair 9	business etiquette & do you think CBA students prepared to job	80	.272	.015
Pair 10	commitment & do you think CBA students prepared to job	80	.292	.009
Pair 11	motivation & do you think CBA students prepared to job	80	.272	.015
Pair 12	accuracy and precision in work & do you think CBA students prepared to job	80	.369	.001

Table 2.2

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of team work is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of interpersonal skills is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.003	Reject the null hypothesis.
3	The distribution of presentation and speaking skills is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.006	Reject the null hypothesis.
4	The distribution of written communication is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.008	Reject the null hypothesis.
5	The distribution of ethical responsibility is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.007	Reject the null hypothesis.
6	The distribution of problem solving and analytical skills is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
7	The distribution of creativity is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.026	Reject the null hypothesis.
8	The distribution of english language skills is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.012	Reject the null hypothesis.
9	The distribution of busniess etiquette is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.052	Retain the null hypothesis.
10	The distribution of commitment is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.070	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

The third part is the achievement results shows the most significant variables are the Compliance with the instructions, achievement and the English language skills. Table 3.1 and 3.2. On the other hand the career center supervisors believes that English language skills is very important to employers in the Saudi labor market.

Table3.1

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	attendance & do you think CBA students prepared to job	80	.262	.019
Pair 2	interpersonal skills & do you think CBA students prepared to job	80	.136	.230
Pair 3	knowledge of the subject & do you think CBA students prepared to job	80	.273	.014
Pair 4	professional skills & do you think CBA students prepared to job	80	.203	.072
Pair 5	achievements level & do you think CBA students prepared to job	80	.263	.018
Pair 6	compliance with instruction & do you think CBA students prepared to job	80	.287	.010
Pair 7	motivation and taking the initiative & do you think CBA students prepared to job	80	.287	.010
Pair 8	english skills & do you think CBA students prepared to job	80	.149	.188

Table 3.2

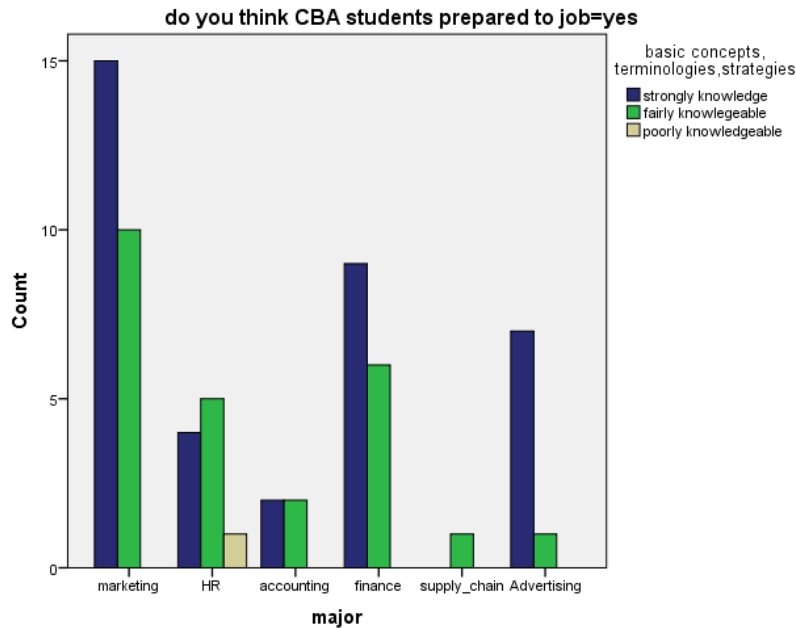
Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of attendance is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.258	Retain the null hypothesis.
2	The distribution of interpersonal skills is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.230	Retain the null hypothesis.
3	The distribution of knowledge of the subject is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.042	Reject the null hypothesis.
4	The distribution of professional skills is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.139	Retain the null hypothesis.
5	The distribution of achievements level is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.035	Reject the null hypothesis.
6	The distribution of compliance with instruction is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.026	Reject the null hypothesis.
7	The distribution of motivation and taking the initiative is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.011	Reject the null hypothesis.
8	The distribution of english skills is the same across categories of do you think CBA students prepared to job.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

To investigate the relation between the major and the employer satisfaction a correlation test (Figure 1), used between the major and the basic concepts and knowledge as it is the most item that reflect the outcome for each program ,results shows that the interns from the marketing department got the highest level ,As employers think that they strongly have the basic concepts and terminologies related to the field ,in the second high score the Finance department and then the Advertising major ,However interns from Advertising College has the highest employment rate after their graduation according to the career center records for Alumni spring 2016,Out of 18 graduate students 15 got job offer and accepted the job.

Figure 1



The descriptive statistics shows that 70% from the employers think that Interns in this study are ready to work in the related job to their majors. And from the comments of the employers, most indicates that they found the interns hard workers and ready to learn. They indicate that with a longer period of training they will achieve the improvement required to fit the job.

On the other hand, most indicates that the sensitivity when doing mistakes or facing unusual problems may be the weakest points among interns.

Conclusion:

In summary, the present paper is an attempt to provide insights regarding the internship program and the benefit of this training method to improve the skills required for the real work environment from the perspective of the employers.

As the employer's satisfaction means more job opportunity, knowing which skills they are looking for in the interns will help to develop the internship programs to meet the market place requirements, as noticed from the interpersonal skills and the ability to analyze and solve the problems results in better evaluation points. The universities should consider improving the courses and provide more simulation exercises to fill this gap. Also improving the internship program design as the length of the program and the evaluation forms to understand better the employers' need. The English language and the written communication could easily be improved to give students more chances in the career jobs. The employers' comments in the open end questions are very important to understand the need in different industries. For example, some employers mentioned the accounting software and other software used in the work place as they noticed that interns do not have enough knowledge about it.

Limitation and Future Research:

The limitation of the study was the number of evaluations available in the career center, increasing the size of the subject, may lead to different results. It included only female students. Also the authors tried to find the students' feedback, but there is no form to study the intern's satisfaction, Comparing Interns' feedback and employer's feedback

is a good area for Future research and comparing the male and female interns in Saudi Arabia to see the differences and the labor market needs.

Future area of studies could be the differences in the evaluations in different majors to see the quality of each department.

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BOOK CHAPTER

Promotional Strategies and New Service Opportunities in Emerging Economies

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Chapter 6

Issues in Service Marketing in Emerging Economies

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ABSTRACT

Globalisation and the resulting increase in competition have forced organisations to seek unique ways to gain a competitive advantage over their competition. One of the strategies successfully adopted is transforming/extending operations into service industry by the manufacturing organisation. This servitisation as packages or 'bundle' of customer focused combination of goods, services, support, self-service and knowledge adds value to core product offering. The focus of service sector marketing is supported by the fact that regarding world gross domestic product (GDP), the share of services increased from 59% in 1985 to 71% in 2011, underlying the major shift in paradigm. In manufacturing industry, this shift, termed as servitisation, has enabled organisations to achieve better profits and financial stability and has also offered them the opportunity to understand their customers better.

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Issues in Service Marketing in Emerging Economies

INTRODUCTION

There is no pure product or service. When a consumer buys something or some solution to satisfy the need, actually the consumer is getting the combination of product and services on a continuum. Some researcher has argued for increasing the elements of services in any tangible product will offer competitive advantages to the organisation. This is known as servitisation of the products. Vandermerwe and Rada (1998) defined servitisation as 'the increased offerings of the fuller market packages or 'bundle' of customer focused combination of goods, services, support, self-service and knowledge to add value to core product offering'. Versprepen and van den Berg (1999) viewed it as a move towards product services by 'adding extra service components to core product'.

According to Vandermerwe and Rada (1988), instead of viewing services and manufacturing from a traditional point of view, servitisation companies offer products and services as a package to create a unique value. Servitisation establishes customer contact points which allow organisations to observe the customers on site and gather information. This, according to Lane and Bachmann (1998), could lead to a long-term relationship, through which companies can build an environment of trust and collaboration. Thus servitisation has a great potential as a service sector promotion strategy in the emerging markets. The emergence of blocks of emerging economies across the globe has opened new markets for servitisation. An emerging economy can be defined as a country that satisfies two criteria: a rapid pace of economic development, and government policies favouring economic liberalisation and the adoption of the free market (Arnold and Quelch, 1998). McKinsey Global Institute estimates that by 2025, 45% of the Fortune 500 list of the world's biggest companies will be based in emerging markets, therefore, suggesting an increased growth of servitisation industry in future. It is also supported by the fact that organisations are increasingly outsourcing their service functions and the tasks which are not part of their core competency and strategy (Leverly, 1998).

Among the several benefits of transforming into services, a strategy to react to changing customer needs while acquiring necessary information from the customer to increase product sales is critical (DeBruicker and Summe, 1985; Hull and Cox, 1994). The information gained could be used in the upstream supply chain to innovate the product according to changing demands. Turunen (2013) stresses the improved relationship between the corporation and customers by adding services into a product based offerings in the process of servitisation. Implementation of servitisation strategy could be challenging, as it requires a revisit to the service marketing strategy of the organisation. Service marketing is related to the marketing of the services such as healthcare services, financial services and hospitality services. It could be challenging for any emerging economy to incorporate this strategy into

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their operations. However, they must transform their operations to stay competitive. To understand the impact of servitisation and how to overcome the challenges involved, this chapter presents a case study of an organisation in India, which is in the process of expanding its operations and facing issues in service marketing due to the conflict between the departments. This chapter provides an opportunity to understand the challenges an organisation could face in the era of servitisation and implementing service marketing.

This chapter is organised as follows: First, the concept of emerging economies, their history, growth and move from manufacturing to service sector is discussed. Next, it explores the term servitisation, the relationship between marketing and supply chain, service marketing and issues in service marketing. The chapter ends with a discussion of the issues of service marketing in emerging economies.

EMERGING ECONOMIES

Initially, Antoine Van Agtmael of the World Bank used the term “emerging economy” in 1981 when he was referring to countries that were “emerging” from the under-development phase towards restructuring their economies along market-orientated lines (Agtmael, 2007). Openness and market-orientated institutional reforms are among the primary conditions required to consider economies as part of the emerging economies. According to Hoskisson et al. (2000, p. 249), emerging economies are “low-income, rapid-growth countries using economic liberation as their primary engine of growth”. They are in transition from traditional agricultural based economies and formerly centrally planned economies. Emerging economies primarily fall into two groups: developing countries in Asia, Latin America, Africa and the Middle East and the economies in the former Soviet Union and China. According to the World Bank, the five biggest emerging markets are Brazil, Russia, India, China and South Africa, which are also names as BRICS. The IMF reported (Almansour et al., 2014) that emerging economies contribute significantly to the global economy and that, for advanced economies to move forwards, they will need to establish a strong link with emerging markets.

India’s step into the emerging market started in 1991 with industrial deregulation, public sector reforms and the liberalisation of government policy (Li and Nair, 2007). Financial deregulation provided greater access to both domestic and international financial markets for Indian firms. This resulted in Indian firms focusing on different modes of internationalisation, cross-border mergers and acquisitions (Aulakh, 2007; Economist, 2007). India is the fastest growing economy in the world. It’s GDP rose by 7.2 percent in the fourth quarter of 2016, outpacing China. This has resulted in inflation falling by half after floating at over 10 percent for years. The

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current account deficit has shrunk, the rupee is stable, and the stock market has boomed (Economist, 2016). Accordingly, Indian GDP composition in 2014 was; agriculture 17.9%, Industry 24.2% and services 57.9%. India is the second largest producer of agricultural products, which accounts for 7.68% of total global output. The GDP of this industry sector ranked 12th in the world, whilst in the service sector, India's world rank is 11th and GDP is \$1185.79 billion. The contribution of the agriculture sector to the Indian economy is higher than the world average of 6.1%, whilst the contribution of industry and services is lower than the world average of 30.5% in the Industry sector and 63.5% in the service sector (CIA Factbook, 2015).

THE MOVE FROM MANUFACTURING TO SERVICE SECTOR

The service sector has been the most dynamic segment of the global economy, and in the Indian economy, the share of services in the GDP has been rising (Nair & Kalirajan, 2016). At the aggregate level, total world trade in services increased from \$0.82 trillion in 1990 to \$4.3 trillion in 2011, representing growth of about 424%. A similar trend is observed in the Indian economy. The composition of agriculture, industry and services, which were 51.81%, 14.16% and 33.25% respectively in 1950-51, has changed to agriculture 18.20%, industry 24.77% and, most significantly, services to 57.03% in 2013-14. Contributing to this trend is the fact that there has been a growing trend across the globe towards manufacturers shifting their focus from production only to providing service. The benefits of this trend have been examined from a variety of perspectives. Critical benefits include differentiation and marketing opportunities which services might bring to the country (Gebauer et al., 2011). Also, it is enabling organisations to respond better to increasing international competition, shrinking profits and improved efficiency. In order to achieve this, organisations are increasingly exploring new venues for profit generation and increasing customer satisfaction, such as, the integrating of goods and services (Baines & Lightfoot, 2013) to capture new markets and increase their profit margins and whilst doing so, increasing the possibility of safeguarding their market share and of keeping competitors out of their customer base (Bustinza, Parry, and Vendrell-Herrero, 2013).

The move by manufacturing organisations into services was initially considered as merely an expansion of some extra limited service offerings which included basic customer-service related services. As organisations from diverse sectors joined the trend and started offering additional services, it became apparent that this concept of providing service has a high growth potential and wider consequences than initially assumed (Spring & Araujo, 2009). To identify the areas covered under this new paradigm, Kotler (1997) classified two broad categories of industrial service:

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maintenance and repair services, and business advisory services, whilst, Mathieu (2001a) divided service into three categories: customer service, product service, and service product. Nevertheless, to complement the core business functions by developing service businesses could be a challenging process. According to Baines (2015), manufacturing companies are increasingly basing their competitive strategy on service innovation, i.e., finding ways to rethink their offerings and replace one-time product sales with an ongoing value creation relationship. To achieve a unique service innovation, organisations must address several critical issues before embarking on such a transformation. These include the organisational structure and its position on the value chain since the characteristics of service delivery systems are significantly different from those of production systems (Baines and Lightfoot, 2013). In addition, firms implement servitisation to gain financial benefits (revenue stream and profit margin), the strategic advantage (competitive opportunities) and product differentiation (Mathe & Stuadacher, 2004; Gebauer & Friedli, 2005).

SERVITISATION

The term “servitisation” was initially applied by Vandermerwe and Rada (1988) to describe the phenomenon of increasing the role of manufacturing by providing services to its consumers. There are various forms of servitisation, that can position on a product-service continuum, ranging from products with services as an ‘add-on’, to services with tangible goods as an ‘add-on’ (Tukker, 2004). Implementing servitisation strategy offers organisations an opportunity to generate a unique competitive advantage, potentially not available to its competitors, therefore not competing on cost alone (Porter & Ketels, 2003). Also, it allows greater differentiation and increased customer satisfaction. Innovative manufacturing firms are extensively implementing this strategy, since it gives them an opportunity to integrate their supply chain with customers, thereby, gathering first-hand information about customer’s needs and wants, market trends, and preferences. Applying this information to become even more innovative and responsive, has been a distinctive feature of the best innovative manufacturing firms (Spring & Araujo, 2009). Baines et al. (2009) concluded that ‘servitisation is the innovation of an organisations capabilities to better create mutual value through a shift from selling products to selling a product-service-system.’ For many years, Dell Computers’ competitive advantage lied in direct distribution of computer and free post sale services. Now Apple computer is known for this servitisation of their electronic and IT product range.

The servitisation adds value to traditional value chain of manufacturing and hence helps in promoting products or services. Some authors even argues for servitisation of products and productisation of the services. The literature identifies three main

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reasons for a firm's servitising; strategic aims, customers' needs and the competitive advantage that services can provide (Davies, 2004; Davies et al., 2006; Martinez et al., 2010). Baines (2015) suggests that the process of servitisation (or service innovation or creating product-service systems) does not simply involve the development of a new service offering for the customer, rather it requires the adoption of new technology and more importantly, a widespread organisational transformation. Unlike traditional methods of production and planning, where the products were designed and manufactured in anticipation of future sales, and generally, the manufacturer's role was limited to the sales of the product, servitisation goes one step further by establishing a deeply rooted customer relationship. It involves providing a product and a service as a complete package according to organisational needs which will satisfy their business goals. Among the benefits derived from servitisation, is that it encourages manufacturers to increase their service position in an attempt to achieve a higher profit margin, a more stable flow of revenues and a better competitive position (Martinez et al., 2010). Whilst Baines (2015) finds that the benefits of servitisation to the manufacturers includes improved customer resilience and opportunities for sustained growth. The most critical challenge to establish servitisation is to figure out the level of service that will be provided. This requires in-depth analysis of the business strategy and the services which could be offered. More recent research suggests that larger firms find it more difficult to achieve the financial benefits of servitisation (Neely, 2009). Gebauer et al. (2005) refer to the phenomenon of increased service offerings and higher cost without higher returns as the 'service paradox in manufacturing companies'.

MARKETING AND SUPPLY CHAIN MANAGEMENT

In emerging economies, customers are becoming more demanding, and the role of marketing is becoming more crucial as all the organisations try to attract customers for their product and services. To cater to the diverse needs of the customer, it requires a working collaboration among departments inside the organisation. However, this could be challenging since each can have their individual goals and strategy which could clash with another department. Such as, in an organisation, 'Marketing people demand a specific level of inventory continually to meet the customer demand otherwise the company will lose the market, however, the cost of maintaining this level of inventory means reducing the company's profit, hence supply chain people would suggest implementing a Just In Time (JIT) inventory system'. This creates a conflict and puts decision makers in a fix. This issue has been observed over time and has caused major inter-departmental rift and loss of revenues. In the case of emerging economies, it could have much wider consequences since many of

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the organisations are new to the globalised competition, and customers are spread over continents and most importantly, have limited resources and experience in the organisation of emerging economies.

AN AUTOMOBILE COMPONENT MANUFACTURER CASE STUDY

The Indian auto industry is one of the largest in the world. The industry accounts for 7.1% of the country's GDP and the sales of passenger vehicles are increased by 16.7% in 2016 (ibef.org). The Indian automotive sector currently is a \$74 billion industry, and by 2026, the industry is expected to achieve a turnover of \$300 billion, a Compound Annual Growth Rate (CAGR) of 15% (Forbes.com). In this section, a case study is presented of an Indian automobile manufacturer, showing the relationship between marketing and supply chain management. In the light of previous research work and theories in this area, the case study will further elaborate. A supply chain and marketing are the core functions in any company, and a sales department is usually included as well, though, often companies prefer sales as a separate entity. Marketing creates customer's interest in a product and services. It also generates the strategy that underlies sales techniques, business communication and business development (Kotler et al., 2008). In other words, it is an integrated process which creates strong customer relationships, and that leads to increasing revenue. Hence, marketing is the front face of products and services to attract the customers. However, the ultimate goal of marketing is to increase the revenue. As per Porter (1985) value chain model shown in Figure 1, marketing & sales are the primary activities for any business.

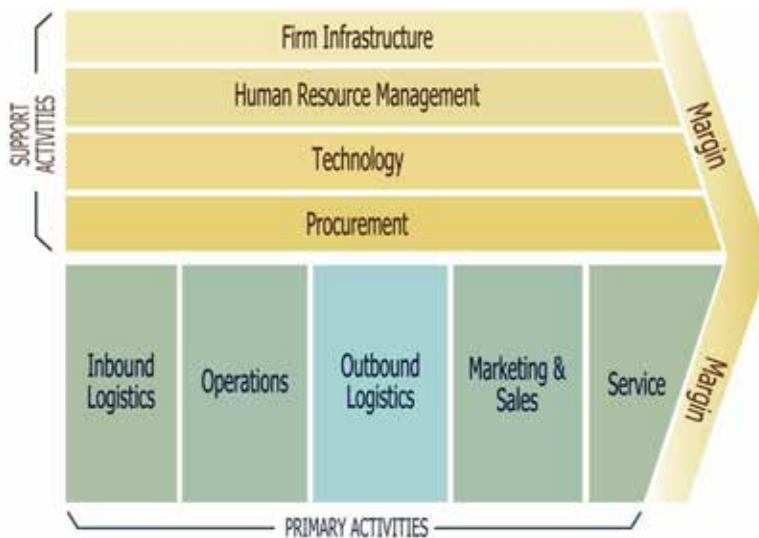
Under the primary activities; inbound logistics, operations and outbound logistics together called supply chain management. It is clear from Figure 1 that marketing & sales are linked to the supply chain management, but the problem arises when there is a conflict of interests between supply chain management and marketing & sales.

PROBLEM STATEMENT

This case study looks at the day to day problems faced by the supply chain and marketing departments. Company 'X' manufactures automobile components and is a medium-sized enterprise in India. Recently, the company embarked upon expanding its operation in the service sector by providing its customers with an additional level of before and after sales service. However, this step has been very difficult to

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Figure 1. Porter's value chain model
(Source: Porter, 1985)



establish, to say the least mainly due to the lack of coordination between the various departments and their struggle to serve and protect their interests rather than looking at the bigger picture. Also, the company is facing new challenges due to the growing competition from other companies and a decrease in the profit margin in the automobile component sector. To overcome these challenges, a new Chief Executive Officer (CEO) was appointed in 2011 to show the leadership needed to overcome these new problems. There were strict guidelines from the Board of Directors to the CEO for showing that the results had to be regarding monetary benefits to the company and its shareholders.

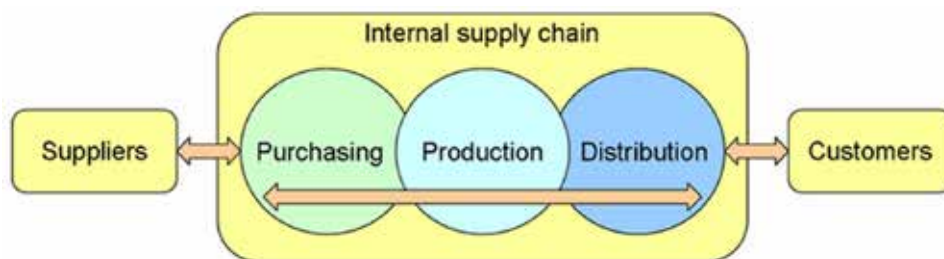
The CEO started his new job by redefining the Key Performance Indicators (KPI) for all of the departmental heads. The CEO first studied the existing organisational structure. As per the organisational structure, he observed that the operation department was controlling the most important functions e.g. production, Maintenance and Planning, and control. The CEO decided to have a meeting with the President of Operations and discussed the current and future KPIs for the three functions under his broad department. A key performance indicator (KPI) is a business measure to evaluate factors that are crucial to the success of an organisation or a department. For example, one KPI for the maintenance department could be the time frame for solving all the breakdown problems on the shop floor, whilst, for the production department, it would be revising and updating the product plan for each day and the operation's shifts.

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The most difficult function in the company was planning and control because this part of the company deals with the inventory management. Keeping the optimum quantity of inventory in the company at any given time was a big challenge, and the company was struggling to keep the optimum quantity of inventory all the time. The company had the tradition of holding a significant amount of extra inventory in the stock with the anticipation that it could be used in the production when needed. After going over the pros and cons of keeping this extra inventory level and discussing with all the stakeholders, the CEO clearly advised the President of Operations and his team of both planning and control departments to follow the Just-in-time (JIT) in their inventory department. The internal supply chain structure of the company is similar to the Chen and Paulraj (2004) diagram of the supply chain. As shown in Figure 2, purchasing, production and distribution were joined to make an internal supply chain.

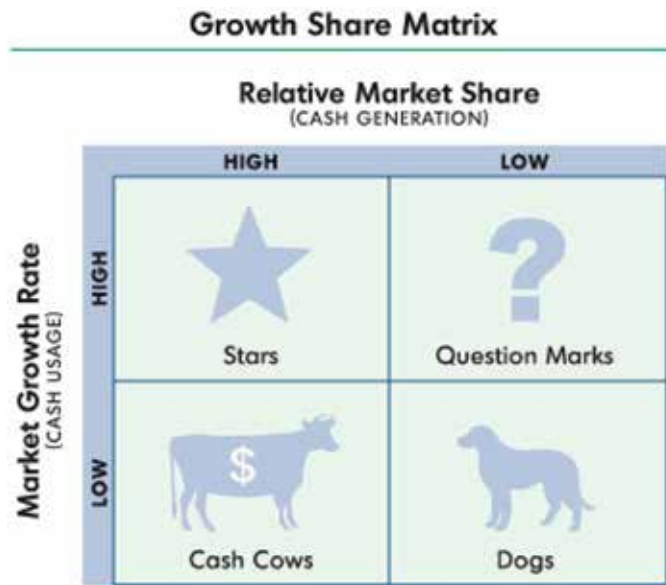
Both purchasing and distribution, in alignment with production, forms part of the internal supply chain, hence the President of Operations being reluctant to fix the zero inventory / just-in-time as the KPI for the planning and control department. At the same time, the CEO advised the President of Marketing and Sales to optimise the revenue in the next financial year, and it was fixed as their key performance indicator. The current scenario created a conflict between the interest of marketing and planning and that of the control department. The marketing department insisted that to gain more market share and to generate more revenue; the company needs to have a specific amount of inventory available at all the time. They related this to the production process and the demand from the market. Also, their insistence was derived from the KPI assigned to them. Their annual performance was required to be evaluated by the revenue generated by them during the year. As per the Boston Consulting Matrix (BCG) given below in Figure 3, marketing people wanted to remain in the cash cow block. They were only concerned with their revenue which relates to their KPI. They were correct in their view to see the business making money, and it is always a good choice to remain in the cash cow block, because by

Figure 2. Internal supply chain
(Source: Chen and Paulraj, 2004)



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Figure 3. Growth-share matrix
Adapted from Henderson, 1970



adopting this strategy, you are generating the revenue by working on the best-selling product of the company.

The matrix shown in Figure 3, is most commonly used by the marketing department to find out the best selling products or cash cows. All the stars in the matrix move to become cash cows and the marketing department strives to remain in the cash cow zone. But for the supply chain department, it doesn't matter where the product lies in the BCG matrix. They are more concerned about the inventory. This leads to the persisting conflict between both departments. As discussed earlier, this conflict becomes more intense in those companies where a large number of high-cost inventories is carried. The CEO of Company 'X' met with the President of Operations and President of Marketing and Sales individually to discuss their issues and concerns. In this situation, the best policies are to the call both departments and discuss their individual interests. Importantly, the discussion should be open and constructive, and it should point towards flaws in the system and how to overcome them.

CONCLUSION

Emerging economies and service marketing are two burning issues in the contemporary business scenario. This chapter dealt with some of the most common challenges faced by companies in emerging economies initiating service marketing activities. The chapter starts with the history of emerging economies, the move from manufacturing to service sector and the marketing and supply chain relationship. It also discussed conflict of interest between marketing and supply chain departments which are very frequent in the auto-component manufacturing sector as companies struggle to keep an optimum level of inventory and also give the good service level to their customers. There is no straightforward solution to these types of problems, especially in developing countries as they are more concerned with cutting cost and improving efficiency. This is a typical case in most small and medium enterprises because they are more focused on production and less on service. However, due to the emergence of the concept of servitisation concept, companies will try to adopt a new framework where they can have both product and services as their outputs.

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KEY TERMS AND DEFINITIONS

BCG Matrix: Developed by Henderson for the Boston Consulting Group (BCG) in 1970 to help corporations to analyse their business.

Emerging Economies: An emerging economy is an economy with low to middle per capita income.

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Just-in-Time (JIT): JIT is a management philosophy to manage inventory by delivering raw material / components immediately before they are required to manage inventory.

Key Performance Indicator (KPI): is a business measure to evaluate factors that are crucial to the success of an organisation or a department.

Manufacturing: The process of converting raw materials into finished goods.

Servitisation: It is a transformation from offering only products to a mix of product and services.

Supply Chain Management (SCM): SCM is the management of the flow of goods and services from raw material supplier to finished goods.



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A Comprehensive Study on PV/BS/UG Hybrid Energy System: "Case study on Saudi Arabia"

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Abstract— In this paper we introduce a fully automated power management control system for hybrid PV/Battery Bank/Utility Grid (PV/B S/UG) system. Different tilt angles have been tested to specify the best tilt angle for the selected site. The generated power from the PV system is measured and compared with the calculated one. The deficit and surplus power have been determined. The power management technique is designed in different operating modes and controlled using a programmed Arduino controller. A full algorithm as well as complete program using C++ have been designed and applied to manage the power flow supplied from the three available sources through the Arduino Nano controller. The introduced system is tested using a real lighting load of University of Business and Technology located in Dhahban-Jeddah, Saudi Arabia. A fuzzy logic design is used to verify the proposed power management system during the day. This methodology uses the hourly radiation, and hourly load power measured at different title angles of PV system. Very valuable results can be extracted from the proposed technique that could help researchers and decision makers. The results obtained from the proposed system have established the economic feasibility of installing hybrid energy systems in many sites of Saudi Arabia.

Index Terms— Hybrid System, Photovoltaic (PV), Battery Storage (BS), Utility Grid (UG), Tilt angle.

I. INTRODUCTION

Solar energy is considered as a main future source of clean and cheap energy because; it is a clean, unfailling and environment-friendly potential resource among all renewable energy options [1]. Saudi Arabia has continuous supply of solar energy during a whole year however; due to seasonal and periodic variations of solar energy photovoltaic system needs a battery bank to store the extra energy [2-5].

PV systems have two major problems; it has a very low conversion efficiency of electric power generation about 10-24% [6], and it is reduced under low irradiation conditions. PV panels have a nonlinear voltage-current characteristic [7] due to the variation of maximum power point (MPP), which depends on the environmental factors, such as irradiation and temperature [8]. To generate a maximum power from PV solar panels, we need a sun tracking system that follows the sun. Automatic solar tracking system using Arduino hardware system design is used for continuously tacking the sun to obtain the maximum power point [9]. Arduino is an open source electronic prototype platform that consists of 8-bit Atmel AVR microcontroller such as Atmega328. In this paper, we obtain the maximum power point using Arduino programming system design.

Power management for any hybrid system is considered as a key role to maximize the system performance [10]. In this paper, a power management of the proposed hybrid PV/BB/UG system given in [11] is controlled by an Arduino system.

II. PROPOSED SYSTEM MODELLING

A. PV System Model

The tilt angle of the PV system in accordance with the movement of the sun determines the intensity of the sunlight falling on the modules surface and, therefore, it will affect the system output power. Due to the Saudi Arabia location at north of the equator, the solar panel is installed facing south. The PV array surface should be positioned directly perpendicular to the sun's rays. This tilt angle of the solar panel has a great effect on the amount of solar radiation will capture and then on the amount of sunlight to be converted into electricity.

The tilt angle of the designed system has been changed to examine the best tilt angle of the selected site. This can be easily achieved using a servo motor coupled on the solar panel system shaft and various readings have been done on the optimum tilt and orientation angle for fixed surfaces.

Therefore, the optimum tilt angle provides maximum power output from the system during the month. The tilt angle can be fixed at a certain angle all year round, seasonally, or monthly changed. In this paper, the PV array is tested at different tilt angle and the PV generated power is measure and then the actual load sharing is calculated and compared with the theoretical results obtained by the Authors [11].

Theoretical calculations were performed to determine total generated power at a given tilt angle.

Generated power calculation:

The average generated power has been estimated hourly, monthly and yearly using Equation (1) [11]:

$$P_h = A_{effy} \times H_{th} \times \eta_o \times \eta_t \times \eta_{pc} \times \frac{V_f}{F_s} \quad (1)$$

where A_{effy} is effective solar cell area yearly, H_{th} is hourly radiation on the tilted surface (kW/m²), η_o is the operating efficiency of the cell, η_t is the transformer efficiency, η_{pc} is the power condition unit efficiency, V_f is the variability factor, and F_s is the safety factor for inaccuracy of the insulation data.

$A_{eff}y$ is effective solar cell area yearly can be calculated using the following Equation (2)[11]:

$$A_{eff}y = \sum_{i=1}^{12} \sum_{t=6.5}^{18.5} \frac{A_{eff}h}{12 \times 8} \quad (2)$$

And $A_{eff}h$ can be calculated from Equation (3):

$$A_{eff}h = (P_L \times F_s) / (H_{th} \times \eta_o \times \eta_t \times \eta_{pc} \times V_f) \quad (3)$$

$$\eta_o = \eta_r (1 - 0.0062(T_c - T_r)) \quad (4)$$

And T_c can be calculated using Equation (5).

$$T_c = T_r + K_l \times H_{th} \times 100 \quad (5)$$

T_c and T_r are the operating and reference temperatures respectively, K_l is monthly average of daily clearness index, and η_r is the reference efficiency.

Hence, the generated power per day and per year is calculated as follow:

$$P_d = \sum_{t=6.5}^{18.5} \frac{P_h}{13} \quad (6)$$

$$P_y = \sum_{i=1}^{12} \frac{P_d}{12} \quad (7)$$

The following Figure (1) illustrates the schematic diagram of the designed system. The connection diagram of the system components and the wiring system is as shown in this figure.

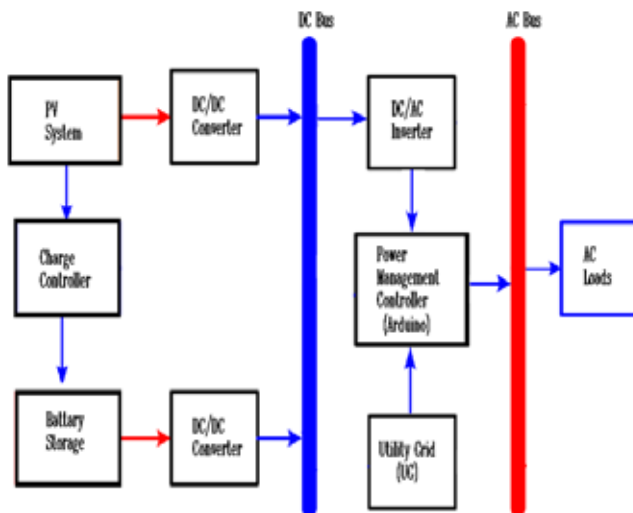


Fig 1: Block diagram of the proposed hybrid system.

According to our model, the power flow management will be using Arduino Nano program. In case of the $P_{PV} > P_L$, the solar panel will connected directly to the load and the battery will charge. In case of $P_{PV} + P_{BB} > P_L$, hence, the PV panels and battery bank will charge the load. In last condition, the $P_{PV} + P_{BB} < P_L$, the utility grid will connected to the load and battery will be charged from the UG. The control unit is controlled by Arduino Nano program.

In this model, we used a small solar panel and servo motor, for testing the value of MPP which are powered by original solar panels, so the overall drawn power is very low. The first part of the Arduino C++ program is responsible for determining the position of the maximum voltage. The PV solar panels are positioned to the new measured angle by Arduino using a servo motor.

B. Battery Storage Model

The energy balance between the PV energy systems and the load; the battery state of charge, SOC, after certain period of time, can be calculated from the following equations for charging and discharging consequently as illustrated in Wqns. (8,9) [13].

$$E_B(t+1) = E_B(t)(1-\sigma) + \text{surplus power} \times \eta_{BC} \quad (8)$$

$$E_B(t+1) = E_B(t)(1-\sigma) - \text{deficit power} / \eta_{BD} \quad (9)$$

Where σ is the hourly self-discharge rate; the manufacturer documentation recommended its value of 0.2% per day for most batteries [13]. (Yang et al., 2008), η_{BC} and η_{BD} are the charging and discharging efficiency of the battery and it is considered 90% and 85%, respectively [14].

C. Arduino Controller Model

The designed and embedded algorithm on Arduino Nano controller is based on the comparison between the output power from PV module at the given tilt angle and decide which switches to turn on and which turns off based on the input load data. The following Figure 2 illustrate the Arduino Nano mechanism,

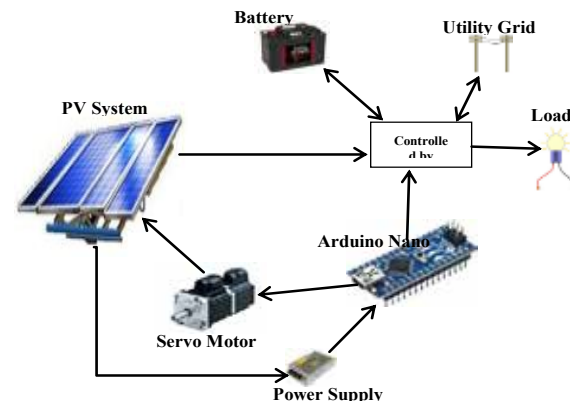


Fig 2: Block diagram of the proposed control system using Arduino Nano

The different possible operation modes are cleared in the following Figure 3. The decision taken by the controller is based mainly which power sources combination is sufficient to supply the load power demand. The proposed four different modules introduced in [11] are considered in our program. The given models are as shown in Figure 3.

III. SYSTEM INSTALLATION

An actual solar radiation per hour in Jeddah site is given in [11]. In this paper, we used different tilt angle to measure the generated power according to its position using a sun tracking system.

The proposed system which consists of 12 PV panels connected in series is installed on the Collage of Engineering and Information Technology (CEIT) building. Different tilt angles are considered such as 0°, 45°, 65°, 90°, 115°, and 180° are illustrated in Figure 5. It is manually adjustable system at this time; however we developed a fully controlled automatically.

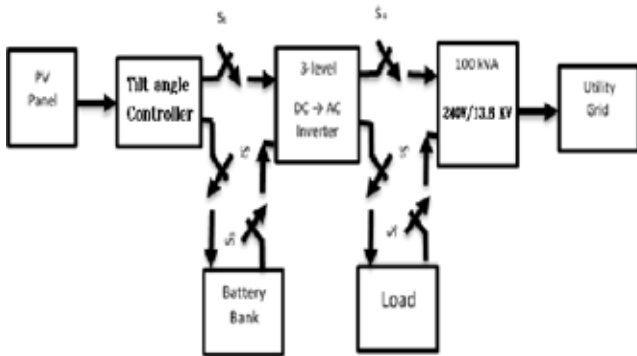


Fig 3: Block diagram of the proposed supply management algorithm.

The following are the four operating modes logic that has been implemented:

Mode 1:

In case of $P_{PV} > P_L$ and P_{BB} is not full, the PV output power will feed the load and charge the battery.

Mode 2:

In case of $P_{PV} > P_L$ and P_{BB} is full, The PV output power will feed the load and feed the utility grid as well.

Mode 3:

In case of $P_{PV} + P_{BB} > P_L$, The PV output power and the battery power will feed the load and the remaining power will feed the utility grid.

Mode 4:

In case of $P_{PV} + P_{BB} < P_L$, The PV output power, battery and the utility grid will feed the load.

The results obtained from the theoretical study done by the authors [11], is illustrated in the following Pie chart, Figure 4. This chart shows the load sharing ratio between the different available sources.

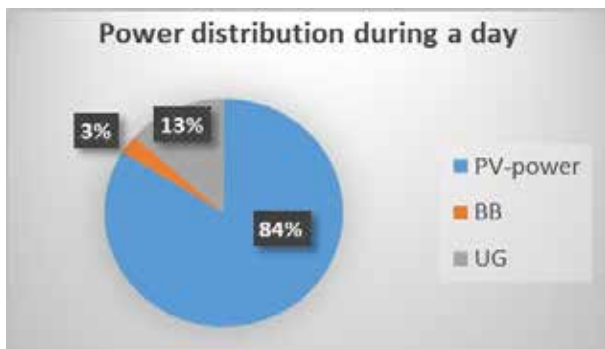


Fig 4: Estimated load sharing during a day(theoretical study)[11].



(a)



(b)



(c)



(d)



(e)



(f)

Figure 5: Solar panels installed on the roof of CEIT at UBT, Dhahban, KSA at tilt angles (a) tilt angle is 0° , (b) tilt angle is 45° , (c) tilt angle is 65° , (d) tilt angle is 90° , (e) tilt angle is 115° , (f) tilt angle is 180° .

IV. RESULTS AND DISCUSSION

In this paper, we designed and installed a hybrid PV and battery storage system connected to the utility grid to feed a 3 kW load in CEIT, UBT lab. The control system uses an Arduino Nano to control the power management via switching system to switch between BS, PV and UG to feed the load. The load is 3 kVA which is located in the CEIT lab and the load demand is illustrated in Figure 6 as load power starting from 9:00 am to 7:00 pm (working hours of the UBT) and remains at 300 W from 7:00 pm to 9:00 am (not working hours).

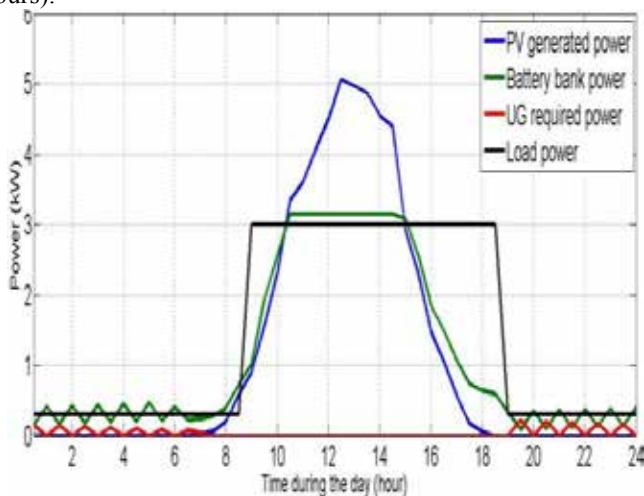


Figure 6: Load power, generated power from PV, storage battery bank power, and UG required power during the day

As clearly shown from Figure 6 and during the night, from 7:00 pm to 9:00 am, the load is 300 VA which is covered from

the UG and the battery. PV panels has no generation and the UG charge the battery storage and feed the load, when the battery can supply the power to the load, the UG is disconnected as shown in Red and Green curves in Figure 6. After 10:00 am, the battery is charged and the solar panels generate a higher power than demand power. On the other hand, when the PV power decreased, the UG will feed the load by 7:00 pm and the battery will follow the cycle again.

In Figure 7, the sharing ratio of each power source is given. About 82% of the demand power is produced from PV solar panels, 12% of the needed power feed from the UG power supply, and the battery bank shares by 6% of the demand power. As noted from this figure, the practical sharing ratio is very close to that obtained from the theoretical study as cleared in Figure 4.

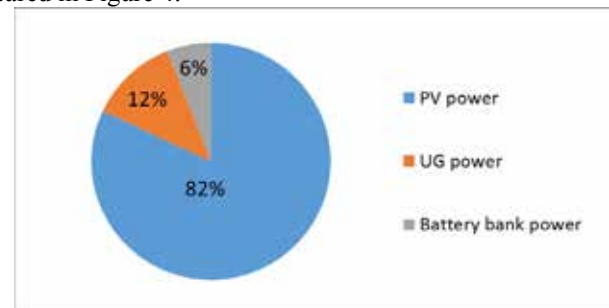


Figure 7: Estimated load sharing during a day (theoretical study)

To enhance our system, we simulate the installed system using Fuzzy logic installed in MATLAB as illustrated in Figure 5. Rules viewer of power management during the day is given in Figure 8.

There are three inputs: PV system, battery banks, and utility grid to receive output power which represents the load demand.

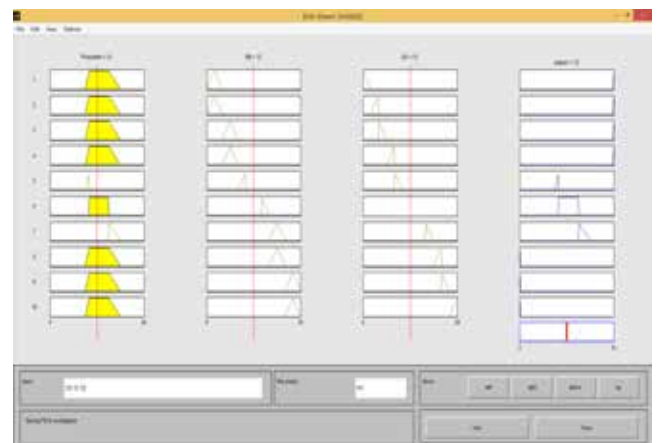


Figure 8: Power management of the installed system using a Fuzzy logic.

In this work we measure the short circuit current, I_{sc} , load current, I_{load} , open circuit voltage, V_{oc} , load voltage, V_{load} , and generated power, P_G at different tilt angles, 45° , 65° , 90° , 115° , and 180° for a load 3 kW/h.

Figure 9 shows the short circuit current for different tilt angles. In the morning, short circuit currents for all tilt angles

are low values then gradually increasing for a maximum value by 12:00 pm and then decreases again with time. A maximum value of the short circuit current is obtained at 12:00 pm for a tilt angle 45° is 8.6 A, however the average maximum current is obtained at tilt angle 65° during the day. At the tilt angle 180° , the measured short circuit current is the minimum where the sun light is reflected from the ground in to PV panels.

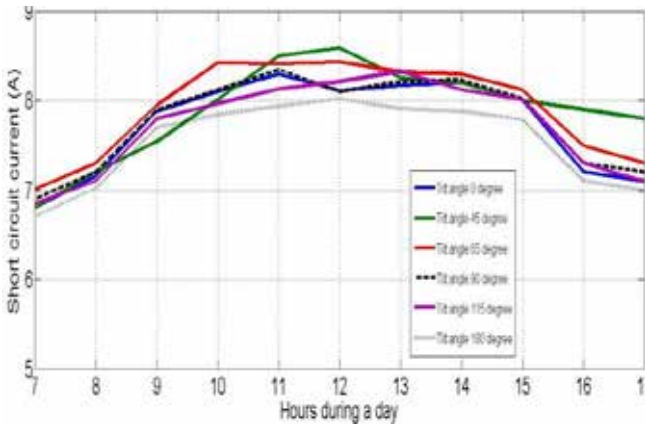


Fig 9: Short circuit current during a day for different tilt angles.

The measured load current during a day for different tilt angles is illustrated in Figure 10. The maximum value of the current is 8.3 A at 3:00 pm for tilt angle 65° .

The load current is reduced to to the connection of 3 kW load. At 12:00 pm the load current is around 7.5 A instead of 8.3 A for the short circuit current.

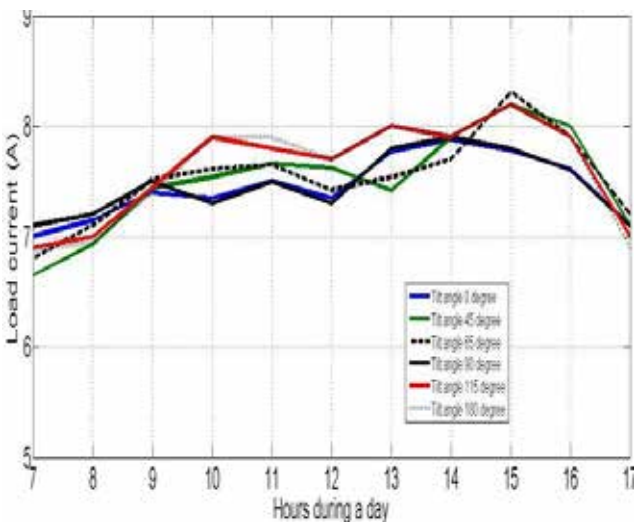


Fig 10: Load current during a day for different tilt angles.

On the other hand, the open circuit voltage during a day is given in Figure 11 at different tilt angles. The peaks are obtained at 12:00 pm and the open circuit voltage is around 420 V. The best average values are measured at tilt angle 90° while the minimum value is measured at 1:00 pm at tilt angle 180° .

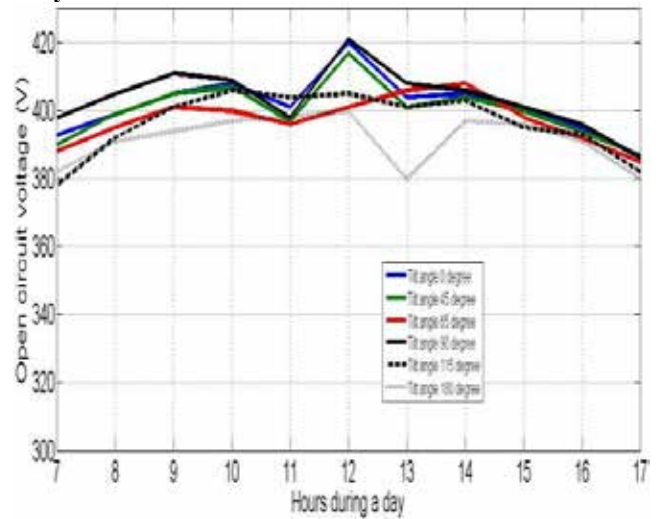


Fig 11: Open circuit voltage during a day for different tilt angles.

Load voltage is measured at different angles during the day for the installed system is given in Figure 12. The maximum voltage is obtained at 12:00 pm at the tilt angles 0° and 180° and the lowest voltage is obtained at 115° of value 315 V. However the most constant value is obtained at tilt angle 65° .

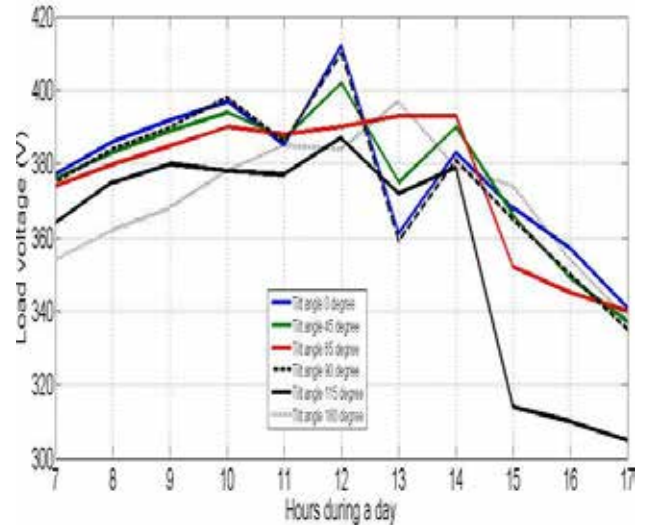


Fig 12: Load voltage during a day for different tilt angles.

In order to measure the performance of the PV panels, we calculate the generated power during the day for different tilt angles as shown in Figure 13. All values are compared to the load power demand, 3 kW. Tilt angles 45° and 65° are the best tilt angles PV panels which generate the most values power.



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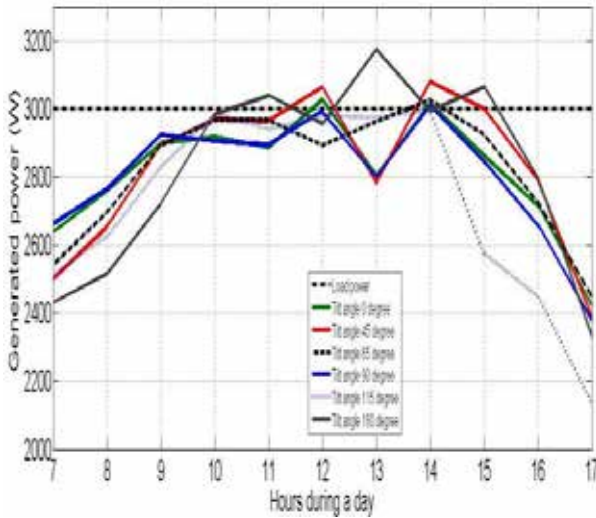


Fig 13: Generated power from PV panels during a day for different tilt angles.

The maximum values of short circuit current, load current, open circuit voltage, load voltage, and generated power from solar panels are summarized in table 1. As seen from this Table, it can be noticed that the maximum generated power is 3180 watt at 180° (horizontal position). Also, as shown in this table, the best tilt angle that give the highest power is 45°.

In Table 2, the time at which the maximum values are obtained is illustrated. A maximum short circuit current is 8.6 A obtained at tilt angle 45° and at 12:00 pm, while the maximum values of load current is 8.3 A at tilt angle 65° and at 3:00 pm. A maximum open circuit voltage is 422 V obtained at tilt angle 90° and at 12:00 pm, while the maximum values of load voltage is 414 V at tilt angle 0° and at 12:00 pm. The maximum generated power is 3180 W obtained at 180° tilt angle and at 1:00 pm.

Table1. Maximum values of short circuit currents, load currents, open circuit voltage, load voltage, and generated power at tilt angles 0°, 45°, 65°, 115°, and 180°.

Tilt angle	0°	45°	65°	90°	115°	180°
Maximum Values						
Short circuit current (A)	8.3	8.6	8.5	8.3	8.4	8
Load current (A)	7.9	8.2	8.3	7.9	8.2	8.2
Open circuit voltage (V)	420	418	405	422	403	400
Load voltage (V)	414	404	394	413	386	396

Generated power (W)	3040	3090	3020	3005	3000	3180

Table2. Time at the maximum values of short circuit currents, load currents, open circuit voltage, load voltage, and generated power at tilt angles 00, 450, 650, 1150, and 1800.

Tilt angle	0°	45°	65°	90°	115°	180°
Time at maximum						
Short circuit current	11:00 am	12:00 pm	10:00 am	11:00 am	1:00 pm	12:00 pm
Load current	2:00 pm	3:00 pm	3:00 pm	2:00 pm	2:00 pm	2:00 pm
Open circuit voltage	12:00 pm	12:00 pm	2:00 pm	12:00 pm	10:00 am	12:00 pm
Load voltage	12:00 pm	12:00 pm	2:00 pm	12:00 pm	12:00 pm	1:00 pm
Generated power	2:00 pm	2:00 pm	2:00 pm	2:00 pm	2:00 pm	1:00 pm

V. CONCLUSION

A hybrid PV/BS/UG system design and implementation has been introduced. The performance of the system is studied for a load of 3 kVA, in UBT University in Jeddah, KSA. The implemented system is a fully automated, where we use different tilt angle algorithm determine the power and consequently the power management technique is controlled using a programmed Arduino Nano chip. We implement the system on the roof of CEIT, UBT and test it using a real lighting load. For different tilt angles, we measure a short circuit current and open circuit voltage of 12 PV panels connected in series at different tilt angles, 0°, 45°, 65°, 90°, 115°, and 180°. A load voltage and current at the same tilt angles are measured and hence the generated power is calculated.

According to our study, PV share by 82% of the power demand, 12% by the utility grid and 6% share by battery bank. The maximum short circuit current 8.6 A obtained at tilt angle 45° and at 12:00 pm, while the maximum load current is 8.3 A at tilt angle 65° and at 3:00 pm. A maximum open circuit voltage is 422 V obtained at tilt angle 90° and at 12:00 pm, while the maximum values of load voltage is 414 V at tilt angle 0° and at 12:00 pm. The maximum generated power is 3180 W obtained at 180° tilt angle and at 1:00 pm.

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A REVIEW OF DRAINAGE MANAGEMENT AND SUSTAINABILITY OF EGYPTIAN HEAVY CLAY SOILS

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ABSTRACT

Reclamation and cultivation of heavy clay soils in Egypt are increased last decades due to high demand for food production. They are very attractive for agricultural expansion in the North of the Nile valley due to their high capacity of water holding and high fertility. High water table, high salinity and low permeability affect the productivity of heavy clay soils. The land drainage is required to improve the productivity these soils. Improvement of soil properties, suitable drainage systems, suitable drainage design, accurate drainage installation and maintenance are required to have feasible drainage system with good performance. The purpose of this paper is to summarize past and present drainage management practices and future challenges and technology to sustainability the agricultural expansion in the heavy clay soils of northern part of the Nile Delta.

KEYWORDS: Drainage; Management; Sustainability; Heavy Clay Soil

1) IMPORTANCE

In Egypt, the heavy clay soils are always threatened by a shallow saline groundwater (Antar et al., 2008). An increased attention has been given to reclaim, improve and manage the Egyptian heavy clay soils to solve problems of saline and sodic for optimal crop production. The saline and sodic problems are in many instances associated with heavy clay soils. Establish of the limits for sustainable farming on heavy clay soils is needed to devise economical types of drainage systems (FAO, 1970). Drainage is an essential tool to combat waterlogging and salinity. Subsurface drainage improves the productivity of poorly drained soils by lowering the water table, creating a deeper aerobic zone (Smedema et al., 2004) and enabling faster soil drying and improving root zone soil layer condition (Jung et al., 2010). (Gehan et al.; 2003) mentioned that the drainage management for problematic heavy clay soils is a multi-disciplinary process concern crop variety, water management, soil improvement, drainage management and socio-economic aspects. Hence, the management of problematic heavy clay areas should be a multi-disciplinary strategy and joint efforts between key persons who involved in this process. (Hamed et al., 2010) were optimistic about the future of the productivity and land reclamation in heavy clay areas. They suggested careful and continuous monitoring of the salinity status in the future. (Qadir et al., 2015) believed that the investments in salt-affected irrigated zones could make a significant contribution to poverty reduction, economic and social development as well as efforts for achieving food security. They predicted that the enhancing soil carbon sequestration will improve the environment by mitigate the climate change impacts.

2) HEAVY CLAY SOIL DEFINITION

(FAO, 2006-a) described the heavy clay soils as vertisols or vertic intergrades that easily to recognize because of their clay texture, cracking structure and their dark colors. (USDA, 1999) defined that

Vertisols as churning, heavy clay soils with a high proportion of swelling clays. These soils form deep wide cracks from the surface downward when they dry out, which happens in most years. Heavy clay soils have high plasticity and shiny surfaces with clay content more than 60%. It has cracks that open and close periodically. (FAO, 1995) considered the soils with 50-80% clay in the topsoil heavy clay soils. (FAO, 2006-b) reported that the vertic horizon is a clayey subsurface horizon that, because of shrinking and swelling, has slickensides and wedge-shaped structural aggregates. It contains 30 percent or more clay throughout a thickness of 15 cm or more. It has wedge-shaped structural aggregates with a longitudinal axis tilted between 10° and 60° from the horizontal. It has slickensides. (USDA, 1999) defined the Vertisols as clayey soils that have deep, wide cracks for some time during the year and have slickensides within 100 cm of the mineral soil surface. (FAO, 1995) mentioned that They shrink when dry and swell when moistened. It defined the heavy clay vertisols as soils having a vertic horizon within 100 cm from the soil surface. The heavy clay soils often have less well-developed structure and a permeability of less than 0.1 m/day. (DRI, 2001) defined the problematic Egyptian heavy clay soil as a clay soil with more than 40% clay, low hydraulic conductivity less than 0.1 m/d and with problems such as salinity, alkalinity, difficult installation of subsurface pipe drains in sticky clays, hard pans, and underlain by saline groundwater with possibly upward seepage.

3) HEAVY CLAY SOIL LOCATIONS

(Dudal and Eswaran, 1988) estimated that 78 Million ha of the dark clay soils in Africa. 69% occur in semi-arid zones and the rest in sub-humid zones. He estimated that 1 Million hectare is found in Nile delta of Egypt. (DRI, 2001) concluded that problematic heavy clay soils represent approximately 260,000 feddan (1 feddan=0.42 ha) in the Nile Delta. Hamul and Zawia (Kafr El Sheikh), El Robh El Sharq (Fayoum), Damietta Dairy Drainage Project (Damietta), El Rowad Area of South El-Hossania (Sharqia); Tina Plain area (North Sinai), Edco area (Beheira) and Integrated Soil and Water

Improvement Project (ISAWIP), El-Serw, and El Halafy (Dakahlia) were identified as heavy clay soils as shown in Figure (1).

4) HEAVY CLAY SOIL PROPERTIES

(Wahab et al.; 2010) concluded that a significant area in the northern Nile Delta is subjected to a high risk of physical and chemical degradation. Moreover, processes of water logging, soil compaction, soil salinity and alkalinity are slight, medium and high in different land units. (Abu Zaid, 1991) concluded that problematic heavy clay soils in the Nile Delta consist of Marine clays, which are highly saline and have poor internal drainage properties.

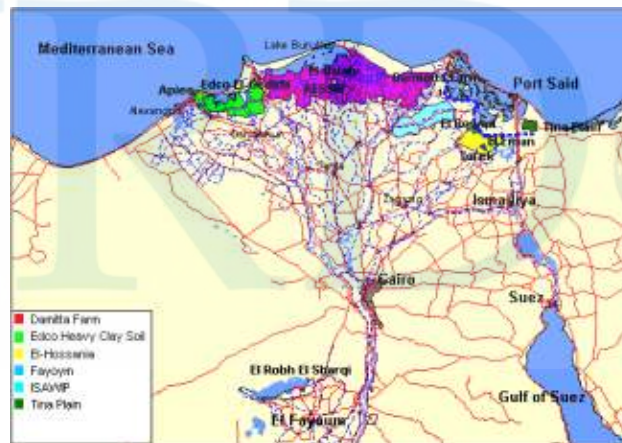


Figure 1. Problematic heavy clay soils in Egypt (DRI, 2001)

The sodicity hazard in these soils is high, their permeability is very low, and reclamation is very difficult and expensive. (Kubota et al., 2017) identified many factors that are affecting soil salinity, including the use of drain water or mixed water as irrigation water and the fluctuation in the water table level, which is related with the efficiency of the subsurface drainage systems. (Stewart et al., 2016) proposed a framework to describe the porosity distribution in shrink–swell clay soils, focusing on three porosity domains (aggregate, shrinkage cracks and subsidence). The behavior of the aggregate domain

can be understood through application of the soil shrinkage curve, for which we proposed a new expression that, when presented in normalized terms, requires only water content and two fitting parameters (or, alternatively, soil suction and four fitting parameters). This new soil shrinkage function is flexible and capable of describing many different shrinkage behaviors; it can also be readily integrated and differentiated, thus allowing estimations of shrinkage phase transitions. (El-Araby et al., 1987), (Boulos et al., 2008), (Hamed et al., 2010), (Selim, 2011), (Mohamedin et al., 2011) and (El-Gammal et al., 2015) investigated the heavy clay soils at 1.0 m depth from the surface of clay content (43-70.5%) in North Delta. The areas were in E1-Zawia (Kafre E1-Shiekh), South El-Husseinia plain of El-Salam canal project (Sharqiah), south of Port Said, El-Hamoul area (Kafr El-sheikh) and Damietta. They found that the bulk density of soils ranged between (1.35-2.15 gm/cm³), the soil salinity EC was (5.58-58.4 dS/m) and the soil alkalinity pH (7.35-8.40). The average water content was (29-51%) and the infiltration rate was (12-60 mm/h). (Abdeldayem et al., 2000) found the soil salinity at 60 cm below surface was more than 100 dS/m before leaching of 22,000 ha of Tina plain in Sinai in North East of river Nile Delta and the soil hydraulic conductivity was 55 mm/day. After leaching, the soil salinity dropped to (9.8-16.1 dS/m) through the soil profile. (Diane Bulot et al., 2017) highlighted the importance of soil hydrodynamic properties on water table drawdown and cranberry yield and showed that nearly 50% of the variance of water table drawdown and crop yield is explained by soil hydrodynamic properties. (Dudal and Eswaran, 1988) mentioned that with rainfall or irrigation, cracks have bigger depth and width and the wedge-shaped soil structure is more distinct. (Kodikara et al., 2002) mentioned that the basic patterns of cracking were identified as orthogonal and non-orthogonal cracking. It was highlighted that the development and response of cracks are dependent on the restraint conditions placed on the soil, severity of the drying cycles and initial state of the soil. The crusting of surface is more frequent. Organic matter is higher in the topsoil and the color becomes darker. (Hussein, 2002) used two criteria

to characterize the extensibility of heavy clay at the site, namely the coefficient of linear extensibility (COLE) and the potential of linear extensibility (PLE). COLE gives an indication of the reversible shrink–swell capacity of a soil. It is calculated from the dry bulk density and the bulk density at 33.3 kPa water suction. PLE is the potential for soil swelling and shrinking in field conditions. It considers swelling and shrinking properties of the individual soil horizons in the studied soil profile. (Reeve et al., 1980) mentioned that the COLE is more than 0.06 in vertic horizons. Soil with $COLE > 0.09$ m is classified by the US, Department of Agriculture, Natural Resources Conservation Service as having Very High shrink–swell potential, and it is frequently assumed in modeling that this class of soil would have a ratio of change in thickness relative to change in depth of water stored of 1:3. PLE is more than 14 cm for high shrinkage heavy clay soils. (Hussein, 2002) found that the Egyptian heavy clay soils in Kafr El-Sheikh have high extensibility. The Value of (COLE) was (0.043-0.168) and the (PLE) value was (7.20-15.03 cm). He mentioned that infiltration, internal drainage, salt movement, root development, and evaporation are important factors that affect soil cracking and soil structure. He found the average crack depth under cultivated lands in Kafr El-Sheikh was (3.30-6.50 cm) while in the bare lands the crack depth was (2.00-6.20 cm). In the harvested cultivated lands 40 to 50 days after irrigation, it was (18.20-21.00 cm). The average crack width in the cultivated lands was (0.8 and 1.8 cm), while in the bare land the crack width was (0.6-2 cm). The crack width in the harvested cultivated lands 40 to 50 days after irrigation was (2.1-3.2 cm). The crack volume per unit surface area was (10.40-52.16 m³/feddan) in the cultivated lands while it was (16.00-120.40 m³/feddan) in the bare lands. The crack volume per unit surface area in the harvested cultivated and bare lands 40 to 50 days after irrigation was (178.70-204.60 m³/feddan).

5) HEAVY CLAY SOIL DEVELOPMENT APPROACH

(Ritzema, 2009) recommended the (Croon, 1997) a three-step development approach for the low-lying areas in the North Delta areas of Egypt. In the first three years after reclamation, surface drainage is installed and salt-tolerant crops are cultivated. Gypsum or other amendments are applied to improve of the top (10-20 cm) of the soil profile. After 3 to 5 years, mole drains are installed and salt resistant/tolerant crops are cultivated to improve soil structure and fertility by nitrogen fixation. If required, more gypsum is applied; Finally, after the heavy clay soils have ripened and reached a hydraulic conductivity greater than 0.1 m/day, subsurface drains can be installed at economical spacing. Subsurface drainage, in combination with the existing surface drainage, enables the cultivation of more profitable, i.e. less salt-tolerant crops. (El-Sanat et al., 2017) recommended that the application of 50% from gypsum requirements (5 Mg compost per Feddan) combined with plowing depth at 60 cm achieved economic production of wheat and maize without adverse effect under salt affected soils at North Delta, Egypt.

6) CROPPING PATTERN AND LAND USE

Water and salt movement in the fields of the Nile Delta are critical factors determining the ability of soils to sustain reasonable production of different crops (Kubota et al., 2017). The impact of human activity on the ecosystem on southeastern part of Burullus Lake in Kafr El-sheikh governorate and the surrounding bare areas is obvious. (Belal, 2006) determined land use and land cover systems as agriculture, bare soil, sabkhas, swamps, fish farms, water bodies and village areas. Barley, Sugar beets and sunflowers are salt tolerant crops usually cultivated in saline and sodic heavy clay soils. (Arafat et al., 2010) stated that due to the intrusion of seawater, most of agricultural lands in the northern Nile delta are affected by different degrees of salinity. (Henkel, 2015) mentioned that rain or irrigation, in the absence of leaching, can bring salts to the surface by capillary action. (USDA, 2010) recommended growing salt tolerant plants which can tolerate the soil salinity. For example, germinating sugar beets die

when the salinity level is high, but mature plants are very tolerant of the same salinity level. (Sherif, 2003) proposed to increase the area of rice cultivation in the southern parts of the Delta and reducing the rice cultivation in the northern parts. This will help mitigate the seawater intrusion on the long term. (Hefny and Shata; 1995) showed that the presence of heavy clay soils and salty groundwater made growing rice inevitable in parts of the northern delta of Egypt despite attributed high rates of water diversion. (Hoang et al., 2016) reviewed the challenges that hinder the improvement of salinity stress tolerance in rice as well as potential opportunities for enhancing salinity stress tolerance in rice crop. (Abdou, 2003) summarized the actual of crops area percent to the total cultivated area in Behera and Kafr El-sheikh of north Egypt as shown in table (1).

Table 1. Actual crops area percentage of total cultivated area in North Delta

Region	Winter Season		Summer Season	
	Crops	%Cultivation Area	Crops	%Cultivation Area
Behera	Wheat	40.8	Rice	36.9
	B.beans	11.5	Cotton	21.5
	Potatoes	13.1	Maize	21.4
	Tomatoes	10.4	Potatoes	11.4
	Clover	24.5	French harricots	8.8
Kafr	Wheat	40.4	Rice	64.4

ElShiekh	B.beans	4.8	Cotton	27.3
	Sugar Beet	33.9	Maize	8.1
	Clove	20.8		

7) DRAINAGE SYSTEMS

Surface drainage considered as an option where ever circumstances cause the watertable to rise to the surface during a critical time of the year. The types of surface drainage are bedding, furrow and ditch systems. If the hydraulic conductivity of the soil is so low (<0.01 m/day) that no subsurface drainage with economically justifiable is possible, one should use a surface drainage system of furrows and small ditches of 40-45 cm, possible combined with bedding of the soil. When the hydraulic conductivity is more than 0.1 m/day, the soils are highly responsive to conventional pipe drainage. The spacing is often determined using local experience, and it varies between 10 and 20m in heavy clay soils. The vertical drainage could be solved if the layer with higher hydraulic conductivity is at depth greater than 2m and the top layer is of very low hydraulic conductivity (Abdulhamid , 2017). (Boulos et al., 2008) recommended to use open drains with an auxiliary tile drainage system for reclaiming the soil salinity. He recommended to use open drain ditches in combination with tile drainage to overcome the slow water movement and accelerate the leaching process. (Smith and Rycroft, 1986) and (Antar et al., 2012) investigated a network of mole drains in northern Nile Delta. They reported that mole drains have great potential for reclamation purposes, but this is not used widely in Egypt. (DRI, 2001) observed that when saturated hydraulic conductivity of the soil is greater than 0.1 m/d; Mole drains at (50-70 cm) depth and (1-3 m) spacing in combination with a subsurface lateral system at (1.0-1.5 m) depth and (20-40 m)

spacing are worked satisfactorily. (Moukhtar et al., 2003) concluded that tile drains combined subsoiling type treatments in heavy clay soils are efficient in lowering the total soluble salts.

8) DRAINAGE DESIGN

(Skaggs, 2016) proposed that technical papers on drainage research studies and engineered design projects should report standard coefficients/parameters that characterize the hydraulics of the system. The following coefficients define key subsurface drainage rates that could be used to quantify the hydraulics of a drainage system. First, the steady subsurface drainage rate (cm/d) corresponding to a saturated profile with a shallow ponded surface. Second, the Drainage Intensity (DI), which represents the drainage rate (cm/d) when the water table midway between parallel drains is coincident with the surface. Third, the hydraulic capacity of the system, often called the drainage coefficient (DC). This value is the rate (cm/d) that the outlet works can remove water from the site. Routine inclusion of these three coefficients in the documentation of research and design projects would be very useful to readers as they compare results of different studies. (Ritzema, 2009) considered the upward seepage in the design criteria of the subsurface drainage system in the northern part of the Nile Delta. He used the design discharge of 1.2 mm/day to maintain the soil salinity below the critical levels for crop production in the northern parts of the Nile Delta. He considered 30m as the minimum spacing between laterals and the average drain depth varied between 1.3 and 1.4 m. For rice and non-rice areas, He used the design drainage rate of 2 mm/day to calculate pipe diameters. He designed the collector pipe drains for a peak discharge of 4 mm/day in rice areas and 3 mm/day for non-rice areas. He took a safety factor of 25% in the design of the collector drains due to sedimentation, irregularities and misalignment. A maximum collector drain depth of 2.5 m is used. The lateral length of 200 m is used for a slope between 0.1 and 0.2%. Collector drains are spaced at 400 m and consisted of pipes with increasing diameter. The diameters are based on the Manning equation for transporting pipes using a roughness coefficient

derived by Visser. (Hussein, 2002) proposed modified drainage design criteria in cracking heavy clay soils in Egypt. Shallower drain depth is proposed to be a maximum of 1.20 m depth instead of 1.50 m. The permissible head loss to be increased from 0.40 to 0.65 m. The drainage rate to be increased from 1.5 to 2.0 mm/day. This will allow a lower drainage resistance, better drainage function. It is and more economic installation by keeping the current practice (20 m spacing). (Pali, 2013) investigated variability in drainable porosity and hydraulic conductivity of saline soils of Haryana state in India. He found that modified Glover equation was the most superior equation for drainage design followed by Integrated Hooghoudt equation and then Van Schilfgaarde equation. (Maged, 2015) considered the effect of cracking depth on the drainage of Egyptian heavy clay soils. He developed drainage design equation for subsurface field drains. He considered the influence of cracking top layer as well as bottom layer and the drainable pore space on the drainage of the soil profile. The unsteady state equation for design spacing between subsurface field drains is developed for use in cracking Vertisols. The drain spacing computed by the new equation has wider spacing compared with the Glover-Dumm equation of unsteady state condition (38-54%) according to crack depth.

9) DRAINAGE INSTALLATION

(Hussein et al., 2000) investigated many problems of the subsurface drainage installation in the heavy clay soils in the northern of the Nile Delta. Poor pipe connections, misalignment and depth fluctuations of collectors and laterals during installation, pipe sedimentation and lack of envelope materials affect are related to lack of planning before construction work and need for good distribution of responsibilities, bad conditions of transporting, storage and handling of material and need to improve inspection techniques. (Croon, 1997) reported that the installation problems were aggravated with the presence of high water table or upward artesian pressure. The investigated problems were high draught requirements and sticky clay not loosening from the digging chain of the trencher. Egyptian Public Authority for

Drainage Projects (EPADP) applied the technique of spraying the trencher box with water to reduce friction with the soil and thus reduce draught requirements as shown in Figure (2). EPADP suggested altering the shape of the digging chain elements to enhance release of the excavated soil.



Figure 2. Spraying the trencher box with water to reduce friction with the soil

(DRI, 2001) suggested using the V-plough drainage trenchless machine shown in Figure (3) for construction in heavy clay soils. Trenchless drainage was a good solution in heavy soils, since the chains and knives of a digging chain of trencher machine are subjected to excessive wear and tear. The installation capacity of collector drainage machines in Egypt decreases from 100 m/h for new machines to 55 m/h for machines older than 15 years. For field drainage machines, the figures are respectively 380 m/h and 90 m/h.



Figure 3. V-plough trenchless drainage machine

10) DRAINAGE MATERIALS

(Ritzema, 2007) adapted that the drainage envelope materials increase the efficiency of subsurface drainage systems by protecting drainpipes against soil particles invasion and facilitating the flow of water into drainpipes by creating a more permeable zone around drains. The application of gravel around the drain has involved quite a few problems. The quality, transportation (geographical availability), application precision, and quality control were weak points in the use of this voluminous costly material as envelope for subsurface drainage pipes. (Nasralla et al., 2009) reviewed the constraints and problems of PVC pipes during transportation. The pipe coils are tightly strapped with ropes on the trucks or trailers with the results that many of the coils have one or more dents or cuts. Damaged pipe sections shown in Figure (4) have to be cut-out during installation and the pipe has to be reconnected with a coupler. This procedure takes time, the machine has to stop, and wastes pipe material and couplers.

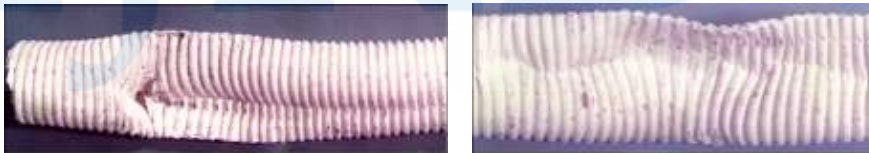


Figure 4. Damaged pipe sections (dents or cuts) during transportation

11) DRAINAGE MAINTENANCE AND PERFORMANCE

(Ritzema, 2009) reported that sustainable drainage systems must be maintained to ensure its effectiveness. The performance of the system has to be checked just after construction completion and before handing over the drainage system to the beneficiaries or organization that will take over the responsibility. Sophisticated checking equipment (Rodding technique and video camera inspection

technique) with specialized personnel are required as shown in Figure (5). Maintenance of subsurface drainage systems consists mainly of removing sediment from the pipes and manholes, repairing and – if necessary - replacing these pipes, manholes and outlets. Maintenance of the open (main) drains is removing sediment and weeds. Improper maintenance of the downstream open drainage system will influence the functioning and maintenance of the subsurface drainage systems.

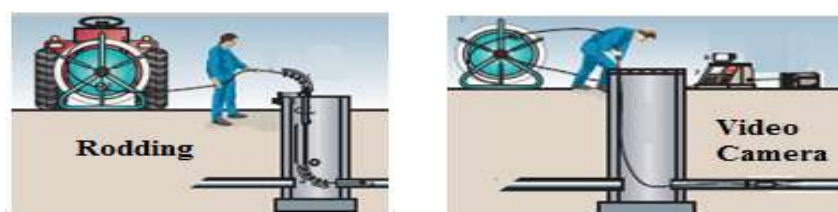


Figure 5. Rodding and video camera inspection techniques

The maintenance frequency is once every 3, 4 or 5 years will depend on the site-specific conditions and installation conditions. (Nijland et al, 2005) proposed measuring performance indicators such as crop yield, water ponding in the fields after irrigation, depth of the groundwater midway between the drains, discharge at the outlet, discharges in some selected manholes, water levels in manholes and sedimentation in manholes. Improved flushing equipment and methods to remove sediment from the drainage systems are proposed. (Nasralla et al., 2009) concluded that the quality indicator remains critical issue for implementing cost effective and efficient systems. Several steps are required to prevent misalignment and blockage of lateral drains such as good training of machine operators and field supervisors on the setting and use of laser equipment and regular calibration of laser control equipment. (DFRA, 2014) recommended to identify who will be responsible for maintenance and its funding either the farmers or the government. (Ritzema, 2009) mentioned that the introduction of the modified drainage system in Egypt in rice areas not only reduced operational costs, but also reduced maintenance

needs as farmers no longer illegally blocked drains to reduce irrigation water losses. Increased farmer's participation led to more ownership and less misuse or illegal drain blocking.

12) PLANNING AND MANAGEMENT OF DRAINAGE SYSTEMS

Drainage planning of heavy clay soils has to be treated as an integrated part of water management. Using an integrated approach in land drainage plays an essential role in improving irrigation and drainage practices in these areas. (Nijland et al., 2005) recommended that administrative preparation process (drainage planning authority) should include specifications of drainage criteria, boundaries of the areas to be drained, type of system to be installed, outlet and pumping requirements, layout of the system, drainage materials to be used, installation equipment, implementation mode and budget. (Gehan, 2007) used a user-friendly knowledge based expert system computer program for Heavy Clay Management Expert System (HCMEXS) as an artificial intelligence management to help users to make appropriate decisions for improving heavy clay management. She utilized HCMEXS in an experimental field of 60 feddans area with saline sodic heavy clay soils in Tina Plain area of North Sinai northern Egypt. The recommended strategy of the expert system succeeded to decrease the soil salinity to about 50% within 6 months of leaching.

13) FUTURE PERSPICTIVES AND CHALLENGES

(De Wrachien, 2003) proposed a new planning principle, design criteria, operating rules, contingency plans and evaluation procedures to respond with climate change. (Bradley et al., 2005) reported that the effect of global climate change on functioning soil can be given by increasing summer temperature, increasing winter temperature, higher rainfall and sea level rise and increased coastal flood risk. (DEFRA, 2014) mentioned that warmer soil temperatures everywhere will accelerate soil processes, leading to more rapid decomposition of organic matter, increased microbiological activity, quicker

release of nutrients, increased rates of nitrification and generally increased chemical weathering of minerals. However, soil temperatures will also be affected by the type of vegetation occurring at its surface, which may change itself because of climate change, or adaptation management. Increasing of drying soil will lead to increasing the difficulties of its management. The higher the seasonal fluctuations in soil moisture, the higher the risk of drastic changes to soil chemistry occurring, e.g. higher leaching of nutrients/pollutants, soil acidification, gradually lower soil cation exchange capacity and thus lower soil buffering capacity. Flooding and sea level rise are likely to lead to a loss of arable land in the coastal areas of Nile Delta. Drainage systems must be re-designed for more frequent extreme events where these are predicted to occur. Inattention could lead to greater frequency of washout events with consequent increase in sediment movement to surface drains. (Qadir et al., 2015) believes that the time has come to harness the potential of saline water and salt-affected land resources as potential business opportunities while adding value to the business dimension through resilience against climate change. (Prasad et al., 2017) stated that Sustainable growth of agriculture totally depends on the new and innovative techniques like nanotechnology. (Patra et al., 2016) mentioned that nanotechnology as an emerging science may play a greater role for managing these salt-affected marginal lands. Though nanotechnology, in respect of both research and development, is yet at a nascent stage, it can be effectively directed toward understanding and creating improved materials, devices, and systems and in exploiting the nano-properties for managing these lands. (Liu and Lal, 2012) proposed a practical strategy that applying nanotechnology in agricultural sector to increase the agricultural production, solve environmental problems. The specific nanotechnology to make a feasible use in soil reclamation and increase soil pH and fertility, improve soil physical structures, reduce mobility, availability, and toxicity of heavy metals and other environmental contaminants and those able to stabilize the soil components and abate soil erosion.

14) CONCLUSION

This paper gives an overview of the history, the present state and the outlook for the future of agricultural drainage practice and management of heavy clay soil in Egypt. The recent shift towards integrated water resources management in such soils has to consider planning, designing and implementing materials and installing technology for the new drainage projects in these soils. It is important to consider the impacts of climatic changes and new technologies on drainage water quantity and quality.



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COMPARING VARIOUS MIDDLE MACHINES WITH TIME SYNCHRONIZATION USING VIDEO STEAMING PROTOCOLS

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Abstract

With an innovative growth of video applications over the Internet, many methods and approaches have been proposed to stream protocol with time synchronization, best-effort networks. In this research work, we propose a distributed multimedia streaming and simulated ADHOC network environment. The main of the research is to reduce traffic via network. The receiver-driven protocol employs four sections, Rate Allocation Algorithm, Packet Partitioning Algorithm Packet Loss Detection Packet recovery and moreover we demonstrate all the above said methods through internet experiments .

Index Terms:

Distributed streaming, RTT Timing Calculation, Forward Error Correction

Introduction:

Network covers a vast area of scientific and engineering knowledge Applications such as audio and video conferencing and the transmission of live or recorded events using audio and video are only two of the many applications that blend multimedia and networks. Networks are designed to reliably transmit data such as files from point to point. Multimedia places further demands on the network. First, data such as audio cannot tolerate delays in delivery. A network whose basic task is to move files from one place to another can transmit data packets at an uneven rate. If portions of a file arrive slowly or out of order, then it is not a problem. Multimedia requires that data packets arrive at the client on time and in the proper order. Real-time protocols and quality-of-service guarantees on the network address this issue. Second, multimedia requires transmitting large amounts of data over the network, and thus uses more of the network's bandwidth than basic network operations such as file transfer.

Implementation Methodology:

In the existing method the ad-hoc network cannot be synchronized so that there is a chance for having more ‘Sending Time’ and having ‘heavy packet loss problem’. If the network is more traffic then this system can't manage it. The final integrated multimedia file may be a corrupted one. In this proposed method we extend our previous work by proposing a novel rate allocation scheme to be used with FEC to minimize the probability of packet loss in bursty loss environments. In general, FEC has been shown to be an effective tool in combating packet loss in streaming applications on the packet switched networks. The main drawback of FEC thought is that it results in bandwidth expansion and hence reduces the amount of available bandwidth for the actual video bit stream. In this work, we show that by combining path diversification and FEC, we can combat bursty loss behavior in the Internet more effectively.

1 Rate Allocation Algorithm (RAA):

In this protocol, the receiver computes the optimal sending rate for each sender based on its loss rate and estimated available bandwidth. The problem of allocating optimal sending rate to each sender can be stated as follows. Let N be the total number of senders, and $L(i, t)$ and $S(i, t)$ be the estimated loss and sending rates, respectively for sender i over an interval $(t, t+\delta)$. Our goal is to find $S(i, t)$, $i = \{1 \dots N\}$, in such a way as to minimize the total lost packets during interval $(t, t+\delta)$ given by,

$$F(t) = \sum_{i=1}^N L(i, t) S(i, t)$$

subject to $0 \leq S(i, t) \leq B(i, t)$ and $\sum_{i=1}^N S(i, t) = S_{req}(t)$, where S_{req} is

$$S_{req}(t) =$$

the required bit rate for the encoded video during the interval $(t, t+\delta)$, and $B(i, t)$ is the TCP-friendly estimated bandwidth for sender i during the interval $(t, t+\delta)$. This algorithm is to minimize $F(t)$, the number of lost packets during interval $(t, t+\delta)$, given instantaneous feedback, and assuming that the estimated loss rate and TCP-friendly available bandwidth are accurate. The idea of the algorithm is as follows. At time t , we sort the senders according

to their estimated loss rates from lowest to highest. We start with the lowest loss rate sender and assign its sending rate to be its TCP friendly estimated bandwidth. We then continue to set each sender's rate to its available bandwidth, beginning with the ones with lower loss rates and moving to the ones with higher loss rates, until the sum of their available bandwidths exceeds the bit rate of the encoded video.

Packet Partition Algorithm (PPA)

We address the issue of packet selection for each sender. After receiving the control packet from the receiver, each sender immediately decides the next packet in the video stream to be sent, using the packet partition algorithm. All the senders simultaneously run this algorithm in a distributed fashion in order to ensure that no two or more senders send the same video packet, and also to minimize the probability of packets arriving late at the receiver due to network jitter.

To decide which packets to be sent by which sender, each sender is assigned to send a contiguous block of data of length proportional to its sending rate. For example, Suppose there are two senders, the allowable sending rates for the first and second senders are 100 and 80 packets/second respectively and total playback rate is 180 packets/seconds. In this case, the first sender is assigned to send the first 100 packets and the second sender, the next 80 packets. Therefore, the receiver has to wait until the entire 180 packets are received before attempting to playback since its playback rate is larger than the sending rate of the first sender. Even though, this strategy avoids duplicating packets between senders, it incurs unnecessary startup delay.

The algorithm can be described as follows. Each sender receives control packet from the receiver through a reliable protocol whenever the receiver determines there should be a change in any of the sending rates.

The basic idea in our packet partition algorithm is that among all senders $i = \{1 \dots N\}$, the one that maximizes the time difference $A\{i,k\}$ between the estimated receive and playback time for k^{th} packet is chosen to send that packet. Hence, maximizing $A(i,k)$ is equivalent to minimizing the probability that the k^{th} packet is late.

Round Trip Time (RTT) Calculation

To calculate the RTT, a single character is send from the source to the destination via middle machine. RTT is the time elapsed between sending of the character and receiving the acknowledgement. RTT time is calculated between the sender to destination via middle machine. The times are calculated by each middle machine and send to the source. This

Round Trip Time is used for determining the packet size that should be send to each receiver.

File Sending

File Size is divided into 4 pieces and they are sending through the 4 middle machines by choosing the order of appropriate middle machines in the calculated packet size.

Middle Machine Nodes Creation

To receive the packet that is being sent, we need to make use of middle machine nodes which may be of any number. Here totally 10 middle machines are created.

Conclusion

The time synchronization using reference unicasts is a distributed video streaming framework using a receiver-driver protocol for simultaneous video streaming from multiple senders to a single receiver in order to achieve higher throughput. In overall concept the video stream protocol based synchronized network is the best one in the views of Time Consumption, Traffic Management, Band width estimation and Packet loss detection and Packet loss reduction.

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Research Article

From Chemistry to Linear Algebra: Balancing a Chemical Reaction Equation Using Algebraic Approach

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ABSTRACT:

Chemical reaction equations are mathematical and symbolic models of real world components. Therefore it is governed by specific rules and principles. Law of the Conservation of Matter is one of them, which states that the total mass of the products must equal the total mass of the reactants. Because of this law, chemical reactions can be thought of as a system of linear equations and as such can be mathematically manipulated. Balancing chemical equations is considered one of the frequent problems faced by chemistry students and scholars that are mostly solved by trial and error. The goal of this work is to present a formal, systematic and computerized method for balancing chemical reaction equations. The linear algebra method of Gaussian elimination in matrix algebra was used in solving this problem for balancing numerous chemical reaction equations, applied manually and as well as using the mathematical software packages MATLAB and MAPLE. Solved problems provided show that linear algebra methodology lends well for both simple and “those which are deemed” complex reactions, which thereafter can be resolved systematically and logically..

Keywords: balancing chemical reaction, algebraic approach, Gaussian elimination method, MATLAB, MAPLE.

[I] INTRODUCTION

Balancing of chemical equation is one of the initial subjects taught in most preliminary chemistry courses. A chemical equation clarifies the reaction. According to Risteski, chemical equation is " a symbolic representation of a chemical reaction and represents expressions of elements, compounds or ions", where the reactants are given on the left-hand side and the products on the right-hand side [1]. In chemistry, balancing a chemical equation is one of the basic requirements. Helmenstine[2] defined balanced chemical equation as "an equation in which the number of atoms for each element in the reaction and the total charge are the same for both the reactants and the products". The unbalanced

chemical equation is utilized to locate a system of linear equations, which can then be solved to get stoichiometric coefficients [1,3].

A chemical equation is said to be balanced, provided that the number of atoms of each type on the left is same as the number of atoms of the corresponding type on the right [4]. This leads to the concept of stoichiometry which is defined as " the quantitative relationship between reactants and products in a chemical equation is" [5]. In other words, stoichiometry is the proportional relationship between two or more substances during a chemical reaction [6]. The ratio of moles of reactants and products is given by the coefficients in a balanced chemical equation [5].

Balancing a chemical reaction equation requires basic skills in algebra. Generally, it is known that the chemical reaction balancing problems are a mathematical problem [7,8]. Chemistry students have had persistent difficulty in topics related to reaction stoichiometry, particularly concerning its application with chemical reactions [9,10]. The aim of this paper is balancing chemical reaction equation using Gauss elimination method in matrix algebra, MATLAB, and MAPLE. This paper explains also how to build and solve a homogeneous system of linear equations that represents a chemical equation. We can handle any chemical reaction with specified reactants and products through using this approach.

This paper comprises of nine sections distributed as follows:

- Section 1 is introduction, discussing about chemical equations, balancing chemical equations, and stoichiometry.
- Section 2 is background, introducing linear algebra approach, methods of balancing chemical equation.
- Section 3 presents the characteristics of algebraic method.
- Section 4 problem statement was presented. Section 5 Gaussian elimination method for solving matrix equations of the form $Ax = b$ was explained. Algebraic approach solution, the MATLAB solution, and MAPLE were applied in sections 6, 7, and, 8 respectively, and in section 9 we conclude by commenting on the solutions.

[III] BACKGROUND

At present, linear algebra has an increasing significance in science, frameworks, electrical networks, traffic flow, economics, statistics, technologies, engineering research, and many others [11]. Additionally, linear algebra also forms a basis of numerical methods; matrices are its primary tool that can hold large amounts of data in a format can easily be accessible by computer. A more general and deterministic method for balancing chemical equations uses linear algebra. Balancing chemical equations is a deep topic at

the intersection between mathematics and chemistry. Balanced chemical equations also lie at the heart of many important areas in chemistry.

Risteski[1], discusses solving matrix equations $Ax = b$ arising from efforts to find out the general methods to balance chemical equations. Likewise, Vishwambhar et al [12], discusses utilizing mathematical modeling for balancing a chemical equation and uses Gauss Elimination method aiming to solve. Gauss Elimination uses converting the given coefficient matrix to an upper triangular matrix and then use back substitution to obtain the solution.

Students who have courses in general chemistry are forced to come over balancing chemical equations. Indeed, this action provides an excellent demonstrative and instructive example of interconnection among stoichiometry rules and linear algebra [2]. Traditionally, several techniques have traditionally been taught in beginning of chemistry courses for balancing chemical reactions. In introductory textbooks, there are three common methods [13]: (a) Inspection: in its simplest form, and most commonly used, this method may be little more than intelligent guessing. For this, sometimes called a trial-and-error method ;(b) Half-Equation Method: this approach, also called the ion-electron method, is used for balancing oxidation-reduction (redox) reactions; (c) Oxidation Number Method, this is another approach for balancing redox reactions. Apart from the three methods previously mentioned, there is also a general method, mostly, less user-friendly, but acknowledged to its systematic approach is ideal for use in computer programs. It is the fourth method (d), which can be described as more general and powerful than previous three ways: is applying linear algebra to solve for balancing chemical reactions with system of equations. The unbalanced chemical equation is used to define the system of linear equations, which can then be solved to produce the stoichiometric coefficients [2]. This method has traditionally been less common than other methods, the reason is probably the inconveniences regarding solving the

systems of linear equations. However, modern mathematics software handles such systems; this makes the software in particular for linear algebra useful, more attractive, and easy to use for balancing chemical equation.

[III] ALGEBRAIC METHOD CHARACTERISTICS

Algebraic method is the most widely used, because it can be applied for balancing of all types of chemical reactions. Perhaps, the most significant characteristic in algebraic method is the guaranteed to obtain the solution. If the chemical reaction equation can be balanced, we will find the coefficients, if cannot be balanced, in this case, we will find that there are variables more than equations, or that equations are conflicting. With other methods like inspection, for instance, we will never have a proof that the chemical equation cannot be balanced.

There is an additional characteristic for this method to be so important. PCs are extremely efficient in solving collections of simultaneous equations, for instance, Gauss elimination method. What was difficult for the individual to do in the past become available, accessible, and easy to use because of the number of programs and packages built in every processor. That is why MATLAB and MAPLE is fit to solve a system of equations whatever the number of unknowns and equations in the blink of an eye.

[IV] PROBLEM STATEMENT

Chemical equations play a key role theoretically as well as in industrial chemistry. Thence, the balanced equation is quite needful in several fields of chemistry. Many students have difficulties in their first chemistry classes in balancing chemical reaction equation. Inspection method for instance but not limited to, is the most popular method used. Frequently, it is believed to be a trial - and - error process; therefore, it can be used only for the simple chemical reactions. However, it still has limitations [12].

In this method, many students typically feel frustrated referring to the trial-and-error method,

when the student experiences a complication with applying it to more advanced problems that do not lend with ease to serendipitous or an instantaneous solution [14]. Therefore, the mathematical method to balance a chemical equation is more approachable than the use of inspection method or other. Algebra approach makes it much easier to balance chemical equations and ionic chemical equations, in particular, those with non-trivial solutions not easily found by inspection [15].

Previous papers about how to balance a chemical reaction equation using algebraic method showed how augmented matrix reduced to row - echelon form directly, without using elementary row operations to rewrite the augmented matrix in row- echelon form [10,12,14,16]. In this paper, we are manually using elementary row operations to reduce the augmented matrix to row - echelon form as illustrated in problem 1. In addition, software environments like MATLAB and MAPLE were also used to reduce the matrix directly which was not clearly stated in other papers. And most of all, and with the availability of Mathematical software, we show through examples that we do not need to carry out these row operations when using those mighty programs.

[V] GAUSS-ELIMINATION

Any system of (k) linear equations in (k) unknowns can be solved systematically and effectively with the assumption that this system solvable. The traditional method to do this for is Gaussian elimination, it is known also as the Gauss-Jordan algorithm. This general subject is known as Linear Algebra. Gaussian elimination is a method for solving matrix equations of the form $A\mathbf{x} = \mathbf{b}$. To perform Gaussian Elimination

1. Starting with the system of below matrix equation:

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1k} \\ a_{21} & a_{22} & \cdots & a_{2k} \\ \vdots & \vdots & \ddots & \vdots \\ a_{k1} & a_{k2} & \cdots & a_{kk} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_k \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_k \end{bmatrix},$$

2. Compose the "augmented matrix equation"

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$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1k} & b_1 \\ a_{21} & a_{22} & \cdots & a_{2k} & b_2 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ a_{k1} & a_{k2} & \cdots & a_{kk} & b_k \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_k \end{bmatrix},$$

Here, the column vector $\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_k \end{bmatrix}$ is carried along for

labeling the matrix rows.

3. Perform elementary row operations to put the augmented matrix into the upper triangular or row echelon form:

$$\begin{bmatrix} a'_{11} & a'_{12} & \cdots & a'_{1k} & b'_1 \\ a'_{21} & a'_{22} & \cdots & a'_{2k} & b'_2 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ a'_{k1} & a'_{k2} & \cdots & a'_{kk} & b'_k \end{bmatrix}$$

4. Solve the equation of the (k^{th}) row for (x_k), then substitute back into the equation of the ($k-1$) first row to obtain a solution for (x_{k-1}) ..., etc., according to the formula:

$$x_i = \frac{1}{a'_{ii}} \left(b'_i - \sum_{j=i+1}^k a'_{ij} x_j \right)$$

[VI] ALGEBRAIC APPROACH SOLUTION-GAUSS-ELIMINATION METHOD

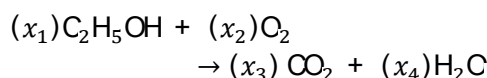
Indeed, balancing the chemical equations provides an excellent model of a relation between stoichiometry basics and linear algebra. In this section, linear algebra approach to balance chemical equation was carried out. The chemical equation balanced in this paper appears in many chemistry textbooks and they are selected with intent to balance them using matrix algebra by Gaussian elimination a logarithm. Being able to balance a chemical reaction equation is a vital skill in chemistry. In the next sections, a look at the steps involved in balancing equations, also, illustration examples of how to balance an equation.

6.1 Problem 1 balance the chemical reaction-Combustion of Ethanol

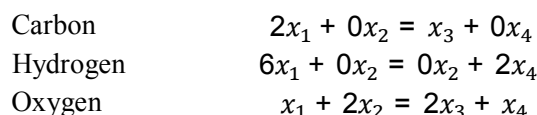
$C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$ - Not balanced.

The equation to balance is identified. This chemical reaction consists of three elements: Carbon(C); Hydrogen (H); Oxygen (O). The equation to balance is identified our task is to

assign the unknown coefficients (x_1, x_2, x_3, x_4) to each chemical species. A balance equation can be written for each of these elements:



Threesimultaneous linear equations in four unknown corresponding to each of these elements. Then, the algebraic representation of the balanced



condition for each element is as follows:

We write these as homogeneous system of three equations, each having zero on its right hand side.

$$2x_1 - x_3 = 0 \dots (1)$$

$$6x_1 - 2x_4 = 0 \dots (2)$$

$$x_1 + 2x_2 - 2x_3 - x_4 = 0 \dots (3)$$

First, note that there are four unknowns, but only three equations. The system is solved by Gauss - elimination method as follows:

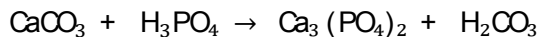
$$\begin{aligned} & \left[\begin{array}{cccc|c} 2 & 0 & -1 & 0 & 0 \\ 6 & 0 & 0 & -2 & 0 \\ 1 & 2 & -2 & -1 & 0 \end{array} \right] \text{Interchanging R3 by R1} \rightarrow \\ & \left[\begin{array}{cccc|c} 1 & 2 & -2 & -1 & 0 \\ 6 & 0 & 0 & -2 & 0 \\ 2 & 0 & -1 & 0 & 0 \end{array} \right] - 6R1 + R2; -2R1 + R3 \\ & \rightarrow \left[\begin{array}{cccc|c} 1 & 2 & -2 & -1 & 0 \\ 0 & -12 & 12 & 4 & 0 \\ 2 & 0 & -1 & 0 & 0 \end{array} \right] - \frac{1}{12}R3 \\ & \rightarrow \left[\begin{array}{cccc|c} 1 & 2 & -2 & -1 & 0 \\ 0 & 1 & -1 & -2/3 & 0 \\ 0 & -4 & 3 & 2 & 0 \end{array} \right] R2 + R3; 2R3 + R1 \\ & \rightarrow \left[\begin{array}{cccc|c} 1 & 2 & -2 & -1 & 0 \\ 0 & 1 & -1 & -1/3 & 0 \\ 0 & 0 & -1 & 2/3 & 0 \end{array} \right] - R_3 \\ & \rightarrow \left[\begin{array}{cccc|c} 1 & 2 & -2 & -1 & 0 \\ 0 & 1 & -1 & -1/3 & 0 \\ 0 & 0 & 1 & -2/3 & 0 \end{array} \right] 4R2 + R3 \\ & \rightarrow \left[\begin{array}{cccc|c} 1 & 2 & 0 & -7/3 & 0 \\ 0 & 1 & 0 & -1 & 0 \\ 0 & 0 & 1 & -2/3 & 0 \end{array} \right] - 2R2 + R1 \\ & \rightarrow \left[\begin{array}{cccc|c} 1 & 0 & 0 & -1/3 & 0 \\ 0 & 1 & 0 & -1 & 0 \\ 0 & 0 & 1 & -2/3 & 0 \end{array} \right] \end{aligned}$$

The last matrix is of reduced row echelon form, so we can stop, and we obtain that the solution of the system of linear equations is:

$$x_1 = (1/3) t; x_2 = t; x_3 = (2/3) t; \text{ and } x_4 = t$$

Where, t is a parameter. Particular solution can then obtain by assigning values to the parameter, for instance $t = 1$. we can represent the solution set as: $x_4 = 1$; $x_3 = \left(\frac{2}{3}\right)$; $x_2 = 1$; $x_1 = \left(\frac{1}{3}\right)$ Thus, the balanced chemical reaction equation is: $\left(\frac{1}{3}\right)C_2H_5OH + (1)O_2 \rightarrow \left(\frac{2}{3}\right)CO_2 + (1)H_2O$, but in the case of chemical equations, all coefficients must be integer and they must be the smallest ones. Multiplying both sides by 3(the least common multiple LCM), we obtain minimal solution with positive integers: $(1)C_2H_5OH + (3)O_2 \rightarrow (2)CO_2 + (3)H_2O$

6.2 Problem 2 balance the chemical reaction-Acid-base reaction between phosphoric acid and calcium carbonate



Again, as in problem (1), we determine the unknown coefficients (x_1, x_2, x_3, x_4) to each chemical element. This chemical reaction consists of five elements: Calcium (Ca); Carbon(C); Hydrogen (H); Oxygen (O); and Phosphorus (P). A balance equation can be written for each of these elements:

$(x_1)CaCO_3 + (x_2)H_3PO_4 \rightarrow (x_3)Ca_3(PO_4)_2 + (x_4)H_2CO_3$. Five simultaneous linear equations in four unknown corresponding to each of these elements. Algebraic representation of the balanced condition for each element condition for each element is as follows:

$$\begin{array}{l} \text{Ca} \quad x_1 = 3x_3 \rightarrow x_1 - 3x_3 = 0 \\ \text{C} \quad x_1 = x_4 \rightarrow x_1 - x_4 = 0 \\ \text{O} \quad 3x_1 + 4x_2 = 8x_3 + 3x_4 \\ \quad \quad \quad \rightarrow 3x_1 + 4x_2 - 8x_3 - 3x_4 = 0 \\ \text{H} \quad 3x_2 = 2x_4 \rightarrow 3x_2 - 2x_4 = 0 \\ \text{P} \quad x_2 = 2x_3 \rightarrow x_2 - 2x_3 = 0 \end{array}$$

To solve the above homogeneous system of linear equations, Gauss - elimination method will be used. Consider the following matrix: $Ax = 0$, yields the matrices shown below:

$$A = \begin{bmatrix} 1 & 0 & -3 & 0 \\ 1 & 0 & 0 & -1 \\ 3 & 4 & -8 & -3 \\ 0 & 3 & 0 & -4 \\ 0 & 1 & -2 & 0 \end{bmatrix}_{5 \times 4}, \quad x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}_{4 \times 1}$$

$$\text{and } 0 = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}_{5 \times 1}$$

The augmented matrix for this system is:

$$\begin{bmatrix} 1 & 0 & -3 & 0 & 0 \\ 1 & 0 & 0 & -1 & 0 \\ 3 & 4 & -8 & -3 & 0 \\ 0 & 3 & 0 & -4 & 0 \\ 0 & 1 & -2 & 0 & 0 \end{bmatrix}$$

Applying Gauss -elimination to rewrite the augmented matrix in row - echelon form as done

$$\text{in problem (1): } \begin{bmatrix} 1 & 0 & 0 & -1/3 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & -2/3 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

The last matrix is now in row echelon form, and the corresponding system of linear equations is as shown below:

Now, by letting $(x_4 = t)$, where t is parameter), we can represent the solution set as:

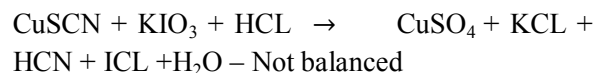
$$x_4 = t ; x_3 = \left(\frac{2}{3}\right)t ; x_2 = t ; x_1 = \left(\frac{1}{3}\right)t$$

Particular solution can then obtained by assigning values to the parameter. For instance, $t = 3$ yields the solution:

$$x_4 = 3 ; x_3 = 1 ; x_2 = 2 ; x_1 = 3$$

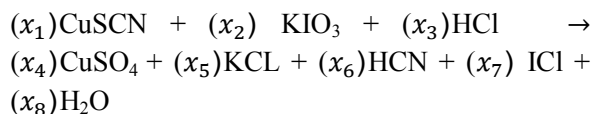
Thus, the balanced chemical reaction equation is: $(3)CaCO_3 + (2)H_3PO_4 \rightarrow (1)Ca_3(PO_4)_2 + (3)H_2CO_3$

6.1.3 Problem 3 balance the chemical reaction-Redox Equation



To the above chemical reaction equation, we determine the unknown coefficients $(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8)$ to each chemical element. This chemical reaction consists of five elements. : Copper (Cu) ; Sulphur(S); Cyanide(CN); Hydrogen (H);potassium(K);

Iodine(I); Oxygen (O); Chlorine(CL). A balance equation can be written for each of these elements:



$$\text{Cu} \quad x_1 = x_4 \rightarrow x_1 - x_4 = 0$$

$$\text{S} \quad x_1 = x_4 \rightarrow x_1 - x_4 = 0$$

$$\text{CN} \quad x_1 = x_4 \rightarrow x_1 - x_4 = 0$$

$$\text{K} \quad x_2 = x_5 \rightarrow x_2 - x_5 = 0$$

$$\text{I} \quad x_2 = x_7 \rightarrow x_2 - x_5 = 0$$

$$\text{Cl} \quad x_3 = x_5 + x_7 \rightarrow x_3 - x_5 - x_7 = 0$$

$$\text{O} \quad 3x_2 = 4x_4 + x_8 \rightarrow 3x_2 - 4x_4 - x_8 = 0$$

$$\text{H} \quad x_3 = x_6 + 2x_8 \rightarrow x_3 - x_6 - 2x_8 = 0$$

To solve the above homogeneous system of linear equations, Gauss - elimination method will be used. Consider the following matrix: $\mathbf{Ax} = \mathbf{0}$, yields the matrices shown the following:

$$\mathbf{A} = \begin{bmatrix} 1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 1 & 0 & -1 & 0 & -1 & 1 \\ 0 & 0 & 3 & -4 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & -1 & 0 & -2 \end{bmatrix}_{8 \times 8},$$

$$\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \\ x_8 \end{bmatrix}_{8 \times 1}, \text{ and } \mathbf{0} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}_{8 \times 1}$$

Now, we used elementary row operations to rewrite the augmented matrix in row - echelon form:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & -1.5 & -0.25 \\ 0 & 1 & 0 & 0 & 0 & 0 & -1.0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & -2.0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & -1.5 & -0.25 \\ 0 & 0 & 0 & 0 & 1 & 0 & -1.0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & -2.0 & 2 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}_{8 \times 8}$$

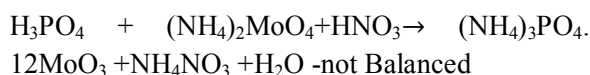
By applying the same steps in previous problems (1 and 2), we obtained the solution of the system:

$$x_1 = 4 ; x_2 = 7 ; x_3 = 14 ;$$

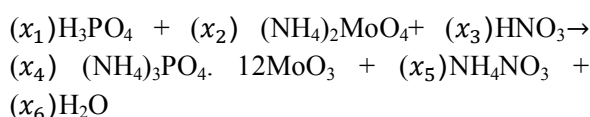
$$x_4 = 4, x_5 = 7, x_6 = 4, x_7 = 7, x_8 = 5$$

Thus, the balanced chemical reaction equation is: $(4)\text{CuSCN} + (7)\text{KIO}_3 + (14)\text{HCl} \rightarrow (4)\text{CuSO}_4 + (7)\text{KCl} + (4)\text{HCN} + (7)\text{ICl} + (5)\text{H}_2\text{O}$

6.1.4 Problem (4): balance the chemical reaction-phosphoric acid reacts with ammonium molybdate and nitric acid.



Where: **H**-Hydrogen; **P**-Phosphorus; **O**-Oxygen; **N**-Nitrogen; and **Mo** - Molybdenum.



Set up system of linear equations:

$$\text{H} \quad 3x_1 + 8x_2 + x_3 = 12x_4 + 4x_5 + 2x_6$$

$$\text{P} \quad x_1 = 12x_4$$

$$\text{O} \quad 4x_1 + 4x_2 + 3x_3 = 40x_4 + 3x_5 + x_6$$

$$\text{N} \quad 2x_2 + x_3 = 3x_4 + 2x_5$$

$$\text{MO} \quad x_2 = 12x_4$$

Thus, the augmented matrix is:

$$\mathbf{A} = \begin{bmatrix} 3 & 8 & 1 & -12 & -4 & -2 \\ 1 & 0 & 0 & -1 & 0 & 0 \\ 4 & 4 & 3 & -40 & -3 & -1 \\ 0 & 2 & 1 & -3 & -2 & 0 \\ 0 & 1 & 0 & -12 & 0 & 0 \end{bmatrix},$$

Reduced to row - echelon form:

$$= \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & -1/12 \\ 0 & 1 & 0 & 0 & 0 & -1 \\ 0 & 0 & 1 & 0 & 0 & -7/4 \\ 0 & 0 & 0 & 1 & 0 & -1/12 \\ 0 & 0 & 0 & 0 & 1 & -7/4 \end{bmatrix}$$

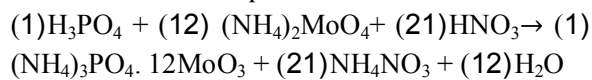
Here, it is clear that there is a free variable (x_6); there are more variables than equations. This free variable can take any value, and the resulting combination of x_1 to x_5 would be a valid solution. To parameterize the free variable and solve for the variables, let us set $x_6=t$ (t is a positive parameter).

$$x_1 = \left(\frac{1}{12}\right)t, x_2 = t, x_3 = \left(\frac{7}{4}\right)t, x_4 = \left(\frac{1}{12}\right)t, x_5 = \left(\frac{7}{4}\right)t, x_6 = t$$

In the last step, we substitute an appropriate value for t (the coefficients in the chemical equation must be integers, therefore let $t = 12$ (LCM)). The solution will be as follows:

$$x_1 = 1, x_2 = 12, x_3 = 21, x_4 = 1, x_5 = 21, x_6 = 12$$

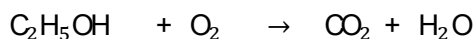
Now, we substitute these coefficients into the balanced chemical equation:



[VII] CORRESPONDING SOLUTION USING MATLAB

MATLAB stands for (MATrixLABoratory) is a general-purpose mathematics program that was originally designed to solve problems involving matrices. This program is ideally convenient for solving matrix equations of the form: $\mathbf{Ax} = \mathbf{b}$. Next, we consider how this system can be solved using MATLAB.

7.1 Problem 1



In this section, a solution to problem (1) will be presented using Matlab. Initially the Matrix of Coefficients A should be inputted.

$$A1 = [2 \ 0 \ -1 \ 0; 6 \ 0 \ 0 \ -2; 1 \ 2 \ -2 \ -1]$$

To solve the equation, the Matlab function `null(A,'r')` is applied. Since this is a homogeneous system of linear equations, i.e. $\mathbf{Ax} = \mathbf{0}$. In Matlab the following command is inputted:

$$\text{Sol1} = \text{null}(A1, 'r')$$

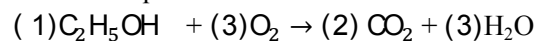
Where $Z = \text{null}(A, 'r')$ is a "rational" basis for the null space obtained from the reduced row echelon form. $A*Z$ is zero, if A is a small matrix with integer elements; the elements of the reduced row echelon form are ratios of small integers, for more info check (17). The result from applying the null function will be:

$$\gg \text{Sol1} = \\ 0.3333 \ 1.0000 \ 0.6667 \ 1.0000$$

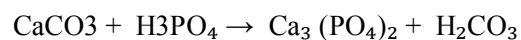
Finally, to get an integer solution, the solution is multiplied by 3 (The LCM of the denominators), the minimum value that would produce an integer solution.

$$\gg \text{Sol1_int} = \\ 1 \ 3 \ 2 \ 3$$

This is the final answer with: $x_1 = 1, x_2 = 3, x_3 = 2$ and $x_4 = 3$. Thus, the balanced chemical equation is:



7.2 Problem 2



To solve problem 2, we input the matrix of coefficients A2

$$A2 = [1, 0, -3, 0; 1, 0, 0, -4; 3, 4, -8, -3; 0, 3, 0, -2; 0, 1, -2, 0]$$

Here, only three equations are needed. Rows 1, 3 and 5 are selected arbitrary; the new sub-matrix is named A2 reduced

$$A2_{\text{reduced}} = A2([1 \ 3 \ 5], :)$$

$$\text{Sol_problem2} = \text{null}(A2_{\text{reduced}}, 'r')$$

$$\gg \text{Sol_problem2} = \\ 1.0000 \ 0.6667 \ 0.3333 \ 1.0000$$

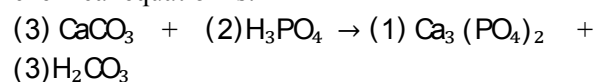
Finally, to get an integer solution, the solution is multiplied by LCM of the denominators of solution.

$$\text{Sol_problem2_int} = 3 * (\text{Sol_problem2})$$

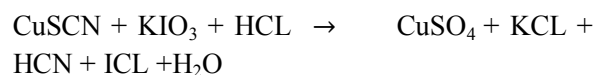
This will result in:

$$\gg \text{Sol_problem2_int} = \\ 3 \ 2 \ 1 \ 3$$

This is the final answer with: $x_1 = 3, x_2 = 2, x_3 = 1$, and $x_4 = 3$. Accordingly, the balanced chemical equation is:



7.3 Problem 3



To solve problem 3, we input the matrix of coefficients A3

$$A3 = [1 \ 0 \ 0 \ -1 \ 0 \ 0 \ 0 \ 0; 1 \ 0 \ 0 \ 0 \ 0 \ -1 \ 0 \ 0; 1 \ 0 \ 0 \ 0 \ 0 \ -1 \ 0 \ 0; 1 \ 0 \ 0 \ 0 \ 0 \ -1 \ 0 \ 0; 1 \ 0 \ 0 \ 0 \ 0 \ -1 \ 0 \ 0]$$

```
0 1 0 0 -1 0 0 0;
0 1 0 0 0 0 -1 0;
0 3 0 -4 0 0 0 -1;
0 0 1 0 0 -1 0 -2;
0 0 1 0 -1 0 -1 0];
```

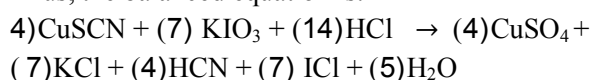
We then follow the same steps performed previously, and multiply the result by the LCM of the denominators, which is equal to 5 for this problem.

```
Sol3=null (A3,'r');
Sol3_int= 5*Sol3
```

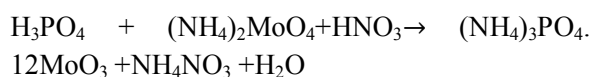
The output would be:

```
>>Sol3_int =
4 7 14 4 7 4 7 5
```

Thus, the balanced equation is:



7.4 Problem 4



To solve problem 4, we input the matrix of coefficients A4

```
A4=
[3      8      1      -12     -4     -2
 1      0      0      -1      0      0
 4      4      3      -4      -3     -1
 0      2      1      -3      -2      0
 0      1      0     -12      0      0]
```

We then apply the null function:

```
Sol4 = null (A4,'r')
>>Sol4 =
0.0833  1.0000  1.7500  0.0833  1.7500
1.0000
```

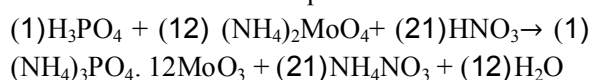
Scaling the solution by the LCM of the denominators (which is equal to 12), the solution will be:

```
Sol4_int = Sol4*12
>> Sol4_int =
1 12 21 1 21 12
```

The final solution is:

$$x_1 = 1, x_2 = 12, x_3 = 21, x_4 = 1, \\ x_5 = 21, x_6 = 12$$

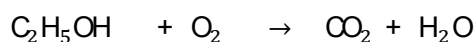
The balanced chemical equation is:



[VIII] RESULTS

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MAPLE – Stands for: Mathematical Problem-solving and programming Environment. Maple package is a kind of external library containing routines that are not loaded as part of the default environment. Each package is usually specialized to a particular kind of computational feature (eg: plotting) or area of mathematical application (eg: linear algebra). Next, we apply MAPLE package on the problems (1, and 2) to find the value of each unknowns (i.e.; solving linear systems using "solve", and matrix inverse method.

8.1 Problem 1



Solution (a) using the "Solve" – method

>restart; with(linalg) :

```
sys := {2*x[1] - x[3] = 0, 6*x[1] - 2*x[4] = 0, x[1] + 2*x[2] - 2*x[3] - x[4] = 0, x[4] = 1};
```

```
sys := {x4 = 1, 2x1 - x3 = 0, 6x1 - 2x4 = 0, x1 + 2x2 - 2x3 - x4 = 0}
```

># First Method,

```
>solve(sys, {x[1], x[2], x[3], x[4]});
```

$$\left\{ x_1 = \frac{1}{3}, x_2 = 1, x_3 = \frac{2}{3}, x_4 = 1 \right\}$$

```
>evalf(%);
```

```
[ 0.33333333333 1. 0.66666666667 1. ]
```

(b) Matrix inverse method

># Second Method,

```
>A := genmatrix( sys, {x[1], x[2], x[3], x[4]}, b);
```

$$A := \begin{bmatrix} 0 & 0 & 0 & 1 \\ 2 & 0 & -1 & 0 \\ 6 & 0 & 0 & -2 \\ 1 & 2 & -2 & -1 \end{bmatrix}$$

```
>evalm(b);
```

```
[ 1 0 0 0 ]
```

```
>linsolve(A, b);
```

$$\left[\frac{1}{3} \ 1 \ \frac{2}{3} \ 1 \right]$$

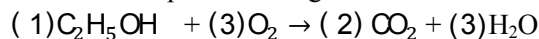
```
>inverse(A);
```

$$\begin{bmatrix} \frac{1}{3} & 0 & \frac{1}{6} & 0 \\ 1 & -1 & \frac{1}{4} & \frac{1}{2} \\ \frac{2}{3} & -1 & \frac{1}{3} & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}$$

>evalm(inverse(A) &* b);

$$\begin{bmatrix} \frac{1}{3} & 1 & \frac{2}{3} & 1 \end{bmatrix}$$

Thus, the balanced chemical reaction equation is: $(\frac{1}{3})C_2H_5OH + (1)O_2 \rightarrow (\frac{2}{3})CO_2 + (1)H_2O$, but in the case of chemical equations, all coefficients must be integer and they must be the smallest ones. Multiplying both sides by 3(the least common multiple LCM), we obtain minimal solution with positive integers:



8.2 Problem 2

Solution

>restart;

>

$$\text{sys2} := \{x[1] - 3 \cdot x[3] = 0, x[1] - x[4] = 0, 3 \cdot x[1] + 4 \cdot x[2] - 8 \cdot x[3] - 3 \cdot x[4] = 0, x[2] - 2 \cdot x[3] = 0\};$$

$$\text{sys2} := \{x_1 - 3x_3 = 0, x_1 - x_4 = 0, x_2 - 2x_3 = 0, 3x_1 + 4x_2 - 8x_3 - 3x_4 = 0\}$$

>solve(sys2, {x[1], x[2], x[3], x[4]});

$$\{x_1 = 3x_3, x_2 = 2x_3, x_3 = x_3, x_4 = 3x_3\}$$

># if we assume $x[3]=t$, then

$$>x[1] = 3 \cdot t; x[2] = 2 \cdot t; x[3] = t; x[4] = 3 \cdot t;$$

$$x_1 = 3t$$

$$x_2 = 2t$$

$$x_3 = t$$

$$x_4 = 3t$$

>t := 1;

$$t := 1$$

$$>x[1] = 3 \cdot t; x[2] = 2 \cdot t; x[3] = t; x[4] = 3 \cdot t;$$

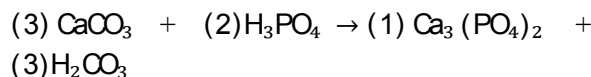
$$x_1 = 3$$

$$x_2 = 2$$

$$x_3 = 1$$

$$x_4 = 3$$

Thus, the balanced chemical reaction equation is:



[IX] CONCLUSION

This work presented a formal, systematic approach for balancing chemical equations. The method is based on the Gaussian elimination method and augmented matrix protocols. The actual notability of the matrices procedure as an effective method for balancing a chemical equation reaction is illustrated through different problems. In other words, the mathematical method presented in this paper was applicable for all cases in chemical reactions. The results indicated that there is no any contradiction between the various methods that were applied to balance the chemical reaction equation and the suggested approach. Likewise, the work concludes by demonstrating how this can be accomplished in different widely adopted software packages such as **MATLAB** and **MAPLE**.

[X]ACKNOWLEDGEMENT

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Economic Advantages of Utilizing the Integrated Quality Software Development Model

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Abstract

New contemporary software development models try to tradeoff among the three major aspects of concern; Cost, time and meeting customer requirements. One of the recently introduced software development models is the Integrated Quality Software Development (IQSD). This model builds on the advantages of both the prototyping and waterfall models and eliminates their limitations. This research presents the development of a cost estimation function that quantifies the economic benefits of implementing the IQSD model. Numerical analysis indicated that the IQSD model outperforms traditional development models from an economic standpoint.

Keywords: Integrated quality software development; Waterfall model; Prototyping model; Software development lifecycle; Cost estimation

Introduction

Today, there is a huge demand for computerized and automated business. Software development companies must deliver and produce software applications that meet customer satisfaction. In addition, both customers and developers have a high concern for development cost and time to penetrate the market. Both conventional and contemporary software development models allow for a tradeoff between cost and risk of not meeting customer satisfaction [1].

In addition, focusing on clarifying and understanding customer requirements is very critical since customer expectations increase by time, and new technologies are becoming more advanced. Spending more for the needed design efforts up front can lead to a cost reduction at the end of the software development life cycle. In contrast, incomplete design efforts can increase the cost of maintenance, as shown in Figure 1 [2].

The Waterfall Development Model has the advantage of low cost and less time, if and only if customer requirements are completely understood and clear [3,4]. The Prototyping Development Model has a good application, which involves customers in the development process, but this model has no obvious end; in other words, it is an open-ended process needing a larger budget and more time [5,6].

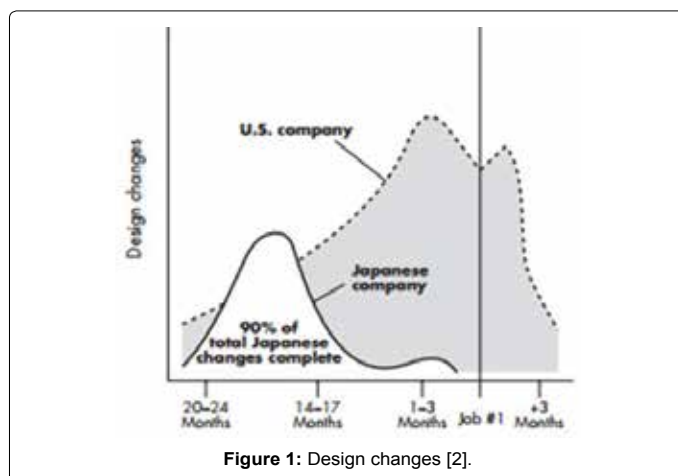


Figure 1: Design changes [2].

Integrated Quality Software Development (IQSD)

The only way to obtain customer satisfaction with low effort is by integrating a model that has the advantages of both the Waterfall Development Model and the Prototyping Development Model—combining these two models and using the advantages of clarifying the voice of the customer as shown in Figure 2. Once the voice of the customer is clearly understood, developers can then switch to the Waterfall Model, using its speed to complete the development process, thus meeting customer requirements and achieving quality.

Customer requirements/analysis

Understanding customer requirements and needs is the core and pillar of any successful process. To produce a successful software application, developers need to comprehend and understand all customers' voices clearly, since the final output or goal depends on their wants and desires in order to launch a successful product.

The first step in producing a successful software application is to define the problem to be solved and then define the intended customers. Customer requirements are derived from either customers or developers [7]. Customer requirements involve communication among these entities and can be categorized into functional and non-functional. Functional requirements are a subset of the entire application requirements and describe how the application or the system will work. Non-functional requirements explain the behavior of the application. In addition, there are many techniques used for collecting customer requirements:

One-on-one interviews: This most common technique focuses on sitting down with customers and inquiring about their needs, in other words, a direct interview between customers and developers, to avoid any misunderstanding of customer requirements [8].

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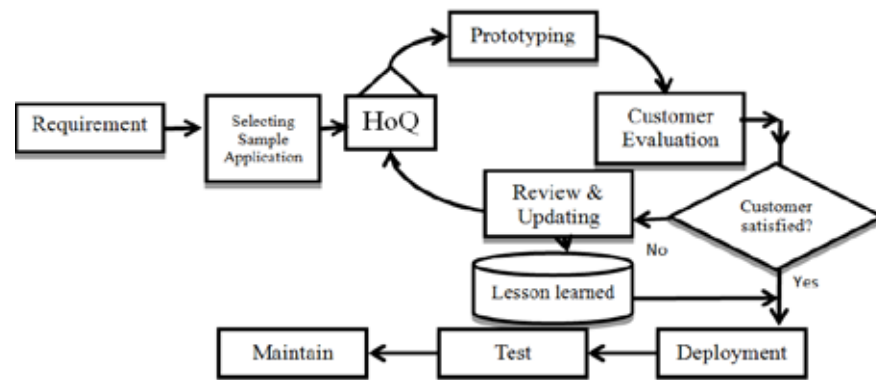


Figure 2: IQSD model [1].

Questionnaires: This technique is used when remote customers or a very large number of customers are involved, or there is no way to meet customers face to face. This technique must focus on avoiding redundancy in the large amount of data that is required [9].

Brainstorming: This technique is used when requirements are ambiguous and there is a need for innovative ideas [10]. First, developers are asked to meet in a room, start innovative brainstorming to solve a problem, and then find alternative solutions. Next, developers prioritize these alternatives. Finally, there is consensus as to the best alternative to finding an optimal solution.

Selecting the sample application

Selecting the sample application is very important in determining and judging the throwaway prototype. By sampling, developers can minimize and limit the possible liability of launching a “sub-par” product. Furthermore, bugs and defects during sampling can be fixed with minimum cost and time.

In order to select the sample application for iterative development, the system (application) must be dividable into subsystems; after that, a Pareto analysis technique for prioritizing these subsystems (subapplications) can be applied. Pareto analysis was discovered by the Italian scholar Vilfredo Pareto and is based on the Pareto principle where 80% of projects or problems are the result of 20% of causes.

In the stage of gathering requirements, customers should first determine the most needed subsystems to be developed and delivered, and then arrange them in ascending order. Based on this process, developers can prioritize subsystems by using Pareto analysis to arrange them according to the magnitude of their needs.

Designing prototype for selected application

Prototyping is a tool that explains whether requirements are met or not. In the prototyping phase, there are several steps, beginning with the house of quality.

House of quality: Sometimes, customers are not aware of exactly what they need, or their requirements are ambiguous. The HoQ technique looks for spoken customer requirements, thus making invisible requirements visible. This method is capable of capturing any misunderstanding of customer requirements by using a correlation matrix between what customers require and how developers design and engineer characteristics in order to meet customer satisfaction.

After gathering customer requirements, the HoQ can be used to

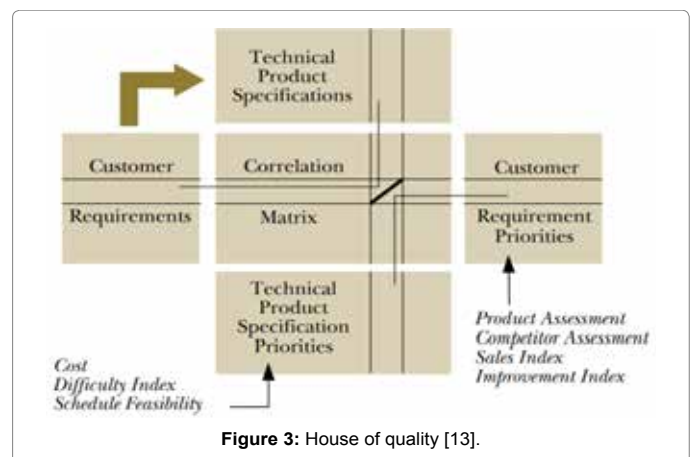


Figure 3: House of quality [13].

translate all customer requirements into engineering characteristics to generate a set of features and functions to achieve customer satisfaction. By using the HoQ in software development, the quality of software will be increased and improved [11-14]. As shown in Figure 3, a series of steps is involved in the construction of the HoQ [13].

Developing a prototype: Early defect detection is recommended in order for developers to correct and fix any problems before system release. In addition, early defect detection can minimize the cost of poor quality. Prototyping enables customers to be involved during the design phase, so that customers can obtain a clear view and awareness of their requirements, which in turn will allow them to better share their ideas. All prioritized engineering characteristics in the HoQ will be implemented in the initial prototype.

Customer evaluation: By having a throwaway prototype, customers are ready to evaluate and provide feedback in order for changes to be made. Customer evaluation can help to implement an effective output system. Once this has succeeded, the next step is to deploy the entire development process for the remaining system subapplication. However, if the customer evaluation is not successful, then reviewing and updating is necessary.

Reviewing and updating: By using customer feedback, requirements and specifications can be improved. In addition, all lessons learned will be documented by using database storage to comprehend and document all customer feedback to incorporate the advantages and eliminate defects in order to accelerate the

development process. By using the lessons learned, this model can implement customer requirements for other subapplications during the prototyping phase, which runs the risk of not meeting customer requirements. Furthermore, this process saves time and cost.

Deployment

During this stage, all programming codes will be accomplished and implemented for the remaining subapplication in order to complete the entire application.

Testing

After accomplishing all required programming codes, they can be tested to ensure that neither bugs nor defects are found in matching customer requirements.

Maintenance

In this phase, the application will be ready to be released, and customers will be encouraged to send their feedback and comments relative to the correction of bugs or further improvement.

Software Cost Estimation

Due to the enormous growing demand for software applications, an appropriate method for cost estimation is needed. This method should be accurate and precise. There are two categories of software cost-estimation models: parametric and non-parametric. The parametric model comes from the statistical analysis of existent data, and the non-parametric model comes from expert and neural network methods. Many examples of parametric methods have been used in the software industry to estimate development cost; this research focuses on the Application Composition Model of the Constructive Cost Model II (COCOMO II) created by Boehm [15]

Application composition model

This model is based on the number of application points (i.e., screens, reports, and 3GL components) [16] and supports a prototyping-based project. To estimate the cost, the following steps are followed [16]:

- 1. Calculate object counts by estimating the number of screens, reports, and 3GL.
2. Categorize objects into three levels of complexity-simple, medium, and difficult-as shown in Table 1, where S, M, and D stand for simple, medium, and difficult, respectively.
3. Based on Table 2, provide a complexity weight for the number of each cell.
4. By adding the weighted objects, count the object points as one number.
5. Estimate the proportion of reused code; then use Equation 1 to calculate the new object point (NOP):

NOP = (Object Points) x (100 - %reuse) / 100

- 6. Calculate the productivity rate (PROD) using Table 3.
7. Finally, calculate the person-months (PM) effort by using Equation 2:

PM = NOP x (1 - %Reuse) / PROD

Parametric models are the most popular technique. They easily allow for modifying input data, and refining and customizing formulas. On the other hand, these models are unable to deal with different development environments. Furthermore, some experiences and factors cannot be quantified by using these models. Periodic calibration using a company's own data is required to assure accuracy [17].

Cost Estimation Function for the IQSD

This section proposes a new software cost estimation function to estimate the total efforts of the integrated quality software development model.

Notation

The following symbols are used in estimating the cost of utilizing the proposed IQSD model:

- Y - Expected level of effort, in person-months, under the application composition model of COCOMO II
Y1 - Cost of iterative development in PM
Y2 - Cost of linear development in PM
a - Learning exponent
X - Expected number of iterations
g - Realization factor
p - Proportion of the sample application

Estimated cost of utilizing the proposed model

The IQSD model is aimed at reducing the risk of not meeting customer requirements and expectations. This is especially useful in developing customized (made-to-order) software systems. To determine the economic consequence of achieving this goal, a cost function for estimating the level of effort is proposed in Equation 3. This function accounts for two terms: one for the level of effort Y1 expected during iterative development of a selected proportion of the system, and the other for the average effort Y2 used during linear development of the remainder of the system. Both terms are estimated based on the expected level of effort Y obtained using the application composition submodel of the COCOMO II. This method is typically utilized to estimate the cost of employing the waterfall development model under the assumption of clear and fixed requirements. As such,

Table with 8 columns: Number of Views, Screens (Number and Source of Data Tables), Number of Sections, Reports (Number and Source of Data Tables). Rows include complexity levels (<3, 3-7, >8) and their corresponding object point levels (S, M, D).

Table 1: COCOMO II Object Point Levels [16].

Object Type	Complexity-Weight		
	S	M	D
Screen	1	2	3
Report	2	5	8
3GL Component			10

Table 2: COCOMO II complexity weight of object points [16].

Developers' Experience and Capability ICASE Maturity and Capability	Very Low	Low	Nominal	High	Very High
PROD	4	7	13	25	50

Table 3: COCOMO II productivity [16].

the level of effort Y is considered a baseline estimate of the development cost expressed as

$$PM = Y_1 + Y_2 \quad (3)$$

Due to the advantages of the COCOMO II, as noted in section 3.1, it is assumed that potential users are familiar with the application composition model and have had more than one chance to calibrate its parameters.

Cost of iterative development: The term Y_1 accounts for the effort made during iterative development of a selected proportion p of the software system. This proportion is developed iteratively following the prototyping model. The resulting prototypes are used to clarify customer requirements and verify their capabilities. The proportion p is viewed as a representative sample of the system under development. It can be determined based on the ratio of its new object point to the estimated total NOPs of the software. The final result represents a functional component of the system that can be evaluated and accepted by the customer. Costs incurred during this iterative development depend on the selected proportion p and number of prototypes developed and evaluated, in an effort to clarify requirements. In obtaining an estimate of such costs, a production progress function is utilized to incorporate the effect of sequential learning on the cumulative cost. As frequently utilized in production planning and cost estimation, such a function requires an estimate of the cost of developing the first prototype $p \cdot Y$, and the learning exponent α . The latter can be attributed to the gains expected from acquiring customer feedback during iterative development and the accumulation of lessons learned. Consequently, the expected effort of iterative development can be expressed as

$$Y_1 = p \cdot Y \cdot X^{1-\alpha} \quad (4)$$

As pointed out by Weheba and Elshennawy [18] it is common practice to estimate the exponent α in terms of the cost reduction for double production. Thus, each time the number of iterations is doubled, the cumulative average effort per iteration is expected to decrease by $2^{-\alpha}$. Utilizing the level of effort from two successive iterations, an appropriate estimate of α can be obtained. It should be pointed out that the learning exponent in this application replaces the reuse rate in the COCOMO II, which is difficult to estimate a priori. The exponent represents a measure of competency of the software development team and its ability to translate customer requirements into technical specifications. With adequate training, higher values of α can be achieved.

The number of iterations X in Equation 4 is typically unknown due to the uncertainty involved. It is likely that the first prototype requires significant changes. And some changes may receive positive evaluations, while others may be shown to have no or even detrimental effect on customer satisfaction. The final prototype may differ

considerably from that initially developed and evaluated. However, the number of iterations X can be assessed by using the realization factor g within the $(0,1)$ interval as defined by Montgomery [19], who indicated that the number of iterations X can be approximated by a geometric random variable with an average $1/g$. Here, the factor g represents the probability that the initial prototype will successfully achieve customer requirements. This is a function of the clarity of the initial requirements and past experience with the same customer. In general, it is appropriate to assume that projects with a high realization require less iterations on the average. In other words, development projects starting with clear and accurate requirements from returning customers should be assigned values of the factor g close to unity. Otherwise, initial subjective estimates of g may be used and updated as records accumulate. An initial value of < 0.25 is appropriate, as recommended by Yelle [20]. Also, it is important to note that Equation 4 indicates that the lower the realization factor g of the first prototype, the higher the effect of the exponent α on the estimated cost. This is expected to compensate for the effect of assuming a constant realization as a characteristic of the geometric distribution.

Cost of linear development: The cost of linear development Y_2 can be estimated using Equation 5, which accounts for the PM effort required for developing the remaining proportion $1-p$ of the system. It is assumed that the development will follow a linear model (waterfall) with a clear and accurate set of requirements. As shown in Figure 2, this stage is aided by lessons learned during iterative development. Such information is typically documented in the house of quality, with clear indications of user requirements and specific design aspects known to achieve them. It is assumed that this stage of development can begin only when a target level of customer satisfaction has been achieved. Utilizing the estimate Y from the COCOMO II, the linear development effort is expected to be

$$Y_2 = (1-p) \cdot Y \quad (5)$$

Total cost function: The total development effort in person-months of utilizing the proposed model can now be estimated by adding Equations 3 and 4:

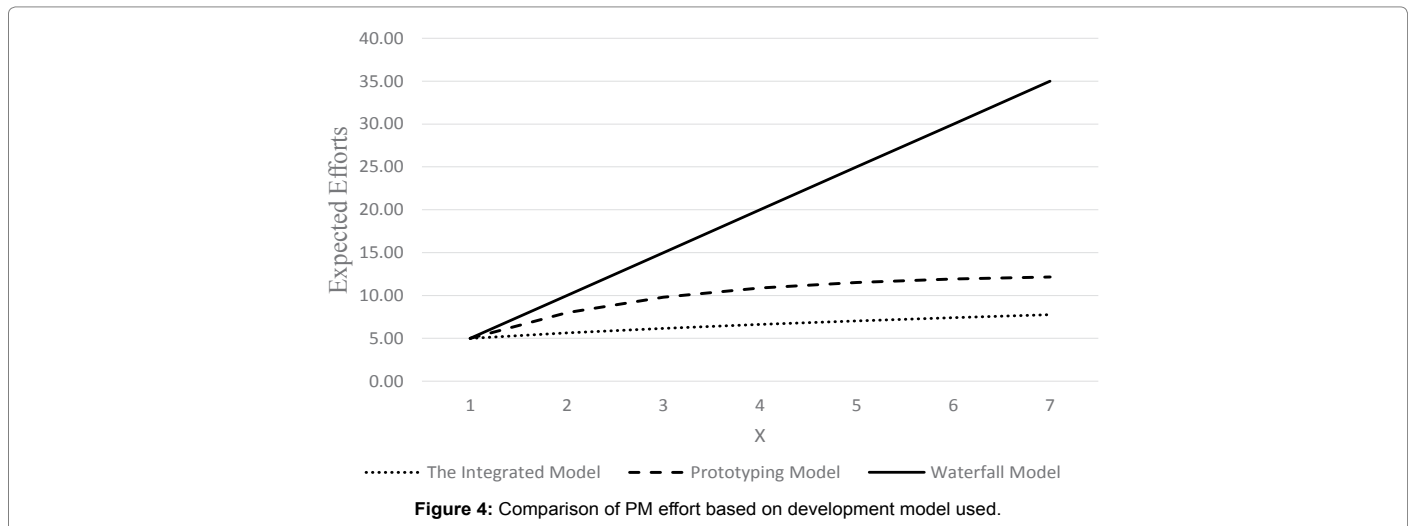
$$\begin{aligned} PM &= p \cdot Y \cdot X^{1-\alpha} + (1-p) \cdot Y \\ &= Y \left[1 + p(X^{1-\alpha} - 1) \right] \end{aligned} \quad (6)$$

An examination of Equation 6 reveals that the theoretical minimum level of PM effort can be achieved when $p=0$ (equivalently $X^{1-\alpha}=1$). At this level, the complete system is developed without iterations at the baseline level of PM effort. This entails the assumption of an accurate understanding of a fixed set of requirements as in the waterfall model. However, should this assumption be violated, then the actual effort of repeated development using the waterfall model is expected to be a multiple of Y , depending on the number of developments required to achieve customer satisfaction. On the other hand, when $p=1$, the development will follow the prototyping model at an estimated effort represented by a multiple (magnitude of $X^{1-\alpha}>1$) of the baseline development effort Y . The main advantage of the proposed IQSD model lies in its ability to represent developers with a middle ground approach, one in which the risk of failure is reduced at a fraction of the cost of repeated development.

The expected level of effort PM as a function of the development model utilized is shown in Table 4, for a development project with an initial effort Y of 5.0 PM (NOP/PROD=5.0). Values of PM for using the IQSD model were calculated based on Equation 6 at various levels of the realization factor g , assuming $p=0.25$ and $\alpha=0.40$. For the waterfall

X	g	Efforts of Integrated Model	Efforts of Prototyping Model	Efforts of Waterfall Model (with iterations)
1.00	1.00	5.00	5.00	5.00
2.00	0.50	5.64	8.00	10.00
3.00	0.33	6.17	9.80	15.00
4.00	0.25	6.62	10.88	20.00
5.00	0.20	7.03	11.53	25.00
6.00	0.17	7.41	11.92	30.00
7.00	0.14	7.77	12.15	35.00

Table 4: Comparison of three models based on assumed data.



and prototyping models, values of PM were calculated based on the application composition submodel of the COCOMO II. The calculated value of the average PM when using the prototyping model is based on a reuse rate of 40%.

The value of the average PM for using the waterfall model, assuming a constant and fixed number of requirements, is calculated at the hypothetical level of realization ($g=1.0$). However, when this assumption is violated, values of g are used to calculate the expected number of redevelopments. This is typical of the waterfall model, as was noted in section 1.

Model performance

Calculated values of the average PM as a function of the development model used at the expected values of X (or $1/g$) are represented graphically in Figure 4. As shown, all three models result in the same average level of PM when no iterations are needed. As the number of iterations increase, the IQSD model tends to outperform both the waterfall and prototyping models. Section 4.3 represents a study of the model performance at varying levels of its parameters.

Conclusions

The objective of this paper was to demonstrate the economic advantages of utilizing the IQSD model. In achieving this objective, a mathematical cost function for estimating the total effort (person-months) was developed. This cost function employs the level of effort obtained by using the application composition model of the COCOMO II as a baseline, given its popularity. It includes two terms: the first accounts for the level of effort required during the iterative development of a selected portion of the system, and the second accounts for the level of effort required for developing the remaining

proportion. The total cost is estimated based on four factors: the expected baseline effort (Y) obtained using the COCOMO II, the proportion of the model selected for iterative development (p), the realization factor (g), and the learning rate (α). Numerical investigation of the model performance over practical levels of these four factors was conducted. The investigation utilized a two-level factorial arrangement and revealed that the expected total effort is more sensitive to changes in the realization factor (g) at the low levels of the learning rate (α). This indicates that high levels of learning are needed when developing software systems for new customers. It was noted that the model is not sensitive to changes in the proportion (p) selected for iterative development. This supports the effective utilization of the HoQ in translating customer requirements into engineering characteristics. In other words, users of the proposed development model should be more concerned with the ability of the selected proportion to reflect as much of the customer requirements, rather than its relative size [21-26].

The IQSD model could be used in product design where rapid prototyping and 3D printing are efficiently utilized for iterative development. This is an area where numerous research efforts have been made to reduce cost and time to market while improving design quality. The model is simple, easy to implement, and reinforces the need for clear communication between developers and customers. It allows developers to utilize customer feedback during the early stages of product development and achieve high levels of satisfaction.

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Electrophotonic improvement of polymer solar cells by using graphene and plasmonic nanoparticles

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ABSTRACT

It is essential to enhance a solar cell performance at near-infrared region which represents almost 40% of sunlight energy. In this paper, an efficient light trapping polymer solar cell which uses plasmonic nanoparticles and antireflection transparent graphene layer is introduced. The shape of the periodic nanostructure of nanocrystalline zinc oxide (nc-ZnO) grown on its flat surface and the thickness of graphene layer are optimized. Lumerical finite difference time domain (FDTD) solution software is used to design and analyze the proposed structure. In addition, electrical and optical models are developed to calculate the short circuit current density, fill factor and overall efficiency of the designed polymer solar cell structure. The distributed gold nanoparticles (Au-NPs) inside the active layer with 41 Au-NPs/unit cell produce the maximum efficiency and short circuit current density, 8.94% and 17.33 mA/cm² respectively, and a high light absorption near-infrared region is obtained. Finally, the electric field distribution inside the solar cell structure is also illustrated in this work.

Keywords: FDTD, Plasmonic Nanoparticles, Polymer Solar Cell, Short Circuit Current Density, Overall Efficiency.

1. INTRODUCTION

Organic photovoltaic devices (OPVs) have drawn much research interest in the past decades due to their low cost, flexibility, lightweight, large area and its roll-to-roll (R2R) production compatibility.⁽¹⁻³⁾ However, the lower efficiency and stability are still massive challenges.⁽⁴⁻⁷⁾ As a result, many techniques have been introduced to enhance the power conversion efficiency (PCE) by optimizing the device structure⁽⁸⁾ and using a plasmonic cavity.⁽⁹⁾ Surface plasmon localization on metallic nanoparticles is considered one of the efficient technique used to increase the optical absorption of solar cells.⁽¹⁰⁾

Qu et al. improved the optical absorption by distributing silver nanoparticles (Ag-NPs) uniformly at the interface between (PEDOT:PSS) poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) and (P3HT:PCBM)

poly(3-hexylthiophene):(6,6)-phenyl-C61-butyric-acid-methyl ester layers.⁽¹¹⁾ The optical absorption enhancement reached to almost 100% when the Ag-NPs were located in the interface layer. Organic solar cell with a thick active layer with 11% power conversion efficiency was obtained theoretically by Nicla et al.⁽¹²⁾

Overall efficiency of a polymer solar cell was improved by using nanoholes photoactive layer to almost 6.7%.⁽⁴⁾ The authors compared their model to Tumbleston et al. model,⁽¹³⁾ where a photonic crystal photoactive layer was used to reach 5.03% efficiency enhancement.

Graphene is a monolayer of carbon atoms packed in two-dimensional (2D) single-atom-thick, which attracted attention in many research areas specially solar cells.⁽¹⁴⁾ Graphene can be used as a highly transparent antireflection coating instead of indium tin oxide (ITO) not only for the remarkable optical, electrical, mechanical and thermal properties but also for the corrosion of ITO due to the chemical interaction with PEDOT:PSS.⁽¹⁵⁾

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Jiang et al. improved the electrical conductivity of PEDOT:PSS to 35% by adding a reduced graphene to the solar cell structure.⁽¹⁶⁾ Carrier mobility and collection efficiency were improved by providing additional charge transport pathways in the hole transport layer when reduced graphene was added.

In this paper, a polymer solar cell light harvesting was improved specially at near infrared region which accounts for almost 40% of the sunlight energy. Short circuit current density (J_{sc}) and light absorption in P3HT:PCBM active layer were simulated by applying a finite difference time domain (FDTD) method using Lumerical FDTD solutions software package. Optimization of a periodic nanostructure shape grown on a nc-ZnO layer and the radius of Au nanoparticles (NPs) distributed inside the active layer are introduced in this work. Different thicknesses and surface shapes of a graphene layer are also studied. Furthermore, the optical absorption has been enhanced by distributing Au-NPs, with different densities, inside the active layer of the proposed solar cell structure.

More sensitive and accurate results can be obtained using FDTD simulation software by minimizing the meshing size, increase simulation time and by using a 3-D analysis. However, the obtained results can be slightly different from the experimental work due to the use of adhesive materials between layers which has a considerable effect but not taking into consideration in the simulation work.

2. THEORETICAL MODEL

In order to calculate the electrical parameters of a polymer solar cell, a single diode model is considered for the filling factor, FF , by applying the Green empirical expression.⁽⁴⁾ In the first step, short circuit current density, J_{sc} , is calculated using Eq. (1) by assuming that, an electron will be produced for every incident photon.⁽¹³⁾

$$J_{sc} = \frac{q}{hc} \int I(\lambda)A(\lambda)\lambda d\lambda \quad (1)$$

where q is the electron charge, h is the Planck's constant, c is the speed of light, $I(\lambda)$ is the standard air mass 1.5 (AM1.5) spectral irradiance and $A(\lambda)$ is the optical absorption.

Absorbed optical power in the proposed structure can be obtained using numerical FDTD solutions by calculating the difference between the optical power at the top and at the bottom of active layer.

The open circuit voltage, V_{oc} , of P3HT:PCBM is considered to be a fixed value equal to 0.62 V as it depends on the energy level of the material.⁽⁴⁾ Hence, the fill factor can be calculated using Eq. (2).

$$FF = \frac{(qV_{oc}/kT) - \ln((qV_{oc}/kT) + 0.72)}{(qV_{oc}/kT) + 1} \quad (2)$$

where k is the Boltzmann constant and T is the absolute temperature.

The fill factor can also be calculated from Eq. (3) as a function of maximum output power P_{max} .

$$FF = \frac{P_{max}}{J_{sc}V_{oc}} \quad (3)$$

By calculating the maximum output power, P_{max} , the overall solar cell efficiency, η , can be calculated as a ratio of maximum output power to solar input power.

Nevertheless, the optical power absorbed in the active layer is affected by Au plasmonic nanoparticles distributed inside the layer, and depends on the maximum value of reflectivity. The transmitted power of plasmonic nanoparticles is affected by NPs shape, relative permittivity of the gold nanoparticles, and dielectric function of the surrounding medium.⁽¹⁷⁾ The maximum value of reflectivity is calculated as in Eq. (4).

$$\lambda_{max} = \frac{P}{g} \left(\frac{\epsilon_d \epsilon_m(\lambda_{max})}{\epsilon_d + \epsilon_m(\lambda_{max})} \right)^{1/2} \quad (4)$$

where ϵ_d is the permittivity of the surrounding medium, ϵ_m is a gold nanoparticles dielectric constant at corresponding λ_{max} , g is an integer and P is structural periodicity. Hence, the dielectric permittivity can be expressed by using a multi-oscillator Drude-Lorentz model:⁽¹⁷⁾

$$\epsilon_m = \epsilon_\infty - \frac{\omega_D^2}{\omega^2 + j\omega\gamma_D} - \sum_{k=1}^6 \frac{\delta_k \omega_k^2}{\omega^2 - \omega_k^2 + 2j\omega\gamma_k} \quad (5)$$

where ϵ_∞ is the Au dielectric permittivity at high frequency, ω_D and γ_D are the plasma and collision frequencies of the free electron gas, δ_k is the amplitude of Lorentz oscillator, ω_k is the resonance angular frequencies and γ_k is the damping constants for k value from 1 to 6.

3. MATERIALS AND STRUCTURE

Lumerical FDTD solutions software, which is an electromagnetic wave solver based on finite difference time domain method, is used in designing and analyzing the proposed polymer solar cell. In this simulation analysis, unit cell dimensions are simulated and optimized to be $w = 460$ nm (width) and $L = 800$ nm (length) with Au back contactor thickness $h = 500$ nm, used as a cathode. A nc-ZnO layer used as an electron transport layer, is grown above Au layer with thickness $t1 = 70$ nm as illustrated in Figure 1. A periodic nanostructure of nc-ZnO material can be attached to the surface with periodicity $t2 = 400$ nm using 2D face centered cube structure. The active layer P3HT:PCBM with thickness $h1 = 590$ nm is utilized to cover the nanostructures of electron transport layer. The PEDOT:PSS layer is used as a hole transport layer (HTL) with thickness $h2 = 50$ nm and graphene layer is used as transparent antireflection layer and as an anode contact

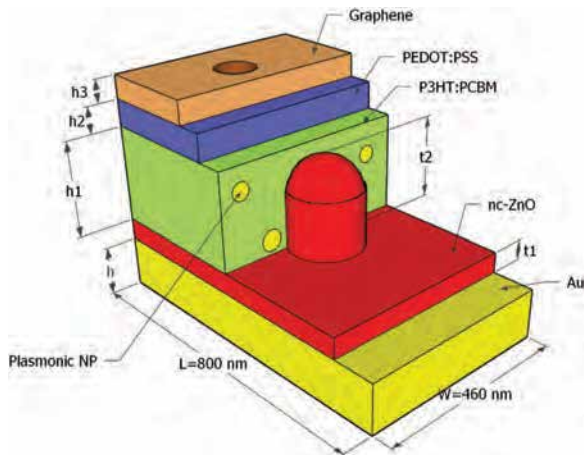


Fig. 1. Schematic diagram of the proposed structure.

with thickness h_3 , need to be optimized. Plasmonic NPs are randomly distributed in the active layer with different concentrations.

A one unit cell has been simulated and the boundary conditions are considered a periodic structure in x -direction and y -direction and perfect matching layer in z -direction. A plane wave source with wavelength band 400–700 nm and offset time 7.5 fs is used as a light source. In addition, the solar generation calculation region is given in the active layer to calculate the short circuit current density.

Energy band diagram illustrates the electrons and holes transportation inside the structure. Energy band diagram of the proposed structure is illustrated in Figure 2. As the electron hole pair is generated in the active layer, electron transport from the active layer to nc-ZnO layer and then to the electrode layer. Consequently, the generated hole transfer from active layer to HTL then to graphene layer.

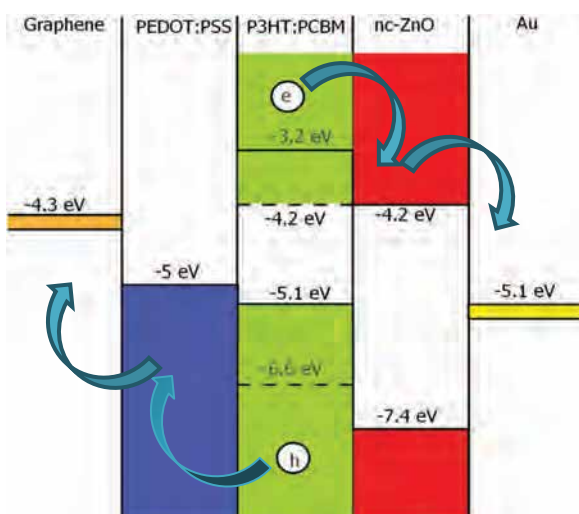


Fig. 2. Energy levels diagram of all materials for the given structure.

4. RESULTS AND DISCUSSION

To maximize the absorbed power in the active layer, the short circuit current density and consequently the overall solar cell efficiency, four phases are introduced.

In the first phase, different shapes of nc-ZnO nanostructure, grown on nc-ZnO flat surface, are simulated to get the maximum short circuit current density and high light absorption. Cylindrical, conical, hemispherical, pyramidal, triangular strip and rectangular strip nanostructure shapes have been studied. The radius of the randomly distributed Au-NP in the active layer is optimized in the second phase. In the third phase, thickness and surface roughness of the graphene layer, replaced ITO layer, are also simulated. Finally, the density of Au-NPs distributed in the active layer are studied and consequently electric field distribution is also developed in different layers inside the proposed structure.

4.1. Different nc-ZnO Nanostructure Shapes

In order to enhance the light absorbed in the active layer, periodic nanostructure of nc-ZnO material is grown inside the active layer with height $t_2 = 400$ nm, where the periodic structure is a FCC in 2D. Different shapes are used in the simulation process, cylindrical, conical, hemispherical, pyramidal, triangular strip and rectangular strip shapes.

Figure 3 shows the absorbed light in the active layer of the given shapes. The absorption of cylindrical and hemispherical shapes is higher than the other shapes specially at wavelength larger than 650 nm.

However, the short circuit current density of the hemispherical shape is higher than the cylindrical shape, 11.07 and 11.06 mA/cm² respectively, as given in Table I. However the 7.15 mA/cm² short circuit current density is obtained in case of a flat ZnO surface. Consequently a

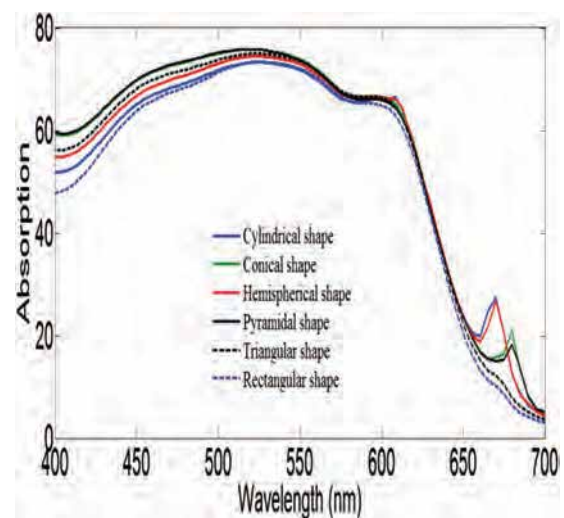








Fig. 3. Absorption of different nanostructure shapes versus optical wavelength.

Table I. Short circuit current density and overall efficiency for different nanostructure shapes.

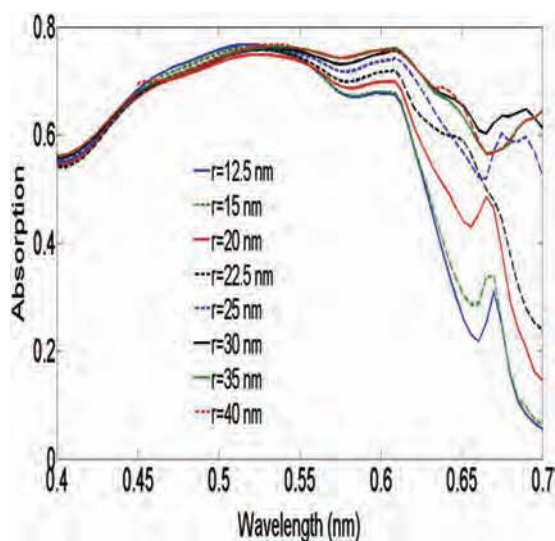
Nanostructure shape	J_{sc} (mA/cm ²)	Efficiency (%)
	11.06	5.70
	10.99	5.66
	11.07	5.71
	10.9	5.62
	10.38	5.35
	9.93	5.12

higher overall efficiency is obtained from the hemispherical shape, 5.71%, and almost 5.7% is obtained from the cylindrical shape compared to 3.68% in case of flat ZnO surface.

Therefore, the hemispherical shape is selected as an optimum shape for giving a higher electrical and optical performance than the cylindrical shape.

4.2. Optimization of Metallic Plasmonic NP Radius

Plasmonic Au-NPs, used to enhance the absorption in the active layer,⁽¹⁷⁾ are randomly distributed inside the active layer (9 Au-NPs). The transmitted and absorbed power of plasmonic nanoparticle depends on its shape as given in Eqs. (4) and (5), so the NP radius has a great effect on the its performance. Figure 4 shows the enhancement of the

**Fig. 4.** Light absorption of different radius of 9 plasmonic Au-NPs distributed in the active layer.**Table II.** Short circuit current density and overall efficiency for different NPs radius.

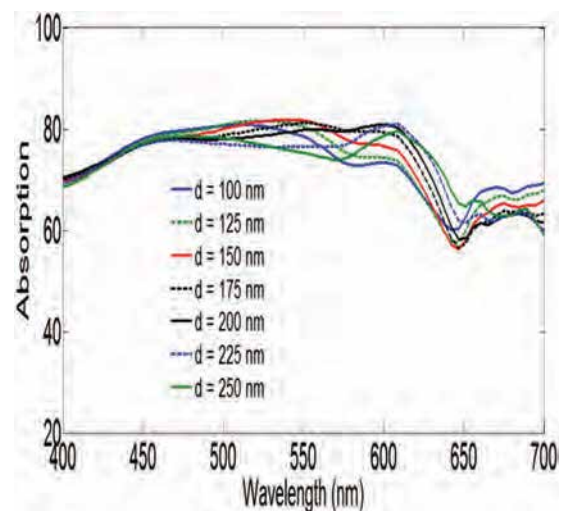
NP radius (nm)	J_{sc} (mA/cm ²)	Efficiency (%)
12.5	11.43	5.89
15	11.66	6.01
20	12.89	6.64
22.5	14.25	7.34
25	14.57	7.51
30	15.4	7.94
35	15.4	7.93
40	15.4	7.93

light absorption for different Au-NPs radii. For radii 12.5, 15, 20, 22.5, 25, 30, 35 and 40 nm, the maximum absorption is obtained at radius 30 nm specially at the longer wavelength band 600–700 nm. Furthermore, the change of NP radius has a slight effect on the optical absorption below 600 nm and has a higher effect at wavelength greater than 600 nm. However the short circuit current density and overall efficiency almost constant for radius more than 30 nm.

Maximum short circuit current density and overall efficiency are obtained at NP radius 30 nm, $J_{sc} = 15.4$ mA/cm² and $\eta = 7.94\%$ as shown in Table II. So, the optimum Au-NP radius is taken to be 30 nm.

4.3. Impact of Using Graphene Layer

In this section, graphene is used as an electrode and as an antireflection transparent layer replacing ITO layer. Optimum graphene thickness is considered as the main parameter that affects both electrical and optical solar cell properties. Different thicknesses are studied and these thicknesses are 100, 125, 150, 175, 200, 225 and 250 nm. As shown in Figure 5, the absorption is highly depending on the wavelength band. At thickness 200 nm, the light

**Fig. 5.** Absorbed light of different graphene thicknesses.

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Table III. Short circuit current density and overall efficiency of different graphene thicknesses.

Graphene thickness (nm)	J_{sc} (mA/cm ²)	Efficiency (%)
100	16.08	8.29
125	16.07	8.28
150	16.08	8.29
175	16.09	8.29
200	16.12	8.31
225	16.07	8.28
250	16.1	8.30

absorption is high between 550 nm and 630 nm the absorption in wavelength band 630–700 nm of 100 nm thickness is more efficient than 200 nm.

To determine which thickness is more convenient, Table III is used to illustrate the short circuit current density and overall efficiency for the given thickness. As noticed in Table III, the maximum short circuit current density is 16.12 mA/cm², and the efficiency is 8.31%, both occurred at graphene thickness 200 nm. So, the optimum thickness of graphene layer is chosen to be 200 nm for its high properties.

In addition, to enhance the light harvesting of the graphene layer, different surfaces shapes are compared to the flat surface. The light absorption of different surfaces is illustrated in Figure 6, these surfaces shapes are flat, conical, periodical hemispherical and inverted hemispherical shapes. As shown in Figure 6, the absorption of the flat surface is typical to inverted hemispherical surface. However, the short circuit current density of the flat surface and inverted hemisphere are 16.12 and 16.74 mA/cm² respectively and consequently the overall efficiencies are 8.31% and 8.63% respectively.

Hence, the inverted hemispherical graphene surface shape is chosen although it gives a lower absorption in the higher wavelength.

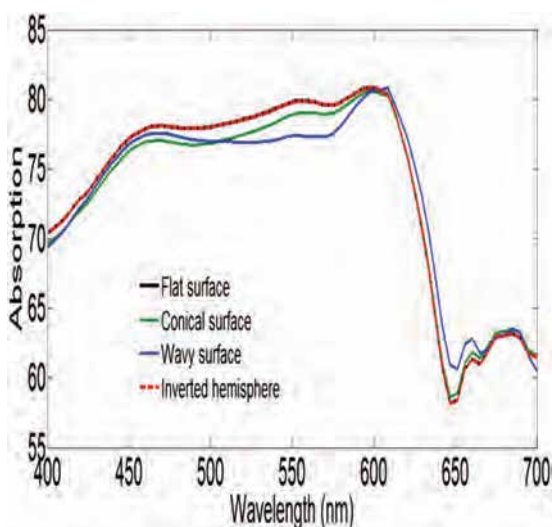


Fig. 6. Absorption of different graphene surfaces shapes.

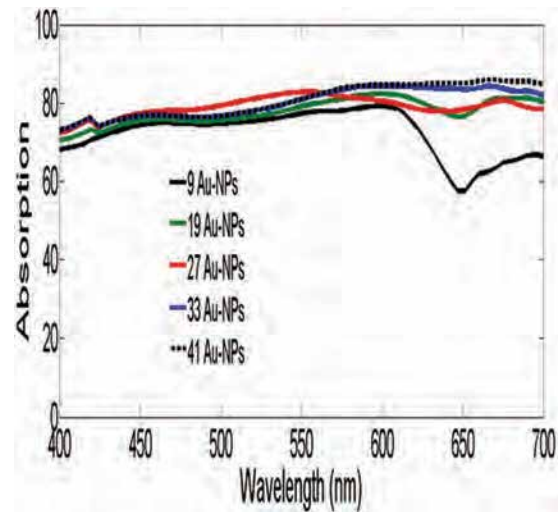


Fig. 7. Absorption of different Au-NPs density inside the active layer.

4.4. Influence of Au-NPs Density

The effect of plasmonic NPs density distributed in the active layer is studied in this section. By randomly distributing 9 Au-NPs/unit cell, the NPs fill almost 2% of the available volume of the active layer. We can increase the NPs density by two nanoparticles at each step to end with 45 Au-NPs/unit cell which fill around 9.5% of the available volume.

Figure 7 shows selected numbers of NPs, the samples are 9, 19, 27, 33, and 41 nanoparticles per unit cell. The maximum absorption occurs at higher wavelengths, 550–700 nm, when 41 Au-NPs are distributed in the active layer.

As illustrated in Figure 8, the average values of the short circuit current density is monotonically increasing with

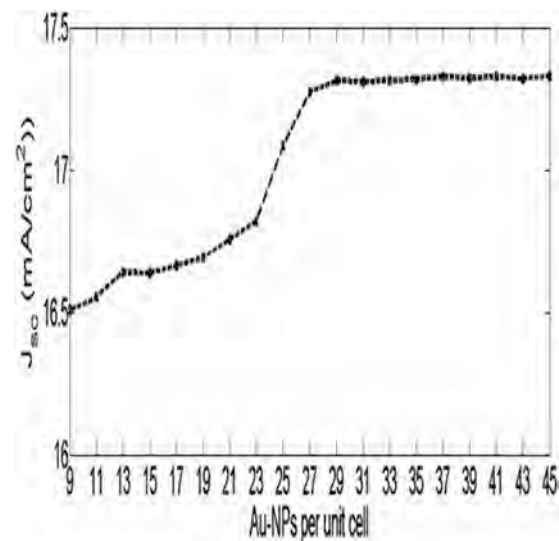


Fig. 8. Average short circuit current density versus the total number of Au-NPs/ unit cell.

Table IV. The electrical parameters of conventional PC, NH and the proposed structure.

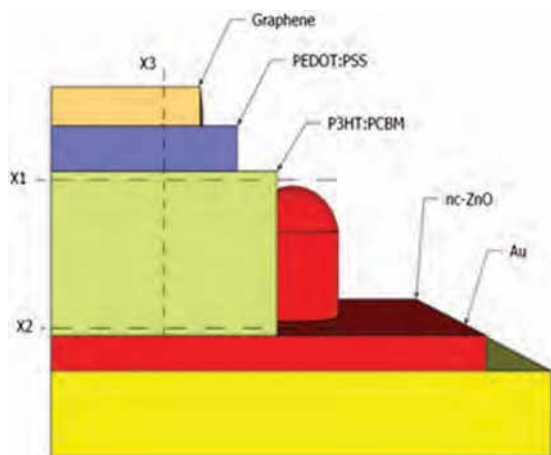
Structure	J_{sc} (mA/cm ²)	Efficiency (%)
Conventional PC ⁽¹³⁾	10.13	5.03
NH ⁽⁴⁾	13	6.71
Proposed structure	17.32	8.94

NPs density until reach to the maximum, 17.327 mA/cm², at density 41 NPs per unit cell.

The overall efficiency is calculated at different NPs density, where the maximum overall efficiency, 8.94%, is obtained at short circuit current density 17.327 mA/cm² and both occurred at 41 Au-NPs/unit cell. The calculated fill factor using Eq. (3) of the proposed structure for 41 Au-NPs is 0.83.

Short circuit current density is totally depends on the carriers transferred from active layer to ZnO layer then to the ohmic contact. Hence, NPs closer to the ZnO nanostructure play the key rule in this case. The average short circuit current density has been simulated using five different random distribution models as shown in Figure 8. Hence, an overall conclusion can be reached, the short circuit current density is not stable for NPs density between 9 and 23 which depends on the selected NPs position and how closer to the ZnO nanostructure and then saturated at 17.3 mA/cm² for NPs density between 25 and 45 NPs/unit cell.

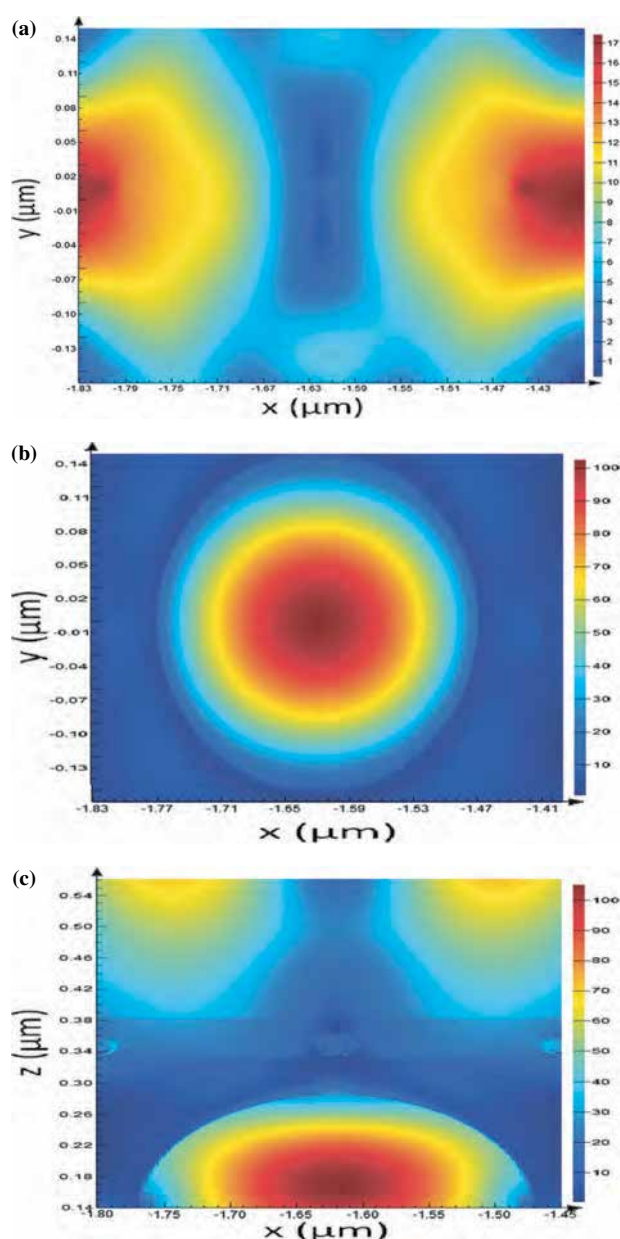
As a comparison, the obtained short circuit current density and overall efficiency from the proposed structure is compared to the introduced nanohole, NH, structure⁽⁴⁾ and the conventional PC structure.⁽¹³⁾ Conventional PC model introduced a short circuit current density 10.13 mA/cm² which improved to be 13 mA/cm² using NH structure and reaches to 17.33 mA/cm² in the proposed model. The overall efficiency is improved to 8.94% instead of 6.71% and 5.03% given by NH and conventional PC structures.

**Fig. 9.** Different positions of electric field layers.

4.5. Electric Field Distribution

Electric field distribution is represented at different layers, inside and outside the active layer, as illustrated in Figure 9. The layers are; x_1 at the top of active layer, x_2 , at the bottom of active layer and x_3 as a vertical layer.

Au-NPs absorb the transmitted light at the top of active layer is illustrated in Figure 10(a). At the bottom of active layer, the light is concentrated in the mid of nanostructure and transferred to the flat surface of nc-ZnO layer as in Figure 10(b). Finally, an overview of light transmission through the structure is given in Figure 10(c). The electric field distribution shows that, the inverted hemispherical

**Fig. 10.** Electric field distribution at different layers in the solar cell structure, (a) at the top of active layer, (b) at the bottom of active layer and (c) vertical layer.

shape in the graphene layer behaves as a nanoantenna which retransmits the light into the solar cell body and then, by the help of Au-NPs, the electric field is transferred and confined into nanostructure of nc-ZnO layer. This happens due to the contrast of reflective index between the nanostructure and the surrounding medium of active layer.

5. CONCLUSION

Optical absorption, short circuit current density, fill factor and overall efficiency of a polymer solar cell are simulated using FDTD method. A major enhancement of the electrical and optical properties in the active layer is achieved by using graphene layer, 200 nm thicknesses, instead of ITO layer. A hemispherical nc-ZnO nanostructure grown inside the active layer produce maximum optical and electrical properties among different simulated shapes. Moreover, Au-NPs, 30 nm radius, are randomly distributed inside the active layer with different concentration. The maximum obtained overall efficiency and short circuit current density are 8.94% and 17.33 mA/cm² respectively when the plasmonic density is 41 Au-NPs/unit cell. In addition, electric field distribution shows that the inverted hemispherical shape in the graphene layer behaves as a nanoantenna by retransmitting the tapped light from the surface into the polymer solar cell structure. Hence, the light is transferred from the Au-NPs distributed in the active layer to nc-ZnO nanostructure and then to the Au electrode layer.

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Research Article

Enhancement of Fluorescence and Photostability Based on Interaction of Fluorescent Dyes with Silver Nanoparticles for Luminescent Solar Concentrators

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For luminescent solar concentrators (LSCs), it is important to enhance the fluorescence quantum yield (FQY) and photostability. Our measurements have demonstrated that the addition of silver nanoparticles to dye solution causes broadening of absorption bands, so the spectral range of sunlight absorbed by LSC has increased. Silver nanoparticles (NPs) were characterized by X-ray diffraction (XRD) and UV-Vis absorption spectra. UV-Vis spectrum showed a single peak at 442 nm due to the surface plasmon resonance (SPR). The position of SPR peak exhibited a red shift after the sample was exposed to UV irradiation (unfiltered light). The optical band gap values have a reduction from 2.46 to 2.37 eV after irradiation for 960 minutes. Such reduction in optical band gap may be due to change in particle size calculated using Mie theory. The photostability of organic dyes used was improved after adding silver nanoparticles. The area under fluorescence spectra of dyes with silver NPs increased by 41–31% when compared with identical dye concentrations without silver nanoparticles as a result of interaction of the species with silver NPs.

1. Introduction

Luminescent solar concentrators (LSCs) were introduced for the first time in 1976 by Weber and Lambe [1] and then studied in detail [2, 3]. LSCs can accept both diffuse and direct sunlight and certainly it is considered that LSCs can perform better under diffuse light than under direct light, so a sunlight tracking system is unnecessary. The LSCs generally contain fluorescent particles such as organic dyes or quantum dots embedded in a transparent matrix medium such as poly(methyl methacrylate), polycarbonate, glass, or even a liquid solution. A typical fluorescent collector absorbs the incident sunlight through the front face of a luminescent plate and a fraction of the reemitted photons are trapped by total internal reflection (TIR) and directed towards a PV cell generally mounted on the edges of the collector. The luminescent solar concentrators using liquid solutions contained between transparent plates have received a little attention [4, 5]. Moreover, they represent an interesting fundamental system which can be used for a wide range of theoretical and spectroscopic

studies, helping to understand the basic performance of fluorescent dye under illumination. Tummeltshammer et al. [6] simulated the efficiency of LSC which employs silver, Ag, nanoparticles to enhance the dye absorption and scatter the incoming light. It was reported that the normalized optical efficiency can be increased from 10.4% for a single dye LSC to 32.6% for a plasmonic LSC with Ag spheres immersed inside a thin dye layer. Enhancement of the efficiency was due to scattering of the particles and not due to dye absorption/reemission. As well, Holland and Hall discussed the enhanced fluorescence from molecules deposited on the surface of an optical waveguide structure. The enhancement was due to the near-field interaction between the Rhodamine B molecules and the waveguide's modal fields [7]. Meyer and Markvart showed that fluorescence spectra of an optically thick medium can be compared to a quasi-black-body radiation with a nonzero chemical potential. It was reported that photons enter into thermal equilibrium upon perfect absorption and reemission, resulting in an equal chemical potential for all photons in the system. It was shown that

photon reabsorption known also as photon recycling gradually brings the emitted photon flux into thermal equilibrium with the collector. Moreover, the key difference is that the chemical potential flux in FSCs is closer to the thermodynamical limit than the chemical potential observed for solar cells [8].

One of the major factors that affect the efficiency of a LSC module is the fluorescence quantum yield (FQY) of the luminescent species used in its design. It has been well established that the fluorescence of dye molecules can be intensified by their interaction with silver plasmons [9–13]. The enhancement of the fluorescence emission of molecules near a metal surface arises from interactions with surface plasmon resonance (SPR) in the metal particles; these interactions may also result in shorting of the excited-state lifetime leading to an improvement in the photostability of the dye [14].

When silver nanoparticles (NPs) are added to the dye solution, the dye molecules will be adsorbed on islands films of the metallic NPs. Also, when the surface plasmon resonance (SPR) of the metallic NPs coincides with the dye absorption band, it will modify the intensity of the electromagnetic field around the molecules which will increase the emitted fluorescence intensity [15]. The modification of the electromagnetic field is due to the very high field gradient near the metallic surface [16].

Mansour examined copolymer films of styrene (ST) with methyl methacrylate (MMA) of different percentage. Differential scanning calorimetry showed a single glass transition at 50/50 ST/MMA. Also, the FTIR spectra of copolymer 50/50 ST/MMA after exposure to UV radiation for 24 h were similar to those before exposure to UV radiation; this indicates that the copolymerization of styrene with MMA modifies the photodegradation behavior of polystyrene [17]. In addition, the value of the band tail of copolymer and homopolymer increased after exposure to UV radiation, while the band gap (E_g) decreased.

Chahal et al. studied the effect of ultraviolet irradiation on the optical and structural properties of PVP-Ag nanocomposite. The optical band gap values reduced from 4.90 eV in pure PVP to 4.11 eV for PVP-Ag nanocomposite prior to irradiation. This value is further reduced to 3.55 eV after UV irradiation for 180 minutes [18].

Jaleh et al. studied the effect of UV radiation on the optical properties, crystallinity, surface energy, and degradation of polystyrene (PS) and PS-TiO₂ nanocomposite. It was found that the optical band gap values reduced from 4.54 eV in pure PS to 4.45 eV for PS-TiO₂ nanocomposite prior to irradiation. This value was further reduced to 3.46 after UV irradiation for 45 h [19]. Debije and Rajkumar studied direct versus indirect illumination of a prototype luminescent solar concentrator. It was illustrated that the LSC device did improve in relative efficiency of the system under cloudy and diffuse light conditions, verifying earlier expectations [20].

In the present work, we aimed to study behavior of silver NPs before and after UV irradiation and enhance the fluorescence of selected organic dyes used in LSC by adding silver nanoparticles into the dye solutions. The photostability and energy gaps of organic dyes before and after adding silver NPs and after UV irradiation have been also investigated.

2. Experimental Procedures

The organic dyes used in this research were obtained from Radiant Dye Laser Accessories GmbH; silver NPs were obtained from Merck. The solvent used is Triton X-100 supplied by Merck. Triton X-100 is favorable because of its highly polar properties which permits dye being studied to dissolve completely in it. Plate samples of thickness ~0.02 cm and dye concentration of 10⁻⁴ ML⁻¹ were prepared by casting method. The dye was homogeneously diffused in the polymer before casting. The samples were irradiated by a 300 W Xenon arc lamp which has a similar spectrum to the sun for 960 minutes with absorbing UV filter and without filter. Xenon arc lamps have a relatively smooth emission curve in the UV to visible spectra, with characteristic wavelengths emitted from 750 to 1000 nm. Absorption spectra for Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100 without and with silver NPs were measured from 190 to 900 nm using UV/Visible absorption spectrometer Perkin-Elmer Lambda 4B. The spectra were recorded for the samples in the form of rectangular discs of area of 3 × 1 cm² and thickness of 0.02 cm. Fluorescence spectra were detected by a Shimadzu RF-5301 PC spectrofluorimeter (Kyoto, Japan) equipped with a 150 W Xenon lamp and using 1.0 cm quartz cells. Details of internal microstructural features are examined by transmission electron microscope (TEM).

3. Results and Discussion

3.1. Characterization of Silver Nanoparticles

3.1.1. Transmission Electron Microscope (TEM). Composites films of PVA-silver NPs were prepared and then UV-irradiated for different times. These composites films were dissolved in distilled water to record the TEM images, as shown in Figures 1(a) and 1(b). It is clearly depicted from TEM micrographs that, before UV exposure, silver NPs dispersed in PVA matrix are of concentrations with almost spherical shape and about 202–96 nm in size, as shown in Figure 1(a). After exposure to UV radiation for 960 min, silver NPs are uniformly disturbed within PVA matrix, as seen in Figure 1(b). Also, silver NPs after UV irradiation have no definite shape and particle size decreased to 89–65 nm.

3.1.2. Absorption Spectroscopy. Figures 2(a)–2(d) represent the optical absorption spectra of silver nanoparticles in Triton X-100 exposed to UV radiations (unfiltered light) for different times varying from 0 to 960 minutes. Curve (a) in this figure shows surface plasmon resonance (SPR) peak at 442 nm with the width of the absorption peak 83 nm. This deep intense absorption band is observed due to the collective excitation of all the free electrons in the surface of the metal nanoparticles. The particle size of silver NPs is calculated from half width at half-maximum (HWHF) of the optical absorption peaks using Mie theory equation [21–23] and tabulated in Table 1.

$$2R = \frac{\lambda_{\max}^2 \nu_f}{\pi c w}, \quad (1)$$

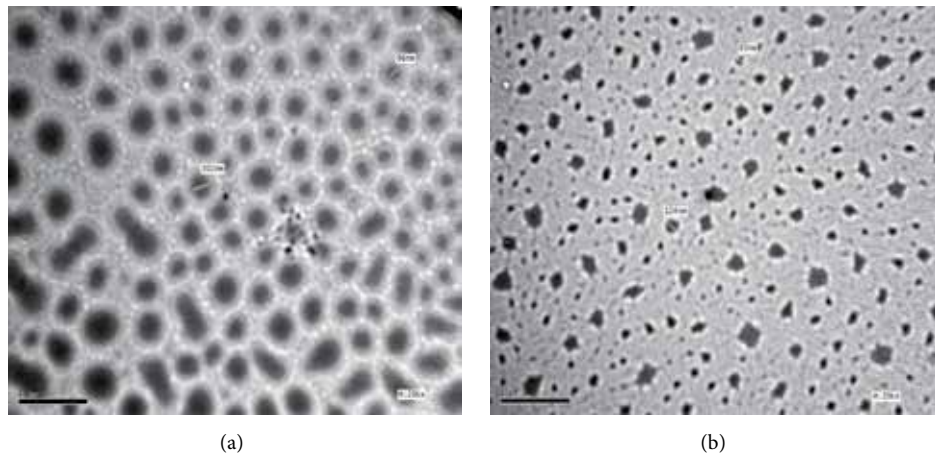


FIGURE 1: Transmission electron microscope (TEM) with particle size of PVA/silver nanocomposites (a) before exposure to UV radiation and (b) after exposure to UV radiation for 960 minutes.

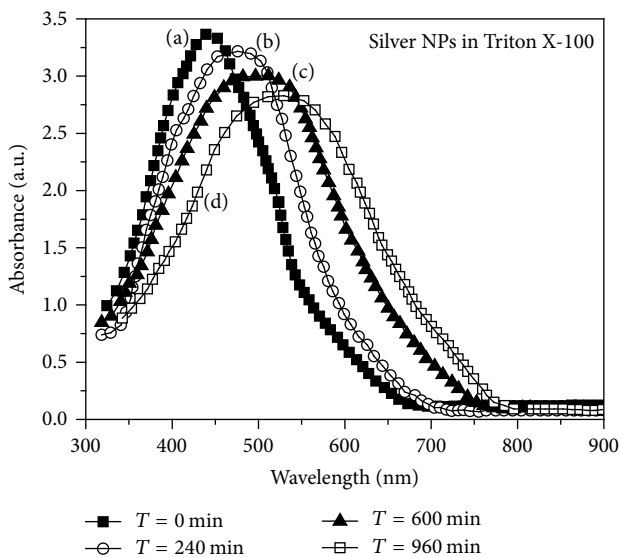


FIGURE 2: Absorption spectra of silver NPs in Triton X-100 before and after exposure to UV radiations (unfiltered light).

where λ_{\max} is the wavelength at maximum intensity of the SPR, v_f is the velocity of the electron at Fermi levels ($1.4 \times 10^6 \text{ ms}^{-1}$ for silver), c is the velocity of light in free space, and w is the half width at half-maximum (HWHM). It is clear that particle size decreases with increasing UV exposure time. The same behavior has been reported for polyvinylcarbazole (PVK) [24]. It was found that particle size analysis PVK with different UV irradiation times showed a size of 10.3 nm before irradiation, 8.1 nm after 1 s, and 10.5 nm after 60 s. These data proposed that photoscission rates are faster than photooxidation rates and result in shorter vinyl chains at time of 1 s. At time of 10 s, oxygen ions, for example, O^- and O_2^- , and radicals, for example, O^* , generated by UV irradiation lead to bridging oxygen between carbazole groups and result in an increase of particle size.

The absorption band is red shifted and HWHM increases from 83 to 132 nm with increase in exposure time to UV

radiations due to the reduction in the particle size of silver NPs as calculated in Table 1.

3.1.3. Optical Band Gap. The optical band gaps, E_g , were calculated by the following Tauc's expression [25]:

$$(\alpha h\nu)^2 = B(h\nu - E_g), \quad (2)$$

where α is the absorption coefficient corresponding to the fundamental absorption edge, $h\nu$ is the photon energy, and B is the constant of proportionality. The values of optical band gap, E_g , can be deduced from the intercept of the linear fitted lines in the plots of $(\alpha h\nu)^2$ versus $h\nu$, as shown in Figure 3(a).

The values of optical band gap so determined are listed in Table 2. It is clear from the table that the value of E_g decreases from 2.46 to 2.37 eV after UV irradiation for 960 minutes which is in accordance with [26]. Such reduction in optical band gap may be due to change in particle size calculated using Mie theory.

Urbach's energy corresponds to the width of the tail of the localized states within the optical band gap. It is linked to the absorption coefficient in the lower energy region of fundamental edge and can be described by the relation [27]

$$\alpha(\nu) = \alpha_o \exp\left(\frac{h\nu}{E_u}\right), \quad (3)$$

where α_o is constant and E_u is the Urbach's energy. From previous equation, it is obvious that the plot of $\ln(\alpha)$ versus $h\nu$ should follow the linear behavior. Figure 3(b) presents such plots for silver NPs before and after UV radiations for different times. The determined values of Urbach's energy are listed in Table 2. It is evident from this table that E_u increases from 0.045 to 0.061 eV after irradiation for 960 minutes.

3.2. Characterization of Fluorescent Dyes in Triton X-100 with Presence of Silver NPs

3.2.1. Absorption Spectroscopy. Figures 4(a)–4(c) show the absorption spectra of Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100, respectively, without and with

TABLE 1: Particle size calculated from Mie theory.

UV exposure time (min)	SPR peak (nm)	FWHM (nm)	Particle size (nm)	Uncertainty
0	442	83	4.20	± 0.40
			3.90	
			3.50	
			4.50	
			3.70	
240	469	96	4.10	± 0.52
			3.10	
			3.40	
			3.90	
			2.90	
600	503	119	3.40	± 0.39
			2.80	
			3.15	
			3.60	
			2.70	
960	523	132	3.20	± 0.26
			2.70	
			3.07	
			3.10	
			2.60	

TABLE 2: The values of optical band gap and Urbach's energy for silver NPs in Triton X-100 before and after exposure to UV radiation for different times.

UV exposure time (min)	Optical band gap E_g (eV)	Uncertainty	Urbach's energy E_u (eV)	Uncertainty
0	3.00	± 0.25	0.053	± 0.006
	2.40		0.050	
	2.43		0.045	
	2.46		0.043	
	2.50		0.060	
240	2.90	± 0.21	0.059	± 0.006
	2.39		0.055	
	2.43		0.047	
	2.49		0.049	
	2.50		0.062	
600	2.70	± 0.13	0.061	± 0.0054
	2.38		0.060	
	2.40		0.054	
	2.47		0.050	
	2.49		0.063	
960	2.55	± 0.08	0.063	± 0.0054
	2.38		0.067	
	2.37		0.061	
	2.40		0.053	
	2.47		0.065	

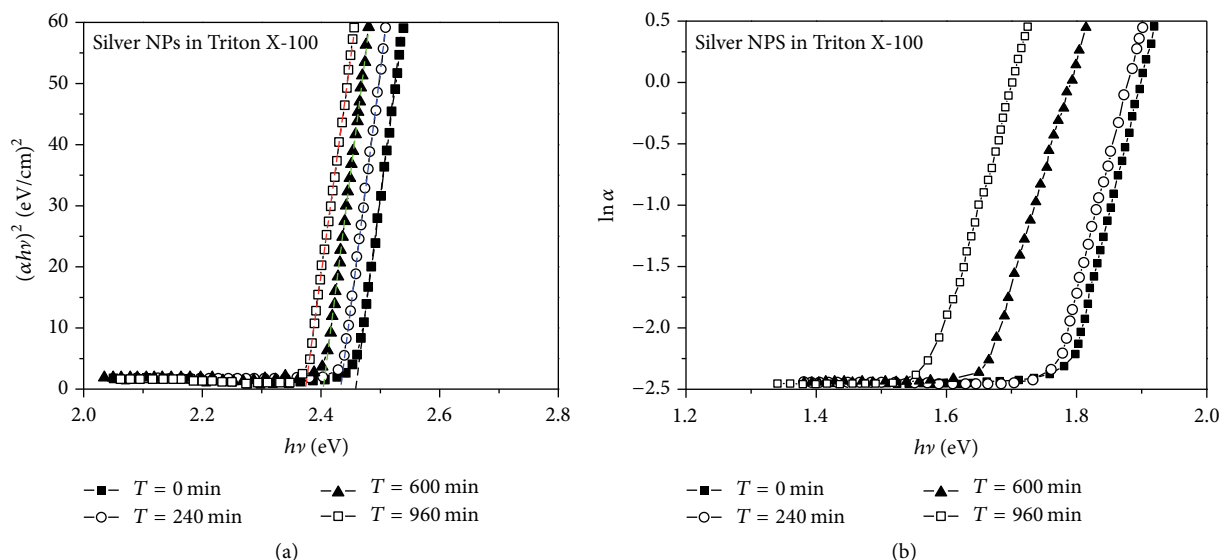


FIGURE 3: Plots of (a) $(\alpha h\nu)^2$ versus $h\nu$ and (b) $\ln \alpha$ versus $h\nu$ for silver NPs before and after exposure to UV irradiation.

silver NPs. The addition of silver NPs to dye solution causes the broadening of absorption bands, as shown in Figure 4(b), so the fluorescent species used utilizes abroad section of solar spectrum. Fluorescent dye without silver NPs exhibited peak 470 nm in the visible region. The 470 nm peak showed a broad feature with a full width at half-maximum absorbance of 49.5 nm. Furthermore, fluorescent dye with silver NPs after UV exhibited peak 475 nm in the visible region. The 475 nm peak showed a broad feature with a full width at half-maximum absorbance of 70 nm. It was found that the percentage increase in absorbed energy from fluorescent to NP/fluorescent dyes after UV is equal to 1.01. In the absorption spectrum of the dyes, we do not observe an additional peak due to silver plasmon which means that we do not have Foster energy transfer but rather a different type of interaction. The enhancement in the silver-dye system is attributed to resonance energy transfer initiated by Raman scattering. It is noted that the incident wavelength energy indicated is not the same energy that exits the sample (i.e., the fluorescence of the system). In addition, it is expected that the electric field interaction from the incident light to the nanoparticle has an effect on the enhancement as well. The overall response is best documented by Mie's theory of scattering [28].

Figure 4(c) shows the absorption spectra of dyes with silver NPs exposed to UV irradiation for 960 minutes. It is clear from this figure that the absorption peak red shifted after UV irradiation.

3.2.2. Optical Energy Gap. Figures 5(a)–5(f) show the plots of $(\alpha h\nu)^2$ versus $h\nu$ for Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100, respectively, without and with silver NPs and also after UV irradiation for 960 minutes. Figures 6(a)–6(f) show the plots of $\ln \alpha$ versus $h\nu$ for Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100 without and with silver NPs and also after UV irradiation for 960 minutes.

The values of optical band gap Urbach's energy are listed in Table 3. It is clear from the table that the value of E_g decreases and that of E_u increases after adding silver NPs to dye solution and also after UV irradiation for 960 minutes. Such a reduction in E_g values can be attributed to the interaction between the electric dipoles of the dye molecules and the surface plasmon of silver NPs. Also, there is a clear blue shift in the values of optical band gap after UV irradiation (without filter) for 960 minutes to dye/silver/Triton X-100. The change in E_g with UV irradiation may be attributed to quantum confinement [29].

3.3. Photostability. The stability of fluorescent dyes is one of the main factors in LSC development. To examine the stability of Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100, the absorbance was measured before and after irradiation with 300 W Xenon arc lamp with absorbing UV filter and without filter for 960 minutes. Silver NPs added to the above samples and measurements are repeated. Figures 7(a)–7(f) show improving stability of organic dyes used after addition of silver NPs. This highlights the importance of silver NPs especially with Rhodamine 6G which experiences photobleaching after exposure for 35 min without silver.

The stability of the organic dyes may be due to the interaction with surface plasmon resonance (SPR) in metal particles; there is also interaction result in shorting of the excited-state lifetime thus improving the photostability of the dye [14]. Audino and Geddes studied the enhanced photostability of fluorophores in the presence of antioxidants and plasmon supporting nanoparticles [30]. It was reported that enhanced photostability was possible due to a coupling in both the fluorophore's ground and excited state, with the emission of the coupled quanta originating from the nanoparticle itself. Also, it was reported that micrometer-sized, bovine serum albumin (BSA) or polyethylene glycol (PEG) coated PDMS wells can

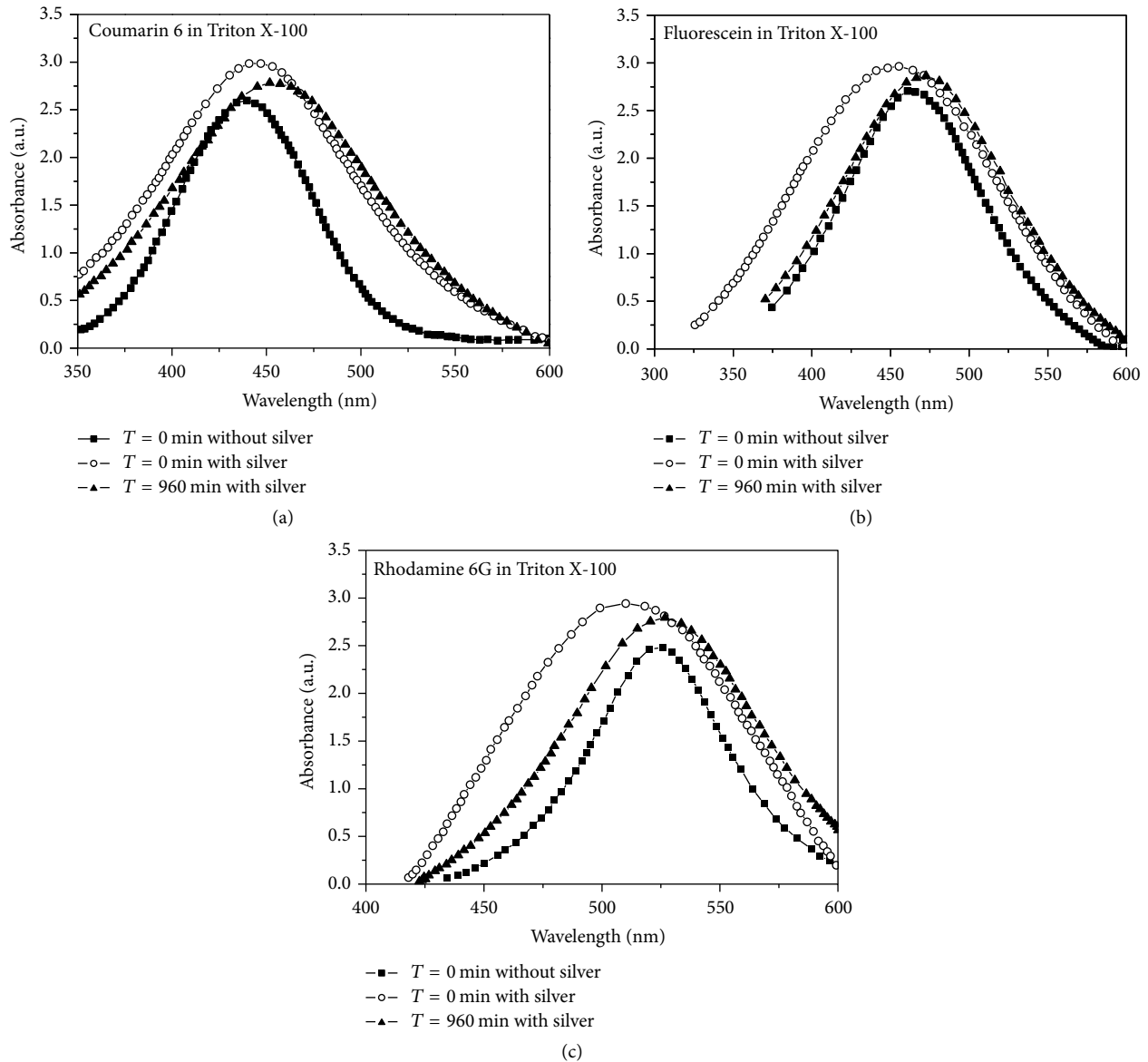


FIGURE 4: Absorption spectra of (a) Coumarin 6, (b) Fluorescein, and (c) Rhodamine 6G in Triton X-100 with/without silver before and after UV irradiation.

TABLE 3: The values of optical band gap and Urbach's energy for Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100 with and without silver NPs before and after exposure to UV irradiation.

Dyes	Before adding silver	E_g	E_u	After adding silver	E_g	E_u
Coumarin 6	$T = 0$	2.56	0.066	$T = 0$	2.47	0.073
	$T = 960$ min with filter	2.51	0.069	$T = 960$ min with filter	2.47	0.075
	$T = 960$ min without filter	2.49	0.071	$T = 960$ min without filter	2.43	0.077
Fluorescein	$T = 0$	2.30	0.039	$T = 0$	2.27	0.051
	$T = 960$ min with filter	2.29	0.041	$T = 960$ min with filter	2.27	0.052
	$T = 960$ min without filter	2.28	0.042	$T = 960$ min without filter	2.26	0.054
Rhodamine 6G	$T = 0$	2.19	0.044	$T = 0$	2.16	0.062
	$T = 40$ min with filter	2.18	0.045	$T = 960$ min with filter	2.16	0.064
	$T = 35$ min without filter	2.17	0.046	$T = 960$ min without filter	2.15	0.067

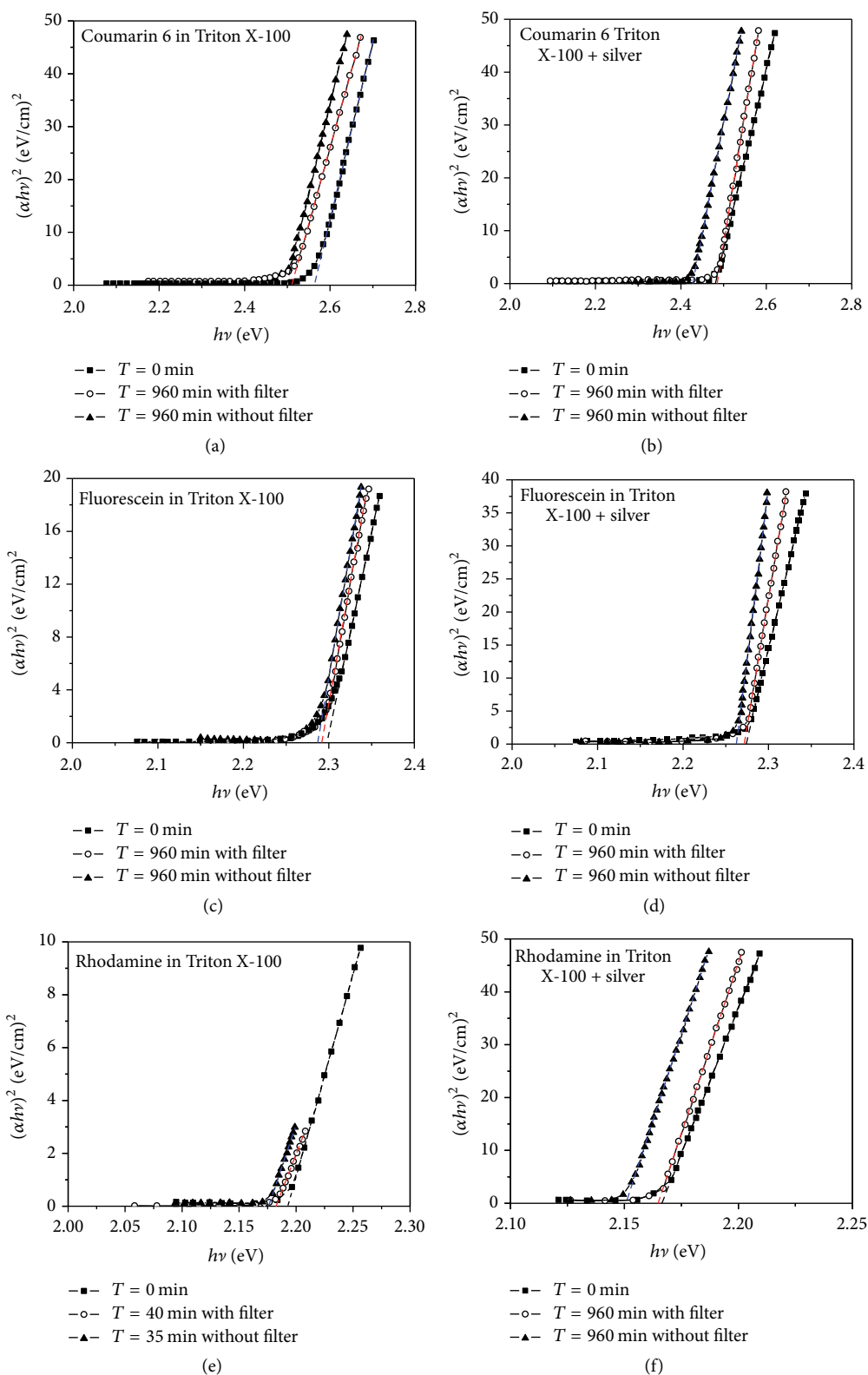


FIGURE 5: Plots of $(\alpha h\nu)^2$ versus $h\nu$ for Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100 without and with silver NPs before and after exposure to UV irradiation with filter and without filter.

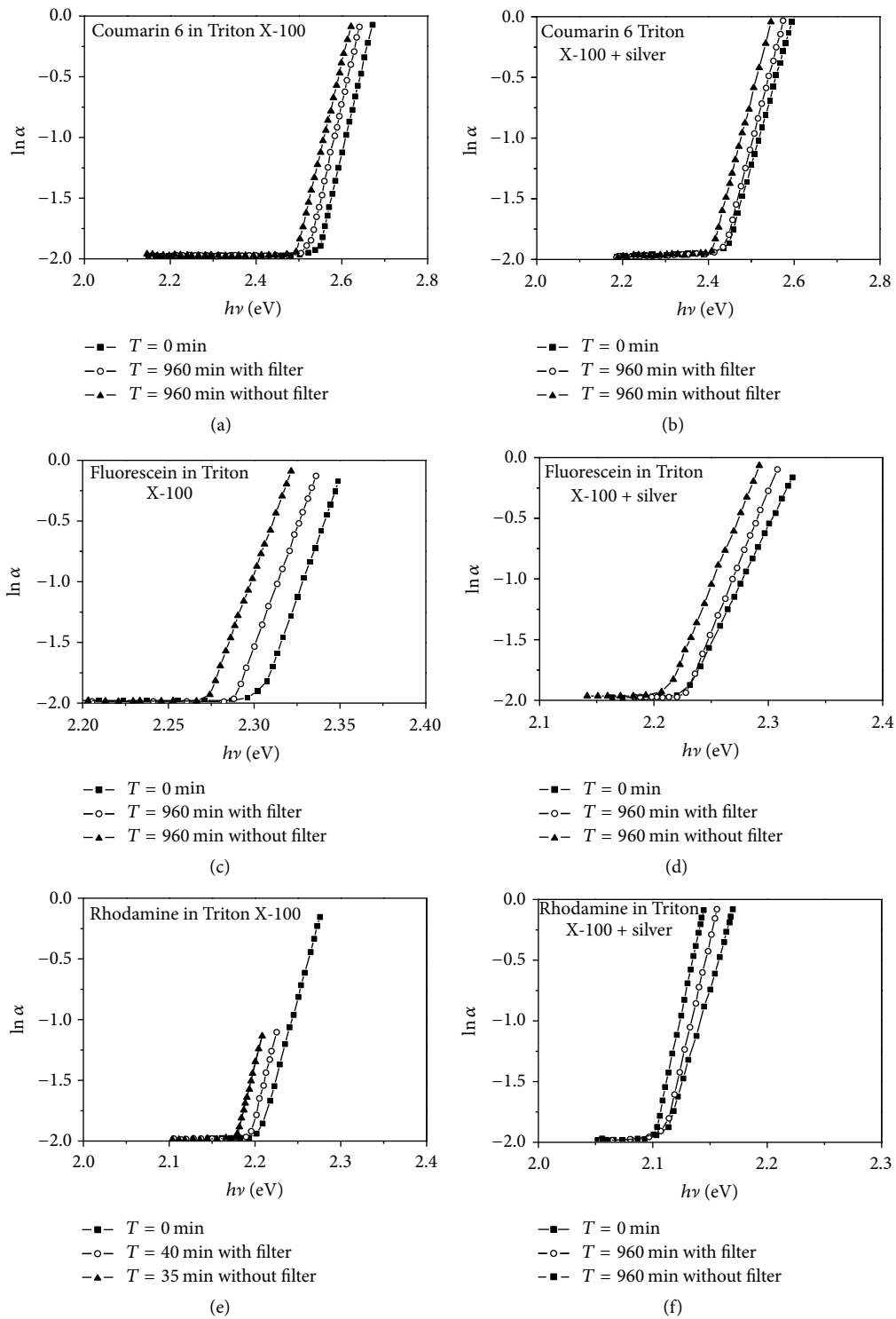


FIGURE 6: Plots of $\ln \alpha$ versus $h\nu$ for Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100 without and with silver NPs before and after exposure to UV irradiation with filter and without filter.

TABLE 4: The kinetics of photodegradation (K) and half-life time ($t_{1/2}$) of dyes/Triton X-100 and dyes/silver NPs/Triton X-100.

Dyes	Conditions	Without filter		With filter	
		K (min^{-1})	$t_{1/2}$ (min)	K (min^{-1})	$t_{1/2}$ (min)
Coumarin 6	Before adding silver	8.37×10^{-5}	8278	5.33×10^{-5}	12984
	After adding silver	3.49×10^{-5}	19847	1.04×10^{-6}	665694
Fluorescein	Before adding silver	9.80×10^{-5}	7062	4.85×10^{-6}	14270
	After adding silver	5.22×10^{-5}	13255	1.24×10^{-6}	554690
Rhodamine 6G	Before adding silver	4.4×10^{-2}	15.74	3.53×10^{-3}	19.59
	After adding silver	4.89×10^{-5}	14143	1.04×10^{-6}	653773

TABLE 5: The area under fluorescence curves for Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100 without and with silver and with silver after UV irradiation for 960 minutes.

Dyes	Conditions	Absorbance wavelength (nm)	Emission wavelength (nm)	Stoke shift ($\Delta\lambda$) (nm)	Area under fluorescence curve
Coumarin 6	Without silver	440	538	98	486.60
	With silver before exposure	440	540	100	686.65
	With silver after exposure	455	562	107	585.68
Fluorescein	Without silver	461	542	81	614.33
	With silver before exposure	454	542	88	806.77
	With silver after exposure	472	562	90	684.93
Rhodamine 6G	Without silver	525	557	32	639.58
	With silver before exposure	510	557	47	874.26
	With silver after exposure	526	583	57	738.54

enhance the photostability of one or a few R6G molecules. Many fluorescent dyes, including R6G, undergo photobleaching via formation of radical ions, and thus, reactions that can effectively help such radical states return to the fluorophore's electronic ground states will lead to an enhancement in the photostability of the fluorescent molecules [31].

Rate constants of photodegradation of dyes are estimated according to [32]

$$K = \frac{2.3}{t} \log \frac{A_o}{A}, \quad (4)$$

where A_o and A are the absorption before and after UV irradiation, t is the time of exposure in minutes, and K is the rate constant. The kinetics of photodegradation (K) and half-life time ($t_{1/2}$) of dyes/Triton X-100 and dyes/silver NPs/Triton X-100 are listed in Table 4. Degradation means that the dye characteristic gets lost. This can be done by decomposition of the dye molecule (this means cracking the dye molecule in the way that you get smaller molecules) or changing the dye molecule by oxidation, reduction, agglutination, or other process, so that the dye characteristic gets lost (not necessarily cracking the dye molecule). Decomposition means that you will decompose the dye molecule (dividing it in parts). From results, it is clear that $t_{1/2}$ values of three fluorescent dyes after

adding silver NPs are extremely increased, especially for Rhodamine 6G. Also, rate of photodegradation, K , of the examined dyes with/without filter after adding Ag NPs decreased.

3.4. Enhancing the Fluorescence of Fluorescent Dyes. Figure 8 shows the fluorescence spectra of Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100 without and with silver NPs. From these figures, the addition of silver NPs to dye solution causes the broadening of fluorescence curves. The area under fluorescence spectra is calculated and listed in Table 5. It is clear from the table that the area increased by 41, 31, and 36% for Coumarin 6, Fluorescein, and Rhodamine 6G dyes, respectively, in Triton X-100 with silver NPs when compared with identical dye concentration without silver NPs. Also, the fluorescence spectra of fluorescent dyes with silver NPs after exposure to Xenon arc lamp 300 W without UV filter for 960 minutes decreased by 15%. This is attributed to the fact that self-absorption is increased and that leads the light that is absorbed to refluoresce in an arbitrary direction, most of which will again be trapped within the sample, and thus there will be a number of generations of fluorescence: the first one is the fluorescence resulting from the initial absorption of light; the second one is the fluorescence resulting from the self-absorption of the first one; the third one is the

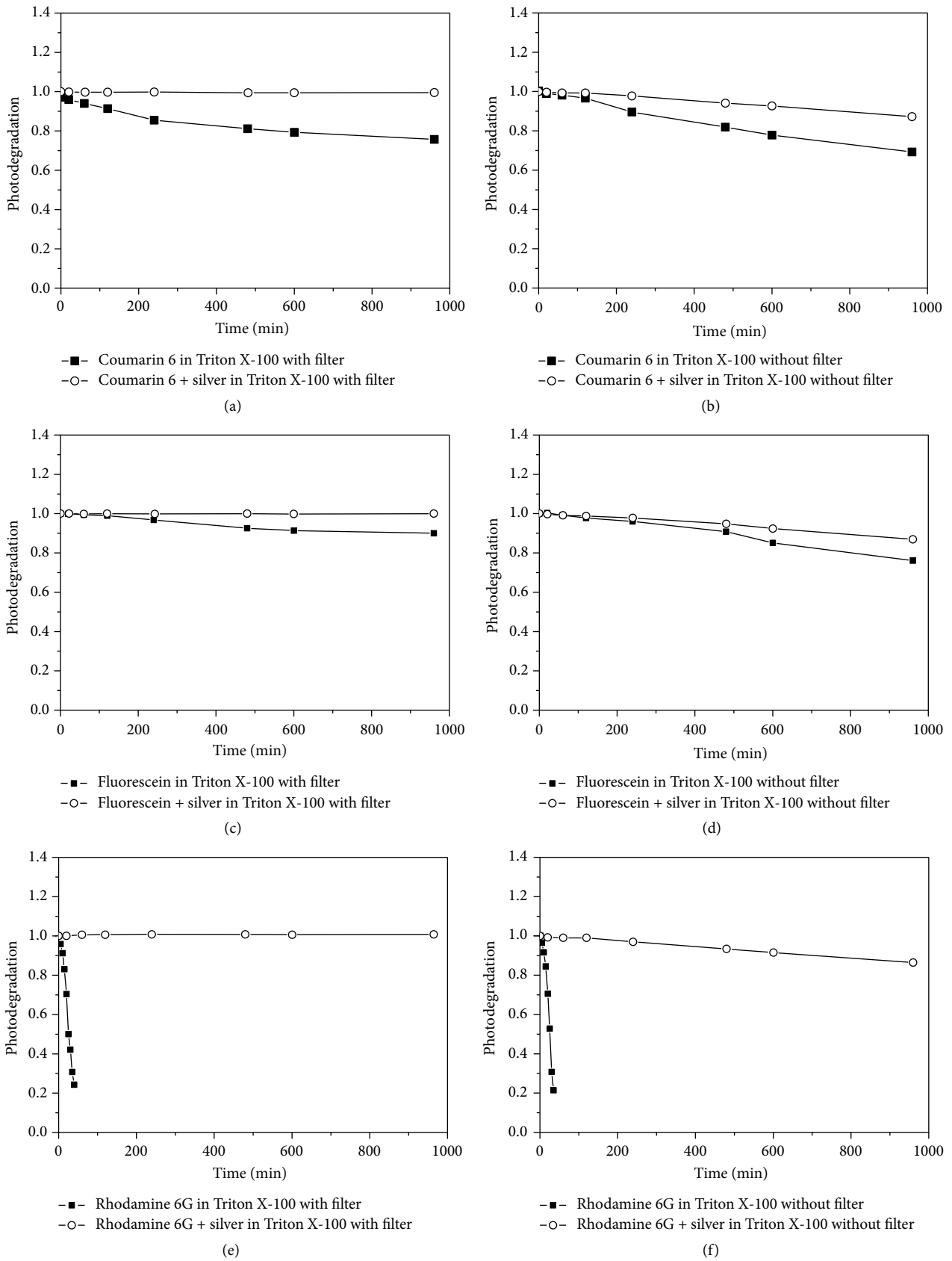


FIGURE 7: The photodegradation of Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100 with and without filter before and after adding silver NPs.

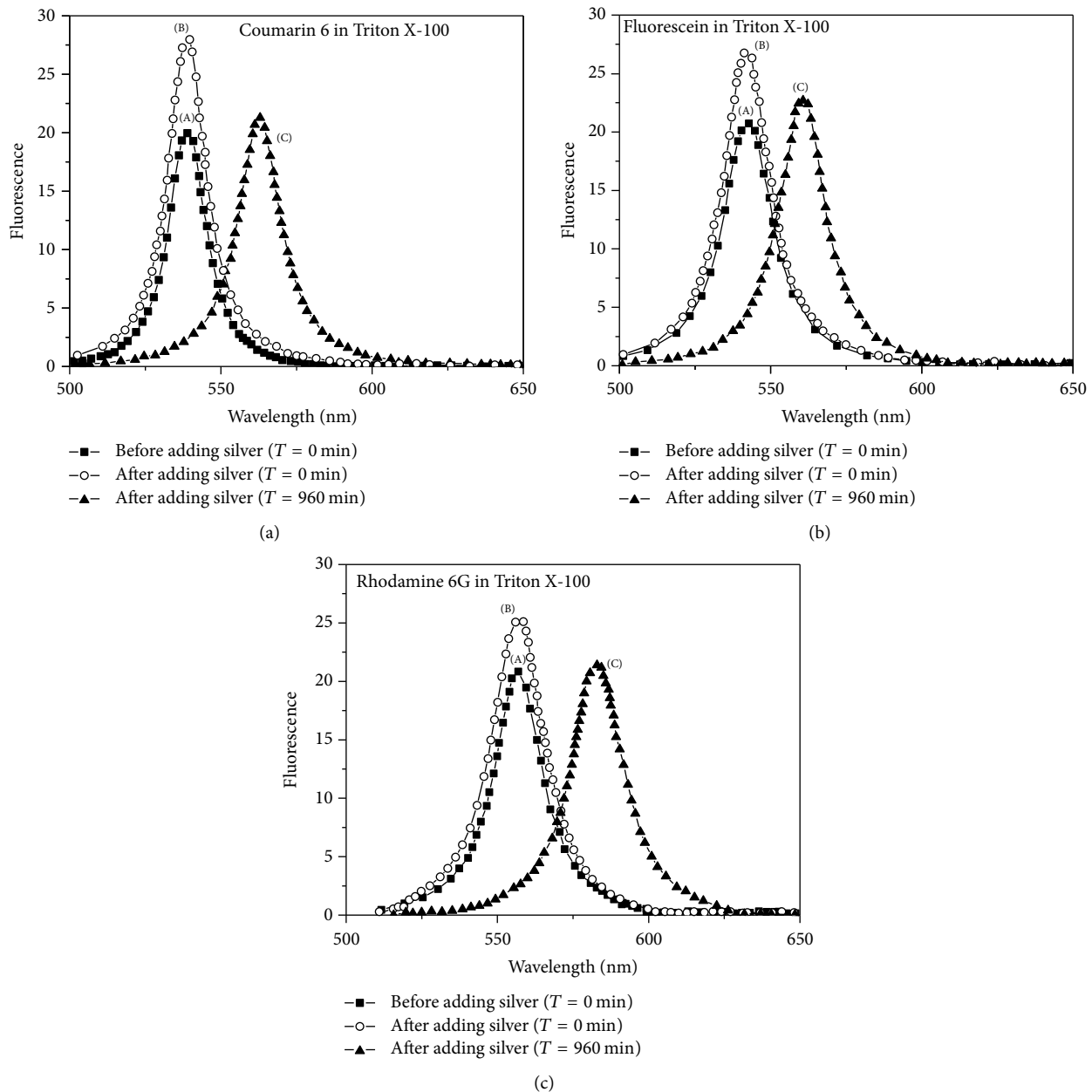


FIGURE 8: Fluorescence spectra of Coumarin 6, Fluorescein, and Rhodamine 6G in Triton X-100 (A) without silver, (B) with silver, and (C) with silver after UV irradiation.

fluorescence resulting from the self-absorption of the second one; and so forth, and so each generation is progressively red-shifted with respect to the preceding generation [33].

4. Conclusion

The challenges in LSC development have been highlighted. One promising concept is the addition of silver nanoparticles (NPs). The results are summarized as follows:

- (1) Silver NPs in Triton X-100 were analyzed by different characterizing methods and it is confirmed that the absorption band exhibited a red shift and broadening after UV irradiation for 960 minutes.
- (2) The optical energy gap (E_g) decreased and Urbach's energy (E_u) increased after irradiation for silver NPs in liquid and in solid matrix.
- (3) The measurements of FQY of Coumarin 6 and Fluorescein at different concentrations reveal the dependence of FQY on concentrations.
- (4) The addition of silver (NPs) to dye solution has been investigated as a means of enhancing the fluorescence of our selected dyes. The increase in fluorescence highlights the importance of silver NPs.
- (5) The photostability of our selected organic dyes in liquid and solid matrix was enhanced by the addition

of silver NPs especially with Rhodamine 6G in liquid in which the photostability extremely increased.

Disclosure

Some part of this study is sequentially presented at Solar-TR-2: Solar Electricity Conference and Exhibition Programme, Turkey, 2013.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

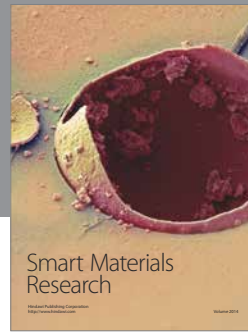
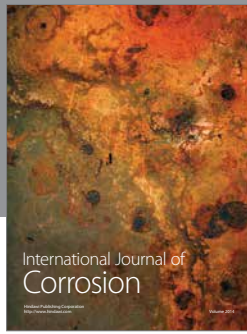
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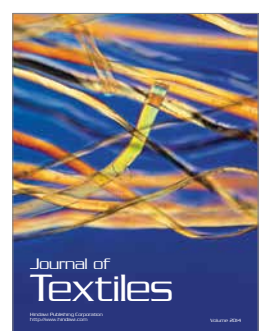
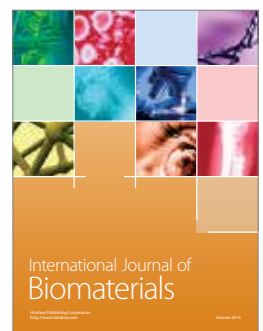
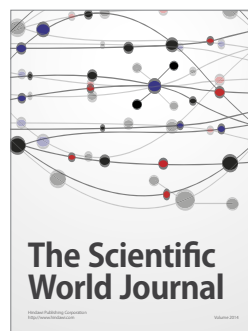
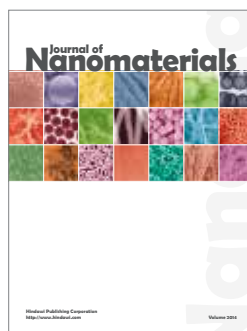
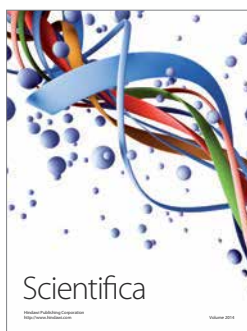
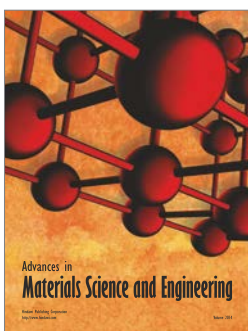
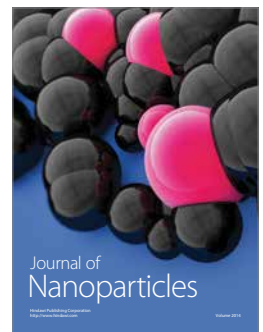
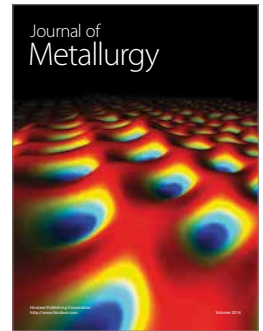
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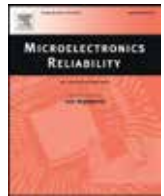
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Enhancing the microstructure and tensile creep resistance of Sn-3.0Ag-0.5Cu solder alloy by reinforcing nano-sized ZnO particles

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ABSTRACT

Sn-Ag-Cu lead-free solders are regarded as a potential substitute for Pb-Sn solder alloys. In the current study, the non-reacting, non-coarsening ZnO nano-particles (ZnO NPs) were successfully incorporated into Sn-3.0Ag-0.5Cu (SAC305) lead-free solder by mechanical mixing of ZnO powders and melting at 900 °C for 2 h. Tensile creep testing was performed for plain SAC305 solder and SAC305-0.7 wt% ZnO NPs composite solders and a Garofalo hyperbolic sine power-law relationship was created from the experimental data to predict the creep mechanism as a function of tensile stress and temperature. Based on the tensile creep results, the creep resistance of SAC305 solder alloy was improved considerably with ZnO NPs addition, although the creep lifetime was increased. From microstructure observation, reinforcing ZnO NPs into SAC305 solder substantially suppressed the enlargement of Ag₃Sn and Cu₆Sn₅ intermetallic compound (IMC) particles and decreased the spacing of the inter-particles between them, reduced the grain size of β-Sn and increased the eutectic area in the alloy matrix. The modification of microstructure, which led to a strong adsorption effect and high surface-free energy of ZnO NPs, could result in hindering the dislocation slipping, and thus provides standard dispersion strengthening mechanism. Moreover, the average activation energy (Q) for SAC305 and SAC305-0.7ZnO alloys were 50.5 and 53.1 kJ/mol, respectively, close to that of pipe diffusion mechanism in matrix Sn.

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1. Introduction

Recently, as micro-/nano-systems technologies are progressive, the size of electrical components is diminishing resulting in an increase in the number of input/output terminals [1]. As a consequence, the numbers of solder joints per package have increased and the dimensions of the solder joints have decreased. Therefore, conventional solder technology can no longer guarantee the solder joint reliability of solder components attributable to the softening nature and the high diffusivity of solder. Thus, for the solder joints with reduced dimension to stay functional, powerful, and reliable, the developing of newly second generation of Sn-Ag-Cu solders is desperately demanded. To get solder joints with higher microstructure stability and better mechanical properties of the conventional solder, a potentially viable and economically affordable innovative approach are to incorporate appropriate second phase particles of the alloy matrix such as TiO₂ [2–6], SrTiO₃ [7], ZrO₂ [8], and Al₂O₃ [9]. Hence, nanoparticles (NPs) have gained increasing attention recently owing to the large surface to volume fraction and quantum size effect.

Therefore, nano-composite alloys are regarded as the most hopeful to substitute the present lead-free solder.

In previous literature studies, Zhao et al. observed that reinforcing (0.25, 0.5 and 1.0 wt%) nano-Al₂O₃ in Sn-3Ag-0.5Cu (SAC305) mainly enhanced the reliability of the micro solder joints, but did not modify the strength of as-soldered joints obviously [10]. Also, Xing et al. reported that 1 wt% Al₂O₃ addition in Sn-9Zn solder improved wettability, mechanical properties and hardness of the composite solder as a result of the changes of the interfaces and the microstructure [11]. Nasir et al. demonstrated that distribution of TiO₂ into lower silver content SAC composite increased the hardness of the composite solders compared with monolithic SAC solder alloy [12]. On the other hand, adding 0.1 wt% nano-TiO₂ to SAC305 solder exhibited the smallest growth rate for both Cu₃Sn and Cu₆Sn₅ IMC layers and gave the most prominent effect on suppressing IMC growth [13]. Also, Wu et al. [14] evaluated that addition 0.5 wt% TiO₂ NPs into Sn-0.3Ag-0.7Cu (SAC0307) solder affected the IMC growth through isothermal aging and mentioned that the growth of the IMC layer is a diffusion-controlled process. Sun et al. showed that addition of (0.05, 0.1, 0.2, 0.3 and 0.4 wt%) Al-NPs to Sn-1.0Ag-0.5Cu (SAC105) solder decreased the wettability and mechanical features of the solder [15]. However, the appropriate doping of TiC NPs to the SAC305 solder matrix could lead to an improvement in both shear strength and microhardness of the composite solders [16].

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Furthermore, the addition of TiO_2 and Al_2O_3 NPs enhanced the overall strength of the eutectic SAC solders. Also, reinforcing Carbon nanotubes (CNTs) into the matrix of solder alloy exhibited a lower diffusion coefficient, which signified that the incidence of CNTs was effective against retarding the growth of the IMC layers [17]. El-Daly et al. concluded that 0.7 wt% SiC NPs decreased the melting range of SAC305 solder even if the undercooling and eutectic temperature prolonged nearly at the SAC305 level [18].

ZnO is considered as workhorse of industrial progress displaying excellent electrical, optical, and chemical properties with wide range of semiconductor applications, in optical apparatus, solar cells, wave devices, sensors, transparent electrodes, antibacterial activity [19]. Hence, Fouda and Eid [20] proposed that addition of ZnO nano-metric particles into Sn-5Sb-0.5Cu enhanced the yield stress by ~12% and the UTS by ~13% but reduced ductility by ~43% of the plain solder. Gu et al. showed that in SAC107-x Fe_2O_3 composite solder, with Fe_2O_3 addition concentration increasing, wettability improved, interfacial IMC layer thickness reduced [21].

In the light of the survey, although a lot of research focuses on the addition of NPs into lead-free solder for the improvement of properties of the solder, most of the works focus on the interfacial morphology and growth of IMC layers at the interface of solder joints. However, the effect of ZnO NPs on the creep properties of SAC305 composite solder hasn't been found in the literature. It is no doubt that creep deformation is considered as the most important micromechanical inelastic deformation mechanism in soldered joints. Under such conditions, thermally activated creep is an important reliability issue caused by the high homologous temperature ($T/T_m > 0.5$) of solders, which plays an active role in the deformation behavior of the solders [22]. Therefore, the present work aimed to study the creep behavior and structural features of the plain SAC305 and nanocomposite SAC305-0.7ZnO alloys. The correlation between these parameters with NPs addition was investigated. Finally, this study is performed with the hope that reinforcing ZnO NPs into SAC305 alloy can improve creep properties and solder joint reliability.

2. Experimental procedures

For the preparation of the Sn-3.0 wt% Ag-0.5 wt% Cu (SAC305) alloy, ingots of Sn, Ag, Cu with high purity 99.99% were melted in a vacuum arc furnace under high purity argon atmosphere to produce rod-like specimen with a diameter of approximately 10 mm. The melt was held at 900 °C for 2 h to complete the dissolution of Sn, Ag, and Cu. Then, the alloy was remelted three times in order to get a homogeneous composition. The nanocomposite solder Sn-3.0 wt% Ag-0.5 wt% Cu-0.7 wt% ZnO (SAC305-ZnO) was prepared by mechanically dispersing 0.7 wt% of ZnO nanopowder into the molten SAC305 solder and remelting in a vacuum furnace for 40 min with electromagnetic stirrer to ensure a homogeneous distribution of the reinforcing particles, then cast in a steel mold. The chemical compositions of the investigated solder alloys are listed in Table 1. The solder ingots were then mechanically machined in wire samples of a gauge length marked 4×10^{-2} m and 1.2×10^{-3} m in diameter, as developed in our previous work [23]. Before tensile creep tests, all specimens were heat-treated at 130 °C for 30 min to stabilize microstructure and remove residual stress and defects produced during the specimen preparation.

Microstructural characterization studies were conducted on metallographically polished samples to investigate morphological characteristics of grains and reinforcement distribution. The common metallographic practices of grinding and polishing were used to prepare

Table 1
Chemical composition of the solders studied (wt%).

Alloy	Ag	Cu	ZnO	Pb	Bi	As	Sn
Sn-3.0Ag-0.5Cu	3.0	0.5	-	0.009	0.007	0.006	Bal.
Sn-3.0Ag-0.5Cu-0.7ZnO	3.0	0.5	0.7	0.011	0.010	0.009	Bal.

the samples. Then the samples were etched with a solution of 2% HCl, 3% HNO_3 and 95 vol% Ethyl alcohol. The presence and distribution of the secondary phases as well as reinforcement was studied using scanning electron microscope (SEM). The SEM used in this study was JEOL model JSM-5410, Japan. An energy dispersive spectrometry (EDS) was used to determine chemical composition of the IMC phases. X-ray diffraction (XRD) was also used to inspect and analyze the phase formation of the solder alloy. X-ray diffractometer operated on 40 kV, and the Cu-K α radiation was used at diffraction angles (2θ) from 20° to 100° with a scanning speed of 1°/min. Hence, the crystal structures were identified by matching the characteristic XRD peaks of JCPDS data. Then, constant-load tensile creep tests were carried out in the air at constant load and temperatures ranging from 25 to 110 °C, using tensile testing machine described elsewhere [24]. The sample was maintained for 5 min at the test temperature to be reached before loading. Five samples were tested for the same testing conditions for each solder specimen and the creep properties were obtained by averaging the test data. The temperature of the sample was controlled within ± 2 °C.

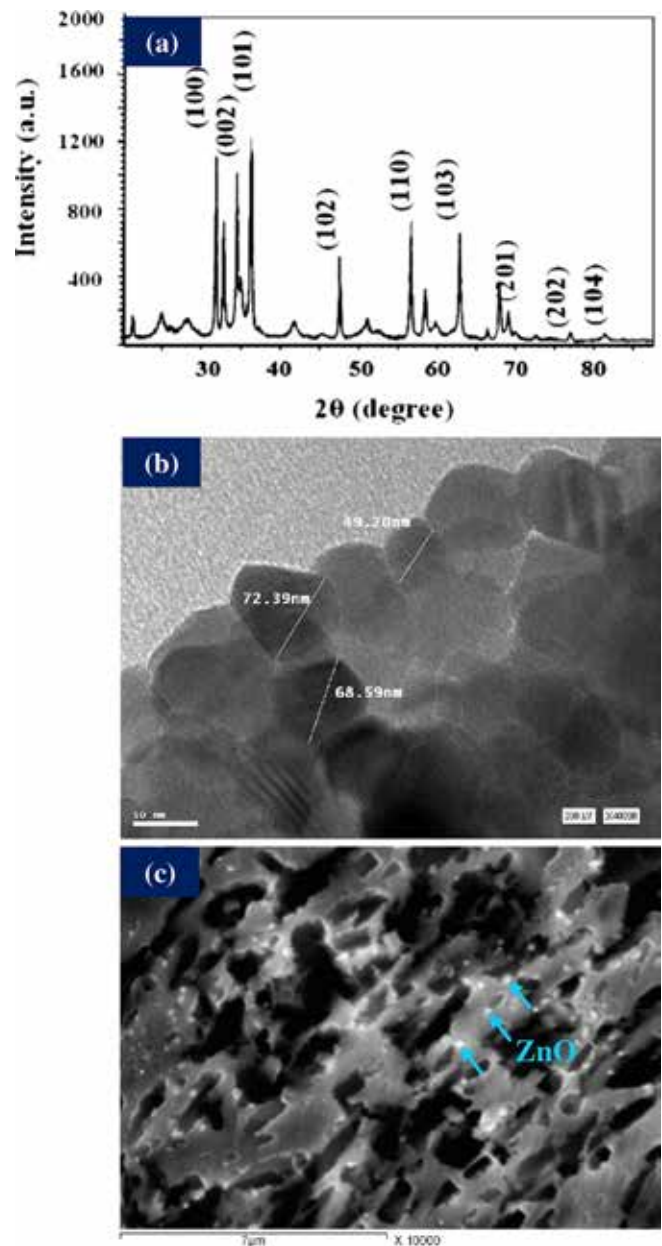


Fig. 1. (a) XRD patterns of ZnO NPs, (b) bright field TEM of ZnO NPs and size distribution, and (c) ZnO particles located on the surface of SAC305-ZnO solder matrix.

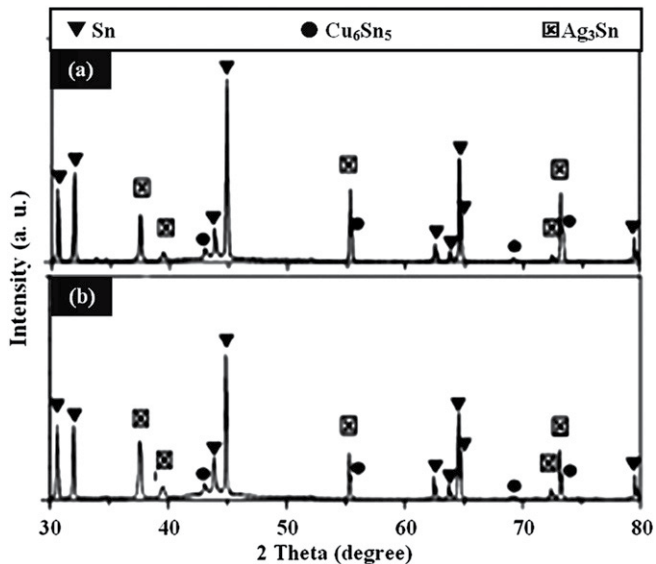


Fig. 2. XRD patterns of: (a) plain SAC305 and (b) composite SAC305–ZnO solder alloys.

3. Results and discussion

3.1. Characterization of ZnO-NPs

The XRD patterns of the ZnO-NPs are illustrated in Fig. 1a. A definite line broadening of the XRD peaks indicates that the prepared material consist of nanoparticles. The diffraction peaks located at $2\theta = 31.67^\circ$, 34.31° , 36.14° , 47.50° , 56.52° , 62.73° , 69.18° , 77.38° and 81.76° were

assigned to (100), (002), (101), (102), (110), (103), (201), (202) and (104) of the wurtzite phase of ZnO NPs (JCPDS No. 36-1451) [25]. The average crystallite size (d) of ZnO NPs was calculated using Scherrer's formula [26]:

$$d = \frac{k\lambda}{\beta \cos\theta}$$

where $k = 0.9$ is the shape factor, λ is the X-ray wavelength of Cu $K\alpha$ radiation (1.54 \AA), θ is the Bragg diffraction angle, and β is the full width at half maximum (FWHM) of the respective diffraction peak. The average crystallite size of ZnO NPs was found to be $21.34 \pm 7.87 \text{ nm}$. Fig. 1b represents a TEM image of the nano-metric ZnO particles used in this study. It is observed that ZnO NPs is uniformly distributed and the particle size of nominally nano-sized ZnO particles is around 50–100 nm [15]. As shown in Fig. 1c, it is clear that the ZnO nano-particles are dispersed uniformly on the surface of the solder matrix as a fine dot-shaped precipitate.

3.2. XRD analysis

Fig. 2 depicts the XRD profiles of the plain solder SAC305 and nano-composite solder SAC305–0.7ZnO. The obtained phases are identified by comparing the Bragg peaks of the ASTM standards. It was observed that three types of phases; β -Sn, Cu_6Sn_5 and Ag_3Sn phases were found. The presence of the IMCs in Sn–Ag–Cu based solders has also been established by other researchers [27,28]. In addition, the peak intensities of SAC305–ZnO composite solder are reduced compared with the plain SAC305 solder, due to the presence of ZnO nanoparticles. This result was in good agreement with those reported for Sn–3.5 wt% Ag–0.25 wt% Cu reinforced with nano-sized ZnO [24].

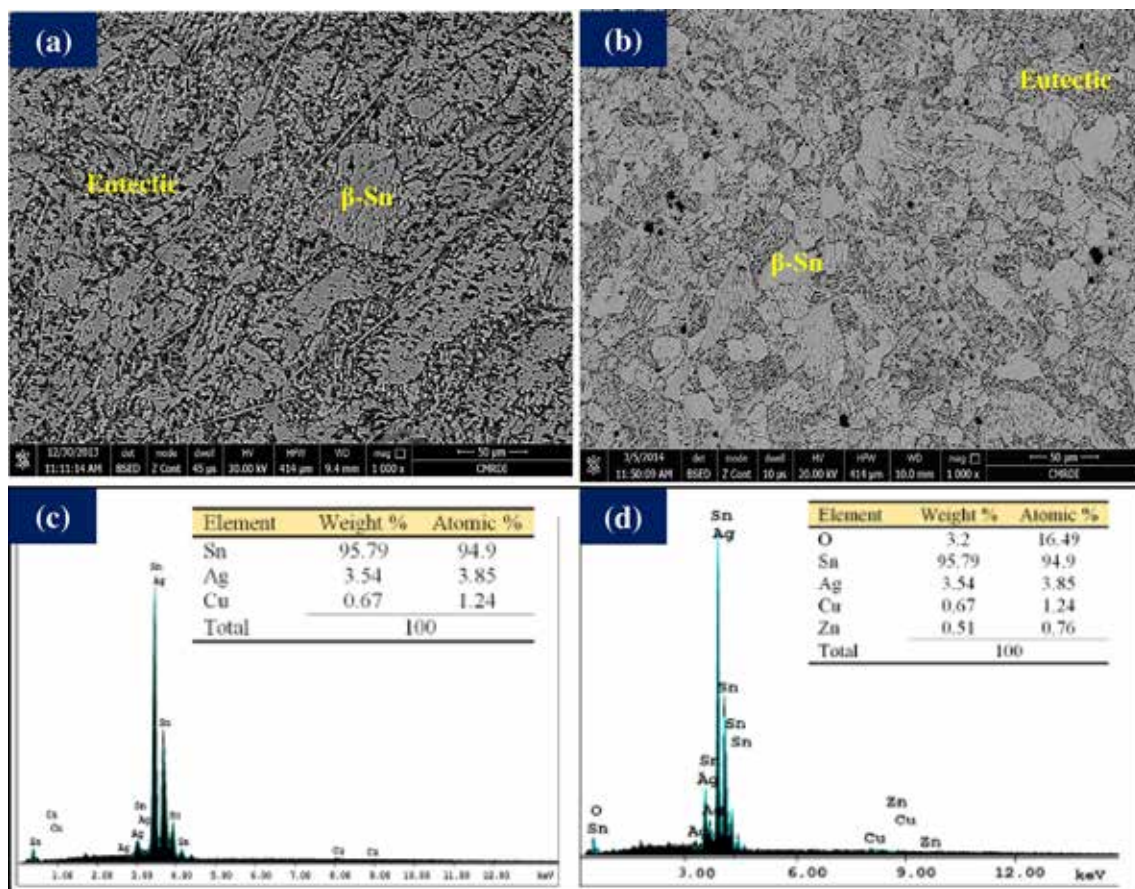


Fig. 3. SEM micrographs of: (a) SAC305 and (b) SAC305–ZnO solder alloys and their corresponding EDS analysis.

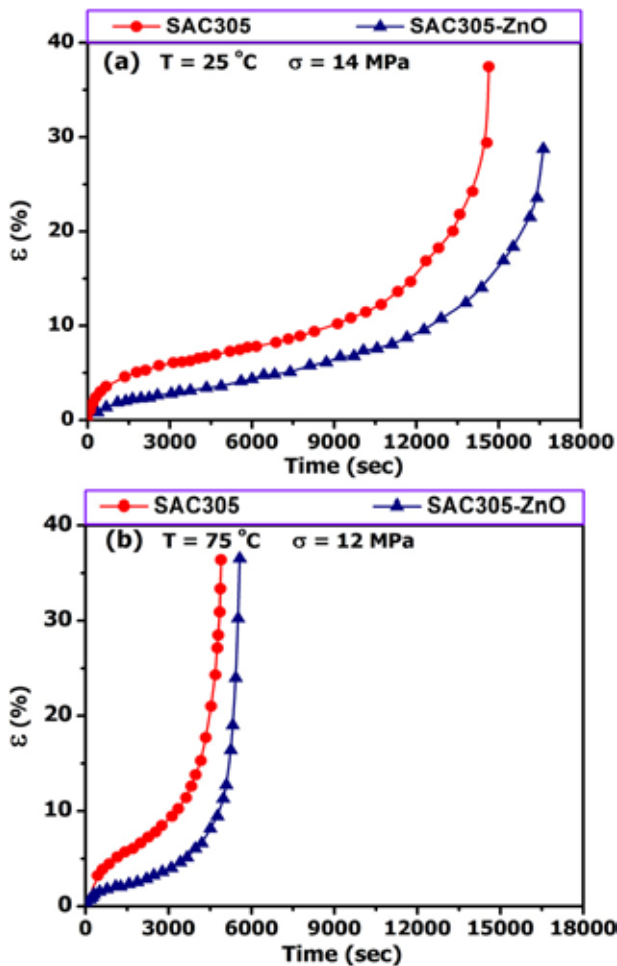


Fig. 4. Comparison creep curves at (a) $T = 25\text{ }^{\circ}\text{C}$ and $\sigma = 14\text{ MPa}$ and (b) $T = 75\text{ }^{\circ}\text{C}$ and $\sigma = 12\text{ MPa}$ for SAC305 and SAC305-ZnO solder alloys.

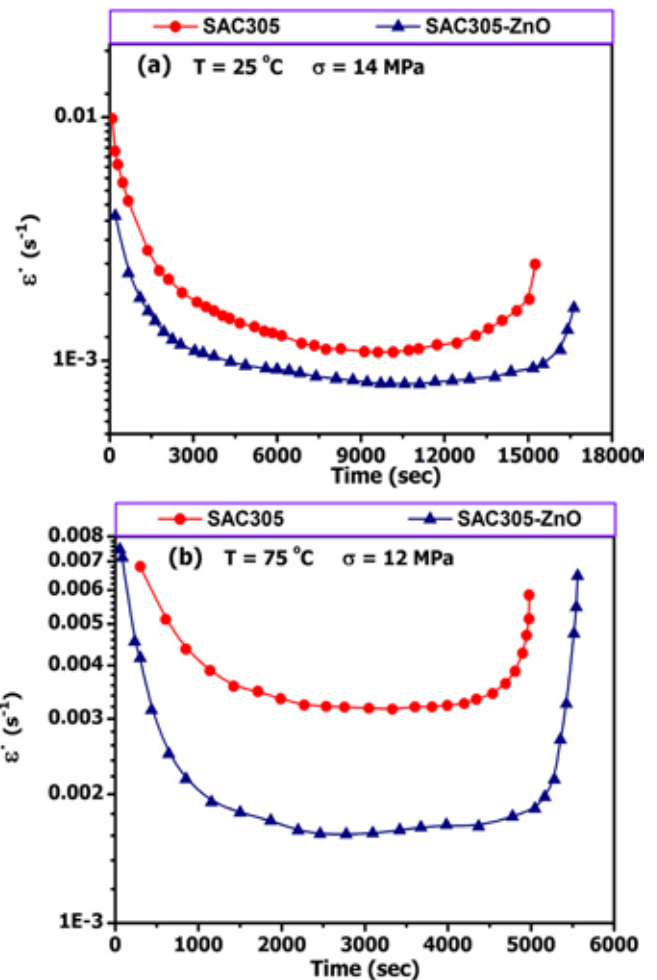


Fig. 5. Comparison creep time-creep rate curves at (a) $T = 25\text{ }^{\circ}\text{C}$ and $\sigma = 14\text{ MPa}$ and (b) $T = 75\text{ }^{\circ}\text{C}$ and $\sigma = 12\text{ MPa}$ for SAC305 and SAC305-ZnO solder alloys.

3.3. Microstructure analysis

Considering the evolution of microstructural phases for both tested alloys specified by SEM/EDS analysis, the surface morphology of as-solidified samples with reinforcing ZnO NPs is shown in Fig. 3. It is observed that the microstructure of monolithic SAC305 and composite solder matrix consist of Sn-rich phases surrounded by needle-like shaped Ag₃Sn IMCs, and irregular polygon Cu₆Sn₅ IMCs also presented in the matrix, as demonstrated in Fig. 3a. Most of the Ag₃Sn IMC phases are found at the boundaries of Sn-rich phases. The average size of β-Sn was 75 μm with an aspect ratio of 1.5. The Ag₃Sn IMC exhibits with an average particle size of 40 μm, but the size of Cu₆Sn₅ IMC is ~5 μm. However, as shown in Fig. 3b, reinforcing 0.7 wt% ZnO NPs into SAC305 seems to suppress the growth of the β-Sn, Ag₃Sn needle-like and the Cu₆Sn₅ polygon particles yielding a uniform dispersion of these IMCs within the Sn-rich mixture producing a fine network like microstructure with the β-Sn [6–7,24]. This result was found to be in agreement with those reported in other researches for SAC355 reinforced with ZnO NPs [29] and for SAC305-La₂O₃ alloy [30]. It was reported that the particle incorporation increased the number of nucleation sites and also limits the grain growth of the matrix resulting in a fine grain microstructure [31]. In the present study, using Image-Pro software, the average grain size of Sn is reduced from 75 to 25 μm after ZnO NPs addition.

The decrease in average β-Sn grain size of composite solder is 3 times lower than that of plain SAC305 alloy. It indicates that the ZnO-NPs have high ability to control grain growth during solid state cooling. In addition, reinforcing ZnO nanoparticles could improve thermal, and mechanical

properties as well as long term reliability of composite solders. Interestingly, the microstructure could be clear evidence of significant decrease in the needle-like Ag₃Sn particles, which are characterized by stumpy spacing [27]. This type of structure can act as more effective pinning action of dislocation motion in the solder matrix, and subsequently affects its physical and creep properties. EDS analysis of the plain SAC305 solder confirmed that the β-Sn phase and eutectic regions are found containing Cu, Sn and Ag (Fig. 3c). Moreover, EDS was carried out for SAC305-ZnO to probe the composition of the attached nanoparticles, as shown in Fig. 3d. It reveals the presence of Zn, O, Cu, Sn and Ag. Further, the network eutectic areas are Cu₆Sn₅ and Ag₃Sn besides the ZnO particles. In general, the obtained refinement microstructure in the nanocomposite solder alloys can be attributed to the pinning action on grain boundaries and/or the increase of nucleation sites by the nanometric particles and/or tiny particles of second phases resulting in limiting their growth [32]. The proposed mechanism for the effect of ZnO-NPs on refinement of the Ag₃Sn IMC can be summarized as follows: During the solidification process, ZnO-NPs, which are mechanically dispersed in the molten of SAC305 composite solder, are clinging to the much larger-sized Ag₃Sn particles just as spheres cling to a plane. This can be simplified by treating the Ag₃Sn crystal surface as a plane and the ZnO-NPs as spheres. Accordingly adsorption of such nano-sized surface active material can decrease the surface energy of the Ag₃Sn crystal [27]. Consequently, the obtained microstructure of the SAC305 composite solder can reflect itself on the creep response and improvement the creep properties of the composite solder.

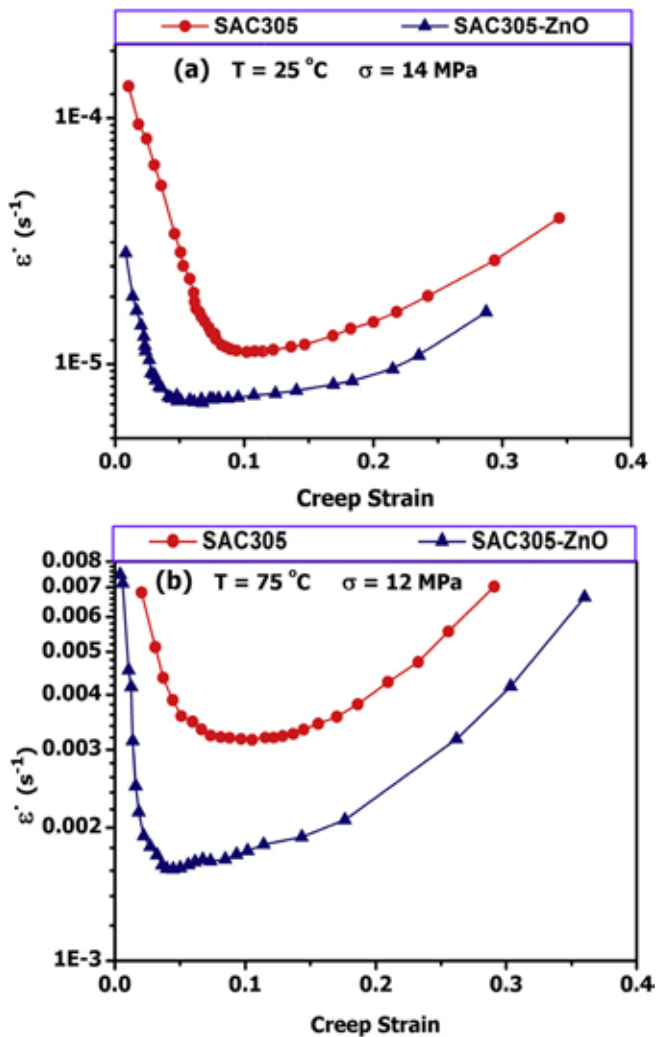


Fig. 6. Comparison creep strain–creep rate curves at (a) $T = 25\text{ }^{\circ}\text{C}$ and $\sigma = 14\text{ MPa}$ and (b) $T = 75\text{ }^{\circ}\text{C}$ and $\sigma = 12\text{ MPa}$ for SAC305 and SAC305-ZnO solder alloys.

3.4. Tensile creep properties

Fig. 4 shows typical recorded creep curves at the fixed (a) stress, σ of 14 MPa and temperature, T of 25 °C and (b) stress, σ of 12 MPa and $T = 75\text{ }^{\circ}\text{C}$ for the SAC305, and SAC305-ZnO alloys. As can be seen, a well-defined steady state was developed after primary creep for all solder alloys. Clearly, all the curves show typical three-stage creep characteristics, which consist of the primary, secondary and tertiary stages. Under the same creep condition, the ZnO-NPs containing specimen shows better creep resistance. Results indicated that the creep curves of both examined alloys are sensitive to the deformation temperature, T and the applied stress σ showing monotonic shift towards higher strains with increasing the deformation temperature. At higher temperatures, the ability of dislocations to climb over particles is apparently fast enough to render the particles as ineffective dislocation barriers. At lower temperatures, the time needed for a dislocation to climb around a particle (for a given stress) is much longer, so the creep resistance is significantly improved [33].

With 0.7 wt% ZnO addition into SAC305 alloy, the creep rupture life (s) grew significantly, the creep deformation (strain) decreased gradually, and the steady state creep rate (s^{-1}) had a dramatic decline. That is, the reinforced particles exhibit strengthening effect on the composite solder [34]. The main reasons for improved creep resistance of composite solders, which can contribute to the strengthening mechanism, such

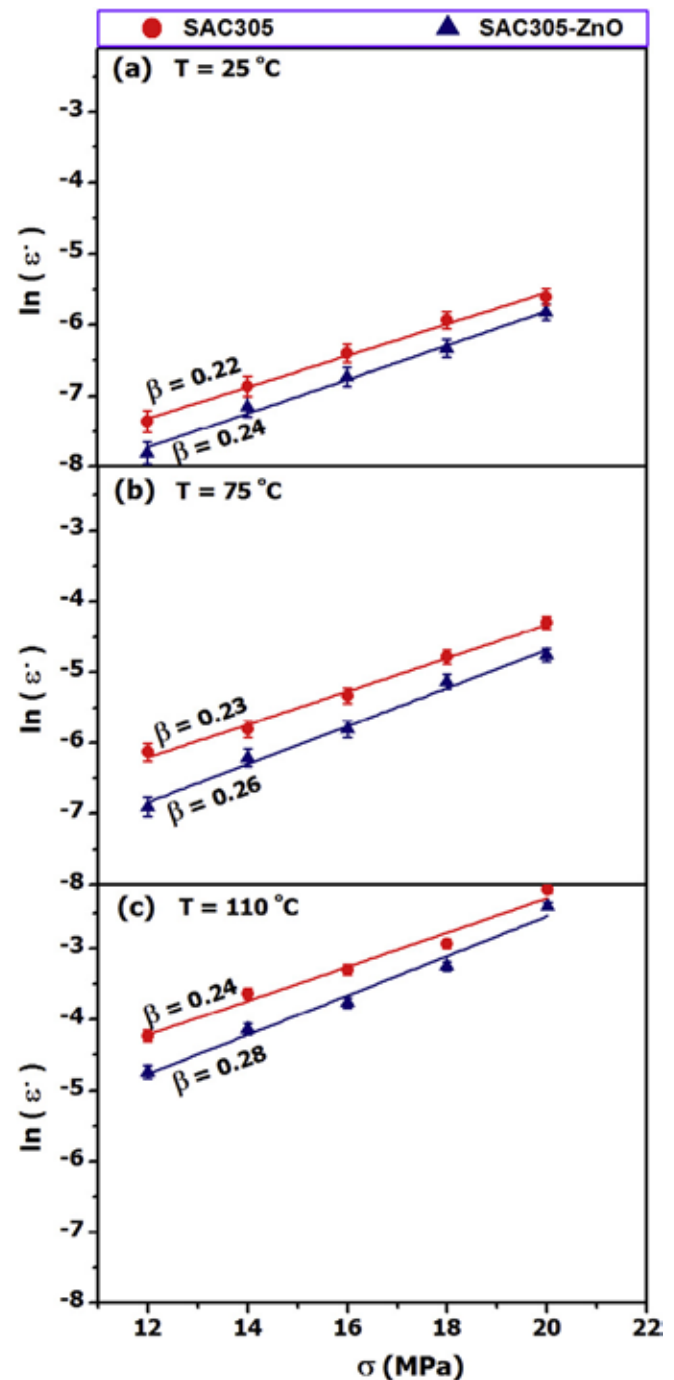


Fig. 7. Relationship between σ and $\ln(\dot{\epsilon})$ at (a) $T = 25$, (b) $T = 75$ and (c) $T = 110\text{ }^{\circ}\text{C}$ for SAC305 and SAC305-ZnO solder alloys.

as (i) the Hall–Petch effect due to grain refinement; (ii) the Orowan strengthening mechanism due to the presence of ZnO NPs in the solder matrix; (iii) generation of geometrically necessary dislocations to accommodate CTE mismatch between the matrix and nanoparticles; and (iv) load bearing effects due to the presence of nano-sized reinforcements, etc. Moreover, the increase in creep property can be attributed to the reduction of the creep damages and the change of microcrack propagation sites during the fracture process, which depends on the refinement of IMCs due to the ZnO NPs [35]. It was also reported that the reasonable clarifications for a higher creep rupture life time for composite solder joints because the ZnO NPs were located at the Sn–Sn grain boundaries and key these grain boundaries. The ZnO NPs served as an

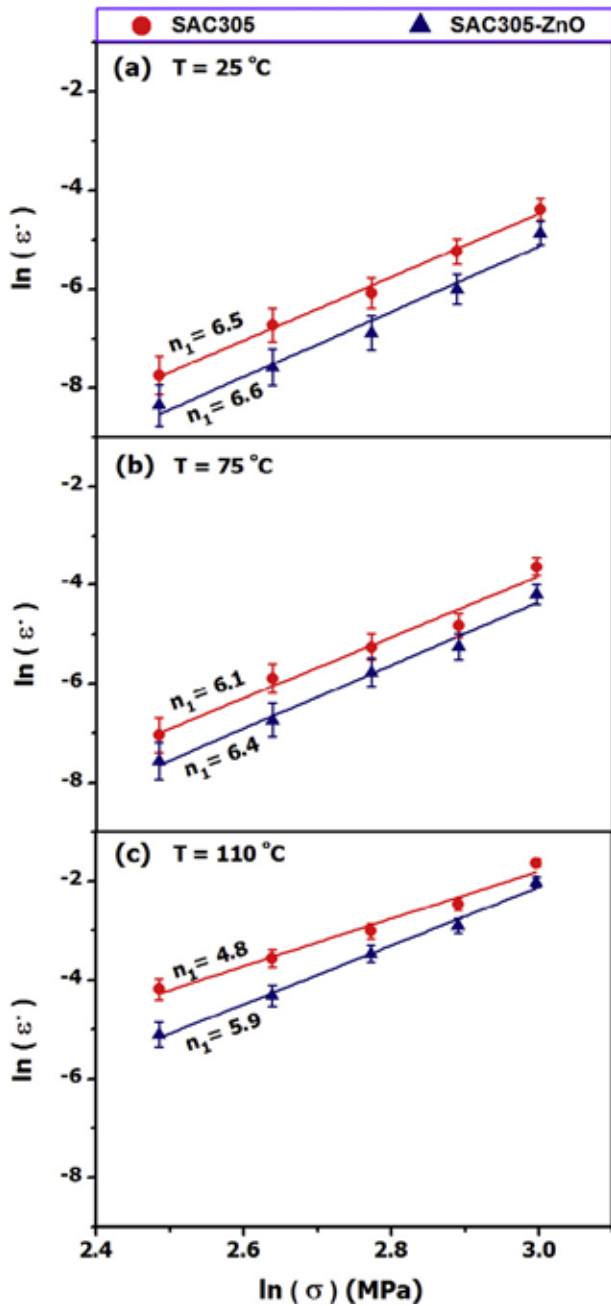


Fig. 8. Relationship between $\ln(\sigma)$ and $\ln(\epsilon)$ at (a) $T = 25$, (b) $T = 75$ and (c) $T = 110$ °C for SAC305 and SAC305-ZnO solder alloys.

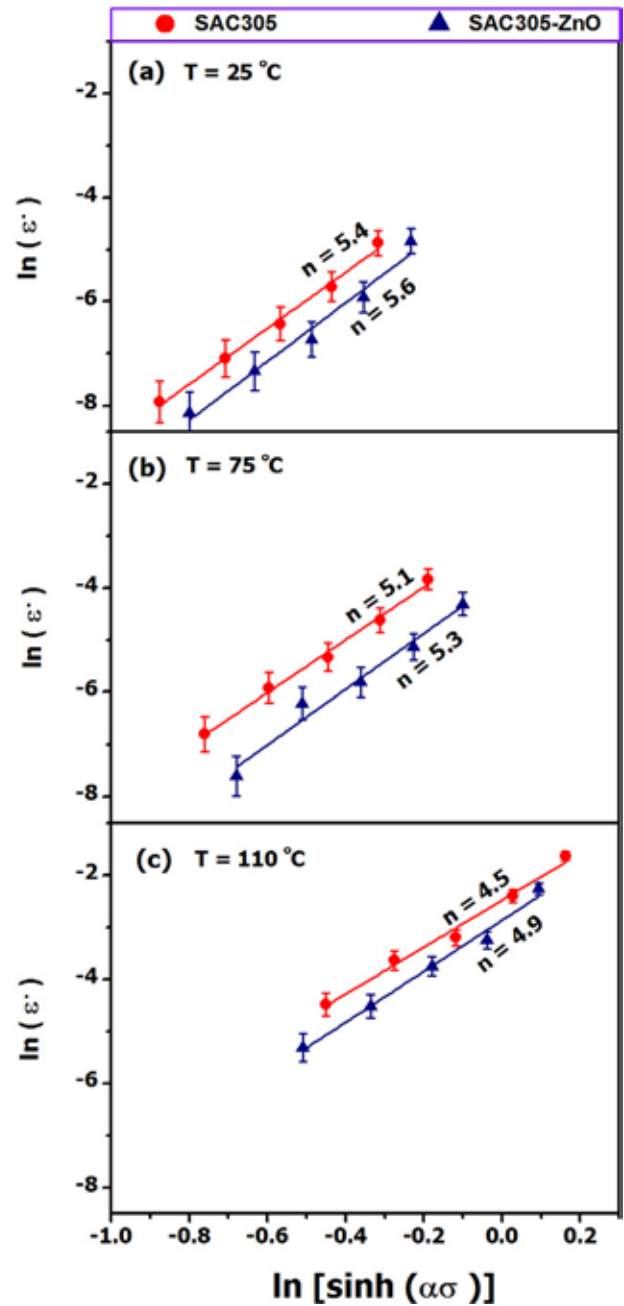


Fig. 9. Relationship between $\ln[\sinh(\alpha\sigma)]$ and $\ln(\epsilon)$ for determination stress exponent (n) values of SAC305 and SAC305-ZnO alloys at: (a) $T = 25$, (b) $T = 75$ and (c) $T = 110$ °C.

obstacle to the dislocation motion as well as grain boundary diffusion during creep tests as reported in Ref. [36].

In order to know additional information on the dominant deformation mode, creep rate-time relationship of the selected solder alloys were performed, as shown in Fig. 5a and b. Further, it can be seen clearly that under the condition of the same tensile stress and testing temperature, the creep lifetime increases with reinforcing ZnO NPs. For example, at $\sigma = 14$ MPa and at $T = 25$ °C, the creep lifetimes are 254.0, 277.0 min for SAC305 and SAC305-ZnO alloy, respectively, showing an obvious addition effect. It is noticed that the SAC305-ZnO alloy showed an increase of creep life time of 91.7%. Consequently, the 0.7 wt% ZnO NPs reinforcing is beneficial to improve the creep strength and prolong the thermal creep life of SAC305 solder alloy. The creep strain-creep rate provides the best description to understand the underlying reasons for the differences in the creep responses of tested solder alloys, as noticed in Fig. 6a and b.

The steady-state creep rate is characterized by the minimum creep rate of about 1.0×10^{-3} , $8.5 \times 10^{-4} \text{ s}^{-1}$ at $T = 25$ °C, and 3.2×10^{-3} , $1.0 \times 10^{-3} \text{ s}^{-1}$ at $T = 75$ °C for SAC305 and SAC305-ZnO alloys, respectively. Clearly, the ZnO NPs alloy showed the lowest creep strain rate however the SAC305 has the highest creep strain-rate. A lower creep rate often suggests a longer thermal creep life. By visually this comparison, it is clear that the SAC305-ZnO alloy showed much more creep resistant (118%) than that of SAC305 alloy.

3.5. Creep stress exponent and activation energy

In order to clarify the creep mechanism of solder joints under electro-thermo-mechanical coupled loads, a constitutive equation can be applied to calculate the creep stress exponent (n) and activation energy (Q), which are specific to the dominant creep mechanism. Steady-state

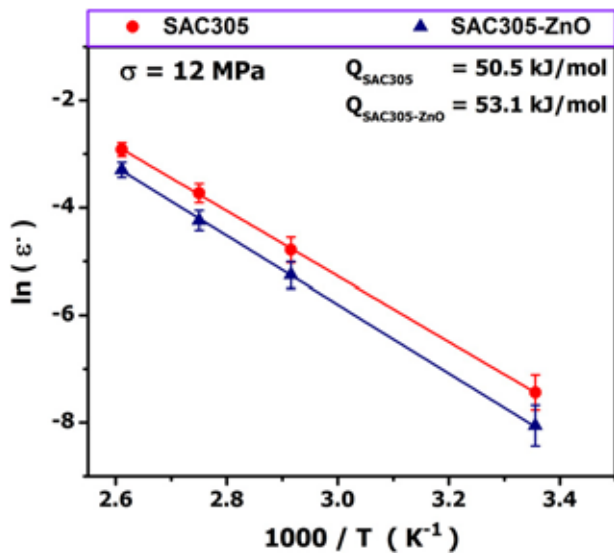


Fig. 10. Temperature dependence of steady state creep rate of SAC305 and SAC305-ZnO alloys.

creep rate, temperature and activation energy with stress during deformation can be modeled by Arrhenius constituent model. This model which combines a wide range of low and high stresses applied and captures up to two different creep mechanisms in a single formulation can be expressed empirically using the following equation [37,38]:

$$\dot{\epsilon} = A [\sinh(\alpha\sigma)]^n e^{-\frac{Q}{RT}}$$

where $\dot{\epsilon}$ is the steady-state creep rate, A is material constant independent of temperature, α is the stress reciprocal, σ is the applied stress, n is the stress exponent, Q is the creep activation energy for deformation, R is the gas constant and T is the absolute testing temperature. The stress level parameter α can be calculated from eq. $\alpha = \frac{\beta}{n_1}$. The values of β constant can be determined from the relationship between steady creep rate and applied stress, as shown in Fig. 7. It can be concluded that the SAC305-ZnO had the lowest steady creep rate for the same stress. The steady strain rate of SAC305 was the largest. The value of β represents the sensitive of steady creep rate on the applied stress. The values of β of SAC305-ZnO were found to be highly relied on the applied stress, followed by SAC305 solder alloy. The constant namely n_1 values estimated from relating $\ln\dot{\epsilon} - \ln\dot{\epsilon}'$ (Fig. 8).

Figs. 9, 10 and Table 2 summarize the creep data including the stress exponent and activation energy for the SAC305 and SAC305-ZnO alloys. As demonstrated, the stress exponent significant decreased from 5.4 to 4.5 and 5.6 to 4.9 for unreinforced SAC305 and reinforced SAC305-ZnO alloys, with increasing temperature from 25 to 110 °C. In fact, the drop of n values with temperature reflects the instability of microstructure at high deformation temperatures. Softening and dissolution of second phase particles are possible causes for the observed instability. It means that the precipitation-strengthening effect is greater at lower

Table 2

The activation energy (Q), stress exponent (n) and parameter (α) values for SAC305 and SAC305-ZnO solder alloys.

Alloy	Q (kJ/mol)	Temperature (°C)	α (MPa ⁻¹)	n
SAC305	50.5	25	0.03385	5.4
		75	0.03771	5.1
		110	0.05000	4.5
SAC305-ZnO	53.1	25	0.03636	5.6
		75	0.04063	5.3
		110	0.04747	4.9

temperatures for the studied alloys. However, several activated processes can occur in particle-strengthened materials, such as particle by-pass by dislocation climb and attractive interactions between dislocations and particles. As well, the high values of the stress exponent in case of SAC305-ZnO reflect the strengthening effect of reinforcements over the whole temperature range tested.

The mechanisms responsible for the creep deformation can be concluded based on the n value of stress exponent and microstructural observations. The n value about 2 was reported for the mechanism by grain boundary sliding, n approximately 3 for creep controlled by viscous glide, n value with 4 to 7 for dislocation climb and higher n value for particle strengthening controlled creep [39,40]. According to the obtained n values, the main mechanisms for creep deformations are the dislocation climb. The dislocation climb is beneficial for the rearrangement of dislocations, and the alloy matrix easily recovers and softens. The grain boundary sliding results in formation of voids and deteriorates the creep life. In our future works, it would be interesting to do TEM on the samples after creep test to see the dislocations and grain boundaries to further confirm the mechanism.

As illustrated in Fig. 10, the activation energy $Q = 53.1$ kJ/mol of SAC305-ZnO alloy is much larger than that $Q = 50.5$ kJ/mol of the SAC305 alloy. A difference is likely due to the presence of the fine IMCs in the β -Sn matrix. It was observed that the obtained Q values are much lower than the activation energy for the lattice self-diffusion of tin (100–130 kJ/mol) [41,42]. The activation energies investigated in this study are relatively close to that for the tensile creep of tin controlled by pipe diffusion and thus the tensile creep behavior can be related to a slip creep mechanism controlled by pipe diffusion [43,44]. However, the calculated Q values were slightly higher than the reported value of 30–40 kJ/mol for the grain boundary diffusion of tin [45].

4. Conclusions

In this study, the effect of reinforcing ZnO NPs on the microstructure characterization and creep behavior of SAC305 was studied. The results are summarized as follows:

- (1) The ZnO NPs have been successfully reinforced in the Sn-3.0 wt% Ag-0.5 wt% Cu alloy by mechanically blending and melting.
- (2) The morphology of the microstructure of the SAC305 solder alloy changed after ZnO NPs addition. Microstructural investigations revealed that the addition of nanosized 0.7 wt% ZnO particles to SAC305 solder inhibited the growth of the grain size as well as the IMCs due to the adsorption of ZnO NPs in the matrix during solidification.
- (3) Creep tests revealed that the addition of 0.7 wt% ZnO NPs decreased the steady-state creep rate while the creep lifetime of the plain SAC305 solder increased.
- (4) The stress exponent values of the SAC305-ZnO alloy over all tested temperatures and loads are higher than that of the based SAC305 alloy. It is expected that the creep resistance of the SAC305-ZnO composite alloy will be superior to that of the SAC305 alloy.
- (5) The average activation energy (Q) values for SAC305 and SAC305-0.7ZnO alloys were 50.5 and 53.1 kJ/mol, respectively, which close to that of pipe-diffusion mechanism in Sn based solder matrix.

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Interaction of Individual Ions, Ion-Water Clusters with Aquaglyceroporin and Aquaporin-1 Channels

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Aquaglyceroporin and aquaporin-1 channels provide a mechanism for the transport of water and ions through cell membranes. The present paper proposes a precise geometric structure of these channels to explain their mechanism as selective channels. It provides a mathematical model to deduce the potential energy of the interaction between non-bonded individual molecules, such as calcium chloride and sodium chloride, interacting with aquaglyceroporin and aquaporin-1 channels, which are assumed to comprise two flaired right cylinders. We evaluate the potential energy both as arising from the calcium, sodium and chlorine as discrete atoms, interacting with the aquaglyceroporin and aquaporin-1 channels which are assumed to have atoms uniformly distributed throughout their volumes. Furthermore, we investigate the van der Waals interaction between ion-water cluster and aquaporins. We present numerical results describing the acceptance of individual molecules inside the aquaporin channels. Our calculations predict that calcium, sodium and chlorine ions and ion-water clusters are readily accepted into the aquaporins.

Keywords: Aquaporins (AQPs), Aquaporin-1 (AQP1), Aquaglyceroporin (GlpF), Calcium (Ca^{+2}), Chlorine (Cl^-) and Sodium (Na^+), Ion-Water Cluster, Lennard-Jones Potential, van der Waals Interaction.

1. INTRODUCTION

The discovery of aquaporins has generated considerable interest for potential applications in medical nanodevices designed to transport individual molecules through cell membranes. Biological systems often motivate scientific research and this applies to the effort to determine the dominant biological function of the GlpF channel over other channel systems. The GlpF channel plays a major role in the transport of water molecules and other small bio-molecules, such as ionic and non-ionic bonded molecules across membranes. The aquaporin family is composed of more than 150 members of protein channels that have so far been identified and deficiency in their function causes physiological disorders.^{1,2} The glycerol facilitator channel (GlpF) belongs to the class of aquaglyceroporins³ and provides a mechanism for transporting water and linear alditols, such as glycerol across cellular membrane.⁴⁻⁶ At physiological conditions, the transport system of aquaporins, includes protons and charged solutes and preserves the electrochemical potential across the cell membrane.² The GlpF channel shown in Figure 1 is the major member of the aquaporin channel family. It is a

highly selective channel that transports water, glycerol and small individual molecules and it is also stereo selective in conducting linear carbohydrates, such as alditols and polyalcohols.^{4,7} The channel structure follows the directions of three glycerol molecules and two water molecules for each functional unit and this unit has two characteristic half-membrane-spanning repeats which are joined by quasi-twofold symmetry. The pore opening measures less than 3.5 Å at its narrowest point, and the constriction region of the channel is approximately 28 Å in length.^{7,8} The main reason for the difference in the magnitude of interaction energy is that the human aquaporin-1 (AQP1) barrier is slightly larger than that of the GlpF.⁹ For more details related to the geometrical structure of the GlpF channel we refer the reader to.^{7,8,10}

Molecular dynamic simulation by de Groot et al.¹¹ suggests that the GlpF channels permeate water diffusively at higher rates compared to other members of the aquaporin family. Moreover, X-ray microscopy analysis confirms that the GlpF permeates water molecules at significantly higher rates than other kind of channels.^{12,13} The mechanistic detail of the glycerol replacement along the line of the exposed carbonyl groups, and the well-defined binding sites inside the channel are formed by the selective filter

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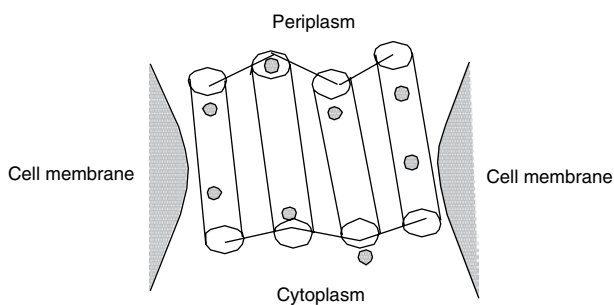


Fig. 1. Structure of functional unit of aquaporin.

and the asparagine-proline-alanine motifs.^{14–18} For example, Tuzun et al.¹⁹ who use the different quantum chemical methods to investigate the electronic and structural of carbon nanobuds and obtain tetramere and pentamer rings. This has led to find out that these nanostructures are more convenience and smooth. In addition, work of Olszewski²⁰ aims to investigate the intervals of the time and energy change of the electron transition which are examined on a semi-classical basis for hydrogen atom. Further, Ono et al.²¹ investigate the atomic nano-sized conductors with less than 100 nanometer that enable for the construction of electronic devices.

This paper examines GlpF and AQP1 interacting separately with each of the two molecules; calcium chloride (CaCl_2) and sodium chloride (NaCl) as indicated in Figure 2. We note that these molecules dissolved in water forming ions Ca^{+2} , Cl^- and Na^+ , and therefore we examine the interaction between these atoms with the GlpF and AQP1 channels with the chemical compositions $\text{C}_{1289}\text{H}_{2527}\text{N}_{315}\text{O}_{591}\text{S}_{11}$ and $\text{C}_{1235}\text{H}_{2468}\text{N}_{320}\text{O}_{601}\text{S}_7$, respectively.²² These ions play critical roles both inside and outside of the individual cells, for example calcium strengthens bone cells and sodium regulates water in biological systems and also employed in the electrical signalling in the brain and nervous system.²³ Moreover, chlorine plays a major role in correcting the body's fluid pressures and maintaining the acid-base balance.^{23,24}

In the present work, the various atomic interactions are modelled assuming discrete atomic distribution. We adopt the six-twelve Lennard-Jones potential for the van der Waals interactions. We perform volume integrations throughout the channel to calculate the total potential energy arising from the interaction with calcium, sodium, chlorine ions and ion-water clusters. Consequently, we calculate an acceptance condition for each molecule to be sucked into the GlpF and AQP1 channels. Using hybrid discrete-continuum model, we determine analytical expressions for the potential energy, involving series of hypergeometric functions which we employ to calculate the numerical solution.

In the following section, we outline the 6–12 Lennard-Jones potential and the method we use to derive the potential energy for various interactions. We obtain the energy

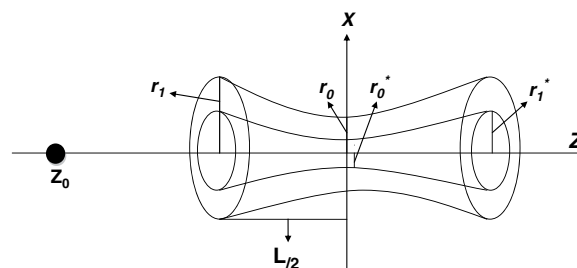


Fig. 2. Geometry of atom on the z -axis interacting with aquaporin assumed to have a flaired right cylindrical structure.

in terms of a series of standard hypergeometric functions. Next, we evaluate the total potential energy by using a discrete model for calcium, sodium and chlorine ions which are assumed to be located on the z -axis. In the continuum approach, we also obtain the interaction between aquaporin channels and Ca^{+2} , Cl^- and Na^+ ions and surrounded by a sphere of water molecules with radius b (ion-water clusters) and the results are presented in the subsequent section. A summary is presented in the final section of the main body of this paper.

2. MATHEMATICAL MODEL

Here, we consider the Lennard-Jones interaction between the aquaporin channel with a specific point of a single non-bonded atom on the z -axis. In this paper we model the aquaporin channel as a flaired right circular cylindrical shell with finite length. We introduce a rectangular coordinate system (x, y, z) which is used as a reference system and we introduce a cylindrical shell with an origin located at the centre of the cylinder, parameterized by $(r\delta\cos\theta, r\delta\sin\theta, z)$, where $\theta \in [-\pi, \pi]$, $z \in [-L/2, L/2]$, $\delta \in [a, 1]$ and $0 < a < 1$. Next, we introduce a single atom as a specific point on the z -axis which is assumed to be located at $(0, 0, z_0)$. This configuration is depicted in Figure 2.

The distance ρ between a typical point in the aquaporin and the atom is given by

$$\begin{aligned}\rho^2 &= (r\delta\cos\theta)^2 + (r\delta\sin\theta)^2 + (z - z_0)^2 \\ &= r^2\delta^2 + (z - z_0)^2\end{aligned}\quad (1)$$

We assume r is defined by a quadratic expression, such that

$$r = r_0 + 4(r_1 - r_0)(z/L)^2 = r_0 + \alpha z^2 \quad (2)$$

where $\alpha = 4(r_1 - r_0)/L^2$, r_0 and r_1 are the outer radii at the middle and at the opening of aquaporin, respectively. The inner radii at the middle and at the opening of aquaporin are given by ar_0 and ar_1 , respectively, where $0 < a < 1$ and we take $a = r_0^*/r_0 \approx 0.25$, where r_0^* is the inner radius at

the centre of the aquaporin. To find the interaction potential between the single atom and the aquaporin channel, we adopt the Lennard-Jones potential which is given by

$$\phi(\rho) = -A\rho^{-6} + B\rho^{-12} = 4\epsilon \left[-\left(\frac{\sigma}{\rho}\right)^6 + \left(\frac{\sigma}{\rho}\right)^{12} \right] \quad (3)$$

where $A = 4\epsilon\sigma^6$ is the attractive constant, $B = 4\epsilon\sigma^{12}$ is the repulsive constant, ϵ is the well depth, σ is the van der Waals diameter. We also use the empirical combining laws²⁵⁻²⁷ given by $\epsilon_{12} = (\epsilon_1\epsilon_2)^{1/2}$, and $\sigma_{12} = (\sigma_1 + \sigma_2)/2$, to determine the well depth and van der Waals diameter between different atoms. By summing all pair interactions, the total potential energy of this system can be given by

$$V_{\text{tot}} = \sum_i \phi(\rho_i) \quad (4)$$

where ϕ is the potential function given in (3). In the continuum approximation, we may replace this summation by the volume integral, where we assume a uniform atomic density throughout the volume of the aquaporin. Girifalco et al.²⁸ state that "From a physical point of view the discrete atom-atom model is not necessarily preferable to the continuum mode. We may also use the hybrid discrete-continuum approach." Thus, from (4) we have

$$\begin{aligned} V_{\text{tot}} &= \eta_c \int_a^1 \int_{-\frac{L}{2}}^{\frac{L}{2}} \int_{-\pi}^{\pi} \phi(\rho) dV \\ &= \eta_c \int_a^1 \int_{-\frac{L}{2}}^{\frac{L}{2}} \int_{-\pi}^{\pi} r^2 \delta(-A\rho^{-6} + B\rho^{-12}) d\delta dz d\theta \quad (5) \end{aligned}$$

where η_c denotes the atomic density per unit volume and dV is the infinitesimal volume element for the cylindrical aquaporin. We note that the volume element is given by $dV = r^2 \delta d\delta dz d\theta$. For detailed analytical evaluation of (5), we refer to the reader to.²⁹

2.1. Calcium Chloride and Sodium Chloride Molecules

In this section, we consider the interaction of ions with aquaporin channels. We propose to model this problem in two steps: firstly, the interaction of the aquaporin with the ion, and secondly, the interaction of the aquaporin with ion and surrounded by a water clusters. Here, we consider this problem as a discrete interaction because these molecules dissolved in water into ions. We investigate the total potential energy for a specific point of calcium (Ca^{+2}), chlorine (Cl^-) and sodium (Na^+) ions on the z -axis interacting individually with GlpF and AQP1 channels assumed to comprise flaired right cylinders. The ion is assumed to be located at $(0, 0, z_0)$ as shown in Figure 2. Thus, the equation of the potential energy is given by

$$\begin{aligned} E_1 &= \eta_c \int_a^1 \int_{-\frac{L}{2}}^{\frac{L}{2}} \int_{-\pi}^{\pi} r^2 \delta(-A\rho^{-6} + B\rho^{-12}) d\delta dz d\theta \\ &= 2\pi\eta_c \int_a^1 \int_{-\frac{L}{2}}^{\frac{L}{2}} r^2 \delta(-A\rho^{-6} + B\rho^{-12}) d\delta dz \quad (6) \end{aligned}$$

2.2. Ion-Water Cluster

In this section, we evaluate the total interaction energy between aquaporin channels and Ca^{+2} , Cl^- and Na^+ ions with water molecules as ion-water cluster with radius b ($b \propto \sqrt{N}$, where N is the number of atoms). We assume that each ion is located at $(0, 0, z_0)$ surrounded by a sphere of water molecules as suggested by Gonzalez et al.³⁰ We obtain the interaction energy in two steps. Firstly, we model the ion as a specific point as shown in Figure 2, where the interaction energy is given in the Eq. (6). Secondly, we assume the water molecules to be on the surface of a sphere of radius b . We note that Ca^{+2} is surrounded by 8 water molecule with radius $b_2 = 1.5\sqrt{2}$ (Fig. 3(a)), whereas, Cl^- and Na^+ are each surrounded by 4 water molecules where $b_1 = 1.5 \text{ \AA}$ ³¹ as shown in (Fig. 3(b)). From Cox et al.,³² we can find that the potential energy is given by

$$\begin{aligned} E_2 &= \eta_s \pi b \iiint \left[\frac{A_{\text{H}_2\text{O}}}{2} \left(\frac{1}{\rho(\rho+b)^4} - \frac{1}{\rho(\rho-b)^4} \right) \right. \\ &\quad \left. - \frac{B_{\text{H}_2\text{O}}}{5} \left(\frac{1}{\rho(\rho+b)^{10}} - \frac{1}{\rho(\rho-b)^{10}} \right) \right] dV \\ &= \eta_s \pi b \int_a^1 \int_{-\frac{L}{2}}^{\frac{L}{2}} \int_{-\pi}^{\pi} \left[\frac{A}{2} \left(\frac{1}{\rho(\rho+b)^4} - \frac{1}{\rho(\rho-b)^4} \right) \right. \\ &\quad \left. - \frac{B}{5} \left(\frac{1}{\rho(\rho+b)^{10}} - \frac{1}{\rho(\rho-b)^{10}} \right) \right] r^2 \delta d\delta dz d\theta \quad (7) \end{aligned}$$

where η_s represents the atomic surface density of sphere of the water molecules. Thus, the total potential energy arising from ion-water cluster interacting with GlpF and AQP1 channels is given by $E^{\text{tot}} = E_1 + E_2$.

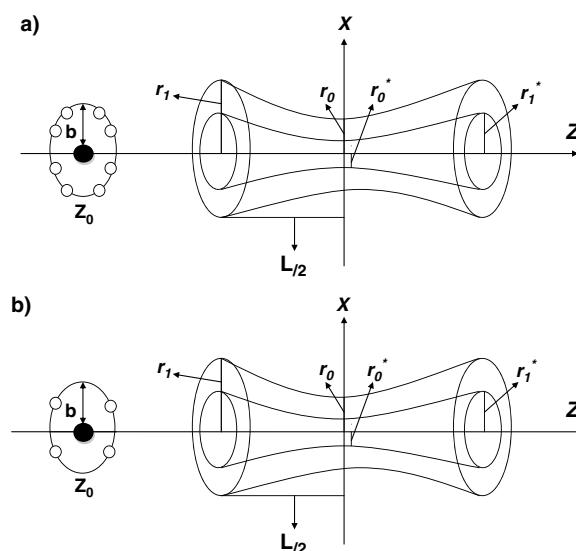


Fig. 3. Geometry of ion with water molecules centred on the z -axis interacting with a flaired right cylindrical aquaporin ((a) Eight water molecules surrounded Ca^{+2} (b) Four water molecules surrounded each Cl^- and Na^+).

Table I. Lennard-Jones constants (ϵ and σ).

Interaction	ϵ (eV $\times 10^{-2}$)	σ (Å)	Interaction	ϵ (eV $\times 10^{-2}$)	σ (Å)
Ca–Ca	4.475	3.399	Cl–Cl	4.266	3.947
Ca–Cl	4.369	3.673	Na–Cl	1.549	3.465
Na–Na	0.563	2.983	H–H	0.191	2.886
O–O	0.260	3.500	C–C	0.455	3.851
N–N	0.299	3.660	S–S	1.881	4.035

3. RESULTS

In this section we determine the potential energy for Ca^{+2} , Cl^- and Na^+ ions and ion-water clusters interacting individually with the GlpF and AQP1 channels assumed to comprise a flaired right cylindrical shape with the chemical compositions $\text{C}_{1289}\text{H}_{2527}\text{N}_{315}\text{O}_{591}\text{S}_{11}$ and $\text{C}_{1235}\text{H}_{2468}\text{N}_{320}\text{O}_{601}\text{S}_7$, respectively. We obtain the plots to determine the total potential energy using the MAPLE and MATLAB software packages. The numerical values used in this model are shown in Table I^{25,27,33,34} and Table II,²² where $N_G = 4737$ and $N_Q = 4601$ ²² are the numbers of atoms in GlpF and AQP1 channels, respectively, V_s is the volume of the cylindrical aquaporin and A_s is the surface area of aquaporin. The attractive constants A and the repulsive constants B are calculated by finding the well-depth ϵ and van der Waals diameter σ for individual atoms interacting with all atoms of aquaporin protein channel as shown in Table III, which has been calculated from Ref. [25,26,33,35].

The results are shown in Figures 4 to 9 for the ions and ion-water clusters interacting with two different of aquaporin channels. We determine these interactions by two different approaches, namely numerical and computational methods. Firstly, we perform integrations over the volume unit to evaluate the numerical solution using the MAPLE package to evaluate integral as in Eqs. (6) and (7). Secondly, we refer to the infinite summation formulation as the computational solution. We need only evaluate the infinite summation to the first 10 terms for the solution to converge. Comparison between the two approaches confirms that the numerical and computational approaches are in good agreement.

Table II. Numerical values of physical parameters used in this model.

Parameter	Symbol	Value
Length of aquaporin	L	28 Å
Outer radius of aquaporin	r_1	15 Å
Inner radius of aquaporin	r_0	12 Å
Distance between calcium atom and chlorine atom	h	3.673 Å
Distance between sodium atom and chlorine atom	f	3.465 Å
Radius of 4 water cluster	b_1	1.5 Å
Radius of 8 water cluster	b_2	$1.5\sqrt{2}$ Å
Volume density for GlpF	$\eta_c = [N_G/V_c]$	$[4737/\pi Lr^2] = 0.3389$ atom/Å ³
Volume density for an AQP1	$\eta_c = [N_Q/V_c]$	$[4601/\pi Lr^2] = 0.3292$ atom/Å ³
Surface density for sphere of water molecules	$\eta_s = \text{Number of atoms}/4\pi b^2$	0.4246 atom/Å ²
Channel wall Thickness	$a = r_0^*/r_0$	0.25

4. DISCUSSION

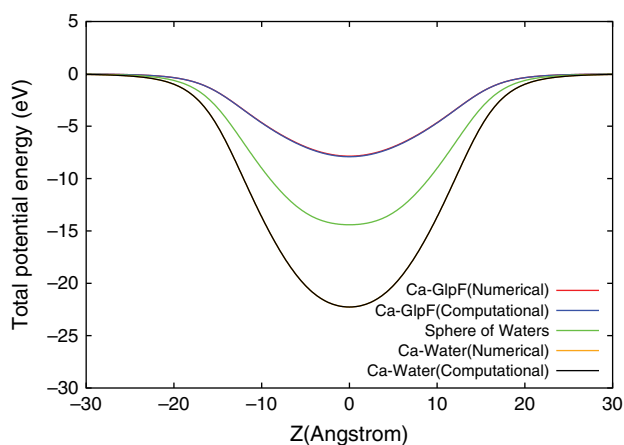
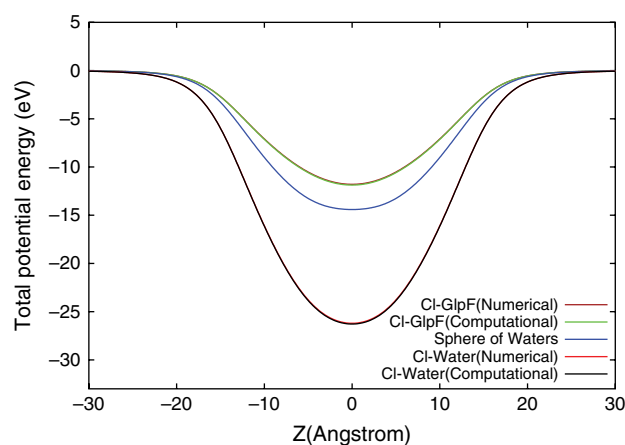
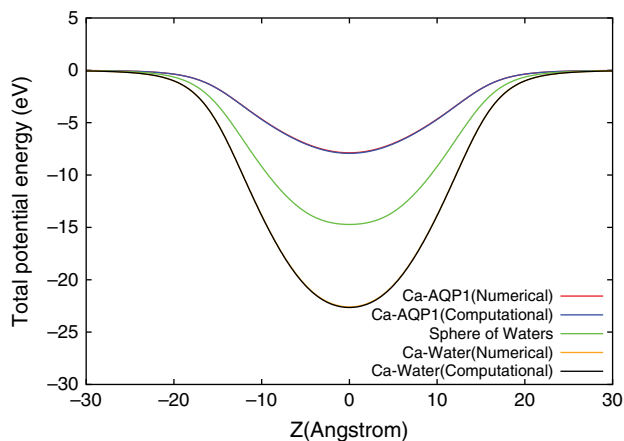
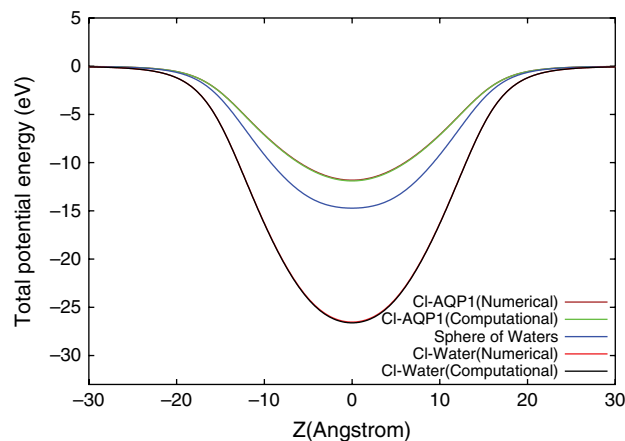
In Figures 4 to 9, we evaluate the interaction energies for the calcium, chlorine and sodium ions and the calcium-water, chlorine-water and sodium-water clusters interacting with two kinds of aquaporin channels, GlpF and AQP1, along the z -axis between $z_0 = -30$ Å and $z_0 = 30$ Å. There is only a very small difference between the computational and the numerical results for the whole range of values considered. We note that the interaction energies are practically zero for $z_0 < -30$ Å and $z_0 > 30$ Å. Our results show that there are no energetic barriers to prevent the encapsulation of these ions and ion-water clusters into the interior of the GlpF and AQP1 channels. Furthermore, we note that the significant region for these interactions is constrained between $z_0 = -20$ Å and $z_0 = 20$ Å. This result agrees with Yu et al.,³⁶ who find that the global minimum energy of the ion-water cluster interactions occur at the centre of the protein channel ($z_0 = 0$ Å) and the curve of harmonic interaction energy mostly constrained to $|z_0| < 20$ Å. Further, we provide the values of minimum energy which occurs at $z_0 = 0$ for various interactions in Table IV.

The analytical results from the potential mean force indicate that the permeability for all ions are different depending on the channels. Here, we conclude that the aquaporin radius r plays a significant role in determining the minimum energy for these interactions, particularly, at the centre of the channel. This is because the distance between the inner aquaporin radius r_0 and the ion-water cluster is lowest there. Our results show that ions surrounded by sphere of water molecules is accepted into the GlpF and AQP1 channels and is sufficient to allow the suction of these ions into the GlpF and AQP1 channels. As shown in Figures 4 to 9 all ions are accepted into these channels and the interaction between the Cl^- , and GlpF and AQP1 channels has the lowest minimum energy around the centre of the channel then followed by Ca^{+2} and Na^+ .

Our results also agree with the work of Phongphanphanea et al.,³⁷ who confirm that chlorine may permeate and have high potential energy at the selective filter in the

Table III. Numerical values of the attractive (A) and the repulsive (B) constants.

Symbol	Value (eV Å ⁶)	Symbol	Value (eV Å ¹² × 10 ³)	Symbol	Value (eV Å ⁶)	Symbol	Value (eV Å ¹² × 10 ³)
A_{OO}	22.63	B_{OO}	41.599	A_{OH}	9.41	B_{OH}	9.972
A_{OS}	79.89	B_{OS}	228.279	A_{ON}	23.41	B_{ON}	49.283
A_{OC}	33.79	B_{OC}	83.240	A_{HH}	4.41	B_{HH}	2.548
A_{HS}	41.10	B_{HS}	70.517	A_{HN}	11.70	B_{HN}	14.383
A_{HC}	17.16	B_{HC}	52.046	A_{CN}	41.26	B_{CN}	115.661
A_{CS}	139.04	B_{CS}	522.516	A_{SN}	97.11	B_{SN}	314.772
A_{CC}	58.71	B_{CC}	191.493	A_{NN}	28.74	B_{NN}	69.083
A_{SS}	324.72	B_{SS}	1401.426	A_{CaN}	42.88	B_{CaN}	82.825
A_{CaH}	17.04	B_{CaH}	16.394	A_{CaO}	34.81	B_{CaO}	58.595
A_{CaC}	62.17	B_{CaC}	141.068	A_{CaS}	108.86	B_{CaS}	287.093
A_{NaN}	10.57	B_{NaN}	14.180	A_{NaH}	4.01	B_{NaH}	2.558
A_{NaO}	8.06	B_{NaO}	9.341	A_{NaC}	15.47	B_{NaC}	24.624
A_{NaS}	36.88	B_{NaS}	68.847	A_{ClN}	65.58	B_{ClN}	198.394
A_{ClH}	27.52	B_{ClH}	43.727	A_{ClO}	53.79	B_{ClO}	143.238
A_{ClC}	92.57	B_{ClC}	325.229	A_{ClS}	219.83	B_{ClS}	888.336
$A_{Na-GlpF}$	8.14	$B_{Na-GlpF}$	10.333	$A_{Ca-GlpF}$	33.45	$B_{Ca-GlpF}$	60.616
$A_{Cl-GlpF}$	51.45	$B_{Cl-GlpF}$	144.952	$A_{Na-AQP1}$	7.61	$B_{Na-AQP1}$	10.292
$A_{Ca-AQP1}$	33.52	$B_{Ca-AQP1}$	60.510	$A_{Cl-AQP1}$	51.53	$B_{Cl-AQP1}$	144.613
A_{O-GlpF}	18.43	B_{O-GlpF}	36.335	A_{H-GlpF}	8.92	B_{H-GlpF}	17.734
$A_{H_2O-GlpF}$	12.09	$B_{H_2O-GlpF}$	23.934	A_{O-AQP1}	18.82	B_{O-AQP1}	36.901
A_{H-AQP1}	9.07	B_{H-AQP1}	17.747	$A_{H_2O-AQP1}$	12.32	$B_{H_2O-AQP1}$	24.131

**Fig. 4.** Total potential energy for calcium ion-water cluster interacting with GlpF.**Fig. 6.** Total potential energy for chlorine ion-water cluster interacting with GlpF.**Fig. 5.** Total potential energy for calcium ion-water cluster interacting with AQP1.**Fig. 7.** Total potential energy for chlorine ion-water cluster interacting with AQP1.

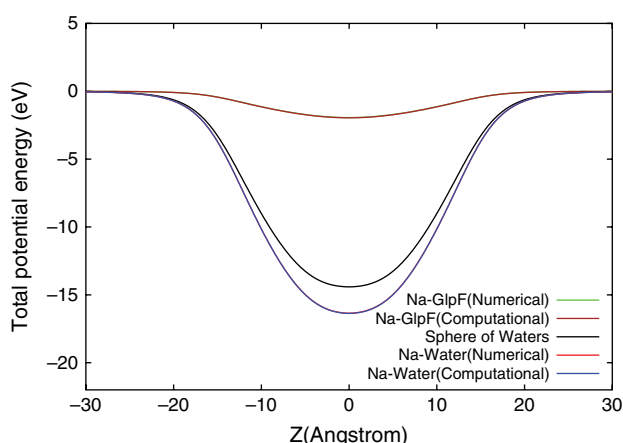


Fig. 8. Total potential energy for sodium ion-water cluster interacting with GlpF.

middle of aquaporin channels. In addition, the sodium ion has multiple high barriers around the selective filter region due to combined effects of the positive repulsion potential. There are two main reasons for the low permeability for different ions, depending on ion and the activation barriers inside the channel. Furthermore, the sodium ion in the middle of the channel ($z_0 = 0 \text{ \AA}$) accompanied by water molecules penetrated the cytoplasmic at the half of aquaporin channel. For the two channels considered in this paper, the encapsulation of calcium and chlorine ions into the AQP1 is more favourable than that of GlpF, whereas the sodium encapsulation is more favourable in the GlpF. Phongphanphanea et al.³⁷ also indicate that the potential mean force of Na^+ in the interior of the channel has multiple high barriers around the asparagine proline alanine (NPA) motif and selective regions which may be barely permeating inside the channels, while the Cl^- ion is largely negative which may be passing through the deep valley (the depth of the valley is approximately 6 kJ/mol) around the SF region. The free energy barrier for the conduction of Na^+ , Cl^- ions and water are 18, 9 and 1.5 kcal/mol,

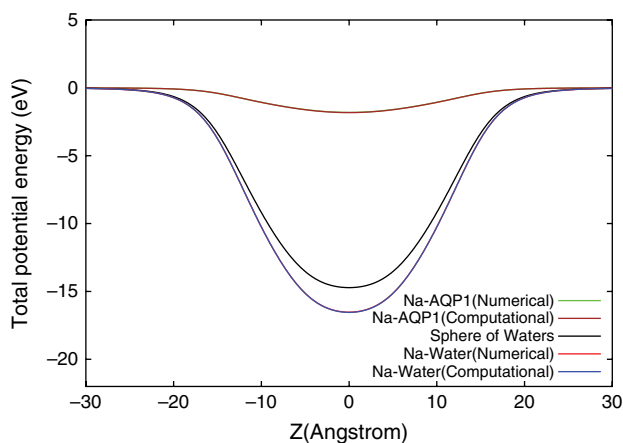


Fig. 9. Total potential energy for sodium ion-water cluster interacting with AQP1.

Table IV. Minimum energies (ME) for different interactions.

Interaction	ME (eV)	Interaction	ME (eV)
Ca-GlpF	-7.85	Ca-AQP1	-7.87
Cl-GlpF	-11.79	Cl-AQP1	-11.81
Na-GlpF	-1.93	Na-AQP1	-1.81
Sphere of H_2O with GlpF	-14.41	Sphere of H_2O with AQP1	-14.71
Ca-Water cluster with GlpF	-22.26	Ca-Water cluster with AQP1	-22.58
Cl-Water cluster with GlpF	-25.90	Cl-Water cluster with AQP1	-26.52
Na-Water cluster with GlpF	-16.31	Na-Water cluster with AQP1	-16.52

respectively³⁸ which are in very good agreement with our results. Moreover, recent experiments have indicated conductance of Na^+ , Cs^+ and K^+ ions through the interior of the AQP1 tetrameres.^{39,40} Further, experimental results for Hidekazu et al.⁴¹ indicate that Ca^{+2} ion surrounded by 8 water molecules has a minimum free energy which is measured to be approximately 8 eV, which is consistent with 8.74 eV obtained here for the same configuration. Al Garalleh et al.^{29,42,43} show that the biological channels, GlpF and AQP1, are able to transport water and small gas molecules, such as carbon dioxide, nitric oxide and ammonia in through cell membrane protein. Our calculations and the recent studies indicate that ions and gas molecules are accepted inside the GlpF and AQP1 channels. The encapsulation of nitric oxide molecule is more favourable inside the aquaporin having about 8 eV, either GlpF or AQP1, then followed by Cl^- , Ca^{+2} , ammonia, carbon dioxide and finally Na^+ ion which is approximately 2 eV. While, the encapsulation of Ca^{+2} -water, Cl^- -water and Na^+ -water clusters have the greatest potential energy of approximately 17–26 eV.

5. CONCLUSIONS

In the present paper, we study the acceptance of individual ions, ion-water clusters through protein channels. We model the interaction between Ca^{+2} , Cl^- and Na^+ ions of CaCl_2 and NaCl , and the GlpF and AQP1 channels which are assumed to have flared right cylindrical shapes with gradual change in the aquaporin radius r . The van der Waals potential energy is calculated using the 6–12 Lennard-Jones potential. We find the total potential energy for various ions, Ca^{+2} , Cl^- and Na^+ , ion-water cluster interacting with cylindrical aquaporins. We include all pairwise interactions to calculate the total potential energy using a discrete-continuum approach to determine the total potential energy. We find that the aquaporin radius r plays a significant role in determining the global minimum energy for these interactions and the suction of these ions into the GlpF and AQP1 channels. In conclusion, our results show that the total potential energy has a local minimum energy around the centre of the aquaporins, where the channels are narrowest. Our calculations show that these ions are encapsulated inside the aquaporin. The results presented here agree with findings shown in previous studies. The present paper deals with a specific

organization form of matter. Other forms and description are given for example in the recent studies.¹⁹⁻²¹ In most cases quantum theory is necessary for the description of the organization forms of matter. But even the interpretation of modern quantum theory seems still to be an open question, as is demonstrated we refer to the Refs. [20, 44].

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Research Article

Mathematical modeling using pure fractions and Monte Carlo simulation to Control Thalassemia Disease Transition.

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ABSTRACT:

Thalassemia is one of the most widely spread genetic disease, especially in the Middle East. The study aims to create a mathematical model for the control of the transition of genetically inherited thalassemia disease. New form of representing the numbers in the unit - interval $[0, 1]$ which is called pure fractions and the theory and properties of pure fractions were examined and applied. To generalize the effectiveness of this innovative model to predict the number of generations needed to eliminate Thalassemia or other similar genetic diseases, Monte-Carlo simulation via MATLAB was used. Results indicated such genetic diseases could be controlled and can be eliminated with proper family policies.

Keywords: Thalassemia disease, pure fraction, reducible pure fraction, mathematical Model, Monte Carlo simulation, MATLAB.

1. INTRODUCTION:

Thalassemia disease: an Overview: In the recent few decades, Thalassemia has recently become a serious threaten and spread widely worldwide. "Thalassemia", a Greek word that means the Mediterranean basin or Cooley's anemia, it is a form of inherited blood disorder in which the body makes an abnormal form of hemoglobin [(1); (2)]. It is most widespread between people of Middle Eastern countries, Greek, Italian, South Asian, and African descent (1). Hemoglobin (Hemoglobin) is the protein molecule in red blood cells which contains iron. It is used that carries oxygen around the human body (3). The disorder results in excessive destruction of red blood cells, which leads to anemia; anemia is a condition in which your body doesn't have enough normal, healthy red blood cells (4).

Thalassemias are genetic disorders inherited from a person's parents (1). This means that one

of the parents carries thalassemia that caused by missing genes which produce the hemoglobin in the human body. If both parents are carriers of thalassemia, the probability of inheriting a more serious form of the disease is greater. The destruction of red blood cells and inappropriate of oxygen transporters leads to forming the abnormal hemoglobin in the body (5).

Persons with thalassemia disease have a fewer red cells blood and less hemoglobin comparing with not infected persons. From moderate to severe anemia, thalassemia kind depends on the physiological conditions of the body. There are two main types, Alpha-thalassemia (α -thalassemia,) and Beta - thalassemia (β - thalassemia) (1), with three types Beta-Thalassemias major (no Alpha-globin assembled), intermediate (some of Alpha-globin is produced) and finally minor (one of the two Beta-globin has a mutation) (6). The common

complaints and signs can be resulted from thalassemia may include Complications may include bones deformity , iron overload and cardiovascular illness .Thalassemia makes the bones marrow expand, thin, brittle and increasing the risk of broken bones, especially in the face and skull areas(6).

The present work introduces a simple and effective methodology for Thalassemia based on the theory of the pure fractions. The developed methodology is suitable for application in a much wider range of thalassemia disease. We define the concept of pure fractions relevant to the considered genetic diseases (Thalassemia).In this paper, we use pure fractions to create a mathematical model for controlling thalassemia disease diagnosis and how to perform Monte Carlo simulation in MATLAB.

The rest of the paper is organized as follows: in Section 2, Preliminaries - mathematical background was introduced. Section 3, presents pure fractions and thalassemia disease. We create a mathematical model for thalassemia disease in section 5, while, an applicable example was explained in section 6. Monte-Carlo Simulation model was built and explained in section 7; also results, discussion and conclusion of the mathematical model are given in Sections 8 and 9 respectively.

2: Preliminaries - Mathematical Background: Theory of numbers is the fundamental theory of mathematics. In the past, this theory has concentrated essentially on the properties of integers (7). However, in recent times, the theories and properties of other classes of numbers have proved worthy of more formal investigation (8). Among the class of numbers whose theory attracts much attention are the numbers in the unit- interval (UI) $[0, 1]$, which we call pure fractions (7).

In mathematics, fuzzy sets are sets whose elements have degrees of membership. Fuzzy sets were introduced by Lotfi A. Zadeh and Dieter Klaua in 1965 as an extension of the classical notion of set [(9); (10)]. At the same time, Sali, defined a more generic type of structure called an L-relation which is applied in an abstract algebraic context (11).

Fuzzy relations are special cases of L -relations when L is the Unit -Interval (UI) $[0, 1]$ figure (1). The UI is the closed interval $[0, 1]$, that is, the set of all real numbers (\mathbb{R}) that is greater than or equal to 0 and less than or equal to 1 (≥ 0 and ≤ 1). It is often denoted by I [(12); (13)]. In the literature, the term "unit interval" is sometimes applied to the other shapes that an interval from 0 to 1 could take: $(0, 1]$, $[0, 1)$, and $(0, 1)$.



Figure (1): UI as a subset of \mathbb{R}

In this paper we formalize some properties of pure fractions and give a biologically related application. We shall create a new form of representation for a given pure fraction. The motivation for the new form is the nature of the numbers $0, 1/2, 2/3, 3/4, 4/5...$ Which are numbers expressible in the form $(1 - \frac{1}{n})$ for an integer $n \geq 1$. We call such numbers co-harmonic fractions. An important characterization of a pure fraction s is that s can be represented in definition (4:1) – section 4. These preliminaries and concepts will be addressed in subsequent items of the research.

3. Pure Fractions and thalassemia disease: The current work presents an efficient and simple methodology for thalassemia transition based on the theory of the pure fractions. This developed methodology is proper for implementation in a much wider domain of thalassemia and other genetic diseases. Through that methodology, the concept of pure fractions relevant to the genetic disease (thalassemia) was defined. In this section, a mathematical model is developed to handle the diffusion of the thalassemia gene in which the concept of reducibility of pure fractions is utilized. The concepts such as reducibility, representation of pure fractions and the fuzzy sets has a significant role in the development of the mathematical model of the current study.

Consider a hypothetical genetic disease (d) and a gene (g) responsible for the disease d . We imagine that every number in the unit interval $[0, 1]$ as representing a possible genotype for g .

That is, each pure fraction $s \in [0, 1]$ measures a corresponding degree of possession and transmission of the gene g by an individual denoted by X , as done in fuzzy logic for truth values Nguyen and Walker (14). It is noticed here that the pure fraction can also be thought of as the probability of possession and transmission of the gene g by the individual denoted by X (13). A person with a "high incidence" of the gene g is defined as someone who has a genotype falling in the sub-interval $I_2 = [1/2, 1)$. An individual with such genotype may suffer from discrimination when selecting a spouse. However, we make the proposition that such an individual would like to have a spouse so that their descendant of some future generation would be more providential and would have a genotype of g that does not fall in sub-interval

I_2 . Such an individual is a descendant with a "low incidence" of g and has a genotype that falls in the subinterval $I_1 = [0, 1/2)$. Based on what is stated above, we will devise a mathematical model, where an individual with a high incidence of the gene g can be matched with the appropriate spouse so that a future descendant can have a low incidence of the gene g .

4. Reducibility of Pure Fractions

Representation: The theory of pure fraction originates from the work on the application of fuzzy sets (13). In this section we will introduce some known and useful definitions; propositions; theorems; regarding pure fractions which will be used for creating the mathematical model to control the transmission of thalassemia disease.

Definition (4.1): If s is called a pure fraction defined on the UI $[0, 1]$, then s can be represented in the following forms:

$$s = \frac{r + \alpha - 1}{\alpha},$$

Where: $r \in [0, 1]$, and α is a positive real number. Let \mathbb{R}^+ be the set of non-negative real numbers (\mathbb{R}), then for a given pure fraction and a positive real number α , we define $r^{[\alpha]}$ by: $r^{[\alpha]} = \frac{r + \alpha - 1}{\alpha}$, (i.e. every pure fraction can be represented in the above form, if $r^{[\alpha]} \notin [0, 1)$ then it is called indeterminate).

Definition (4.2): Reducibility of the pure fractions is generated by the two subintervals of $[0, 1]$, i.e., irreducible pure fractions are defined in the subinterval $[0, \frac{1}{2}]$ and reducible pure fractions are defined in the subinterval $[\frac{1}{2}, 1]$.

Definition(4.3): Two sequences $\{x_n\}$ and $\{y_n\}$ of pure fractions are said to constitute a Genetic Remediation Scheme (GRS) if:

- 1) x_1 is reducible
- 2) $y_n = x_n^{[1/2]} = 2x_n - 1$, $n = 1, 2, \dots$
- 3) $x_{n+1} = \frac{1}{2}(x_n + y_n)$
- 4) The iteration stops when x_N is irreducible for some positive integer N .

Theorem (4.4): The sequences $\{x_n\}$ and $\{y_n\}$ of pure fractions that constitute a Genetic Remediation Scheme (GRS) are decreasing and finite. Furthermore, for every k such that $\{y_k\}$ is reducible we have $y_{k+1} \geq y_k^{[1/2]}$.

Proof: first we want to prove that the sequences are decreasing and reducible. It is given that there are two sequences $\{x_n\}$ and $\{y_n\}$ with a GRS property, definition (4.3), then we have $\{y_k\}$ such that:

$$y_k = x_k^{[1/2]} = 2x_k - 1 < 2x_k - x_k = x_k, \cdot x_k^{[1/2]} = 2x_k - 1, \text{ this implies that:}$$

$$x_{k+1} - \frac{1}{2}(x_k + y_k) < x_k, \text{ then } y_{k+1} = x_{k+1}^{[1/2]} < x_k^{[1/2]} = y_k.$$

In addition we have:

$$y_k < x_k \rightarrow y_k < \frac{1}{2}(x_k + y_k) = x_{k+1}. \text{ Hence, } y_k^{[1/2]} < x_{k+1}^{[1/2]} \text{ whenever } y_k \text{ is reducible.}$$

Second to prove the sequences are finite, suppose there exists no positive integer N s.t x_n is irreducible.

Then $x_n \geq \frac{1}{2}, \forall n$. Since $\{x_n\}$ is decreasing and bounded, $\{x_n\}$ converges to some pure fraction s .

Similarly, $\{y_n\}$ converges to some pure fraction t . Consequently,

$$s = \lim_{n \rightarrow \infty} x_{n+1} = \frac{1}{2} \lim_{n \rightarrow \infty} (x_n + y_n) = \frac{1}{2}(s + t)$$

. Thus $s = t$. Then

$$s = \lim_{n \rightarrow \infty} y_n = \lim_{n \rightarrow \infty} (2x_n - 1) = 2s - 1 \rightarrow s = 1$$

. But $s \leq x_1 \leq 1$. Therefore, we have a contradiction and this completes the proof.

Proposition 4:5: Let $s \in [0, 1)$. Then, the following conditions are equivalent for a positive integer n .

1. $s = r^{[n]}$ For some $r \in [0, 1)$
2. $i(s, 0) \geq n$
3. $1 > s \geq 1 - \frac{1}{n}$

Definition 4:6: A pure fraction s is called reducible if s satisfies any of the equivalent conditions of Proposition 4:5 for some integer $n \geq 2$. Otherwise, s is called irreducible. As a consequence of Proposition 4:5, a pure fraction s is irreducible $\Leftrightarrow s = 1$ or $s < \frac{1}{2}$. Thus, we have a partition of $[0, 1)$ into $I_1 = [0, \frac{1}{2})$ & $I_2 = [\frac{1}{2}, 1)$ consisting, respectively of irreducible and reducible pure fractions. Based on the above definition, we have a partition of the UI $[0, 1)$ into: $I_1 = [0, \frac{1}{2})$, and $I_2 = [\frac{1}{2}, 1)$ to determine the reducibility and irreducibility of the pure function which controls the transmission of the thalassemia as follows:

$$s = \begin{cases} I_1 = [0, \frac{1}{2}), \text{ irreducible pure fraction (keep iteration)} \\ I_2 = [\frac{1}{2}, 1), \text{ reducible pure fraction (stop iteration)} \end{cases}$$

5. Mathematical Model for Thalassemia Disease: The mathematical model was developed based on the definitions, theories, and assumptions that have been mentioned in sections 3 and 4. Also, we adopt previous studies uses a mathematical model for the control of the transmission of genetic diseases using pure fractions conducted by Boniface Eke1, Asamoah Nkwanta; and S. Thakur et al; 2016) [(15; 16);]. The theory and properties of pure fractions are used which are defined by Eke in 2008 (13).

Suppose that g denotes a gene which is responsible for the Thalassemia disease T . Also, there is a function: $T: H \rightarrow [0, 1]$, s.t the following assumptions are satisfied:

- For a "genotype" $t = T(X)$ the followings are holds:
 - i. X is completely free of $g \Leftrightarrow t = 0$
 - ii. X has a "low incidence" of $g \Leftrightarrow t \in [0, \frac{1}{2}]$
 - iii. X has a "high incidence" of $g \Leftrightarrow t \in [\frac{1}{2}, 1]$
- If $t = r^n$, then r is also in the range of T .
- The genetic structure of an individual is proportional to that of his/her parents x' , and y' , hence:

$$T(X) = \frac{t}{t+1}$$

- If both X and Y are in danger of the Thalassemia disease T then an individual Y will not accept X for a marital partner if:

Since we have the function $T : H \rightarrow [0,1]$, then we can set the condition “marital connections” such that an individual X with genotype $T(X) \in [0,1]$ can be “tolerated for marriage” by an individual Y only if they can have a descendant Z , such that $T(Z) > \frac{1}{2}$. Now to solve the problem “marital connections” suppose that for the any positive integer n , $\{x_n\}$ and $\{y_n\}$ are the sequences of individuals with their genotype sequences $\{x_n\}$ and $\{y_n\}$.

$$T(y) < \min \left(T(x_n)^{\frac{1}{n}} + T(y_n)^{\frac{1}{n}} \right)$$

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method utilizes iterative random sampling to produce simulated data to use with a mathematical model(13). Mathematical models are one of analysis systems that use this technique.

To generalize the usefulness of the proposed approach to predict the number of generations needed to eliminate Thalassemia or other similar genetic diseases, Monte-Carlo simulation via MATLAB will be used in this work. This approach of using both Fuzzy sets and discrete even simulation is not new, previous work has been done as in Zhang et al. (18).

In this section we extend the calculations made in Section 6 to a population of 500,000 individuals with uniformly distributed, random and high incidence of the Thalassemia gene $\in I_2$, the goal would be to evaluate how many generation needed so that all generated members of the final population have low incidence of the Thalassemia gene.

As in Section 6 also we assume assumption 4.5 holds for choosing a partner. We model this problem using Monte Carlo simulation using MATLAB. For the purpose of demonstration we limit the number of children per generation to one child.

Figure (2) shows the histogram for the number of generations needed so that the final generation has low incidence of the X gene. The mean number of generations needed to eliminate this gene based on our assumptions would be equal to 4 generations.

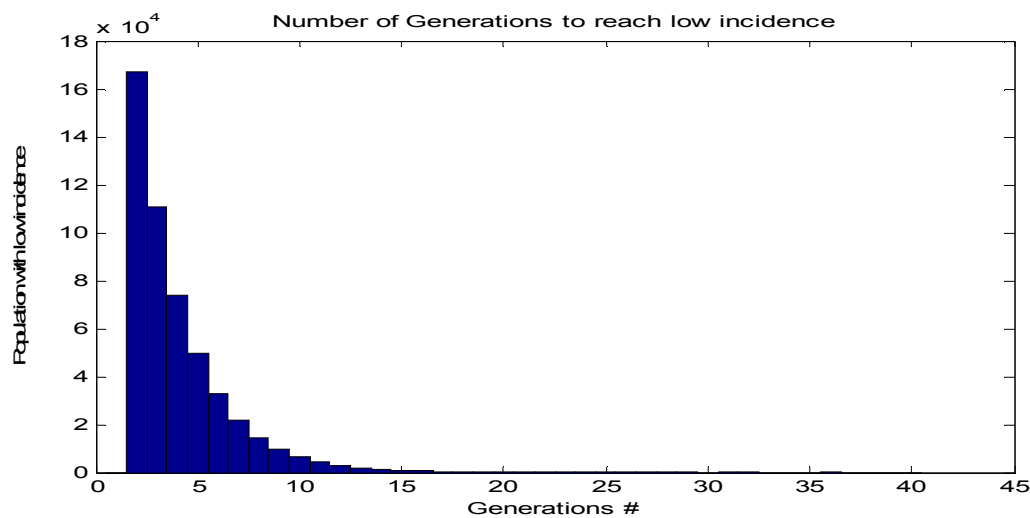


Figure (2):The number of generations needed to obtain the whole population with low incidence of Thalassemia.

Of course, it is hard to obtain a partner with assumption 4.5 exactly holds. The assumption 4.5 should be thought of as an upper limit, i.e. if an individual wants to have a spouse/husband with Thalassemia gene, the spouse/husband's incidence should be less than or equal to the value obtained from assumption 4.5. If this modification is applied then we would expect to eliminate the disease in lesser number of generations than before. Figure 2 shows this

new assumption and its corresponding results. **Figure (3)** shows the number of generations needed to obtain a population with low incidence of the Thalassemia disease with new policy applied. In this scenario, the average number of generations needed to eliminate the high incidence of the gene is just below 3 generations.

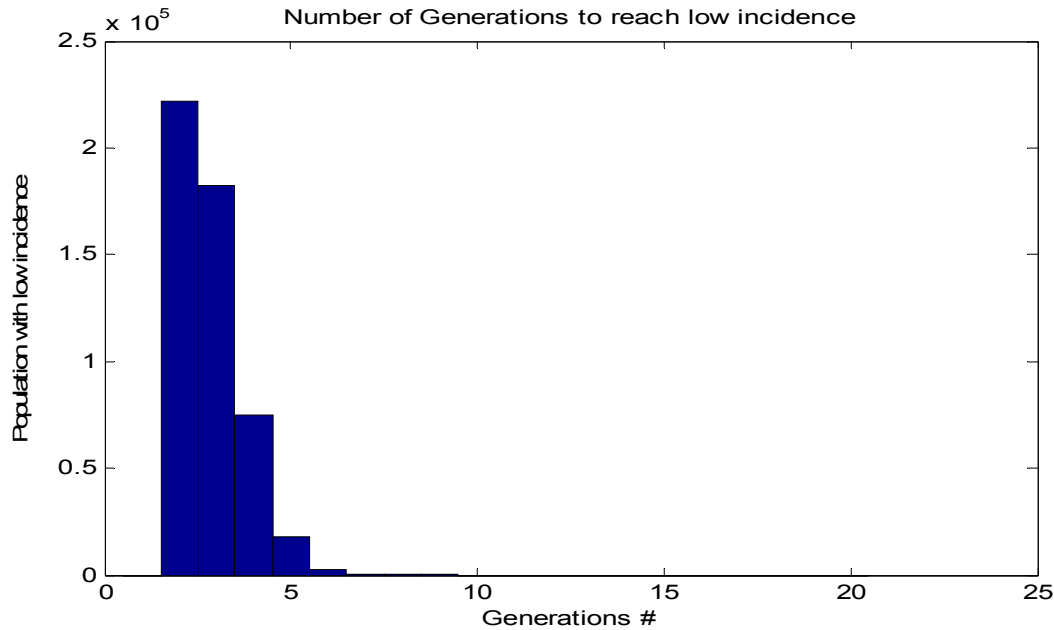


Figure (3): The number of generations needed to obtain a population with low incidence of Thalassemia.

8. RESULTS AND DISCUSSION:

We constructed a mathematical modeling using pure fractions and Monte Carlo simulation to control Thalassemia Disease transition. An example in section 6 has been applied to demonstrate the simplicity of the technique. Through the computed iteration see Table 1, we have X_n s.t for generation $N = 6$, $X_6 < \frac{1}{2}$, hence $X_6 \in I_1$.

Therefore, after the 6th. Generation X_1 and Y_1 will have the descendant X_6 who has a “low incidence” of the thalassemia gene with genotype. The study of the genotypes for thalassemia disease which is a genetic disease is the motivation for the development of the mathematical model and the Monte Carlo simulation. For this genetic disease, the people in danger are those with the genotypes $X \in [\frac{1}{2}, 1)$. The genotypes in $[\frac{1}{2}, 1)$ are all reducible pure fractions. In this paper, the objective of creating this mathematical model is the controlling the transition of genes with “high incidence” genotypes to reach at genotypes $X \in [0, \frac{1}{2})$ with “low incidence” so to get a healthy offspring from such a genetic disease over the future generations.

The mathematics of pure fractions was so appropriate for this objective. The theory of pure fractions is completely new in the sense in which the authors believe this work is the first study to formalize and standardize special structural properties of pure fractions. The theory shows potential for further research and applications. Particularly, the type of Genetic Remediation Scheme (GRS) can be modified to apply into many other genetic diseases. Monte-Carlo simulation on the other hand proved these results by testing a large population of 500,000 individuals with the thalassemia gene.

9. CONCLUSION:

In this research article, pure fraction plays a very useful role to control the transmission of thalassemia gene and to create a new generation without thalassemia Major or severe forms of thalassemia gene. Here, we adopt the concept of pure fraction to obtain a mathematical model that controls the thalassemia disease transmission. GRS can be determined depends on the value of X_n , if it is in the domain of I_2 or I_1 . This model would help to the reduce thalassemia risk in future generation and to improve the medical care. The model was mathematically proved by the Monte-Carlo Simulation as well. Future outlooks could be

extended to treat other variant infected and target cells.

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Modeling of Encapsulation of Alanine Amino Acid inside a Carbon Nanotube

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Abstract

Carbon nanotubes play a significant role in facilitating and controlling the transportation of drugs and bio-molecules through their internal and external surfaces. Carbon nanotubes are also selective nano-devices because of their outstanding properties and huge potential use in many bio-medical and drug delivery applications. The proposed model aims to investigate the encapsulation of Alanine molecule inside a single-walled carbon nanotube, and to determine the minimum energy arising from the Alanine interacting with single-walled carbon nanotubes with variant radius r . We consider two possible structures as models of Alanine amino acid which are a spherical shell and discrete configuration modelled as comprising three components: the linear molecule, cylindrical group and CH_3 molecule as a sphere, all interacting with infinite cylindrical single-walled carbon nanotube. The adsorption of Alanine amino acid and magnitude of total energy for each orientation calculated based on the nanotube radius r and the orientation angle ϕ which the amino acid makes with central axis of the cylindrical nanotube. Our results indicate that the Alanine molecule encapsulated inside the nanotubes of radius greater than 3.75 Å, which is in excellent agreement with recent findings.

Keywords: Carbon nanotube (CNT); Alanine amino acid; Encapsulation; Potential energy; van der Waals Force; Lennard-Jones potential

Introduction

The area of nanotechnology and nanoscience has witnessed unexpected growth of researches and applications which aim to design and enhance new nano-devices by manipulating in their nano-scales size, unique features and distinct properties. These Engineered nano-devices are very important and preferable tools, such as carbon nanotubes (CNTs), nanobuds and fullerenes which can be used as carriers in the diseases diagnosis and treatment [1,2]. The debut of CNTs has initially generated much interest in their potential applications in designing life sciences since its discovery [3]. The usefulness of nano-particles in medicinal applications, especially in drug delivery and disease therapy has spread rapidly [4]. Their distinct properties have motivated scientists to investigate the possibility of combination between carbon nanostructures and drugs, and the mechanisms of their reactions and encapsulation [5-7]. For example, they can be used as carriers in drug delivery applications to increase the efficiency of treating the infected sites, attacking the pathogens and inhibiting the growth of viruses and cancer cells by reducing the toxicity and solubility rate, especially in aqueous media [8-11]. Dresselhaus et al. [12] predict that the CNT with Chiral vector (5, 5) would be the most significant physical nanotube. CNTs have a huge potential for enhancing new techniques for drug delivery applications and can be covalently and non-covalently bonded to bio-molecules, such as α -amino acids and drugs [7,9,13]. Long-term studies have addressed the ability of proteins and amino acids to conjugate with carbon nanotubes by using different methods; Molecular Dynamic Simulations (MDSs), Density Functional-Based Plus (DFBP) and Spanish Initiative Simulations (SIESTA) [14-16]. Amino acids can interact with either the outer wall (binding) or the inner surface (encapsulation) of multi-walled (MWCNTs) and single-walled carbon nanotubes (SWCNTs) [17]. An on-going work aims to study the encapsulation of Alanine molecule inside a cylindrical SWCNT.

Amino acids a family of biological compounds that have a critical role in many metabolic functions in the human body. They are classified into two sub-functional groups, proteinogenic and non-proteinogenic,

based on the synthesization by the human body, such as Phylanine, Histidine, Alanine, Cystine, ...etc. Alanine is a non-essential amino acid in human because it can be synthesized in the body. It is known to be one of the most important amino acids synthesized long before it was first isolated from the natural resources in 1879 by Adolph Strecker [18,19]. It is a hydrophobic and ambivalent molecule with a chemical formula $\text{C}_3\text{H}_7\text{NO}_2$, this means that it can be found inside or outside of the protein molecule. Under biological conditions, Alanine's structure can be divided into three sub-groups; α -amino group (NH^+ : Protonated, value of $\text{pK}_{a1}=9.69$), α -Carboxylic acid group (COO^- : Deprotonated, value of $\text{pK}_{a2}=2.34$) and a side chain methyl group (value of pK_{a3} is still unknown) which is classified as non-polar at physiological pH [20]. It is found in a wide variety of daily food, especially in meats, fish and seeds, can be manufactured in the human body from branched chain of amino acids, such as Pyruvate, Valine and Leucine and is also arisen together with generating glucose and lactate from protein via Alanine cycle [21]. Alanine has a vital role in Glucose-Alanine cycle between liver and tissues, which is used as fuel in muscles and other tissues. After being formed, passed to the blood then transported to the liver. The Glucose-Alanine cycle contributes in removing Glutamate and Pyruvate from the muscle, which then find their way to the liver and participating in urea cycle to form urea [22,23]. Long-term study conducted by Imperial College London confirmed that the high level of Alanine amino acid can increase energy intake, cholesterol and the blood pressure levels [23]. In addition, it supports prostate health, guards against producing the toxic substances which leads to breaking down the proteins in the muscles,

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strengthens the immune system by producing the anti-bodies if needed, and plays a key role by transferring the nitrogen from peripheral tissues to the liver [23,24]. Taking an oral dose of Alanine with insulin-dependent diabetes can be more effective than a conventional bed-time snack [24]. The adsorption of different amino acids inside single-walled carbon nanotubes (SWCNTs) has been studied and investigated [17,25-28].

The recent studies have gained much more attention and also intensively studied the combination of carbon nanodevices with different bio-molecules as inhibitors for disease therapy or as safe agents for drug delivery system, such as amino acids and drugs [17,18,26,29,30]. This has led to motivating the scientific researchers to enhance the ability and conductivity of these carbon nanodevices by manipulating in their conductivity and intrinsic structural properties [31-35]. Trzaskowski et al. [36] indicate that amino acids may bind to the outer surface and interact with the interior wall of CNTs. In addition, Roman et al. [37] calculate the adsorption of different amino acids on graphite sheet and the (3, 3) SWCNT by using the density functional theory (DFT). Further example, Vardanega et al. [38] show that the adsorption (outer surface) and encapsulation (inner wall) of amino acids with a dielectric SWCNT is carried out. Chang et al. [39] theoretically study and investigate the encapsulation of amino acids. Inside Zigzag SWCNTs and their results reveal that the stability of amino acids along the interior cavity wall. Ganji [17] also calculates the encapsulation of Histidine, Phenylalanine, Cysteine and Glycine amino acids inside the SWCNTs by using the Spanish Initiative Simulations (SIESTA) with thousands of atoms and the Density Functional Theory Based Methods (DFT and DFTB⁺). Recent computational, numerical and experimental results show that the interaction energies arising from different amino acids interacting with inner surface of SWCNTs with variant radius r are very small in the range of approximately -0.1 to -0.8 kcal/mol compared to those of gas molecules and nucleic acid bases of approximately 20.8 and 20.1 kcal/mol, respectively [40-44].

In this paper, we only examine the encapsulation of Alanine amino acid inside a SWCNT as shown in Figure 1. Here, we propose a mathematical model by assuming the Alanine molecule as comprising three parts (discrete approach): a group of atoms as a linear molecule, a cylindrical group of atoms and a spherical shell and all atoms containing the Alanine molecule assumed to be as a spherical shell (continuum approach). Each orientation interacting individually with an infinite nanotube of radius r which is assumed to be uniformly distributed, well-defined and characterized as a perfect cylinder.

In the next section, we briefly outline the two significant physical concepts of van der Waals force and Lennard-Jones potential, and also determine the values of minimum energies by using a discrete-continuum approach and depending on the inner radius of nanotube r and the orientation angle φ . Followed by a discussion and analysis are in results section. Finally, conclusions are given in the last section.

Modelling Approach

In this model, we obtain the biophysical model which describes the encapsulation of Alanine molecule inside SWCNT of radii r as a mathematical model to determine the interaction energy between specific atoms at point P inside cylindrical nanotube. Next, we use the Cartesian coordinate system (x, y, z) as a reference to model the two interacting molecules, Alanine molecule and the SWCNT as a perfect and well-defined cylinder. We assume that the specific point at atom P parameterized by $(0, 0, \delta)$, where $0 \leq \delta \leq r$. Next, we apply the discrete continuum approximation by using van der Waals force and Lennard-

Jones potential to model the encapsulation of Alanine amino acid inside infinite SWCNT of radius r . The Lennard-Jones potential is given by

$$\Psi(\rho) = \frac{-A}{\rho^6} + \frac{B}{\rho^{12}} \quad (1)$$

where, ρ denotes the distance between two well-defined different molecules, $\Psi(\rho)$ is the potential function, the significant physical parameters, A (attractive) and B (repulsive), are calculated by using the empirical combining laws given by where E is the well depth, σ is the van der Waals diameter and ζ is the non-bond energy [45,46]. Here, we apply discrete-continuum approximation, specific atom is assumed to be uniformly distributed over the surfaces of the two interacting molecules. To obtain the total energy for all orientations as in Figure 2(ii), we first need to determine the interaction energy between the atoms at point P inside an infinite SWCNT as shown in Figure 1(i). The magnitude of total energy arising from the interaction between a specific atom at point P and the cylindrical nanotube can be mathematically obtained by performing a surface integral of the Lennard-Jones potential over the nanotube and given

$$E_{\text{int}} = \eta_c \eta_l \int_{\delta_c} \int_{\delta_l} \Phi(\rho) d\delta_l d\delta_c \quad (2)$$

Where η_c and η_l are the mean surface densities of atoms on the two interacting molecules, and

$d\delta_c$ and $d\delta_l$ are typical surface elements located on the two interacting molecules.

Adsorption of Alanine inside SWCNT

Alanine as a spherical shell

In this proposed model, we apply the continuum approach and Lennard-Jones potential together to determine the minimum energy arising from Alanine-SWCNT interaction. The cylindrical nanotube is assumed to be as a perfect cylindrical shell which can be parameterized by $(r \cos \theta, r \sin \theta, z)$, the Alanine amino acid assumed to be a spherical molecule of radius r_s located at $(r_s \sin \varphi \cos \theta, r_s \sin \varphi \sin \theta, r_s \cos \varphi)$ as shown in Figure 2 and the distance between the spherical shell and cylindrical tube is given by

$$S_r = \int_{-\infty}^{\infty} \frac{\delta E}{\delta Z} dz = E(\infty) - E(-\infty)$$

From Cox et al. [47], we find the interaction energy between the sphere of atoms of radius r_s and cylindrical nanotube as

$$E_{\text{spherical-CNT}} = \pi r_s \eta \int_{-\infty}^{\infty} \int_{-\pi}^{\pi} \left[\frac{A}{2} \left(\frac{1}{\rho(\rho+r_s)^4} - \frac{1}{\rho(\rho-r_s)^4} \right) - \frac{B}{5} \left(\frac{1}{\rho(\rho+r_s)^{10}} - \frac{1}{\rho(\rho-r_s)^{10}} \right) \right] r dz d\theta \quad (3)$$

where $\eta_N = 13/\text{volume}$ of the sphere is the atomic volume density of the spherical molecule (CH_3).

Alanine comprised as three configurations

We assume that the centre of Alanine molecule is located at the origin (center of the infinite cylindrical nanotube). The minimum energy arising from the interaction between Alanine molecule and a cylindrical SWCNT with infinite length is accounted in three orientations as shown in Figure 2. Firstly, the two carbon and one nitrogen atoms forming a linear molecule which is assumed to be located at $(0, 0, t \cos \varphi + z_0)$, where $t \in [0, \sigma_{\text{CN}} + \sigma_{\text{CC}}]$ and the distance ρ_1 between the linear chain and the nanotube is given by $\rho_1^2 = r_2^2 + (z - (t \cos \varphi + z_0))^2$. From work of Al Garalleh et al. [48] defining D_n as

$$D_n = r \int_{-(\sigma_{\text{CN}} + \sigma_{\text{CC}})/2}^{(\sigma_{\text{CN}} + \sigma_{\text{CC}})/2} \int_0^{2\pi} \int_{-\infty}^{\infty} \frac{1}{\rho_1^{2n}} dz d\theta dt \quad (4)$$

so, the interaction energy between linear molecule and cylindrical nanotube can be given by

$$E_{\text{Linear-CNT}} = \eta_c \eta_l (-AD_3 + BD_6) \quad (5)$$

where η_c and $\eta_l=3/\text{length}$ of linear molecule are the atomic surface densities for the carbon nanotube and linear chain (a nitrogen and two carbon atoms), respectively.

Secondly, we assume a group of two oxygen and four hydrogen atoms as a cylindrical shell of radius r_1 . This cylinder is assumed to be located at $(r_c \cos \theta, r_c \sin \theta, t+z_0)$ and $t \in [0, \sigma_{CO} + \sigma_{CH}]$,

where the distance ρ_2 between the nanotube of radius r and the cylindrical group of radius r_c is given by

$$\rho_2^2 = (r \cos \theta - r_c \cos \theta)^2 + (r \sin \theta - r_c \sin \theta)^2 + (z - (t + z_0))^2$$

From the work of Cox et al. [49], if T_n is given by

$$T_n = r \int_{-\sigma_{CN} + \sigma_{CC}/2}^{\sigma_{CN} + \sigma_{CC}/2} \int_0^{2\pi} \int_0^{2\pi} \int_{-\infty}^{\infty} \frac{1}{\rho_2^{2n}} dz d\theta d\theta dt, \quad (6)$$

the interaction energy between cylindrical group pf atoms and cylindrical nanotube is given by

$$E_{\text{Cylinder-CNT}} = \eta_c \eta_g (-AT_3 + BT_6) \quad (7)$$

where $\eta_g=6/\text{surface area}$ of the cylinder group is the atomic surface density of the cylindrical group. Finally, we consider the carbon and three hydrogen atoms (CH_3 molecule) as a sphere of radius $b=\sigma_{\text{CH}}$ which is assumed to be located at $(b \sin \varphi \cos \theta, b \sin \varphi \sin \theta, b \cos \varphi)$ and the distance between the spherical shell and cylindrical tube is given by $\rho_3^2 = (r \cos \theta - b \sin \varphi \cos \theta)^2 + (r \sin \theta - b \sin \varphi \sin \theta)^2 + (z - b \cos \varphi)^2$. We find the interaction energy between the sphere of radius $b=\sigma_{\text{CH}}$ and cylindrical nanotube by using the equation 3 which can be given

$$E_{\text{CH}_3\text{-CNT}} = \pi b \eta_H \int_{-\infty}^{\infty} \left[\frac{A}{2} \left(\frac{1}{(\rho_3(\rho_3 + b)^4)} - \frac{1}{\rho_3(\rho_3 - b)^4} \right) - \frac{B}{5} \left(\frac{1}{(\rho_3(\rho_3 + b)^{10}} - \frac{1}{\rho_3(\rho_3 - b)^{10}} \right) \right] r dz d\theta \quad (8)$$

Where $\eta_H=4/\text{surface area}$ of the sphere is the atomic surface density of the spherical molecule (CH_3). Thus, we gather all sub-interactions arising from the encapsulation of Alanine molecule inside SWCNT of

radius r to determine the magnitude of total energy which is given as

$$E_{\text{tot}} = E_{\text{Linear-CNT}} + E_{\text{Cylinder-CNT}} + E_{\text{CH}_3\text{-CNT}} \quad (9)$$

Acceptance and suction energies

To demonstrate the adsorption of the Alanine molecule inside a SWCNT, we first need to determine the acceptance and suction energies. We then evaluate the acceptance energy moving from $-\infty$ to z_0 to determine whether the Alanine amino acid will be sucked into a cylindrical SWCNT. Next, we calculate the suction energy which is the total energy for a molecule moving from $-\infty$ to ∞ . Based on work of Cox et al. [55], a molecule is accepted inside a CNT if the acceptance energy (A_r) is greater than zero, which is given by noting that z_0 is the root of equation $\partial E/\partial z=0$, which is the point where the molecule is about to enter the nanotube. The suction energy (S_r) is calculated as the total integral of the axial force from $-\infty$ to ∞ and is given by

$$A_r = \int_{-\infty}^{z_0} \frac{\delta E}{\delta Z} dz = E(Z_0) - E(-\infty) \quad (10)$$

Noting that z_0 is the root of equation $\partial E/\partial z=0$, which is the point where the molecule is about to enter the nanotube. The suction energy (S_r) is calculated as the total integral of the axial force from $-\infty$ to ∞ and is given by

$$S_r = \int_{-\infty}^{\infty} \frac{\delta E}{\delta Z} dz = E(\infty) - E(-\infty) \quad (11)$$

The suction energy S_r can be converted directly to the kinetic energy of the moving molecule, in the case there is no energy dissipation.

Results and Discussion

Here, we apply the discrete-continuum approach to evaluate the interaction energy of encapsulation of Alanine inside SWCNT. The well-depth E , van der Waals diameter σ and non-bond energy ζ are shown as in Table 1. The significant physical parameters and radii r of carbon nanotubes involved in this model are calculated as in Table 2. The attractive ($A=4_e\sigma^6$) and repulsive ($B=4_e\sigma^{12}$) constants are calculated by using the concepts of well-depth E and the van der Waals diameter σ and are given in Table 3. We calculate the atomic densities from dividing the number of atoms for each interaction pair by the volume or surface of the assumed structure and also determine the radius of the CNT r by using the chirality concept $((n, m))$, as shown in Table 4, which can be calculated by using the relationship as shown in Figure 3 [56],

$$r = 0.3915 \left[j \sqrt{(n^2 + m^2 + nm)} \right] \quad (12)$$

Maple package used to evaluate and plot the minimum energy arising from the interactions between Alanine and SWCNT of radii r (the SWCNT assumed to be characterized by well- defined with an infinite length). The magnitude of Alanine-SWCNT interaction depends on the nanotube radius r and the orientation angle φ as shown in Figures 4 to 11. By considering the nanotubes $(9, 0)$, $(8, 2)$, $(6, 5)$, $(7, 4)$, $(8, 3)$, $(9, 2)$, $(10, 3)$ and $(13, 0)$ which have radii $r=3.523, 3.591, 3.735, 3.775, 3.861, 3.973, 4.615$ and 5.089 \AA , respectively, and assuming that $\varphi=0, \pi/6, \pi/3$ and $\pi/2$. In this model, we deduce the minimum radius of the nanotube that will accept the Alanine molecule for each configuration and find out that the encapsulation of Alanine occurs when r is greater than 3.75 \AA . The lowest interaction energy is obtained when $r=4.615 \text{ \AA}$ ($(10, 3)$ nanotube) and is more favorable when Alanine molecule as a spherical structure for continuum approximation and $\varphi=0$ then followed by $\pi/6, \pi/3$ and $\pi/2$ for discrete approximation. The magnitude of the minimum energies for both configurations is given in Table 4. For all orientations, we note that there is a minimal difference in the value of interaction energy inside SWCNTs and the

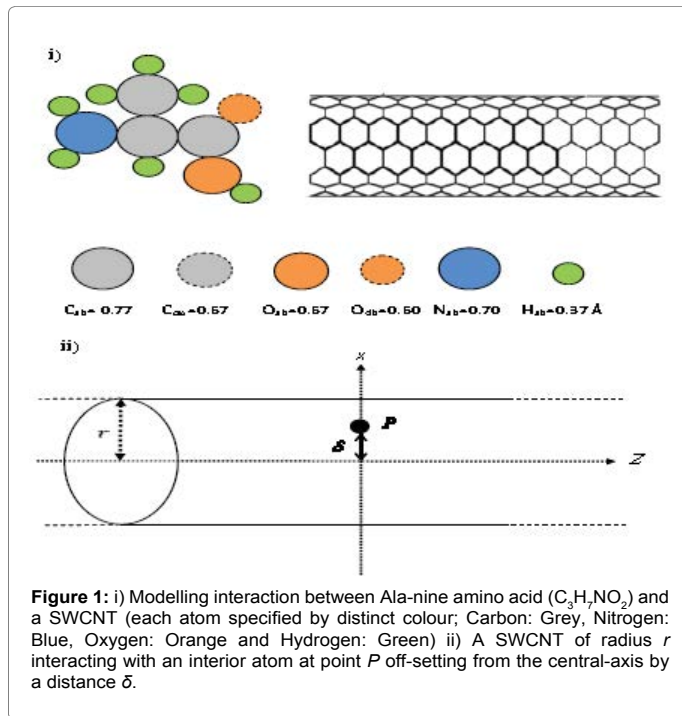


Figure 1: i) Modelling interaction between Alanine amino acid ($\text{C}_3\text{H}_7\text{NO}_2$) and a SWCNT (each atom specified by distinct colour; Carbon: Grey, Nitrogen: Blue, Oxygen: Orange and Hydrogen: Green) ii) A SWCNT of radius r interacting with an interior atom at point P off-setting from the central-axis by a distance δ .

Interaction	E (Å)	σ (Å)	ζ (Kcal/mol)	Interaction	E (Å)	σ (Å)	ζ (Kcal/mol)
H-H	0.74	2.886	0.044	O-H	0.96	3.193	0.051
O-O (sb)	1.48	3.5	0.06	O-O (db)	1.21	3.5	0.06
N-N	1.45	3.66	0.069	N-H	1	3.273	0.055
C-C (sb)	1.54	3.851	0.105	C-H	1.09	3.368	0.068
C-C (db)	1.34	3.851	0.105	C-O (sb)	1.43	3.675	0.079
C-O (db)	1.2	3.675	0.079	C-N	1.47	3.755	0.085

Table 1: The Lennard-Jones constants (E : Bond length, σ : Non-Bond distance and ζ : Non-Bond energy) (sb: single bond; db: double bond) [45,50-53].

Radius of CNT (9,0)	3.523 Å [54]
Radius of CNT (8,2)	3.591 Å [54]
Radius of CNT (6,5)	3.735 Å [54]
Radius of CNT (7,4)	3.775 Å [54]
Radius of CNT (8,3)	3.861 Å [54]
Radius of CNT (9,2)	3.973 Å [54]
Radius of CNT (10,3)	4.615 Å [54]
Radius of CNT (13,0)	5.089 Å [54]
Radius of the cylindrical group	$r_c=2.39$ Å
Radius of the hydrogen sphere	$b=1.091$ Å
Radius of the spherical shell	$r_s=3.205$ Å
Length of the cylindrical group	$L=6.41$ Å
Surface density for carbon nanotube	$\eta_c=0.381$ Å ⁻²
Atomic line density of the linear carbon atoms	$\eta_l=0.732$ Å ⁻¹
Surface density of the cylindrical group	$\eta_g=0.063$ Å ⁻²
Surface density of the sphere (CH ₃)	$\eta_H=0.268$ Å ⁻²
Volume density of the Alanine as spherical shell	$\eta_D=0.095$ Å ⁻³

Table 2: Parameters for carbon nanotubes and Alanine amino acid.

Interaction	Attractive	Value (Å 6 kcal/mol)	Repulsive	Value (Å12 ×103 kcal/mol)
C-C	A_{CC}	22.63	B_{CC}	65.533
H-C	A_{HC}	17.16	B_{HC}	31.729
N-C	A_{NC}	41.26	B_{NC}	115.661
O-C	A_{OC}	33.79	B_{OC}	83.246
S-C	A_{SC}	139.04	B_{SC}	522.516
O-H	A_{OH}	9.41	B_{OH}	9.972
N-H	A_{NH}	11.7	B_{NH}	14.383
CNT	A_{CNT}	17.4	B_{CNT}	29
Linear Molecule	A_{Line}	28.84	B_{Line}	66.286
Sphere of Hydrogen	A_{Sphere}	4.41	B_{Sphere}	2.548
Cylindrical group	A_{Cyl}	16.87	B_{Cyl}	39.908
Alanine molecule as spherical shell	A_D	17.05	B_D	32624
Line-CNT	$A_{Line-CNT}$	23.12	$B_{Line-CNT}$	47.643
Sphere-CNT	$A_{Sphere-CNT}$	10.91	$B_{Sphere-CNT}$	15.774
Cylinder group-CNT	$A_{Cyl-CNT}$	17.14	$B_{Cyl-CNT}$	34.454
Alanine-CNT	A_{D-CNT}	17.23	B_{D-CNT}	30812

Table 3: Numerical values of the attractive and repulsive constants.

Alanine amino acid is unstable and repulsive when $r < 3.75$ Å. For both configurations, our calculations indicate that the (10, 3) SWCNT is the most favorable physical tube with a minimum energy of approximately -0.77 Kcal/mol.

Next, we evaluate and plot the acceptance energy Wr by using equation (11) for various radii of SWCNTs and different values of orientation angle. We comment that the acceptance occurs when Wr is greater than zero. The Alanine amino acid is not completely encapsulated

into such nanotubes of radius $r < 3.75$ for all orientations as shown in Figure 12. Furthermore, our results show that the acceptance of Alanine is more favorable when the Alanine as spherical molecule then followed by $\varphi=0^\circ$, $\varphi=\pi/6$, $\pi/3$ and $\pi/2$, respectively. We can also determine the suction energy of the Alanine as a function of the nanotube radius r by using equation (11). As shown in Figure 13, the SWCNT of radius greater than 3.75 Å will accept the Alanine for all orientations. The Alanine amino acid prefers to be inside the nanotube of radius $r > 3.75$

Radius (Å)	$E(\varphi=0)$	$E(\varphi=\pi/6)$	$E(\varphi=\pi/3)$	$E(\varphi=\pi/2)$	$E(\text{Spherical shell})$
3.523	1.725	1.708	1.702	1.698	1.868
3.59	0.963	0.954	0.951	0.948	1.043
3.735	-0.037	-0.038	-0.038	-0.037	-0.041
3.775	-0.209	-0.208	-0.207	-0.206	-0.226
3.861	-0.474	-0.472	-0.47	-0.469	-0.515
3.98	-0.675	-0.678	-0.68	-0.684	-0.734
4.615	-0.709	-0.704	-0.702	-0.699	-0.769
5.195	-0.485	-0.482	-0.48	-0.479	-0.527

Table 4: Interaction energy (E kcal/mol) for Alanine amino acid interacting with infinite SWCNTs of radii r for different values of φ .

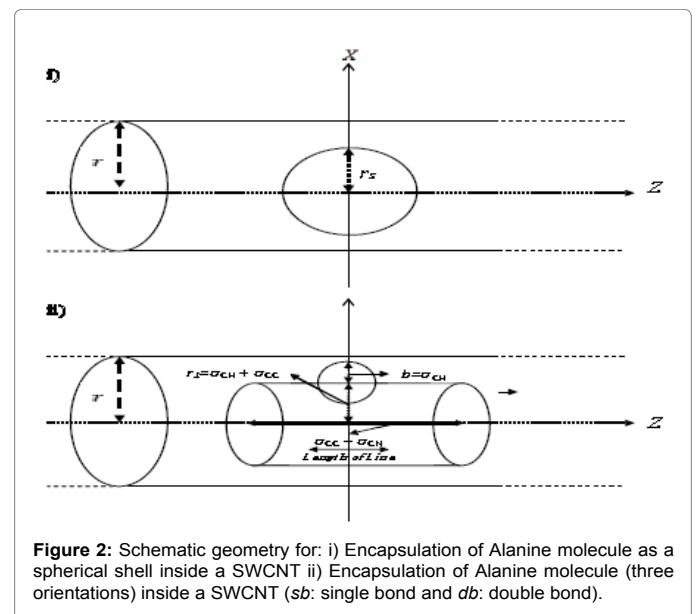


Figure 2: Schematic geometry for: i) Encapsulation of Alanine molecule as a spherical shell inside a SWCNT ii) Encapsulation of Alanine molecule (three orientations) inside a SWCNT (sb: single bond and db: double bond).

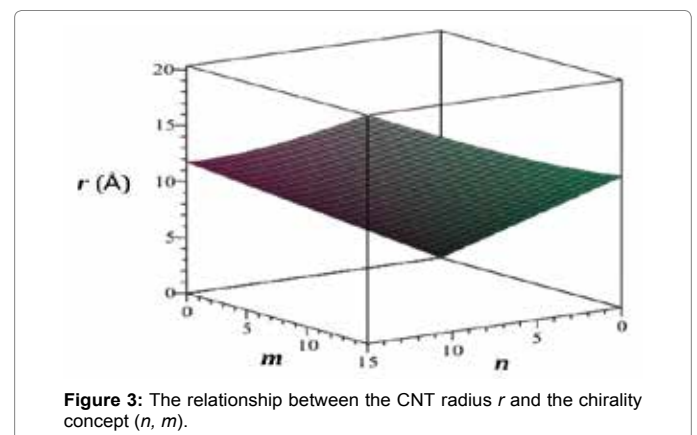


Figure 3: The relationship between the CNT radius r and the chirality concept (n, m) .

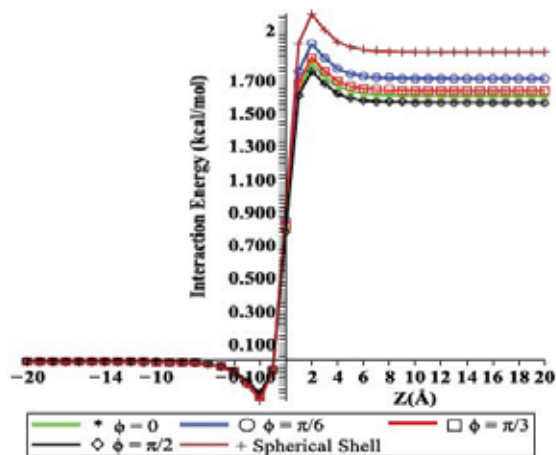


Figure 4: Interaction energy (V) arising from the encapsulation of Alanine amino acid inside a cylindrical SWCNT (Special case: $r=3.523$ Å and variant orientation angle ϕ).

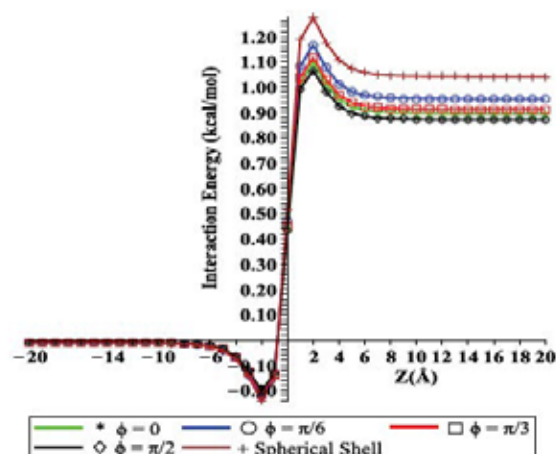


Figure 5: Interaction energy (V) arising from the encapsulation of Alanine amino acid inside a cylindrical SWCNT (Special case: $r=3.591$ Å and variant orientation angle ϕ).

Å. For the tubes with radius $r > 3.75$ Å, there are no energetic barriers to prevent the encapsulation of the Alanine amino acid. Based on our results, the acceptance and suction energies are shown to agree with the results obtained from analyzing the total interaction energy. The latter calculations confirm the results above and show that the Alanine amino acid is encapsulated inside SWCNTs for any values of ϕ when $r > 3.75$ Å. Our results are in excellent agreement with recent findings of Ganji's work [17] which shows that the magnitude of minimum energy arising from the encapsulation of different amino acids, Histidine, Glycine, Cystine and Phenyalanine, inside a SWCNT of radius $r=5.089$ ((13, 0)) are in the range of -0.1 to -0.8 kcal/mol compared to our results which is about -0.53 kcal/mol.

Based on our calculations as in Table 4, the magnitude of the interaction energies shows minimal difference for all both configurations (ϕ variant orientations) and the minimum binding

energy arising from the encapsulation of Alanine inside the infinite SWCNT of radius $r=4.615$ ((10, 3)) is approximately -0.77 kcal/mol. Our results consistently agree with Roman et al. [37] who investigate nucleic acid bases adsorption on a (10, 0) SWCNT, and also with those of Trzaskowski et al. [36] and Vardanega et al. [38] who investigate the conjugation between the α -amino acids and carbon nanostructures. Their results indicate that the adsorption of amino acids are carried out and stable along the Zig-zag SWCNTs and graphite sheet. Most of recent theoretical and computational studies have intensively investigated the encapsulation of different amino acids, especially on a (3,3) nanotube [17,27,29,31,32]. Their computational and experimental results confirm that the amino acids can be encapsulated inside a carbon nanotube of radius greater than 3.75 Å. Based on work of Dresselhaus et al. [12] who predict that the (5, 5) would be the most distinct physical nanotube, this means that the researchers need to pay more attention to enhance its ability, by manipulating in its chemical and physical properties, to be more effective in reality and used as carrier for disease therapy and drug delivery.

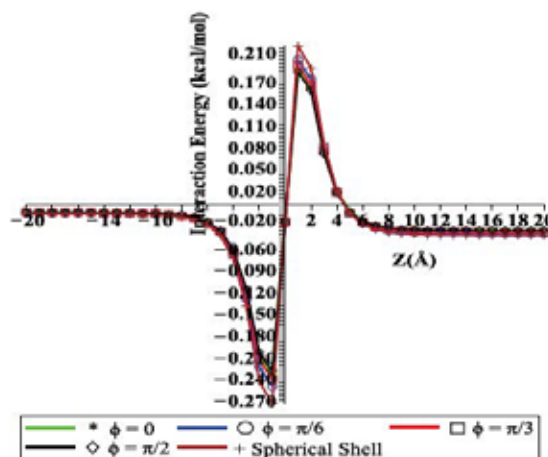


Figure 6: Interaction energy (V) arising from the encapsulation of Alanine amino acid inside a cylindrical SWCNT (Special case: $r=3.735$ Å and variant orientation angle ϕ).

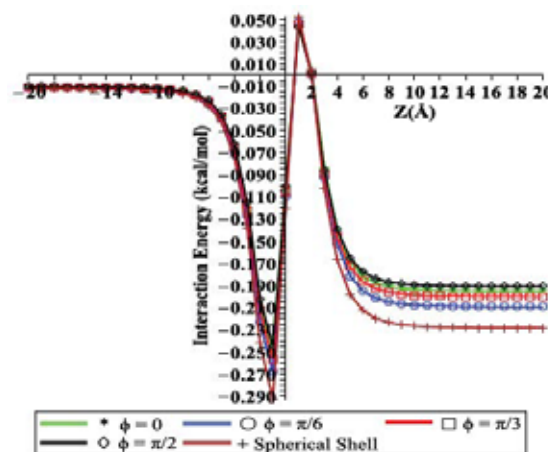


Figure 7: Interaction energy (V) arising from the encapsulation of Alanine amino acid inside a cylindrical SWCNT (Special case: $r=3.775$ Å and variant orientation angle ϕ).

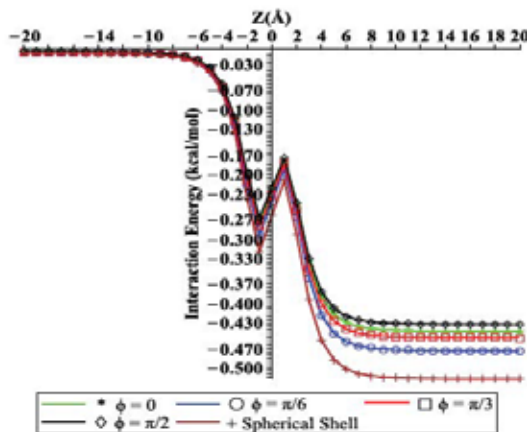


Figure 8: Interaction energy (V) arising from the encapsulation of Alanine amino acid inside a cylindrical SWCNT (Special case: $r=3.861$ Å and variant orientation angle ϕ).

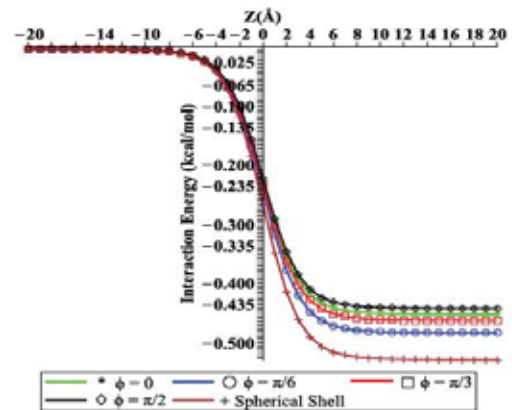


Figure 11: Interaction energy (V) arising from the encapsulation of Alanine amino acid inside a cylindrical SWCNT (Special case: $r=5.089$ Å and variant orientation angle ϕ).

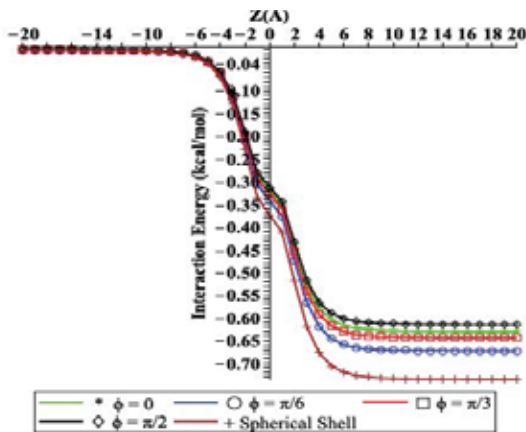


Figure 9: Interaction energy (V) arising from the encapsulation of Alanine amino acid in-side a cylindrical SWCNT (Special case: $r=3.973$ Å and variant orientation angle ϕ).

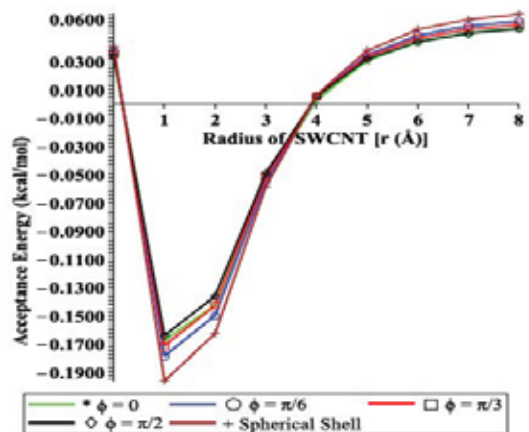


Figure 12: Acceptance energy (Wr) arising from the encapsulation of Alanine amino acid inside infinite SWCNTs of various radii r (variant values of orientation angle ϕ).

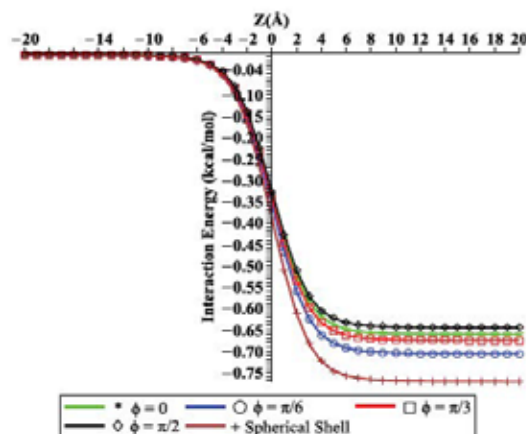


Figure 10: Interaction energy (V) arising from the encapsulation of Alanine amino acid inside a cylindrical SWCNT (Special case: $r=4.615$ Å and variant orientation angle ϕ).

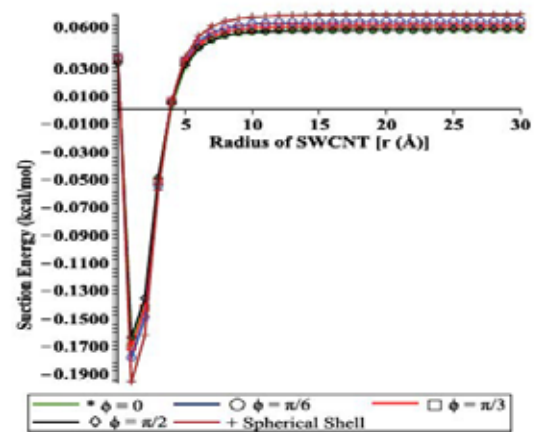


Figure 13: Suction energy (S_r) arising from the encapsulation of Alanine amino acid in-side infinite SWCNTs of various radii r (variant values of orientation angle ϕ).

Conclusion

In this paper, we use the van der Waals force and Lennard-Jones potential together with discrete-continuum formulation to obtain a mathematical model which describes the adsorption of Alanine amino acid inside the SWCNT with infinite length. We consider two possible structures as models of Alanine; spherical shell and can be accounted in three parts; linear molecule, cylindrical group of atoms and CH₃ molecule as sphere, we then gather all sub-interactions to determine the total potential energy. We also evaluate and plot the potential energy (for each configuration) of Alanine amino acid interacting with inner surface of the carbon nanotube of various sizes. The minimum binding energy depends directly on the radius of the nanotube r and the orientation angle ϕ . We note that (10, 3) of radius $r=4.615$ Å is the most favourable nanotube. For each configuration, we find that Alanine is unstable and rejected inside the SWCNT of radius $r<3.75$ Å. Overall, our results are in very good agreement with Ganji [17] who calculates the interaction energy (in the range of -0.1 to -0.8 kcal/mol)

for encapsulation of different α -amino acids inside SWCNTs and also with the long-term studies which have indicated that the encapsulation of protein as biosensors, peptides and different amino acids inside the graphite sheet and CNTs are carried out, especially when r is greater than 3.75 Å [25,27,29,31,32].

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Modelling Interaction Between a Methane Molecule and Biological Channels

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Aquaporins are small ubiquitous membranes in biological channels that play significant role in the transportation of nano-sized materials, such as water and other biomolecules, into cell. The present work proposes a mathematical model to determine the potential energy of the interaction between a methane molecule and three different types of aquaporin channels, which are aquaporin-Z, aquaglyceroporin and aquaporin-1. We adopt a continuous model, where all atoms comprising the aquaporin channels are assumed to be uniformly distributed throughout their volumes. We also assume that a methane molecule comprises two parts: A single point representing the carbon atom at the centre and a spherical shell of four evenly distributed hydrogen atoms. Our results indicate the naturalistic acceptance of a methane molecule inside aquaglyceroporin and aquaporin-1 channels, but the repulsion occurs for the case of aquaporin-Z channel.

Keywords: Aquaporin-Z (AqpZ), Aquaglyceroporin (GlpF), Aquaporin-1 (AQP1), Methane Gas (CH₄), Lennard-Jones Potential, van der Waals Interaction.

1. INTRODUCTION

Aquaporin is a family of membrane proteins that enable water and small molecules to permeate cell membranes. Aquaporins from human cells were discovered in 1992 and since then several aquaporin channels have also been identified and pioneered by Peter's Agre team.¹ Examples of these channels are aquaporin-Z (AqpZ), aquaglyceroporin (GlpF) and aquaporin-1 (AQP1), as shown in Figure 1. Members of the aquaporin family are widely distributed in various organs and have been found in different sites of human body, such as brain, kidney and eubacterian.^{2,3} The family of variant protein channels, from AQP1 to AQP12 and AqpZ,⁴ is clustered into three distinct groups according to their permeability characteristics and to the number of atoms forming these protein channels.^{5–8} Firstly, the biological water selective channels, AqpZ, AQP1, AQP2, AQP4, AQP5, AQP6 and AQP8, where AqpZ is only capable of transporting water molecules through cell membranes and blocking the ionic and non-ionic bonded molecules, while AQP1, AQP6 and AQP8 are able to permeate nitrate, chloride ions and ammonia, respectively.^{9–12} Second is aquaglyceroporin family (GlpF) which consists of AQP3, AQP7, AQP9 and AQP10 channels, usually permeable to water, urea, glycerol and other small neutral

solutes.^{5,6,9,13} AQP9 is a water channel and also permeable to neutral solutes, urea, glycerol, pyrimidines and purines, while AQP10 is able to transport water not glycerol and urea as well as AQP7 and AQP9 are also permeable to arsenite.^{14–16} Third group has only two intracellular proteins, AQP11 and AQP12. In compared to efficiency of AQP12, AQP11 has a major role in integrity maintenance, transports water in liposomes when reconstituted, but fails to display water in oocytes.^{17–19} On the other hand, substrate specificity of AQP12 is still vague.^{19–21} For full detail related to the geometrical structures of these aquaporin channels and their functions and characteristics, we refer the reader to Refs. [22–26]. Specifically, experimental results of Wang's work show that the inner pore diameter of GlpF or AQP1 is approximately 13 Å,²⁵ which is larger than that of AqpZ channel (1 Å).²⁷ Some of aquaporin channels allow the passage of gas molecules, such as carbon dioxide, ammonia, nitric oxide and methane.^{23,24,28}

Methane is a chemical compound composed of one carbon and four hydrogen atoms with a chemical formula CH₄. Methane was first spontaneously identified in the marshes of Lake Maggiore Straddling Switzerland and Italy by the Italian physicist Don Alessandro Volta in 1776, having been inspiring to find out the substance after reading Benjamin Franklin's paper about "flammable air."²⁹ Methane gas had been captured arising from the marshes,

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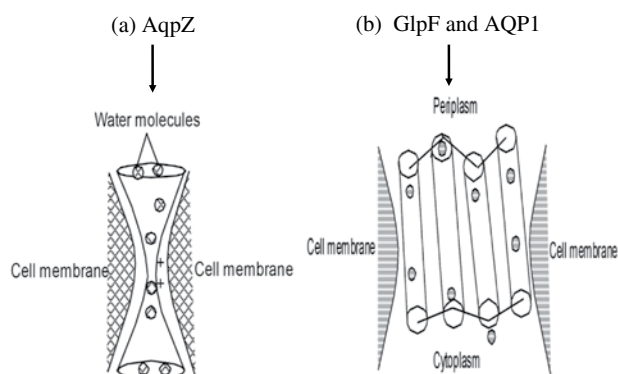


Fig. 1. Functional unit of geometrical structure of aquaporin channels: (a) AqpZ, (b) GlpF and AQP1.²⁷

then been isolated as a pure gas in 1778 and it easily ignited with an electrical spark.^{29,30} Humans and animals are the main resources of methane emissions.^{31,32} It is the simplest member in alkanes, and a principal component of natural gas and its huge abundance makes it one of the most attractive fuel resources.³³ At the beginning, scientific researchers had been facing challenges in capturing and storing methane due to its gaseous property.³¹ In its natural state, methane was found at standard conditions of pressure and temperature in two main areas, below the ground and under the sea floor, and it easily finds its way to the atmosphere which is called atmospheric methane.³¹ Methane reactions are very difficult to control, such as combustion, halogenation and steam reforming to syn-gas. Mechanism of partial oxidation to methanol has challenge because of the typical progress depending on carbon dioxide and water even with insufficient amount of oxygen.³⁴ Methanol is completely arising from methane by the anzyme methane mono-oxygenase.³¹ It is very weak acid due to its high density being heavier than air and can be used in industrial chemical process and transported as a liquid natural gas.^{29,30,35}

The study of aquaporin channels on the transportation of waters and biomolecules across cell membranes has led to the development of modern medical and biological applications, such as drug delivery and water desalination.³⁶ The molecular selectivity of AQP1 and GlpF channels has been investigated.³⁶ Further, Hub's work has shown that GlpF and AQP1 channels can facilitate the transport of gases, such as NH_3 and CO_2 into cells.³⁷ Several recent studies indicate that small gas molecules transported by membrane proteins and should not be ignored.^{28,37,38} The potential mean forces have also been computed for the permeation of these biomolecules into AQP1 and GlpF using numerical and computational approaches. Recent experiments show that the transportation of the larger molecules through aquaporins occurs for those small with and long thin shapes.^{39,40} These channels are also useful for separation of gases, such as removing carbon dioxide molecules from mixtures with methane.

The recent work on one-dimensional aquaporin channels shows that the Tris(5-acetyl-3-thienyl) methane is able to pass through these channels.⁴¹ Chen et al.⁴² employs the Brownian dynamics fluctuation dissipation theorem and steered molecular dynamic simulations to calculate the free energy for the permeation of water and hydration of methane molecules through GlpF. In addition, Adisa et al.⁴³ investigate the encapsulation of methane gas inside carbon nanotube bundles and his results show that carbon nano-structures could be a superior for storage methane molecules at natural conditions (carbon is an essential component in chemical formulas of all aquaporin protein channels). Moreover, Skowronski et al.⁴⁴ suggest that several sub-types AQP1, AQP5 and AQP9 are involved in the regulation of water and other biomolecules homeostasis in the reproductive system of gilts. Al Garalleh et al.⁴⁵⁻⁴⁷ show that the biological channels, GlpF and AQP1, are able to transport water and small gas molecules, such as carbon dioxide, nitric oxide and ammonia through cell membrane protein. The rate of diffusion of methanol (CH_3OH) or methane (CH_4) through the hydrophobic region of the phospholipid bilayer of cell membrane is approximately 50 times faster than that of urea.^{26,48} Barrer et al.⁴⁹ state that the permeation of methane or nitrogen across vulcanized rubber (bilayer) membranes of aquaporin channels is about 7.15–11.3 percentage. Further, Wang et al.⁵⁰ use the molecular dynamics performed with NAMD to show that the gas transportation through AQP1 is valid with two complementary methods, implicit ligand sampling and explicit gas diffusion simulation. The simulation results suggest that the AQP1 central pore may function as a pathway for gas molecules and the four monomeric pores of AQP1 serve as water channels to cross the membrane.⁵¹ The transportation of other molecules, either charged or uncharged, depends on the kind of aquaporin channel and its inner radius which plays a significant role in controlling the permeation of these molecules and determining the global minimum energy.^{28,41,42,45-47} Oliva et al.⁵² show that AqpZ channel has positive charges around its wall which can block all kinds of molecules and ions to pass through AqpZ membranes, excepting water molecules.

In this paper, we investigate the acceptance of a methane molecule inside the biological channels (AqpZ, GlpF and AQP1), which are assumed to have a profile of right cylindrical channel. To obtain the interaction energy we adopt the discrete-continuum approach and the Lennard-Jones potential. For a methane molecule, the four hydrogen atoms are assumed to be on a spherical shell and the carbon atom is assumed to be a single point located at the centre of the spherical shell. We perform volume integration throughout the channel to calculate the total interaction potential energy due to these interactions. The analytical expressions for the potential energy obtained involve series of hypergeometric functions, which can be readily computed using an algebraic computer package, such

as MAPLE. Our study indicates that gas molecules are accepted inside GlpF and AQP1 channels while prevented to enter the AqpZ channel. We note that the chemical compositions of AqpZ, GlpF, and AQP1 with chemical compositions of $C_{906}H_{1885}N_{272}O_{463}S_4$, $C_{1289}H_{2527}N_{315}O_{591}S_{11}$ and $C_{1235}H_{2468}N_{320}O_{601}S_7$, respectively. In order to determine the total interaction energy, we perform surface and volume integrations of the potential energy between the carbon atom as a discrete point and the four hydrogen atoms as a spherical shell interacting with AqpZ, GlpF and AQP1, respectively.

In the following section, we outline the Lennard-Jones potential and the method used to derive an expression for the interaction potential of a methane molecule and the AqpZ, GlpF and AQP1 channels. In Section 3, we present the numerical results of our model. A summary is given in the final section of this paper.

2. INTERACTION ENERGY

2.1. Interaction Between an Aquaporin Channel and a Single Atom

We begin by considering the Lennard-Jones interaction between an aquaporin channel (either, AqpZ, AQP1 or GlpF) which is assumed to be a flaired right cylinder and a discrete point representing a single atom located on the z -axis. Here, by using a rectangular coordinate system (x, y, z) as a reference, the atom is assumed to be located at $(0, 0, z_0)$ on the z -axis. This cylinder can be parameterized by $(r\delta \cos \theta, r\delta \sin \theta, z)$, where $z \in [-L/2, L/2]$, $\theta \in [-\pi, \pi]$ and $\delta \in [a, 1]$, where $0 < a < 1$ and r is represented a parabolic curve as shown in Figure 2 and defined by the quadratic equation.

$$r = r_0 + 4(r_1 - r_0)(z/L)^2 = r_0 + \beta z^2 \quad (1)$$

where r_0 and r_1 are the outer radii at the middle and at the opening of aquaporin, respectively, and $\beta = 4(r_1 - r_0)/L^2$. The quantities $a r_0$ and $a r_1$ are defined as the inner radii at

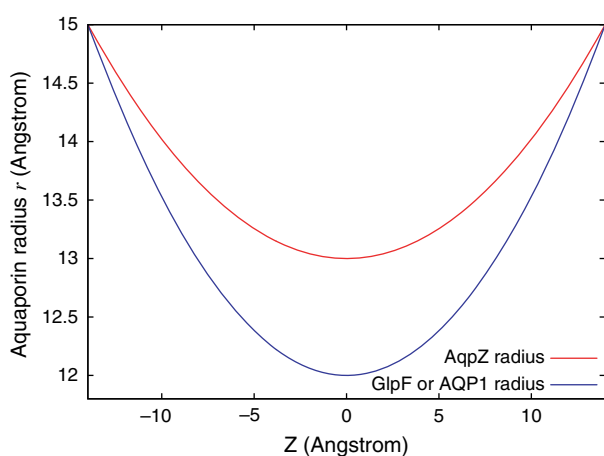


Fig. 2. The relationship between the aquaporin radius and the value of z along the z -axis.

the middle and at the opening of aquaporin, respectively, and we take $a = r_0^*/r_0 \approx 0.25$, where r_0 is the inner radius at the centre of the aquaporin. The distance ρ between the atom and a typical point in the channel volume is given by

$$\rho^2 = r^2\delta^2 + (z - z_0)^2 \quad (2)$$

To find the interaction potential between the single atom and the aquaporin channel, we adopt the Lennard-Jones potential which is given by

$$\Phi(\rho) = -A\rho^{-6} + B\rho^{-12} = 4\epsilon \left[-\left(\frac{\sigma}{\rho}\right)^6 + \left(\frac{\sigma}{\rho}\right)^{12} \right] \quad (3)$$

where ϵ is the well depth and σ is the van der Waals diameter. We also make use of the empirical combining laws⁵³⁻⁵⁵ given by $\epsilon_{12} = (\epsilon_1\epsilon_2)^{1/2}$ and $\sigma_{12} = (\sigma_1 + \sigma_2)/2$ to determine the well depth and van der Waals diameter for two atoms of different species. $A = 4\epsilon\sigma^6$ and $B = 4\epsilon\sigma^{12}$ are the attractive and repulsive constants, respectively. By summing all pair interactions, the total potential energy can be given by

$$V_{\text{tot}} = \sum_i \Phi(\rho_i) \quad (4)$$

where Φ is the potential function given in (3). In the continuum approximation, we may replace this summation by the volume integral, where we assume a uniform atomic density throughout the volume of the aquaporin. Thus, from (4) we have

$$\begin{aligned} V_1 &= \eta_c \int_a^1 \int_{-L/2}^{L/2} \int_{-\pi}^{\pi} \Phi(\rho) dV \\ &= \eta_c \int_a^1 \int_{-L/2}^{L/2} \int_{-\pi}^{\pi} r^2\delta(-A\rho^{-6} + B\rho^{-12}) d\delta dz d\theta \end{aligned} \quad (5)$$

where η_c represents the atomic density per unit volume and dV represents the volume element of the cylindrical aquaporin given by $dV = r^2\delta d\delta dz d\theta$. For detailed analytical evaluation of (5), we refer the reader to Ref. [46].

2.2. Interaction Between an Aquaporin Channel and a Methane Molecule

In this section, we consider the interaction of a methane molecule with aquaporin channels. We propose to model this problem in two parts. Firstly, we study the interaction of the aquaporin (either AqpZ, GlpF or AQP1) with the carbon atom which is assumed to be located at $(0, 0, z_0)$ as shown in Figure 3. From the work of Al Garalleh et al.,⁴⁶ the equation of the potential energy is given by

$$\begin{aligned} E_1 &= \eta_c \int_a^1 \int_{-L/2}^{L/2} \int_{-\pi}^{\pi} r^2\delta(-A\rho^{-6} + B\rho^{-12}) d\delta dz d\theta \\ &= 2\pi\eta_c \int_a^1 \int_{-L/2}^{L/2} r^2\delta(-A\rho^{-6} + B\rho^{-12}) d\delta dz \end{aligned} \quad (6)$$

Secondly, we consider the interaction of the aquaporin with the four hydrogen atoms which are assumed to be

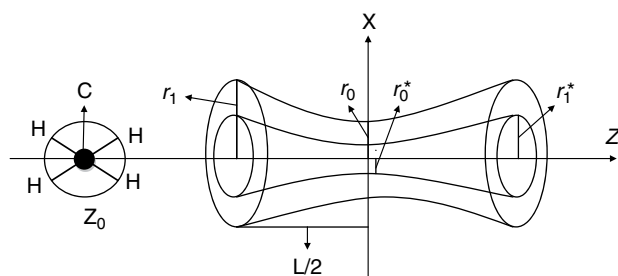


Fig. 3. Geometry of atom on the z -axis interacting with aquaporin assumed to have a flaired right cylindrical structure.

on a spherical shell of radius $b = 1.087 \text{ \AA}$ (Fig. 3). From Ref. [56], the potential energy is given by

$$E_2 = \eta_H \pi b \iiint \left[\frac{A_H}{2} \left(\frac{1}{\rho(\rho+b)^4} - \frac{1}{\rho(\rho-b)^4} \right) - \frac{B_H}{5} \left(\frac{1}{\rho(\rho+b)^{10}} - \frac{1}{\rho(\rho-b)^{10}} \right) \right] dV$$

$$= \eta_H \pi b \int_a^1 \int_{-L/2}^{L/2} \int_{-\pi}^{\pi} r^2 \delta \left[\frac{A_H}{2} \left(\frac{1}{\rho(\rho+b)^4} - \frac{1}{\rho(\rho-b)^4} \right) - \frac{B_H}{5} \left(\frac{1}{\rho(\rho+b)^{10}} - \frac{1}{\rho(\rho-b)^{10}} \right) \right] d\delta dz d\theta \quad (7)$$

where η_H represents the atomic surface density of the sphere of the four hydrogen atoms and b is the radius of the sphere of the four hydrogen atoms. We then combine the interactions in (6) and (7) to determine the interaction energy for the whole system.

3. NUMERICAL RESULTS

Here, we evaluate the total energy arising from a methane molecule interacting with aquaporin channels and we obtain the plots of the potential energy using MAPLE, MATLAB and GNUPLOT packages. The parameters used in this model are shown in Tables I and II which are taken from Ref. [27]. We note that $N_A = 3530$, $N_G = 4737$ and $N_Q = 4601$ are the numbers of atoms in AqpZ, GlpF, and AQP1 with chemical compositions of $C_{906}H_{1885}N_{272}O_{463}S_4$, $C_{1289}H_{2527}N_{315}O_{591}S_{11}$ and $C_{1235}H_{2468}N_{320}O_{601}S_7$, respectively. V_c is the cylinder volume and A_s is the surface area of the sphere of four hydrogen atoms. A and B are the attractive and repulsive constants, respectively, which

Table I. The Lennard-Jones constants (ϵ : Bond length and σ : Bond energy) (single bond: sb, double bond: db).^{54,55,57-60}

Interaction	ϵ (Å)	σ (Å)	Interaction	ϵ (Å)	σ (Å)
H-H	0.74	2.886	O-H	0.96	3.193
O-O (sb)	1.48	3.500	O-O (db)	1.21	3.500
N-N	1.45	3.660	N-O	1.40	3.580
N-H	1.00	3.273	C-C (sb)	1.54	3.851
C-C (db)	1.34	3.851	C-O (sb)	1.43	3.675
C-O (db)	1.20	3.675	C-N	1.47	3.755
C-H	1.09	3.368	S-S	2.05	4.035
S-H	1.34	3.461	S-C	1.82	3.943

Table II. Numerical values for other physical parameters.²⁷

Parameter	Symbol	Value
Length of aquaporin	L	28 Å
Outer radius of aquaporin	r_1	15 Å
Inner radius of AqpZ	r_0	13 Å
Inner radius of GlpF or AQP1	r_0	12 Å
Radius of sphere of hydrogen atoms	b	1.087 Å
Volume density for an AqpZ	$\eta_c = [N_A/V_c]$	$[3530/\pi Lr^2]$ $= 0.2234 \text{ atom/\AA}^3$
Volume density for an GlpF	$\eta_c = [N_G/V_c]$	$[4737/\pi Lr^2]$ $= 0.3389 \text{ atom/\AA}^3$
Volume density for an AQP1	$\eta_c = [N_Q/V_c]$	$[4601/\pi Lr^2]$ $= 0.3292 \text{ atom/\AA}^3$
Surface density for a sphere of hydrogen	$\eta_s = 4/A_s$	0.2695 atom/\AA ²
Channel wall thickness	$a = r_0^*/r_0$	0.25

are calculated from finding the well-depth ϵ and the van der Waals diameter σ for a methane molecule, a carbon and four hydrogen atoms, interacting with all of the atoms comprising the cylindrical aquaporin channels, as shown in Table III.

In Figures 4–6 the interaction energies are given for both numerical and computational solutions. The computational solution is referred to the evaluation of the first 10 terms in the infinite summation formulation for the five special cases as mentioned in Appendix A of Ref. [46]. The numerical solution is referred to the volume integral in Eq. (7) using the numerical integration

Table III. Numerical values of the attractive (A) and repulsive (B) constants derived from Refs. [54,55,57].

Element	Symbol	Value ($\text{eV}\text{\AA}^6$)	Symbol	Value ($\text{eV}\text{\AA}^{12} \times 10^3$)
OO	A_{OO}	22.63	B_{OO}	41.599
OH	A_{OH}	9.41	B_{OH}	9.972
OS	A_{OS}	79.89	B_{OS}	228.279
ON	A_{ON}	23.41	B_{ON}	49.283
OC	A_{OC}	33.79	B_{OC}	83.240
HH	A_{HH}	4.41	B_{HH}	2.548
HS	A_{HS}	41.10	B_{HS}	70.517
HN	A_{HN}	11.70	B_{HN}	14.383
HC	A_{HC}	17.16	B_{HC}	52.046
CN	A_{CN}	41.26	B_{CN}	115.661
CS	A_{CS}	139.04	B_{CS}	522.516
SN	A_{SN}	97.11	B_{SN}	314772
CC	A_{CC}	58.71	B_{CC}	191.493
NN	A_{NN}	28.74	B_{NN}	69.083
SS	A_{SS}	324.72	B_{SS}	1401.426
C-AqpZ	A_{C-AqpZ}	32.00	B_{C-AqpZ}	97.362
H-AqpZ	A_{H-AqpZ}	8.94	B_{H-AqpZ}	17.214
C-GlpF	A_{C-GlpF}	32.41	B_{C-GlpF}	99.162
H-GlpF	A_{H-GlpF}	8.92	B_{H-GlpF}	17.734
C-AQP1	A_{C-AQP1}	32.45	B_{C-AQP1}	99.031
H-AQP1	A_{H-AQP1}	9.07	B_{H-AQP1}	17.747
CH ₄ -AqpZ	A_{CH_4-AqpZ}	16.94	B_{CH_4-AqpZ}	41.554
CH ₄ -GlpF	A_{CH_4-GlpF}	17.02	B_{CH_4-GlpF}	42.524
CH ₄ -AQP1	A_{CH_4-AQP1}	17.18	B_{CH_4-AQP1}	42.504

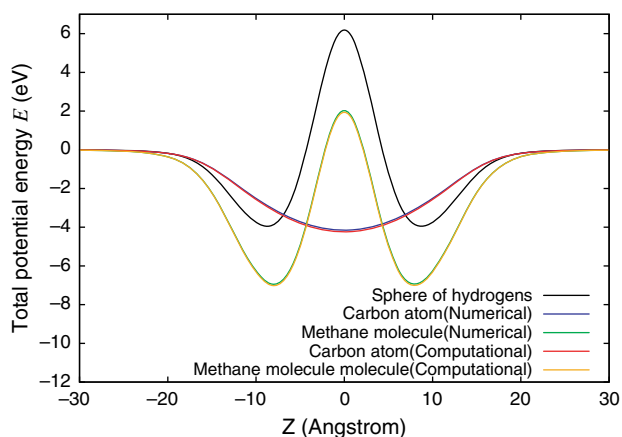


Fig. 4. Potential energies for carbon atom, sphere of hydrogen atoms and methane molecule interacting with AqpZ.

package in MAPLE. As seen in Figures 4–6, there is a minimal difference in the magnitude of the potential energies between the numerical and computational solutions.

In Figure 4, we present the interaction energies for a methane molecule, a carbon atom and the hydrogen sphere, each interacting with the aquaporin channel AqpZ. We note that the interaction energy is approximately zero at the extremities of the aquaporin channel and reaches its maximum value at the centre of AqpZ channel (when $z = 0$). At $z = 0$, the minimum interaction energies for the carbon-AqpZ and the hydrogen-AqpZ are approximately -4.15 eV and -6.18 eV, respectively. This model suggests that there is an energetic barrier which prevents the methane molecule to be accepted in the interior of the AqpZ channel. In Figures 5 and 6, the encapsulations of methane molecule inside the GlpF and AQP1 channels are presented. We find that the interaction energies are approximately zero at the open ends of the channel and have minimum values of approximately -6.13 eV and -6.16 eV, respectively. The interaction of carbon-AQP1 is approximately -3.94 eV which is slightly greater than that

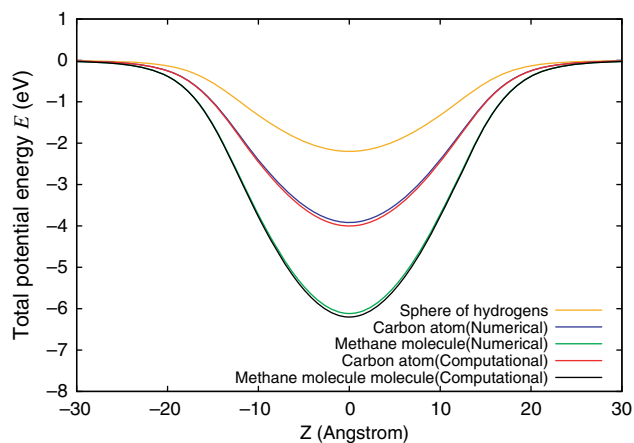


Fig. 5. Potential energies for carbon atom, sphere of hydrogen atoms and methane molecule interacting with GlpF.

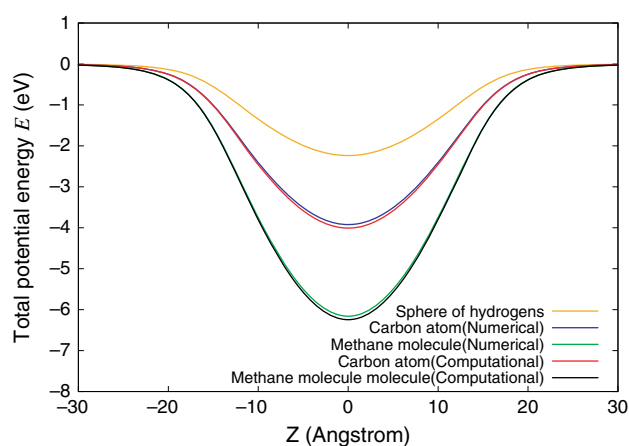


Fig. 6. Potential energies for carbon atom, sphere of hydrogen atoms and methane molecule interacting with AQP1.

of carbon-GlpF (-3.91 eV). Furthermore, the hydrogen sphere-GlpF and hydrogen sphere-AQP1 interactions are equal having the value approximately -2.23 eV at the centre of these channels. Our results indicates that the encapsulation of the methane molecule is more favorable inside the AQP1 channel. These results suggest that methane can enter the GlpF and AQP1 channels without energy barriers to prevent its encapsulation.

Our results agree with the Brownian dynamics fluctuation dissipation theorem, (dynamics simulation systems)⁴² and the potential mean forces using both numerical and computational approaches.²⁸ Our calculations and these recent studies indicate that ions and gas molecules are accepted inside the GlpF and AQP1 channels. The numerical values for the interaction energies are in excellent agreement with recent experimental and computational studies.^{42,44,52}

4. CONCLUSION

In this paper, we investigate the acceptance of a methane molecule inside various aquaporin channels. We evaluate the potential energy by applying two approaches, namely discrete-continuum and completely discrete approaches. We model the methane molecule where the carbon atom as an arbitrary point and the four hydrogen atoms as a spherical shell, with both entities interacting with the three different kinds of aquaporins. We also use the Lennard-Jones potential to calculate the energy for each interaction. We find that the aquaporin radius r plays a prime role in controlling the energy for these interactions. In conclusion, our results show that the total potential energy for the methane has a local minimum energy around the centre of the GlpF and AQP1 channels, where the channels are narrowest. This indicates that the methane molecule is encapsulated inside the GlpF and AQP1. However, it is rejected from the AqpZ channel, as the energy profile is maximized inside the channel. The results presented here agree with findings shown in previous studies.

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Modeling of encapsulation of Cystine amino acid inside a single-walled carbon nanotube

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ABSTRACT

Carbon nanotubes are very important types of nano-materials that are capable of transportation of different biomolecules, through their external and internal walls, to the targeted cells. In this paper, we model the interaction which is arising from the encapsulation of Cystine amino acid inside a single-walled carbon nanotube. Carbon nanotube are selective and excellent nano-devices because of their huge potential that is used in protein delivery and disease treatment. We consider two possible structures as models of Cystine amino acid which are an ellipsoid and cylinder group of atoms. We adopt the Lennard-Jones potential and continuum approach to obtain the interaction energy for each configuration. Our results indicate that the radius of nanotube plays a critical role in determining the magnitude of total energy and the encapsulation of Cystine occurs when $r > 3.391 \text{ \AA}$ which are in a very good agreement with recent experimental studies. Our model predicts that the scientific researchers could design and develop new nano-devices with distinct properties to avoid the energetic barriers and increase the ability of nanotube for maximum loading of targeted drug delivery.

Keywords: Carbon Nanotubes (CNTs), Cystine Amino Acid, Encapsulation, Potential Energy, van der Waals Interaction, Continuum Approximation, Lennard-Jones Potential.

1. INTRODUCTION

Nanotechnology has recently gained a great interest to study the applications of extremely invisible things and can be used across all modern scientific fields, such as medicine, engineering, physics and chemistry. In 1959, Nanotechnology concept had started by the American physicist Richard Feynman's idea entitled "There is a plenty of room at the bottom."⁽¹⁾ Nanotechnology is an interdisciplinary research effort bridging from biology, chemistry and physics to engineering and medicine and also involves the ability to control the transportation of individual molecules at the nano-scale levels. The area of nanotechnology has a rapid growth and focus on designing new nano-devices by manipulating their distinct features and intrinsic properties. These synthesized nano-particles

are wholly composed of carbon atoms, such as nanobuds, graphite, CNTs and fullerenes. CNTs are very excellent and interesting agents that have very unique properties, such as carbon which can bond to itself, low solubility and high conductivity^(2,3) as transporters in drug delivery and disease therapy applications.⁽⁴⁻⁶⁾ Their distinct properties offer a great opportunity for the scientific researchers to study the possibility of conjugation between these nano-devices and different drugs, such as proteins, drugs and amino acids.⁽⁶⁻⁸⁾

Amino acids a family of significant biological compounds which are containing different functional groups, that are classified into two sub-families upon; proteinogenic and non-proteinogenic, and they play major roles in nutrition and other biological functions in the human body, such as Histidine, Alanine, Cystine and other types of amino acids. Cystine is classified as non-essential

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proteinogenic amino acid containing sulfur with chemical formula $C_6H_{12}N_2O_4S_2$ and consists of two identical molecules of Cystine (L-Cystine: $C_3H_6NO_2S$).⁽⁹⁾ Half of Cystine bottom is a Cysteine (L-Cysteine), which is by taking and rotating it, it will give the top half of Cystine (the two halves are mirror images).⁽¹⁰⁾ The thiol side chain is an essential component in Cystine which often participates in enzymatic reactions and susceptible to oxidation when used as foods additive.⁽⁹⁾ In 1810, Cystine was first discovered and identified by William Hyde and found in different sites in the human body, such as hair and skin. Human hair and skin contain approximately 10–14 percentage of Cystine, which means that human body can normally synthesize it.⁽¹¹⁾ Cystine plays a significant role in maintaining the structures of proteins made

in human body, considered as a component of antioxidant and contributing in producing other amino acids, such as Taurine, as well as Cystine which can be used as a source of energy by converting it to glucose.⁽¹²⁾ In addition, it protects and strengthens the lining wall of stomach and intestines, helps to prevent damage arising from using Aspirin and other drugs and regulates the communication (signals) between immune system cells.⁽¹²⁾ Moreover, Cystine amino acid functions as a catalyst in many sophisticated metabolic cycles.⁽¹⁰⁾ For example, Cystine supplements can be used as anti-aging product to improve the skin elasticity and Cysteine is more easily absorbed by human body in compared to Cystine. So, most supplementary products contain Cysteine rather than Cystine.⁽¹³⁾ Yuan who use the molecular dynamic simulations (MDS)

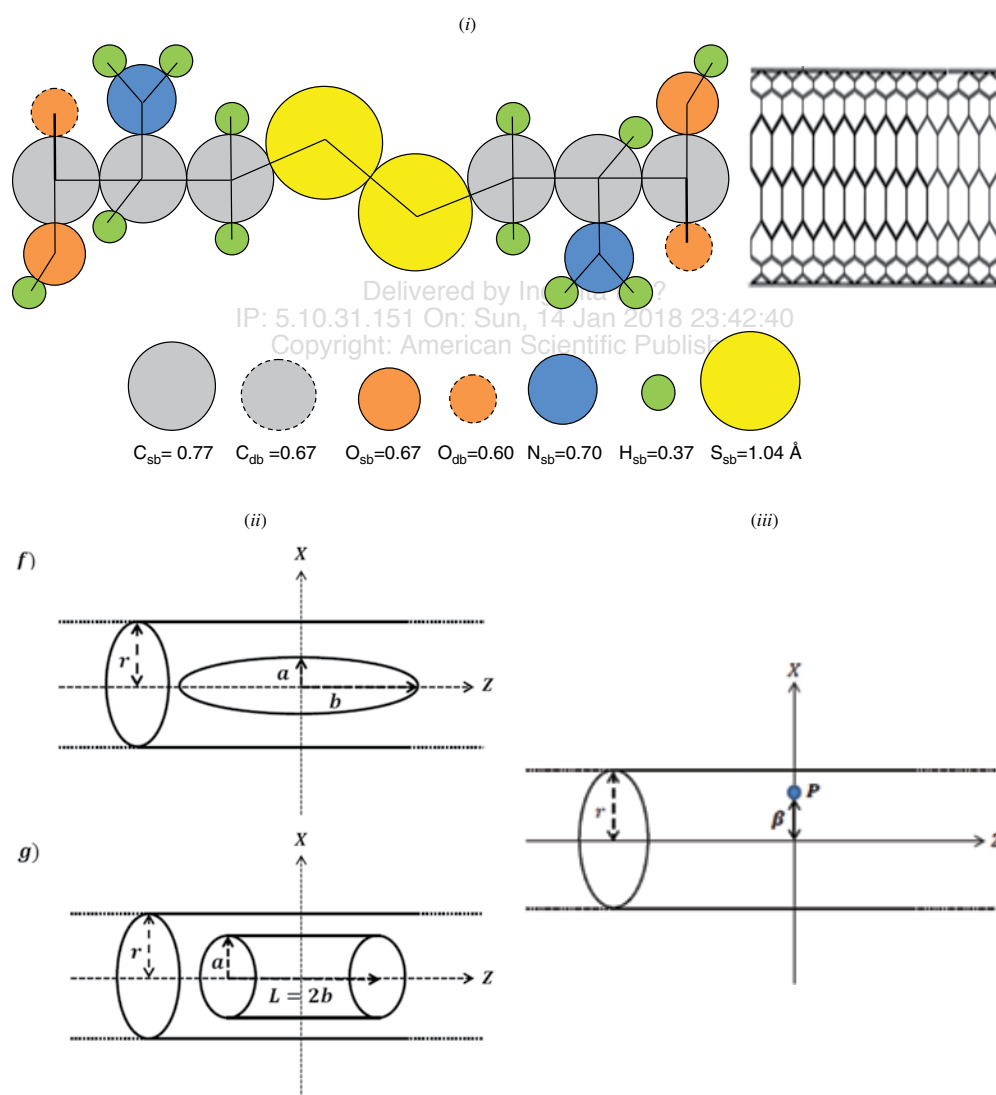


Fig. 1. (i) Modelling geometry for the interaction between Cystine amino acid ($C_6H_{12}N_2O_4S_2$) and SWCNT (each atom specified by distinct colour; Carbon: Grey, Nitrogen: Blue, Oxygen: Orange and Hydrogen: Green). (ii) Schematic geometry for encapsulation of Cystine amino acid ($C_6H_{12}N_2O_4S_2$) (spheroidal and cylindrical configurations) inside an infinite SWCNT of radius r (sb: single bond and db: double bond). (iii) A SWCNT of radius r interacting with an interior atom at point P off-setting from the central-axis by a distance β .

to calculate the acid dissociation constant (pKa) of the thiol side chain in Cystine on the dimeric, monomeric, and decameric forms.⁽¹⁴⁾ At physical conditions, pKa values are highly affected by oligo-meric state which is ranging from 8.0 to 8.6, while the value of pKa of an isolated Cystine is 8.3.⁽¹⁵⁾ So, to calculate the value of pKa, the side effects unit–unit interaction must be considered.⁽¹⁶⁾

Over the past few decades, long-term studies have discussed the combination of carbon nano-materials with different biomolecules as safe agents for drug delivery system. They can be conjugated with various biomolecules and delivered to the targeted cells. For example, a fullerene C₆₀ can be widely used as an antiviral compound against the growth of two types of human immunodeficiency virus (HIV1 and HIV2),^(17–19) as medical antioxidants to treat the infected sites, as a photosensitizer for transferring electron⁽²¹⁾ and as carrier to deliver genes and drugs into targeted cell.^(22, 23) In addition, CNTs have a huge potential that can be bonded (covalently and non-covalently) to biomolecules, such as carriers to deliver the acetylcholine drug to treat Alzheimer disease,⁽²⁴⁾ as biosensors to detect different molecules^(25, 26) and as transporters to carry out proteins and amino acids, either to repair the damaged cells or inhibit the unexpected growth of pathogens.^(27–31) The encapsulation of proteins and different amino acids has recently gained much more attention to observe their behavior under physiological conditions.^(32, 33) CNTs can be functionalised with proteins, bioactive peptides and nucleic acids and used to deliver their components to targeted cells and organs.⁽³⁴⁾ Amino acids can possibly interact with the inner surface and bond to the outer wall of CNTs.⁽³⁵⁾ The adsorption of amino acids inside a single-walled carbon nanotube (SWCNT) is carried out.⁽³⁰⁾ The non-covalent interaction energy between different amino acids and carbon nano-devices has been investigated by using the density function theory (DFT) and the Moller–Plesset perturbation theory (MP2).^(32, 36) The DFT method has been experimentally used to calculate the encapsulation of Cystine, Phenylalanine, Histidine and Glycine inside the (13, 0) SWCNT⁽²⁷⁾ and other amino acids inside the Zig–zag SWCNTs which reveals that they are acceptable and stable along their interior walls.⁽³¹⁾ Furthermore, the experimental results of the most recent studies used MDSs show that the minimum energies which are arising from amino acids interacting with CNTs occur in the middle of nanotube in the range of –0.1 to –0.8 kcal/mol which are very small compared to that of gas molecules and nucleic acid of approximately 20.8 and 20.1 kcal/mol.^(29, 37–40)

In our model, we aim to investigate the encapsulation of Cystine amino acid inside SWCNTs of radii r as shown in Figure 1(i). Here, we propose a mathematical model by assuming the Cystine amino acid in two possible configurations, as a spheroidal structure (an ellipsoid) and cylindrical shell, each configuration interacting with a SWCNT

which is assumed to be characterized and well-defined as a perfect cylinder.

In the first section, we briefly outline the van der Waals force and Lennard-Jones potential. Next, we determine the interaction energy by using a continuum approach and depending on the inner radius of nanotube r . Followed by a discussion and analysis our results in Section 3. Finally, remarks and conclusions are given in the last section.

2. MODELING APPROACH

In this paper, we assume that the encapsulation of Cystine inside a SWCNT as a physical adsorption model obtained mathematically by van der Waals forces. We use the continuum approach and Lennard-Jones potential together to model the van der Waals interaction of Cystine amino acid inside the SWCNTs of various radii r . The Lennard-Jones potential is given by

$$\Phi(\rho) = -A\rho^{-6} + B\rho^{-12} = 4\epsilon[-\sigma^6\rho^{-6} + \sigma^{12}\rho^{-12}] \quad (1)$$

where ρ denotes the distance between two molecular structures, $\Phi(\rho)$ is the potential function, and $A = 4\epsilon\sigma^6$ and $B = 4\epsilon\sigma^{12}$ are the attractive and repulsive constants, respectively. We use the empirical combining law to calculate A and B which are given by $\epsilon_{12} = \sqrt{\epsilon_1\epsilon_2}$ and $\sigma_{12} = (\sigma_1 + \sigma_2)/2$, where ϵ is the well depth (bond length) and σ is the van der Waals diameter.^(41, 42)

2.1. Cystine Molecule Interacting with a Carbon Nanotube

We use the Lennard-Jones potential to determine the interaction energy between an atom at point P inside cylindrical nanotube. Next, we use the Cartesian coordinate (x, y, z) as a reference system to model the two interacting molecules, Cystine molecule and the cylindrical nanotube. We assume that the point at atom P has coordinates $(\beta, 0, 0)$, where $0 \leq \beta \leq r$. Therefore, the distance ρ from point P to typical surface element of the cylindrical tube given by

$$\begin{aligned} \rho^2 &= (r \cos \theta - \beta)^2 + r^2 \sin^2 \theta + z^2 \\ &= (r - \beta)^2 - 4\beta r \sin^2(\theta/2) + z^2 \end{aligned} \quad (2)$$

Here, we apply continuum approximation to evaluate the interaction energy between the atom at point P and the cylindrical nanotube which can be obtained by performing a surface integral of the Lennard-Jones potential over the cylindrical nanotube. From the work of Thamwattana,⁽⁴³⁾ the interaction energy is given by

$$\begin{aligned} E_a &= \eta_c \int_V \Phi(\rho) dV \\ &= \eta_c \int_V (-A I_3 + B I_6) dV \end{aligned} \quad (3)$$

where η_c and is the atomic surface density of atoms on the nanotube and dV is the typical surface element.

For Cystine molecule, there are two possible structures; an ellipsoid and cylinder group of atoms. The integral I_n ($n = 3, 6$) is defined by

$$I_n = r \int_{-\infty}^{\infty} \int_{-\pi}^{\pi} \frac{1}{[(r-\beta)^2 - 4\beta r \sin^2(\theta/2) + z^2]} d\theta dz \quad (4)$$

Thus, we can determine the molecular interaction arising from the Cystine by performing the volume integral of E_c over the volume of the Cystine molecule, namely

$$\begin{aligned} E_d &= \eta_s \int_V E_a(\beta) dV \\ &= \eta_s \eta_c \int_V (-AI_3(\beta) + BI_6(\beta)) dV \\ &= \eta_s \eta_c \int_V (-AK_3 + BK_6) dV \end{aligned} \quad (5)$$

where β is the distance from the nanotube axis to a typical point of the certain biomolecule and η_s is the mean volume density of the biomolecule, which depends on the assumed configuration of the interacting biomolecule and K_n can be given as

$$K_n = \int_V I_n(\beta) dV \quad (6)$$

2.1.1. Spheroidal Model

By using the rectangular coordinate, we define the nanotube as a cylinder parameterized by $(r \cos \theta, r \sin \theta, z)$ and the Cystine molecule assumed to be as a spheroidal structure, parameterized by $(ar \cos \theta \sin \phi, ar \sin \theta \sin \phi, br \cos \phi)$, where $0 \leq r \leq 1$, $-\pi < \theta \leq \pi$, $0 \leq \phi \leq \pi$, and a and b are the equatorial semi-axis length and polar semi-axis length (along the z -axis) of spheroidal structure, respectively, as shown in Figure 1(ii). Further, the distance is given by $\rho^2 = a^2 r^2 \sin^2 \phi$ and the spheroidal volume element is $dV = a^2 b r^2 \sin \phi dr d\phi d\theta$. From the work of Thamwattana,⁽⁴³⁾ the interaction energy between a spheroidal molecule and a cylindrical nanotube is given as

$$E_{\text{Sph-CNT}} = \eta_c \eta_s (-AK_3 + BK_6) = \eta_c \eta_s \int_V (-AJ_3 + BJ_6) dV \quad (7)$$

where η_c and η_s are the atomic volume densities of the cylindrical nanotube and spheroidal molecule, respectively. So, the integral J_n ($n = 3, 6$) is given by

$$J_n = \int_{-\pi}^{\pi} \int_0^{\pi} \int_0^1 a^{2n+2} b r^{2n+2} \sin^{2n+2} \phi dr d\phi d\theta \quad (8)$$

by using relation between the beta and hypergeometric functions, K_n can be expressed in terms of

$$\begin{aligned} K_n &= \frac{8\pi^2 a^2 b}{3r^{2n-2}} \beta(n-1/2, 1/2) \\ &\times \sum_{m=0}^{\infty} \frac{(n-1/2)_m (n-1/2)_m}{(5/2)_m m!} \left(\frac{a^2}{r^2}\right)^m \end{aligned} \quad (9)$$

To obtain and evaluate the interaction energy for each configuration as shown in Figure 1, we need to determine the energy which is arising from the specific atom at point P inside the cylindrical nanotube as it is shown in Figure 1(ii(f)) (this atom is within the volume of Cystine and the Cystine-SWCNT interaction is calculated at the point P inside the SWCNT).

2.1.2. Cylindrical Model

Here, we model the Cystine model as a cylinder located at the origin (centered) with radius a and length $L = 2b$ as shown in Figure 1(ii(g)). A typical point in the cylinder can be parameterized by $(ar \cos \theta, ar \sin \theta, z)$, where $0 \leq r \leq 1$, $-\pi \leq \theta \leq \pi$ and $-L \leq z \leq L$. Therefore, the distance δ is given by $\delta^2 = a^2 r^2$ and the volume element of cylinder is $dV = a^2 r dr d\theta dz$. From Thamwattana's work,⁽⁴³⁾ the interaction energy between a cylindrical molecule and a cylindrical nanotube is given as

$$\begin{aligned} E_{\text{Cyl-CNT}} &= \eta_c \eta_d (-AK_3 + BK_6) \\ &= \eta_c \eta_d \int_V (-AT_3 + BT_6) dV \end{aligned} \quad (10)$$

where η_d is the atomic volume density of the cylindrical molecule. So, the integral T_n ($n = 3, 6$) is given by

$$T_n = \int_{-L}^L \int_{-\pi}^{\pi} \int_0^1 a^{2n+2} r^{2n+2} dr d\theta dz \quad (11)$$

Again by using the beta and gamma functions, K_n is given as

$$\begin{aligned} K_n &= \frac{4\pi^2 a^2 L}{r^{(2n-2)}} \beta(n-1/2, 1/2) \\ &\times \sum_{m=0}^{\infty} \frac{(n-1/2)_m (n-1/2)_m}{(2)_m m!} \left(\frac{a^2}{r^2}\right)^m \end{aligned} \quad (12)$$

2.1.3. Acceptance and Suction Energies

To demonstrate the encapsulation of the Cystine amino acid inside a SWCNT, we determine the two physical quantities; acceptance and suction energies. First, we evaluate the acceptance energy which is moving from $-\infty$ to z_0 to determine whether the Cystine molecule will be accepted into a cylindrical SWCNT. Then, we calculate the suction energy which is the total energy for a molecule that is moving from $-\infty$ to ∞ . Based on work of Cox,⁽⁴⁶⁾ a molecule is accepted inside a CNT if the acceptance energy (A_r) is greater than zero, which is given by

$$A_r = \int_{-\infty}^{z_0} \frac{\partial E}{\partial z} dz = E(z_0) - E(-\infty) \quad (13)$$

noting that z_0 is the root of equation $\partial E/\partial z = 0$, which is the point where the molecule is about to enter the nanotube. The suction energy (S_r) is calculated as the total integral of the axial force from $-\infty$ to ∞ and is given by

$$S_r = \int_{-\infty}^{\infty} \frac{\partial E}{\partial z} dz = E(\infty) - E(-\infty) \quad (14)$$

We note that in the case where there is no energy dissipation, the suction energy S_r can be converted directly to the kinetic energy of the moving molecule.

3. RESULTS AND DISCUSSION

In order to obtain this model mathematically and evaluate the potential energy arising from the Cystine-SWCNT interaction (continuum approach), we need to determine all the numerical and physical parameters which are involved in this model. The well-depth ϵ and van der Waals diameter σ for different atoms are as shown in Table I. The radii r of CNTs and physical parameters involved in this model are given in Table II. The attractive (A) and repulsive (B) constants are calculated by using the well-depth ϵ and the van der Waals diameter σ and are given in Table III. We also calculate the volume densities for both configurations, spheroidal structure (η_s) and cylindrical shell (η_d), as the total number of atoms that are containing the specific molecule are divided by the volume of the molecule structure which are $\eta_s = 26/(4\pi a^2 b/3)$ and $\eta_d = 26/(2\pi a^2 L)$, respectively. The radius of CNT r can be determined by using the relationship (Chirality (n, m)) given as,⁽⁴⁷⁾

$$r = 0.3915\sqrt{n^2 + nm + m^2} \quad (15)$$

Next, MAPLE used to evaluate and plot the interaction energy for both configurations, spheroidal molecule and cylindrical shell, inside SWCNTs of various radii r (both configurations have similar trend). The interaction energy is evaluated and plotted for each configuration to determine the encapsulation of Cystine amino acid inside a SWCNT depends on the nanotube radius r along the range of z -axis. The minimum energy for each configuration is obtained based on the equilibrium position of Cystine molecule which is being away from the interior wall of nanotube. We also deduce the critical radius r of carbon nanotube that will accept the Cystine molecule. In this model, we consider the nanotubes (6, 3), (7, 2), (8, 1), (5, 5), (9, 0), (7, 4), (8, 3), (9, 2), (10, 3) and (13, 0) which have radii $r = 3.105, 3.204, 3.325, 3.390, 3.523, 3.775, 3.861, 3.973, 4.615$ and 5.195 Å, respectively. As shown

Table I. The Lennard-Jones constants (ϵ : Bond length and σ : Non-bond distance) (single bond: sb, double bond: db).^(41, 44, 45)

Interaction	ϵ (Å)	σ (Å)	Interaction	ϵ (Å)	σ (Å)
H-H	0.74	2.886	O-H	0.96	3.193
O-O (sb)	1.48	3.500	O-O (db)	1.21	3.500
N-N	1.45	3.660	N-H	1.00	3.273
C-C (sb)	1.54	3.851	C-H	1.09	3.368
C-C (db)	1.34	3.851	C-O (sb)	1.43	3.675
C-O (db)	1.20	3.675	C-N	1.47	3.755
N-O	1.09	3.368	S-S	2.05	4.035
S-H	1.34	3.461	S-C	1.77	3.943

Table II. Parameters for carbon nanotubes and Cystine amino acid.

Radius of CNT (6, 3)	3.105 Å ⁽⁴⁸⁾
Radius of CNT (7, 2)	3.204 Å ⁽⁴⁸⁾
Radius of CNT (8, 1)	3.325 Å ⁽⁴⁸⁾
Radius of CNT (5, 5)	3.390 Å ⁽⁴⁸⁾
Radius of CNT (9, 0)	3.523 Å ⁽⁴⁸⁾
Radius of CNT (7, 4)	3.775 Å ⁽⁴⁸⁾
Radius of CNT (8, 3)	3.861 Å ⁽⁴⁸⁾
Radius of CNT (9, 2)	3.973 Å ⁽⁴⁸⁾
Radius of CNT (10, 3)	4.615 Å ⁽⁴⁸⁾
Radius of CNT (13, 0)	5.090 Å ⁽⁴⁸⁾
Equatorial-axes of the spheroidal shell	$a = 1.795$ Å
Polar semi-axes of the spheroidal shell	$b = 5.87$ Å
Length of cylinder group of atoms	$L = 2b = 11.74$ Å
Surface density for carbon nanotube	$\eta_c = 0.381$ Å ⁻²
Volume density for spheroidal molecule	$\eta_s = 0.3283$ Å ⁻³
Surface density of the cylindrical group	$\eta_d = 0.1095$ Å ⁻³

in Figures 2 to 4(i) and (ii), we observe that the spontaneous encapsulation of Cystine molecule inside SWCNT occurs when its radius greater than 3.391 Å and the values of minimum interaction energies are obtained when r in the range $3.391 \text{ Å} < r < 5.195 \text{ Å}$. The lowest interaction energies for ellipsoid-SWCNT and cylinder-SWCNT interactions are obtained when $r = 3.973$ then followed by 3.861, 3.775, 4.615, $r = 5.195$, 3.523 and $r = 3.391$ Å, numerical solutions are calculated as given in Table IV. For both configurations, the Cystine amino acid is unstable and repulsive when $r < 3.391$ Å, and the (9, 2) CNT ($r = 3.973$ Å) is the most favorable nanotube. For both interactions, spheroidal-SWCNT and Cylindrical-SWCNT, with minimum energies of approximately -1.085 and -2.122 kcal/mol, respectively.

The acceptance and suction energies of the Cystine molecule can be determined as a function of nanotube radius r to confirm the above results, proposed by Cox.⁽⁴⁶⁾ We then evaluate and plot the acceptance energy inside SWCNTs of radii r by using the physical adsorption concepts. We also comment that the acceptance occurs when A_r is greater than zero. As shown in Figure 4(iii), the

Table III. Numerical values of the attractive (A) and repulsive (B) constants involved in this model.

Interaction	Attractive	Value		Value (Å ¹² × 10 ³ kcal · mol ⁻¹)
		(Å ⁶ kcal · mol ⁻¹)	Repulsive	
C-C	A_{CC}	22.63	B_{CC}	65.533
H-C	A_{HC}	17.16	B_{HC}	31.729
N-C	A_{NC}	41.26	B_{NC}	115.661
O-C	A_{OC}	33.79	B_{OC}	83.246
S-C	A_{SC}	139.04	B_{SC}	522.516
O-H	A_{OH}	9.41	B_{OH}	9.972
N-H	A_{NH}	11.70	B_{NH}	14.383
CNT	A_{CNT}	17.40	B_{CNT}	29.000
Cystine	A_{Cys}	29.03	B_{Cys}	74966
Cystine-CNT	$A_{Cys-CNT}$	23.22	$B_{Cys-CNT}$	51.983

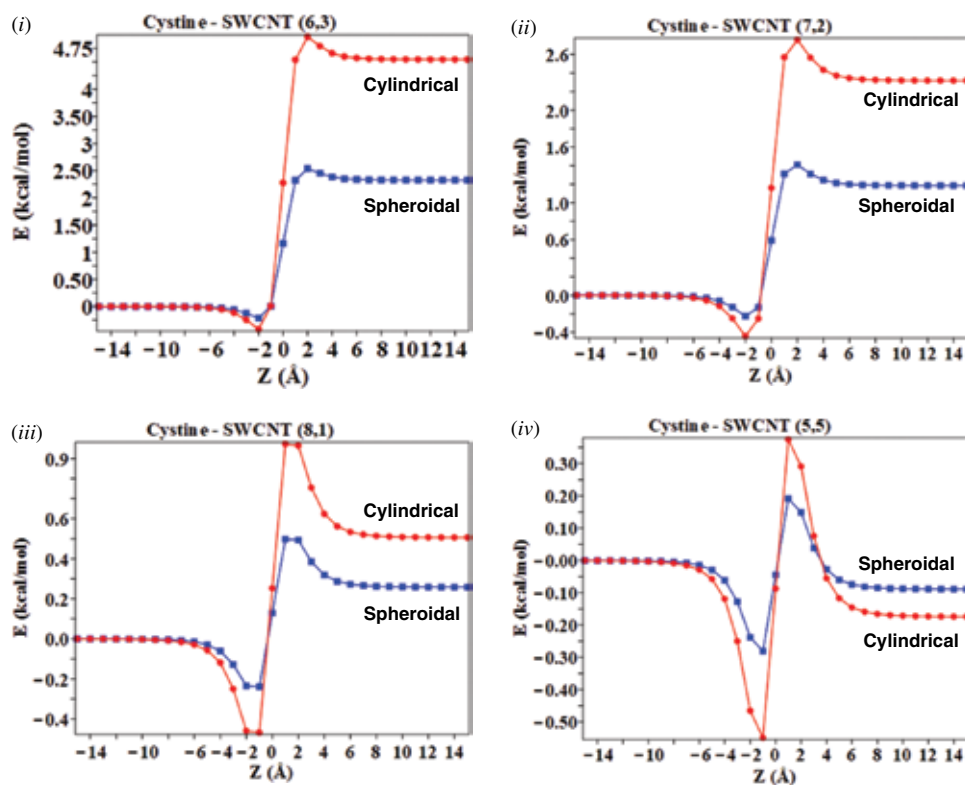


Fig. 2. Interaction energy (E) arising from the encapsulation of Cystine amino acid inside SWCNTs with varian radii r (i) Cystine-SWCNT (6, 3) (ii) Cystine-SWCNT (7, 2) (iii) Cystine-SWCNT (8, 1) (iv) Cystine-SWCNT (5,5).

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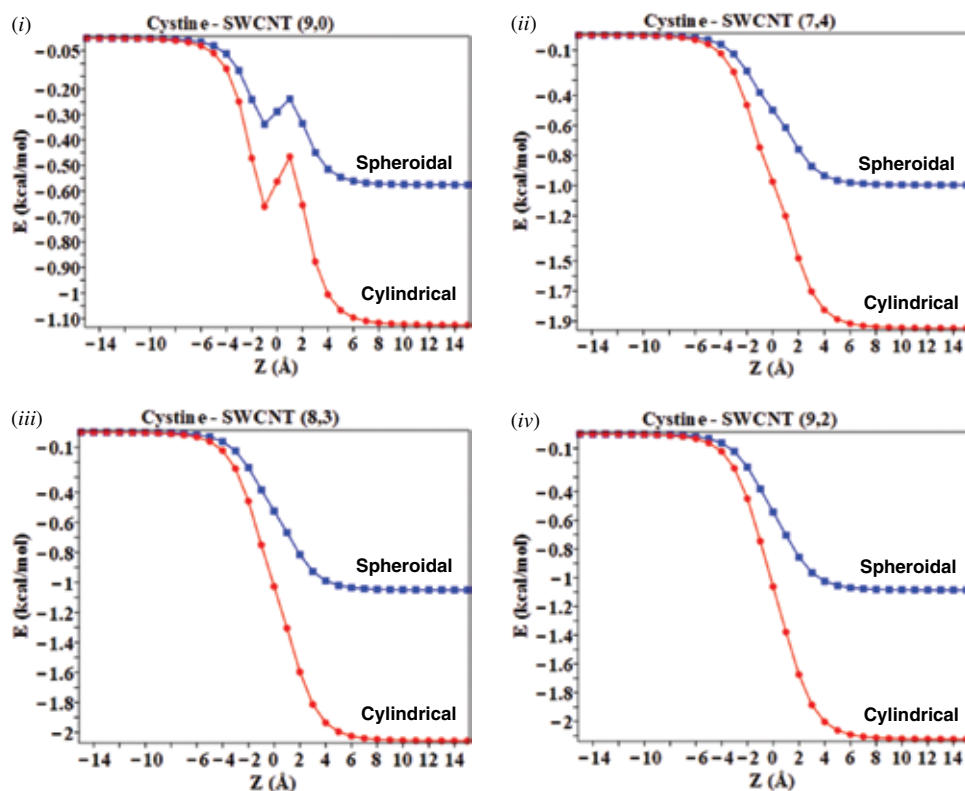


Fig. 3. Interaction energy (E) arising from the encapsulation of Cystine amino acid inside SWCNTs with varian radii r (i) Cystine-SWCNT (9, 0) (ii) Cystine-SWCNT (7, 4) (iii) Cystine-SWCNT (8, 3) (iv) Cystine-SWCNT (9, 2).

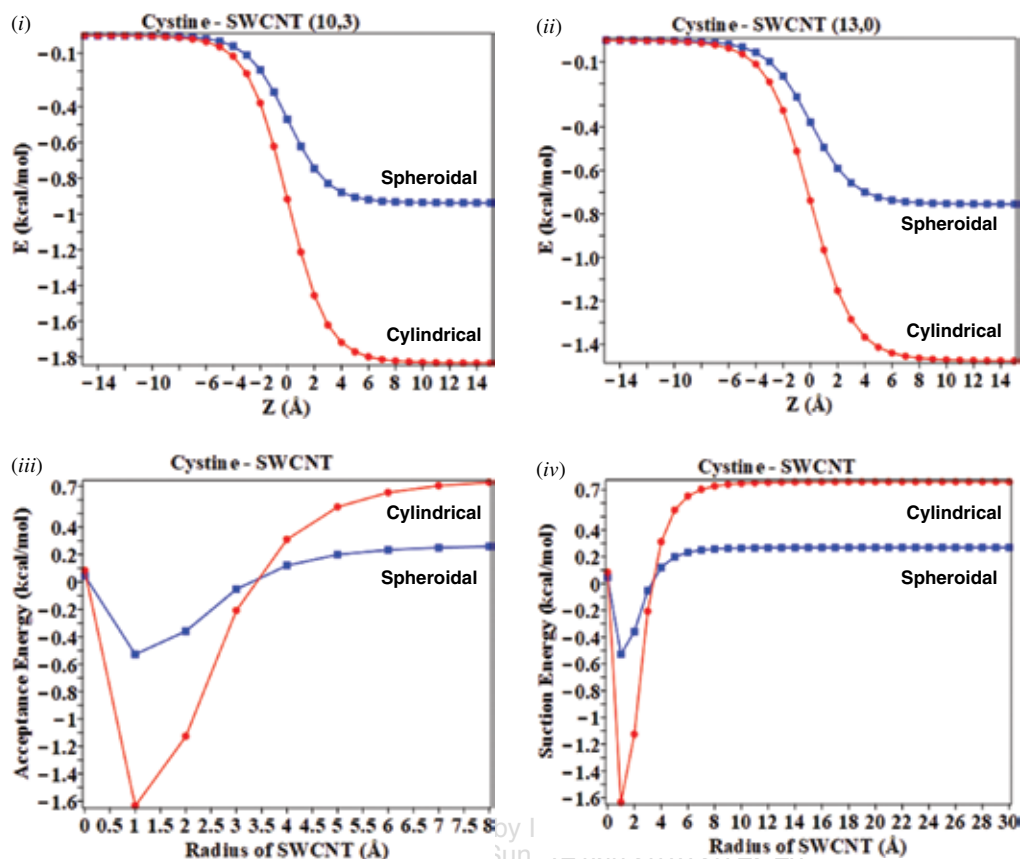


Fig. 4. Interaction energy (E) arising from the encapsulation of Cystine amino acid inside SWCNTs with various radii r (i) Cystine-SWCNT (10, 3) (ii) Cystine-SWCNT (13, 0) (iii) acceptance energy (iv) suction energy.

Cystine amino acid will not completely be encapsulated into those tubes with $r < 3.4 \text{ \AA}$. Furthermore, our results show that the acceptance of Cystine is more favourable when $r > 3.391 \text{ \AA}$ ((9, 2) nanotube). For the nanotube of radius $r > 3.391 \text{ \AA}$ as shown in Figures 2–4, there are no energetic barriers to prevent the encapsulation of the Cystine amino acid. The results obtained from analyzing the total energy which are consistently agree with the results based on the acceptance and suction energies as shown in Figures 4(iii) and (iv). Both configurations confirm that the Cystine will be encapsulated inside SWCNT when $r > 3.391 \text{ \AA}$.

Our results are in excellent agreement with the recent findings. For example, our results show that the minimum energies for the encapsulation of Cystine inside various SWCNTs for both configurations, spheroidal and cylindrical structures, are in the range of $-0.093 < E < -1.085$ and $-0.181 < E < -2.122 \text{ kcal/mol}$, respectively, which are in comparable with Ganji's work which investigates the encapsulation of different amino acids, including Nonionic-Glycine, Histidine, Phenylalanine and Cystine inside the (13, 0) SWCNT.⁽²⁷⁾ His results support what we have achieved in this model. In addition, they show that the Cystine molecule inside the (13, 0) nanotube of radius $r = 5.195 \text{ \AA}$ has the minimum binding energy in the range

of approximately -0.1 to -0.8 kcal/mol which is in a very good agreement with our results. Our calculations indicate that the minimum energies for both configurations, spheroidal and cylindrical structures, are -1.085 and -2.122 kcal/mol , respectively. For instance, work of Jiabin and Ganji who also investigate the adsorption of different amino acids inside different SWCNTs of variant radii r ^(49,50) and Roman's work focus on investigating nucleic acid bases adsorption on a (10, 0) SWCNT⁽²⁸⁾ as well as Al Garalleh's work show that the L-Histidine amino acid encapsulated inside SWCNT of radius $r > 3.7 \text{ \AA}$.⁽⁴⁰⁾ Their results confirm that the nanotube radius r plays a critical role in determining the encapsulation of different amino acids inside CNTs of variant radius r .

Furthermore, as shown in Figures 2 to 4(i) and (ii), we can obviously see that there is a significant difference in the magnitude of the interaction energies for the two proposed configurations. The volumes of spheroidal and cylindrical shells are 79.183 and 237.551 \AA^3 , respectively. The volume of the spheroidal shell is smaller than that of cylindrical one despite both structures have the similar dimensions. This means that cylinder has the maximum binding energy and the larger size of cylinder ends that requires a larger size of a nanotube to accommodate the cylindrical Cystine compared to that of the spheroidal shell. Based on

Table IV. Interaction energy E (kcal/mol) for Cystine amino acid interacting with SWCNTs of radii r .

Radius of CNT (Å)	E (Spheroidal-CNT)	E (Cylindrical-CNT)
3.105	2.326	4.549
3.204	1.186	2.319
3.325	0.259	0.508
3.391	-0.093	-0.181
3.523	-0.575	-1.124
3.775	-0.994	-1.944
3.861	-1.051	-2.054
3.973	-1.085	-2.122
4.615	-0.936	-1.831
5.089	-0.749	-1.464

our results as shown in Table IV, we can conclude that the Cystine amino acid is more stable and attractive inside the nanotube of radius $r > 3.391$ Å and the magnitude of the interaction energies shows minimal difference for all values of nanotube radius r which is greater than 3.391 Å. As a result, our model predicts that there are energetic barriers preventing the encapsulation of Cystine molecule inside a SWCNT with $r < 3.391$ Å. This means that the (5, 5) CNT is the smallest effective nanotube that can be used to encapsulate different nucleic and α -amino acids which is in a good agreement with work of Dresselhaus who predict that the (5, 5) nanotube would be the most significant and smallest physical nanotube for drug delivery system.⁽¹⁶⁾

4. CONCLUSION

We use the Lennard-Jones potential and a continuum formulation to model and investigate the adsorption of the Cystine amino acid inside SWCNTs of radii r . The proposed model considers a special case by assuming the SWCNT to be well-defined and characterized which excludes the pressure and electrostatic effects. The interaction, acceptance and suction energies are obtained by doing volume integrals and expressed as special functions. The interaction energy is practically zero outside the SWCNT along the distance z . The potential energy arising from Cystine-SWCNT interaction is evaluated for various sizes of nanotubes. Our findings show that a SWCNT with radius $r \geq 3.391$ Å will accept the Cystine molecule for both configurations. They also indicate that the nanotube of $r < 3.391$ Å has energetic barriers which prevent the Cystine amino acid to be encapsulated inside those nanotubes. Overall, our results are completely consistent with Ganji's findings who use the density function theory (DFT) to calculate the total energies of different amino acids inside SWCNTs and his results indicate that the minimum interaction energies are in the range of -0.1 to -0.8 kcal/mol.⁽²⁷⁾ The experimental results of long-term studies show that the encapsulation of various amino acids are acceptable and stable along the interior wall of SWCNTs by using different methods, especially the Moller-Plesset perturbation theory (MP2) 36, molecular dynamic

simulations (MDSs).^(29,39) We comment that our results and recent experimental findings are closer, this could offer a unique opportunity to the scientific researchers to design new nano-devices of radius $r < 3.391$ Å that are capable of carrying out bio-molecules and drugs to the targeted cells by manipulating in their nano-scale size, conductivity and outstanding properties to increase their maximum loading, and controlling the electrostatic effects.

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Reforming Saudi Arabia's Energy Policy by Developing the Solar Industry for Residence and EVs: A System Dynamics Approach

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Abstract

This paper analyzes the benefits of installing solar photovoltaics (PV) for both residences and electric vehicles (EVs) on a nationwide scale to support the energy initiatives of Saudi Arabia's Vision 2030. In a different study, the author projects the impact of developing the residential PV industry only. However, this paper emphasizes the additional impact of meeting EV energy consumption needs. In 2016, Saudi Arabia possessed 19 million vehicles; of that total, only 34 thousand were registered hybrid cars and EVs. By 2030, the kingdom will possess 26 million vehicles, or 19 million vehicles if considering the completion of four main cities' metro projects. The transition from 19 million motor vehicles (MVs) to EVs with electric stations is more achievable when considering the execution of the metro projects. Through a system dynamics (SD) simulation, the results show that the elimination of MVs will reduce carbon dioxide by 127 million metric tons, saving 771 million barrels of oil and creating 143 thousand jobs. Additionally, considering the different scenarios of oil prices throughout the simulated years, gross domestic product (GDP) increases by \$170.6, \$231.3, and \$343.9 billion for the low price (LP), medium price (MP), and high price (HP) scenarios, respectively. The development of both projects, the residential and EV station PVs, results in a GDP of \$1388.7, \$1490, and \$1708.2 billion in the year 2030 for LP, MP, and HP, respectively.

Key Words: Policy Reform, System Dynamics, Gasoline, Solar Energy, EV, Saudi Arabia, Oil.

Introduction

Vehicles are the major transportation method in urban and rural areas of Saudi Arabia, with 19 million registered vehicles for the adult population of 20 million (CIA, 2017), or 95 cars for every 100 adult persons. Uniquely, adult drivers in Saudi Arabia consist of male nationals and foreigners; women in the kingdom do not drive at present, but as of June 2018, women will be permitted to drive (Hubbard, 2017). In the case of households, additional vehicle purchases and the employment of foreign drivers are mainly for women and non-adult transportation requirements. Nevertheless, a decrease in the number of foreign drivers and an increase in the number of independent women driving will begin as of 2018, yet the need for vehicles will remain as the main method of transportation.

Nineteen million vehicles consumed 16 million tons of gasoline in 2017, meaning a consumption of 227 million barrels of oil and the emission of 37 million metric tons of CO₂. Saving barrels of oil and reducing carbon dioxide emissions can be done by transitioning from motor vehicles (MVs) to electric vehicles

(EVs) and expanding alternative transportation city networks. Fortunately, Saudi Arabia is undergoing major metro projects for four of its main cities, as shown in Table 1.

Table 1: Vehicles and Public Transportations (Numbers are in thousands unless otherwise stated)

Year	2017	2018	2019	2020	2021	2022	2023
Total Vehicles	19,299	19,753	20,217	20,692	21,178	21,676	22,185
Total Vehicles (Metro Projects Considered)	19,299	19,576	19,860	20,053	20,249	20,259	20,267
Riyadh Metro Daily Gasoline Liter Savings	-	400	400	400	400	400	400
Jeddah Metro Daily Gasoline Liter Savings	-	-	-	-	-	429	429
Makkah Metro Daily Gasoline Liter Savings	-	-	-	-	-	-	-
Almadina Metro Daily Gasoline Liter Savings	-	-	-	219	219	219	219
Total Daily Gasoline Liter Savings	-	400	400	619	619	1,047	1,047
Annual Gasoline Liter Savings	-	146,000	146,000	225,753	225,753	382,319	382,319
Annual Gasoline Savings in million liters	-	146	146	226	226	382	382
Gasoline Annual Consumption in million liters	16,042	16,226	16,415	16,527	16,642	16,602	16,562
Annual Distance in million km	189,295	191,472	193,693	195,019	196,373	195,907	195,431
Year	2024	2025	2026	2027	2028	2029	2030
Total Vehicles	22,707	23,240	23,786	24,345	24,917	25,503	26,102
Total Vehicles (Metro Projects Considered)	20,274	20,280	20,090	19,893	19,690	19,481	19,264
Riyadh Metro Daily Gasoline Liter Savings	400	400	400	400	400	400	400
Jeddah Metro Daily Gasoline Liter Savings	429	429	429	429	429	429	429
Makkah Metro Daily Gasoline Liter Savings	-	-	432	432	432	432	432
Almadina Metro Daily Gasoline Liter Savings	219	219	219	219	219	219	219
Total Daily Gasoline Liter Savings	1,047	1,047	1,480	1,480	1,480	1,480	1,480
Annual Gasoline Liter Savings	382,319	382,319	540,145	540,145	540,145	540,145	540,145
Annual Gasoline Savings in million liters	382	382	540	540	540	540	540
Gasoline Annual Consumption in million liters	16,521	16,479	16,278	16,073	15,864	15,651	15,433
Annual Distance in million km	194,946	194,450	192,082	189,665	187,199	184,681	182,112

The metro projects will decrease vehicle dependency by 7 million vehicles by 2030, a 27% decrease. However, 19 million vehicles will still roam the streets, consuming gasoline and emitting carbon dioxide.

Literature Review

In a study of Brazilian taxi MVs transitioning to EVs, the scenarios consist of 25%, 50%, 75% and 100% transitions while adding two different daily travel distances for each transition, 200 km and 400 km, over a 15-year period (Sodr, Carolina, & Teixeira, 2016). The results show that although the acquisition of EVs is higher than that of MVs, the annual maintenance and operational costs were lower by almost 50% for EVs. Additionally, the energy consumed by EVs was four times lower than that consumed by MVs, with an 18% to 64% reduction in carbon dioxide emissions, depending on the energy generation efficiency. Although the study results show a considerable reduction in carbon dioxide emissions, renewable energies are not used to charge Evs. Meaning the consideration of renewable energies in charging EVs would achieve greater decrease in carbon dioxide emissions as suggested in our study and by Nunes, Figueiredo, and Brito (2016), who stated, "EVs are much more on-board energy efficient and clean, as long as they charge using renewable electricity." Furthermore, they stated that emissions can be mitigated by 48% to 70% by 2050 if the usage of renewable energy and EVs is dominant.

Alhazmi and Salama (2017) conducted a two-part study to measure the economic feasibility of EV charging stations. The first part showed that reduction of the annual investment costs of stations is possible when the location of stations is strategic. The second part of the study showed that when EV penetrates a specific market by 20%, it makes a direct profit. In addition, stations with larger charging capacity are more cost-effective if the location of fast charging stations is within high-traffic areas or if EV market penetration has reached 10% or higher. In our study, an EV market penetration of 8.6%, 18.2%, and 28.8% is reachable in the years 2023, 2024, and 2025, respectively, to possibly attract investors.

A study of 14 countries was conducted by Li, Chen, and Wang (2017) to analyze EV demand; 96% of EV sales is from these countries. The increase in renewable energies had a positive impact: A 1% increase in renewables increased EV demand by 2% to 6%. Additionally, the study suggested that the gross domestic product (GDP) variable had no impact on EV demand. This is true even in Saudi Arabia, a country not included in the study, with less than 1% of EVs at present. However, the increase in EVs due to policy changes in our study suggests an increase in GDP due to Okun's law (Kaboub, Forstater, & Kelsay, 2015), which states that GDP will increase by 1.75% to 2% if unemployment decreases by 1% in Saudi Arabia.

Research Questions

The question the author asks here is what economic impact will result from reforming Saudi Arabia's energy policy and developing the solar industry for residential and EV use.

The author suggests that diversifying the economy and becoming independent from oil is crucial to the country's economic survival, in parallel with the Saudi Vision 2030's energy initiatives that dictate energy conservation and the use of renewables for the sake of energy independence and reduction of carbon dioxide emissions. Therefore, focusing on eliminating gasoline and conventional residential energy consumption is important. The consumption of residential electricity comprises almost half of domestic energy consumption, and vehicles are the main type of transportation in the kingdom.

Methodology

To analyze the impact of the development and installation of photovoltaic panels for residential buildings and EV stations, we use the system dynamics (SD) approach using *Vensim* software. SD is a simulation modeling method used for solving complex and dynamic problems; this gives decision makers better insight into the specifically intended time frame.

The researcher designed two stock and flow diagrams (SFDs) covering a period of 12 years, from the year 2018 to the year 2030, in parallel with the Saudi Vision 2030. The SFD is an interactive simulation model that links variables with other variables and stock variables. However, stock variables are unique as they accumulate and dissipate through the influence of inflows and outflows in the model.

This research used secondary data in addition to a study previously done by the author (Banjer, 2017). The first SFD, in Figure 1, shows the EV and gasoline model using a subtraction of \$118 million from gasoline sales to gradually develop solar EV stations over the course of 12 years.

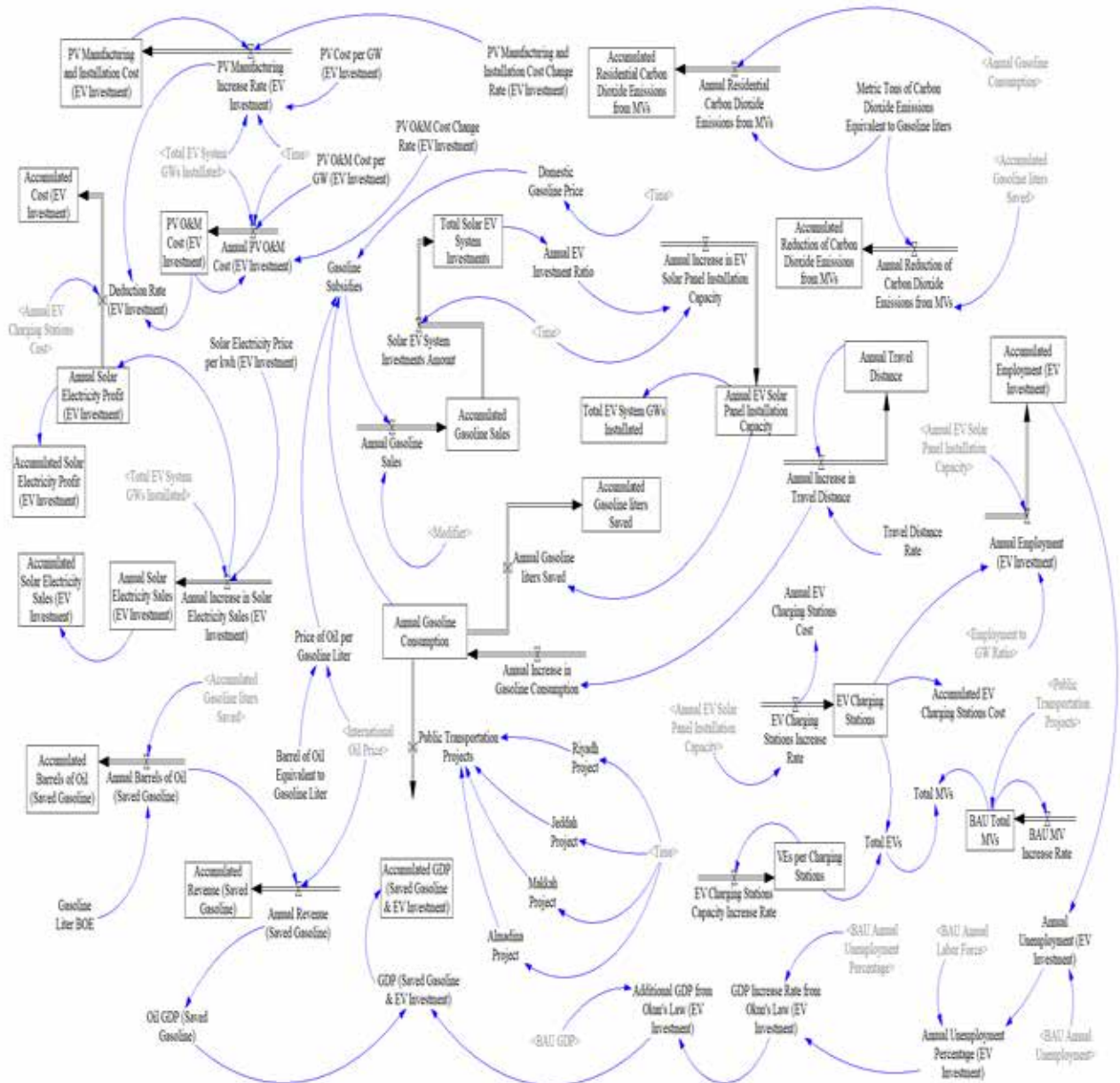


Figure 1.

In this study, we assume that the construction of the mega project takes three years, so by the year 2021 manufacturing and installation begins. The construction period, the required funds, and the solar panel module efficiency are all analyzed based on a study conducted to attract potential investors in a solar panel manufacturing company in Saudi Arabia (H. Yamani, personal communication, August 19, 2017). Additionally, based on the Saudi Vision 2030's energy initiatives, we chose to increase solar energy by 9.5 GW in the simulation (Borgmann, 2016), changing the domestic gasoline and residential electricity prices accordingly.

Moreover, the model considers the four ongoing major metro projects, which will decrease the use of vehicles. It is also assumed by the year 2030 MVs will be gradually replaced with EVs and gasoline stations with EV stations.

Oil production is assumed to be static at an annual rate of 3.741 billion barrels annually throughout the simulation, meaning 10.25 million barrels daily. The production rate is derived from the year 2016, the year with the lowest oil price in recent years.

For further insight, the author designed three scenarios for oil price: low, medium, and high oil prices (LP, MP, and HP, respectively). The oil scenarios are within two main scenarios, the default Vision 2030 with three oil price scenarios and the three scenarios suggested by the author (LPS, MPS, and HPS). A total of six scenarios, therefore, are used to compare and analyze the differences and benefits of such implemented reforms.

Results

Oil & Carbon Dioxide Emissions

By 2030, results show that Saudi Arabia will save a total of 771 million barrels of oil from gasoline alone, as shown in Figure 3.

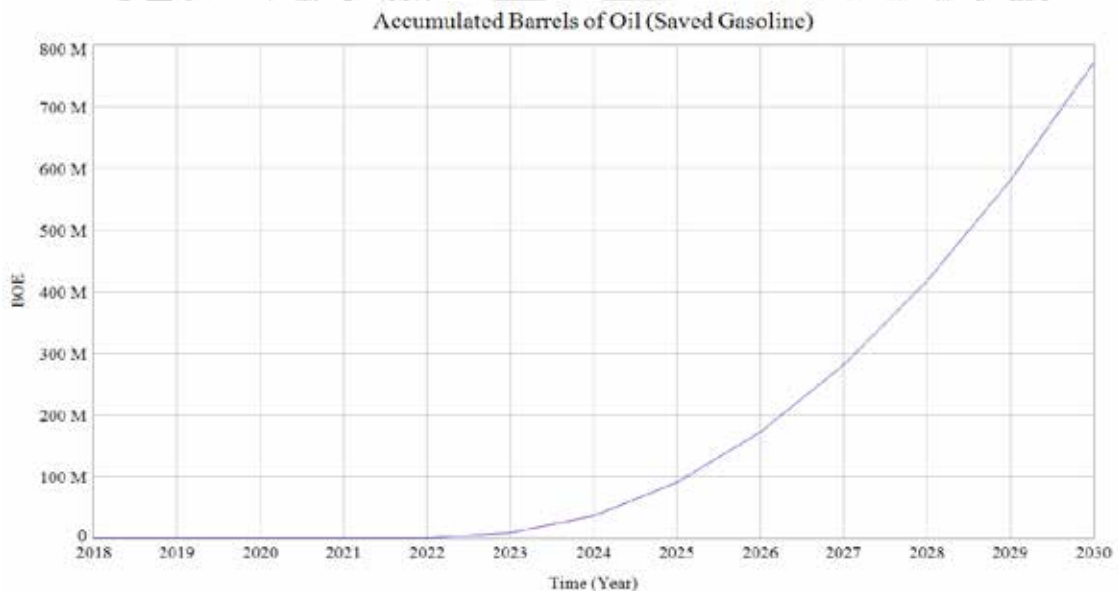


Figure 3.

Furthermore, Saudi Arabia will save a total of 1.75 billion barrels of oil, as shown in Figure 4, a year's worth of oil exports.

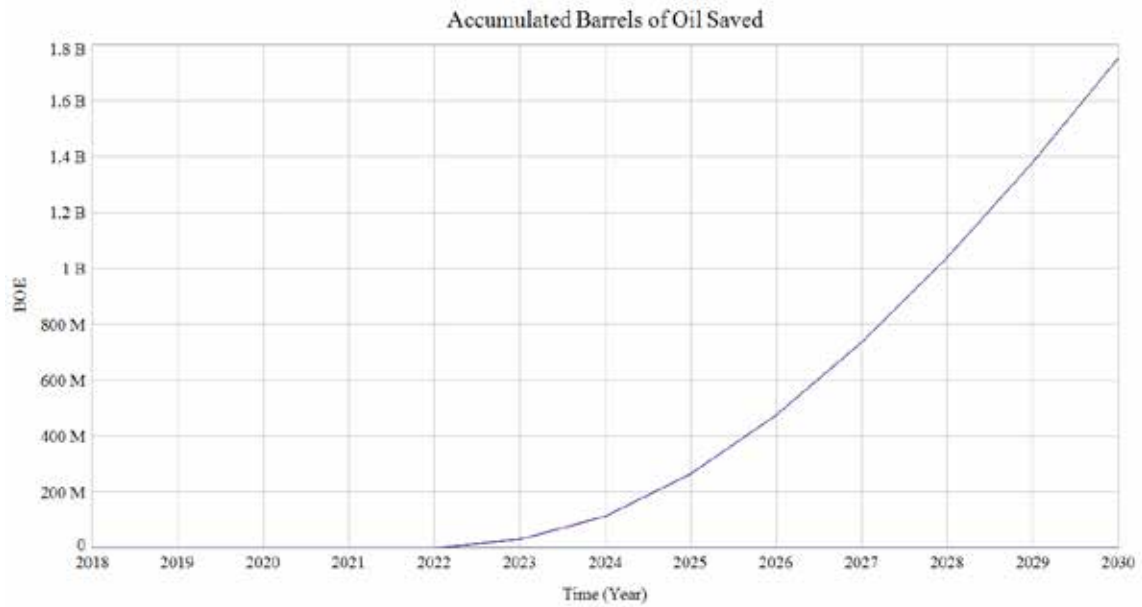


Figure 4.

The oil saved from the project means a reduction of 654 million metric tons of CO₂ emissions, as shown in Figure 5, and 127 million metric tons of carbon dioxide emissions from gasoline alone, as shown in Figure 6. Twenty percent of carbon dioxide emissions come from MVs alone.

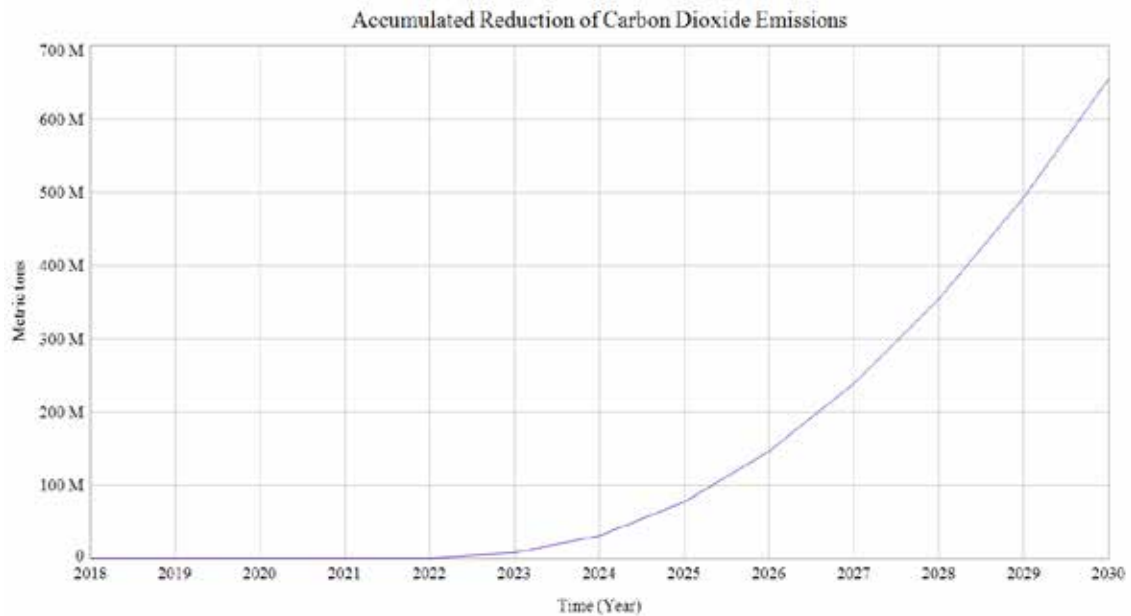


Figure 5.

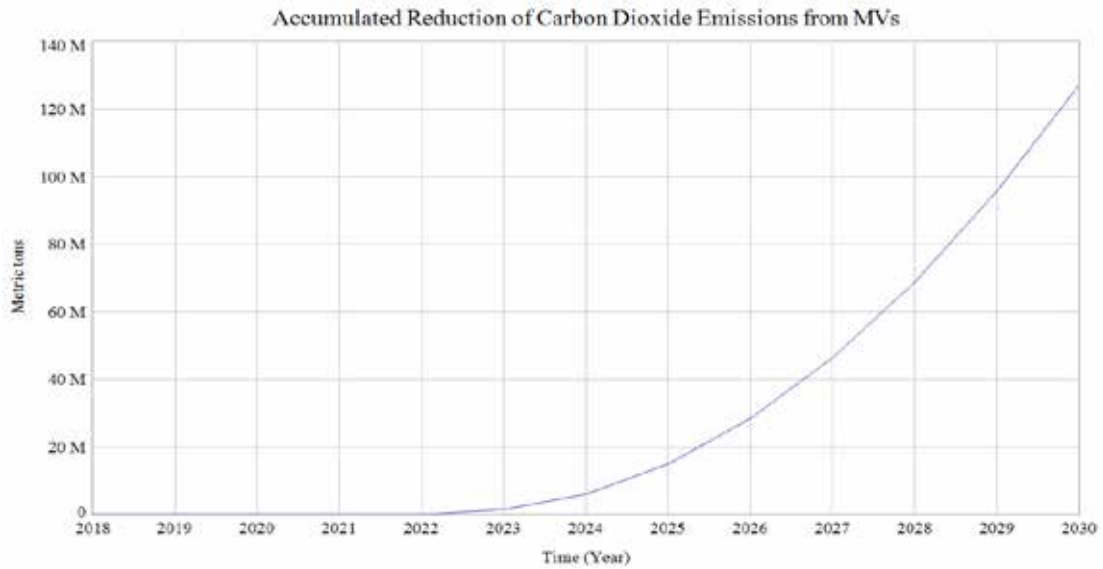


Figure 6.

GDP and Employment

GDP is considered an indicator of a country's economic health. Results show that the economic impact of developing the solar energy industry is positive. GDP from gasoline saved and EV investment show an increase of \$53.2, \$69.5, and \$104.6 billion by the year 2030 for the LPS, MPS, and HPS scenarios, as shown in Figure 7.

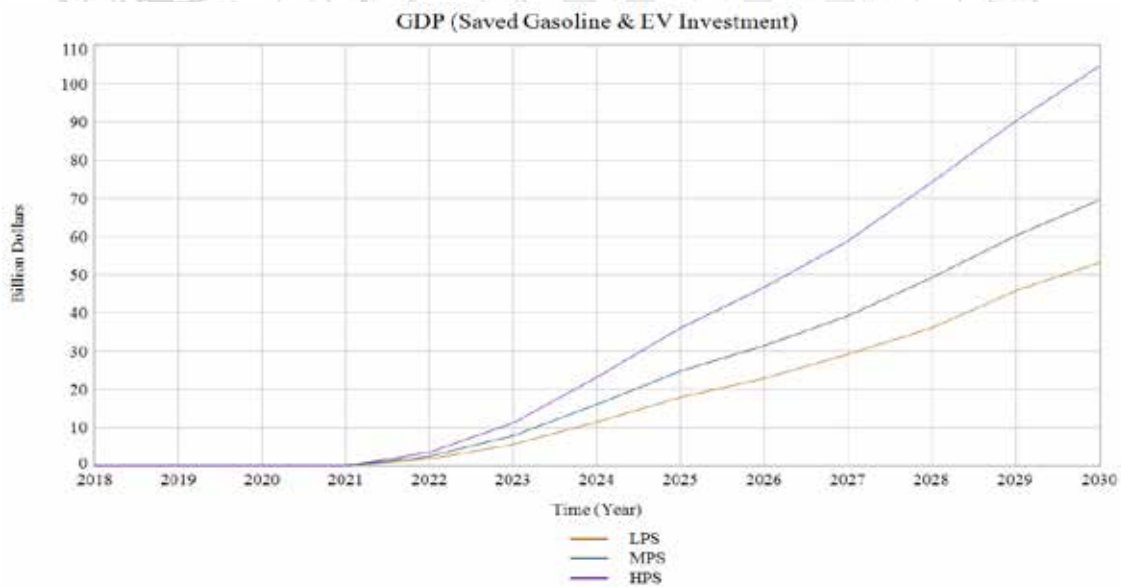


Figure 7.

The GDP for the projects by the year 2030 will be \$1388.7, \$1490, and \$1708.2 billion for the LPS, MPS, and HPS, respectively, as shown in Figure 8.

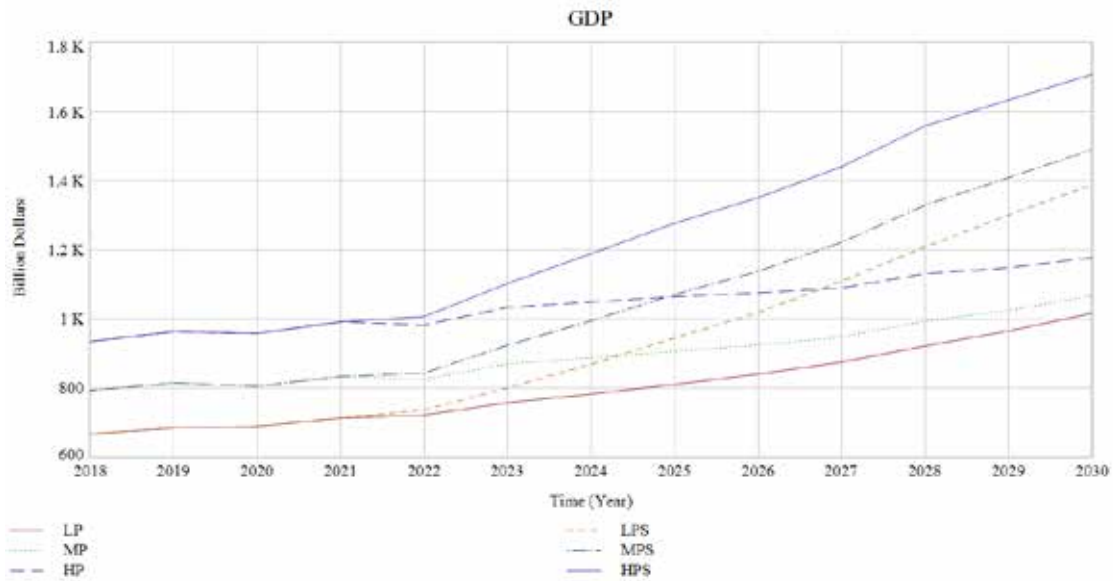


Figure 8.

Vision 2030 scenarios show considerably lower GDP compared to the suggested scenarios. Even with the highest oil price scenario of Vision 2030, the GDP is \$211 billion lower compared with the lowest suggested scenario GDP by the year 2030.

Additionally, employment affects GDP positively, as mentioned previously and shown in Figure 9.

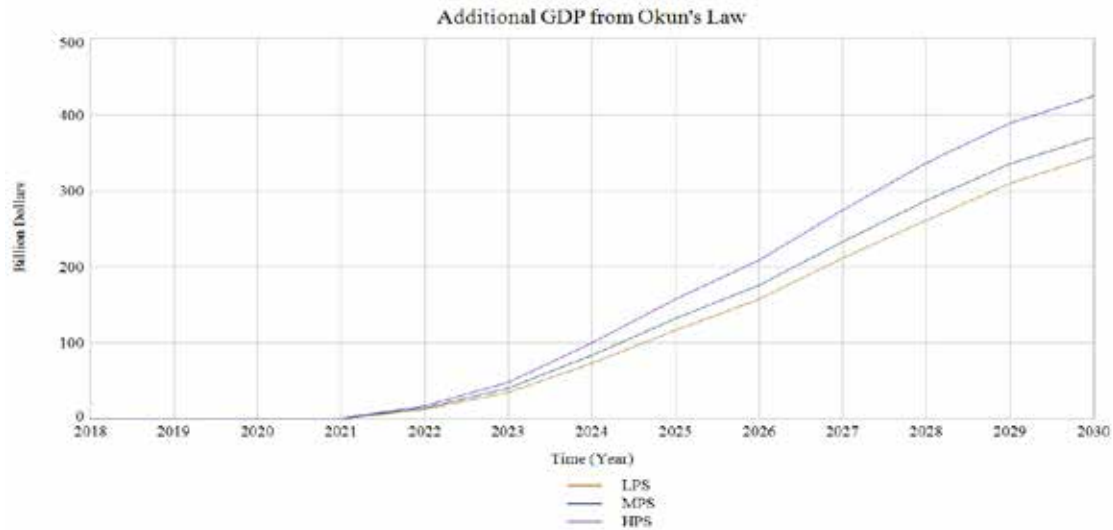


Figure 9.

By the year 2030, additional GDP from Okun's law is \$345.3, \$370.5, and \$424.7 billion for LPS, MPS, and HPS, respectively. The high additional GDP is a result of a 1.354 million decrease in the Unemployed Saudi population by the year 2030, as shown in Figure 10.

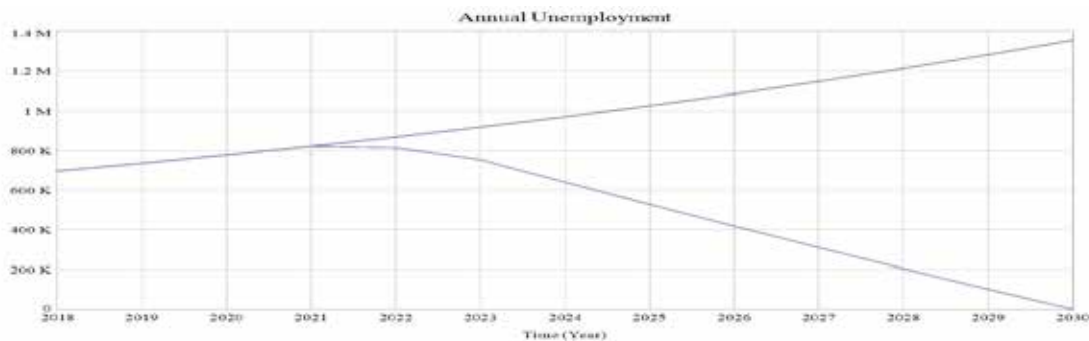


Figure 10.

Conclusion

This study gives insight into the importance of diversifying and investing in the economy, beyond saving oil. GDP from oil saved is \$53.2, \$69.5, and \$104.6 billion compared to \$345.3, \$370.5, and \$424.7 billion from employment. Nevertheless, high oil prices will always benefit the country as it is a great support to the Saudi economy.

Future Research

With the new decree allowing women to drive, different possibilities may arise. Increasing the demand for vehicles is one possibility that leads to more possibilities.

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Synthesis and Structural NMR Characterization of Novel PPG/PCL Conetworks Based upon Heterocomplementary Coupling Reactions

Lothar Jakisch, Mazen Garaleh, Mareen Schäfer, Anton Mordvinkin, Kay Saalwächter,* and Frank Böhme*

A new approach to hybrid model network formation based upon heterocomplementary end-linking of four-arm star poly- ϵ -caprolactone (PCL) and linear polypropylene glycol (PPG) precursors is demonstrated. Specifically, hydroxy-terminated PCL($-\text{OH}$)₄ and an amino-terminated linear PPG($-\text{NH}_2$)₂ are reacted with a bifunctional coupling agent containing one carboxylic acid chloride group and one oxazinone group. PCL($-\text{OH}$)₄ is first reacted with the former in a solution, and the so-obtained oxazinone-terminated intermediate is then reacted with PPG($-\text{NH}_2$)₂ to form a network both in the solution and in the melt. A strong effect of electron-withdrawing groups on the reactivity of the oxazinone group, and thus on the network formation, is evidenced. Network structure and properties are studied by swelling experiments and low-field multiple-quantum (MQ) NMR, which confirm the successful formation of hybrid networks and provide information on the significant network inhomogeneities. On the methodological side, a reliable approach to MQ NMR data analysis for networks of variable degree of inhomogeneity is discussed.

1. Introduction

Polymer buildup by terminal group coupling is frequently used for chain extension or preparation of segmented block and graft copolymers. Apart from direct reactions between terminal groups of the building blocks, the utilization of coupling agents

has proved successful. If the terminal groups of the building blocks are equal, symmetric bifunctional coupling agents such as bisoxazolines,^[1] bisoxazinones,^[2] diisocyanates,^[3] bislactams,^[4,5] and bisepoxides^[6] can be used. However, in these cases, linking does not only occur between different building blocks but also between building blocks of the same type. This severely restricts the formation of defined structures. To overcome this problem, we utilized coupling agents with different highly selective reacting groups which enabled us to perform heterocomplementary carboxy/amino^[7,8] and hydroxy/amino^[9,10] group coupling. By this way, defined block and graft copolymers based on polyamides, polyesters and polyethers were synthesized in the melt.^[11–13]

The potential application of heterocomplementary terminal group reactions is particularly relevant for the synthesis of conetworks in which the arms of different star-shaped prepolymers are linked to each other.^[14,15] Here, different methods of click-chemistry such as azide-alkyne cycloaddition^[16,17] and thiol-ene coupling^[18–20] as well as Diels-Alder reactions^[21] have been utilized, among others.^[14,15] This kind of network formation ensures a high degree of structural definition since the degree of crosslinking, the node distance, and the segment lengths are predefined by the prepolymers.

As an important example, Sakai et al.^[22] introduced a new type of model network designated as tetra-PEG gel, which is obtained by heterocomplementary coupling of two orthogonally functionalized tetrahedron-like polyethylene glycol (PEG) macromonomers ($A_4 + B_4$). The approach was later extended to hybrid gels.^[14,15,23] Such gels are characterized by their homogeneous structure and resultant high mechanical strength. A combined proton NMR and Monte-Carlo simulation study showed that these kinds of gels possessed only a small extent of both large-scale concentration and local-scale topological (connectivity) inhomogeneities.^[24]


In this study we focus on the ability to prepare conetworks with model character by using multifunctional coupling agents as a new and flexible synthetic platform. As mentioned above, such coupling agents proved very useful in preparing segmented block and graft copolymers, but might have restrictions

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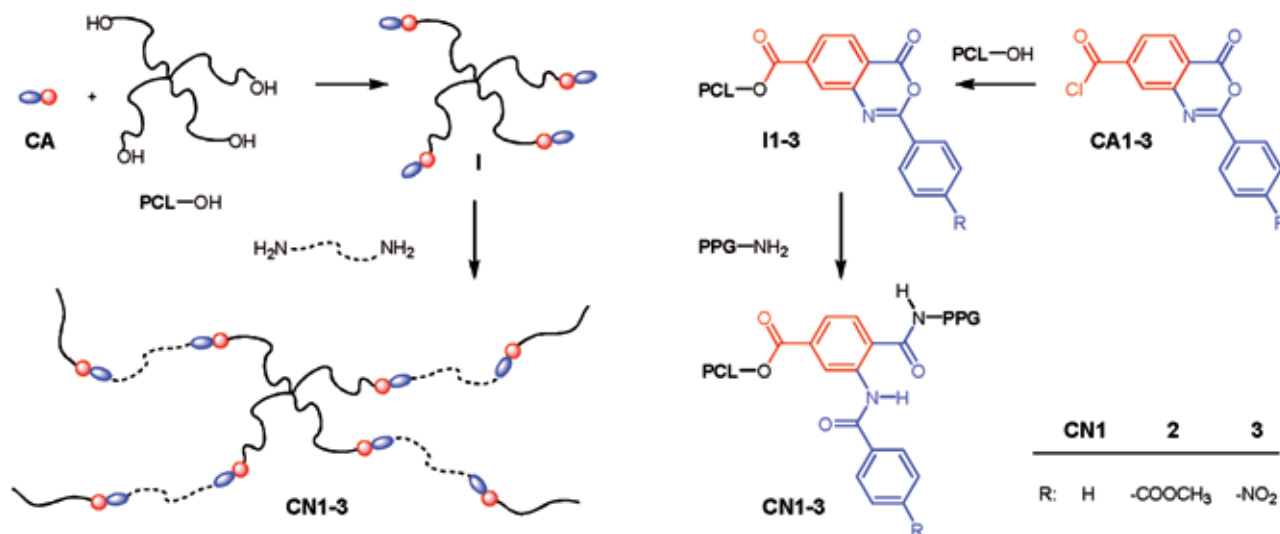
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Scheme 1. Conetworks prepared by heterocomplementary terminal group coupling.

for crosslinking reactions because of reduced mobility in a network. It is thus of interest to test this synthesis approach for networks and to characterize their final structure.

Specifically, we describe the preparation of conetworks based on a hydroxy-terminated four-arm poly- ϵ -caprolactone star (PCL(-OH)₄, B₄) and an amino-terminated linear polypropylene glycol chain (PPG(-NH₂)₂, A₂), see **Scheme 1**. The coupling agents used (CA1-3) possess a carboxylic acid chloride group which reacts in the first step with the hydroxy groups of PCL. In the second step, a conetwork is formed by the reaction of the oxazinone terminated PCL with the amino group terminated PPG. In order to adjust the reactivity of the oxazinone group, electron-withdrawing substituents (R: COOCH₃, NO₂) were introduced in the coupling agent.

It is important to note that the resulting A₂/B₄ networks are expected to feature significant amounts of defects,^[25,26] in particular when the conversion is not close to 100%. Our work is thus only the first step toward the preparation of truly homogeneous model conetworks, which should be prepared from two star-like components.^[22] In conetworks, the miscibility of the components is another important issue. Blends of PCL and PPG have rarely been investigated, but recent work on micelle-forming multiblock copolymers containing PCL and PPG suggest that they mix at elevated temperature, and allow PCL to crystallize at somewhat lower temperature than in the bulk.^[27]

The degree of crosslinking is assessed macroscopically by means of swelling experiments, and microscopically by modern NMR spectroscopic investigations. The used low-field multiple-quantum (MQ) experiment^[21,28–32] is well-suited to provide in-depth information on the network quality, i.e., not only on the degree of crosslinking but also on the network (in)homogeneity in terms of a crosslink density distribution and the amount of non-elastic defects. To this end, we also discuss a robust fitting strategy of MQ NMR data to characterize the network (in)homogeneity that overcomes limitations of previous approaches.

2. Experimental Section

2.1. Materials

All chemicals and solvents (analytical grade) were received from Aldrich and used without further purification. ϵ -Caprolactone was distilled from CaH₂ under reduced pressure. Sn(oct)₂ was purified by azeotropic distillation using dry toluene followed by vacuum distillation after the removal of toluene. Poly(propylene glycol) bis(2-aminopropyl ether) (PPG(-NH₂)₂), with a declared number-average molecular weight (M_n) of 4000 g mol⁻¹ ($M_w/M_n = 1.38$) was also received from Aldrich. 4-(Methoxycarbonyl) benzoic acid chloride was synthesized from 4-(methoxycarbonyl) benzoic acid by treatment with thionyl chloride under reflux and subsequent removing of the residual thionyl chloride by distillation.

2.2. Coupling Agents CA1-3

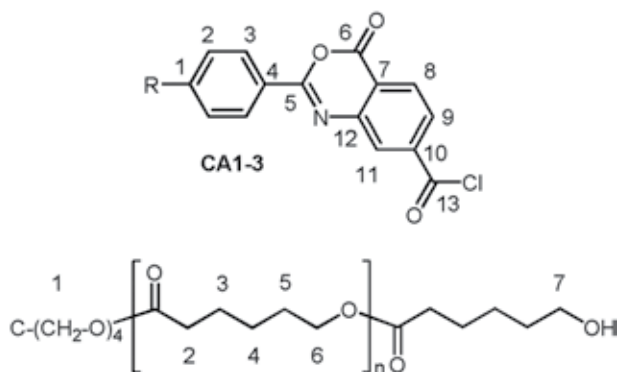
Coupling agents CA1-3 (see **Scheme 2**) were prepared as described earlier by the reaction of respective benzoic acid chlorides with 2-aminoterephthalic acid in the presence of triethylamine and subsequent treatment of the reaction product with thionyl chloride under reflux.^[8]

CA1: mp: 141–143 °C (*n*-hexane). ¹H NMR (CDCl₃, ppm): $\delta = 8.45$ (s, 1H, H¹¹), 8.36 (d, 1H, H⁸), 8.33 (d, 2H, H³), 8.15 (d, 1H, H⁹), 7.63 (t, 1H, H¹), 7.55 (t, 2H, H²).

¹³C NMR (CDCl₃, ppm): $\delta = 167.34$ (C¹³), 158.34 (C⁵), 158.16 (C⁶), 147.26 (C¹²), 139.79 (C¹⁰), 133.26 (C¹), 130.45 (C¹¹), 129.45 (C⁴), 129.27 (C⁸), 128.85 (C²), 128.73 (C⁹), 128.52 (C³), 121.51 (C⁷).

CA2: mp: 196 °C (toluene). ¹H NMR (CDCl₃, ppm): $\delta = 8.46$ (s, 1H, H¹¹), 8.39 (d, 2H, H³), 8.37 (d, 1H, H⁸), 8.18 (d, 1H, H⁹), 8.18 (d, 2H, H²), 3.97 (s, 3H, CH₃).

¹³C NMR (CDCl₃, ppm): $\delta = 167.34$ (-COCl), 166.05 (-COO-), 157.84 (C⁶), 157.45 (C⁵), 147.00 (C¹²), 140.01 (C¹⁰),



Scheme 2. Assignments for CA1-3 and PCL(–OH)₄.

134.17 (C¹), 133.34 (C⁴), 130.69 (C¹¹), 129.99 (C²), 129.45 (C⁸), 129.34 (C⁹), 128.50 (C³), 121.65 (C⁷), 52.53 (CH₃).

CA3: mp: 191–193 °C (toluene). ¹H NMR (CDCl₃, ppm): δ = 8.53 (d, 2H, H³), 8.51 (s, 1H, H¹¹), 8.41 (d, 1H, H⁸), 8.40 (d, 2H, H²), 8.24 (d, 1H, H⁹).

¹³C NMR (CDCl₃, ppm): δ = 167.24 (–COCl), 157.41 (C⁶), 156.30 (C⁵), 150.58 (C¹), 146.64 (C¹²), 140.19 (C¹⁰), 135.09 (C⁴), 130.77 (C¹¹), 129.89 (C⁹), 129.61 (C⁸), 129.57 (C³), 124.03 (C²), 121.66 (C⁷).

2.3. Hydroxy-Terminated Four-Arm Star PCL (PCL(–OH)₄)

Two samples of PCL(–OH)₄ (see also Scheme 2) with slightly different molar masses were synthesized. The molar mass was adjusted by the ratio of pentaerythritol and ε-caprolactone.

Sample 1: ε-Caprolactone (60 mmol) and pentaerythritol (1 mmol) were weighed under nitrogen into a cylindrical glass reactor equipped with a flat blade stirrer and heated at 140 °C for 30 min to get a homogenous mixture. The Sn(oct)₂ initiator (0.08 mmol) was injected by means of a syringe in the form of a 0.5 M solution in dry toluene under nitrogen. The reaction vessel was placed into an oil bath preheated to 100 °C. After 6 h, the reaction mixture was diluted with dichloromethane and precipitated in cold methanol. *M_n* (theoretical) = 7000 Da, *M_n* (NMR) = 7 800 Da, *M_n* (SEC) = 9 500 Da, *M_w*/*M_n* = 1.18.

Sample 2: same procedure as for Sample 1 with an ε-caprolactone/pentaerythritol ratio of 80 :1 (mol/mol). *M_n* (theoretical) = 9 300 Da, *M_n* (NMR) = 9 500 Da, *M_n* (SEC) = 11 100 Da, *M_w*/*M_n* = 1.16.

¹H NMR (CDCl₃, ppm): δ = 4.11 (s, H¹), 4.07 (t, H⁶), 3.65 (t, H⁷), 2.31 (t, H²), 1.66 (m, H^{3/5}), 1.39 (m, H³).

2.4. Functionalization of Four-Arm Star PCL (II-3)

Intermediates II-3 were obtained by conversion of PCL(–OH)₄ with the respective coupling agents CA1-3 in the presence of triethylamine. A typical procedure is described as follows: An amount of 1 mmol of poly(ε-caprolactone) star shaped oligomers and 8 mmol of the carboxylic acid chloride were dissolved in 70 mL dry dichloromethane in a round bottle flask equipped with a flat blade stirrer and gas-inlet gas-outlet tubes.

8 mmol of triethylamine was added dropwise at room temperature to the solution. After 48 h, the resulting product was precipitated in cold methanol.

I1: ¹H NMR (CDCl₃, ppm): δ = 8.34 (s, H¹¹), 8.33 (d, H³), 8.30 (d, H⁸), 8.12 (d, H⁹), 7.60 (t, H¹), 7.53 (t, H²), 4.40 (t, ArCOOCH₂–), 4.06 (t, AlkCOOCH₂–).

I2: ¹H NMR (CDCl₃, ppm): δ = 8.40 (d, H³), 8.36 (s, H¹¹), 8.34 (d, H⁸), 8.18 (d, H²), 8.16 (d, H⁹), 4.40 (t, ArCOOCH₂–), 4.06 (t, AlkCOOCH₂–), 3.97 (s, CH₃).

I3: ¹H NMR (CDCl₃, ppm): δ = 8.52 (d, H³), 8.39 (s, H¹¹), 8.38 (d, H²), 8.34 (d, H⁸), 8.20 (d, H⁹), 4.41 (t, ArCOOCH₂–), 4.06 (t, AlkCOOCH₂–).

The assignment was according to CA1-3, see Scheme 2.

2.5. Conetworks CN1-3

Conetworks were synthesized by conversion of the intermediates II-3 with PPG-(NH₂)₂ in the melt and in the solution.

Preparation in the Solution: An amount of 0.2 mmol (0.80 g) of PPG-(NH₂)₂ (*M_n* = 4000 g·mol^{–1}) and 0.1 mmol (0.9–1.07 g) of oxazinone-terminated four-arm star PCL (II-3) were dissolved in 50 mL of dry toluene and heated under reflux for 6 h under nitrogen. After cooling the networks were separated from the toluene solution, washed with toluene, and dried at 60 °C in vacuum. For the determination of the soluble content, the combined toluene solutions were evaporated to dryness.

Preparation in the Melt: An amount of 0.2 mmol (0.80 g) of PPG-(NH₂)₂ (*M_n* = 4000 g·mol^{–1}), 0.1 mmol (0.9–1.07 g) of oxazinone-terminated four-arm star PCL (II-3) and a small amount of Irganox 1076 (0.5%) as antioxidant were added in a small glass flask with a magnetic stirrer and heated at 150 °C for 1 h under nitrogen. Generally, the viscosity of the sample increased distinctly within 5–20 min so that further mixing became impossible. After cooling and addition of toluene, the swollen networks could be removed from the glass. Then, the networks were washed with toluene and dried at 60 °C in vacuum. For determination of the soluble content the combined toluene solutions were evaporated to dryness.

In all cases, the samples were perfectly transparent under the given preparation conditions, and also at the NMR experimental temperature of 100 °C where PCL was also molten. This suggests that PCL and PPG were fully miscible under all relevant conditions. A sample overview is given in Table 1.

2.6. Swelling Experiments

Swelling experiments with the dried networks were performed with toluene at room temperature for 48 h. After that, the weight of the swollen network was determined immediately. For calculation of the volumetric degree of swelling $Q = V_{\text{pol}}/V_{\text{tot}}$, the densities of the components were taken into account, using an average value of 1.06 g cc^{–1} for the combined polymer component (consisting of roughly equal parts of PCL and PPG) and 0.87 g cc^{–1} for toluene.



Table 1. Sample overview.

Sample	R ^{a)}	Synthesis	M _n (PCL(-OH) ₄)	Finite (equilibrium) swelling
CN1 _s	H	solution	9500	–
CN1 _m	H	melt	9500	+
CN2 _s	COOCH ₃	solution	9500	–
CN2 _m	COOCH ₃	melt	9500	+
CN3 _s	NO ₂	solution	7800	+
CN3 _m	NO ₂	melt	7800	+

^{a)}Substituent of the coupling agent used.

2.7. Chemical Analyses

High-resolution ¹H NMR spectra (500.13 MHz) and ¹³C NMR spectra (125.74 MHz) were recorded on an Avance III 500 NMR spectrometer (Bruker). CDCl₃ (δ_H = 7.26 ppm, δ_C = 77.0 ppm) was used as solvent, lock, and internal standard. Signal assignments were verified by ¹H–¹H and ¹H–¹³C correlated 2D NMR spectra.

FTIR spectra were recorded on a Tensor 27 FTIR spectrometer (Bruker) with an ATR unit (Pike “MIRacle” with a diamond crystal) with 16 scans and a resolution of 2 cm⁻¹.

GPC measurements were performed with an HPLC pump, series 1200 (Agilent Technologies), a 1 PL MIXED-C column (300 × 7.5 mm and 5 μm PSgel from Agilent Technologies), and an ETA-2020 – RI and viscosity detector (Bures). THF (stabilized with 0,025 % BHT) was used as eluent at room temperature with a flow rate of 1.0 mL min⁻¹. Polystyrene standards were used for calibration.

2.8. Low-Field MQ NMR

MQ NMR is a well-established technique that, similar to (but more quantitative than) traditional Hahn-echo T₂ relaxometry, provides molecular-scale information on the degree of crosslinking of an elastomer or gel.^[28,30–32] The main observable is the so-called residual dipolar coupling D_{res} (in rad s⁻¹), which is a fast-limit dynamic average of the instantaneous and orientation dipole–dipole coupling between the protons fixed to the polymer backbone, measured in the elastomeric state far above the glass transition. It quantifies the degree of anisotropy of the segmental motion, which is in turn directly proportional to the inverse number of segments between crosslink^[28,29] or entanglement^[31,32] constraints. The technique also probes quantitatively the local degree of inhomogeneity in terms of a distribution of D_{res},^[30] and the amount of elastically inactive defects.^[24,31,32] For the lack of a model-dependent conversion factor, and some ambiguity related to the superposition of the signals from PCL and PPG chains,^[32] D_{res} is just reported here, and we refrain from converting it into actual constraint density.

MQ NMR data taken on a Bruker minispec mq 20 (Larmor frequency 20 MHz, B₀ = 0.47 T) at 100 °C, i.e., well above the melting point of PCL in the samples, were measured and analyzed according to previously published procedures.^[28,30,32]

Relevant steps in the analysis of the two signal functions, the summed MQ intensity I_{ΣMQ}(τ_{DQ}) providing the defect fraction as well as the intensity normalization to correct for relaxation decay (see below), and the normalized double-quantum (DQ) buildup I_{nDQ}(τ_{DQ}) providing D_{res} and its distribution, will be illustrated in Section 3. Due to the effect of slowly relaxing entanglements, the defect fraction measured in the bulk is often significantly smaller than the true fraction of elastically inactive defects relevant for the swollen state, f_{def,sw}.^[33] To better interpret the equilibrium swelling experiments,^[34] f_{def,sw} is determined by MQ NMR experiments at room temperature on samples swollen in perdeuterated toluene at a polymer weight fraction of 0.1.

2.9. MQ NMR Data Analysis for Inhomogeneous Networks

As this study is dealing with networks with potentially significant structural variability, we illustrate the utility and the implementation of an improved approach to characterize network (in)homogeneity via the analysis of the I_{nDQ}(τ_{DQ}) signal function. For a rather homogeneous elastomer, a recently published universal fitting function can be used directly^[30]

$$I_{nDQ}(\tau_{DQ}, D_{res}) = 0.5 \left(1 - \exp[-(0.378 D_{res} \tau_{DQ})^{1.5}] \right) \cos[0.583 D_{res} \tau_{DQ}] \quad (1)$$

In order to account for a distribution P(D_{res}), one can either resort to a purely numerical assessment of P(D_{res}) by integral inversion techniques,^[30] or assume a priori a certain distribution shape in a simpler fitting procedure, which then involves only an integration over the distribution

$$I_{nDQ}(\tau_{DQ}) = \int P(D_{res}) I_{nDQ}(\tau_{DQ}, D_{res}) dD_{res}$$

Previously, we have often resorted to assume a simple Gaussian distribution, where for the simpler and approximate case of an inverted-Gaussian buildup function in place of Equation (1), the integral can even be solved analytically.^[28] This approach is subject to serious limitations for inhomogeneous networks featuring a fitted average D_{av} that is larger than the fitted standard deviation σ of the distribution. In such a case, the distribution extends significantly into the negative quadrant. Negative D_{res} values are not meaningful, and implicit folding of this part of the distribution into the positive quadrant challenges the meaning of the fitted parameters. A more physical approach is to use a skew distribution bound to a positive value range. Swollen networks are often intrinsically rather inhomogeneous, and a generic Γ distribution fulfilling this requirement proved useful in such cases^[28,29]

$$P(D_{res}) = \sqrt{\frac{27 D_{res}}{2 \pi D_{av}^3}} \exp[-3 D_{res} / (2 D_{av})] \quad (2)$$

This distribution function does not have a separate width parameter, as its width depends on its average D_{av}, restricting its general use. Therefore, following a first demonstration of Lorthioir et al. for the special case of ²H DQ buildup in a copolymer block,^[35] this study here advocates the use of a log-normal distribution of D_{res} in terms of ln(D_{res})



$$P(\ln(D_{\text{res}})) = \frac{1}{\sigma \ln \sqrt{2\pi}} \exp\left[-\frac{(\ln(D_{\text{res}}) - \ln(D_{\text{med}}))^2}{2\sigma^2}\right] \quad (3)$$

which depends on the median D_{med} and the standard deviation σ_{\ln} . Notably, σ_{\ln} as defined on the $\ln(D_{\text{res}})$ scale is dimensionless, and one can show that $1.023\sigma_{\ln}$ is equal to the full width at half-maximum of the distribution after converting to a $\log(D_{\text{res}})$ scale. It is thus a convenient measure of the full distribution width in *decades*. Note that numerical integration is best performed on a scale linear in $\ln(D_{\text{res}})$

$$I_{\text{nDQ}}(\tau_{\text{DQ}}) = \int P(\ln(D_{\text{res}})) I_{\text{nDQ}}(\tau_{\text{DQ}}, D_{\text{res}}) d\ln(D_{\text{res}}) \quad (4)$$

Practical aspects and an implementation are presented in the Appendix. To illustrate the fitting approach, **Figure 1** shows nDQ buildup data calculated using Equations (1) and (2) and a fit to this model data based upon Equations (1), (3), and (4). It is seen that the buildup data based upon a Γ distribution are well represented by the log-normal distribution, with little possibility of a distinction when considering the common experimental noise level. Further, the Γ distribution, which is somewhat skewed even on the logarithmic scale, is demonstrated to be relatively well approximated by Equation (3).

Note that there is no a priori reason to favor one type of distribution over the other in a fit to experimental data. Therefore, the log-normal distribution fit is clearly favored, as it (i) represents the to date most general approach to characterize the distribution width and (ii) provides an unbiased average D_{res} value in terms of D_{med} . Aspect (ii) is rather relevant for data analyses and interpretation, as recently shown in an erratum.^[36] For wide and skew distributions, the arithmetic average (D_{av}) on a linear value scale is not a good representative of the measured ensemble, so the median (D_{med}) should be used. The data in **Figure 1** demonstrates that D_{med} from the fit is 25% lower than the input value for D_{av} for the given Γ distribution, whose width

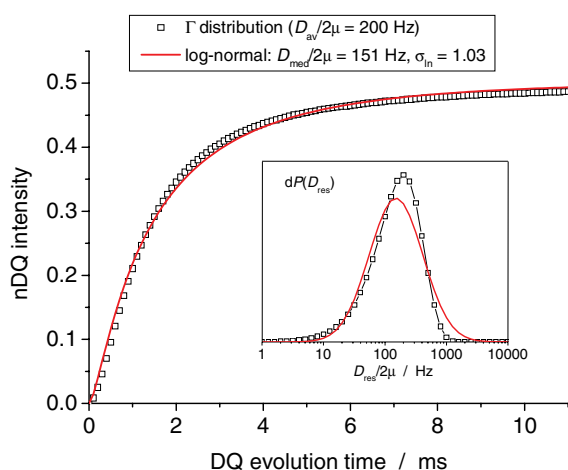


Figure 1. Normalized DQ buildup curve based upon a Γ distribution of residual couplings D_{res} with arithmetic average $D_{\text{av}}/2\pi = 200$ Hz, Equation (2), as compared to a fit assuming a log-normal distribution, Equations (3) and (4), resulting in a median coupling $D_{\text{med}}/2\pi = 151$ Hz and logarithmic standard deviation $\sigma_{\ln} = 1.03$. The inset shows the corresponding distribution functions (the Γ distribution was multiplied by $D_{\text{res}}/2\pi$ to account for the logarithmic x-axis scale, noting that $dx = x d \ln x$).

covers about 1 decade. MQ NMR provides proton-intensity- and thus average segment-based information, such that the resulting D_{med} is compatible with a measure of the weight average of the constraint density (or equivalently, the inverse effective network chain molecular weight). Recent work on model-inhomogeneous networks has demonstrated that such a measure was indeed best representing the macroscopic properties.^[37] Finally, it is stressed that systematic deviations between such a fit and experimental data might still remain, which means that more complex approaches such as a bi-component fitting function should then be considered.

3. Results and Discussion

3.1. Network Preparation

The synthesis of the hydroxy-terminated four-arm star PCL(OH)₄ was performed by ring opening polymerization (ROP) of ϵ -caprolactone (CL) initiated by the four hydroxy groups of pentaerythritol in the presence of Sn(oct)₂ as catalyst according to known methods.^[38] The molar mass was adjusted by the molar ratio of CL/OH and determined by ¹H NMR terminal group analysis. For this, the signal of the CH₂ group adjacent to the OH terminal group at 3.65 ppm (H^7) was used. The experimental values (M_n (NMR) = 7800 and 9500 Da) agree very well with the theoretical ones. Values obtained by GPC (M_n (SEC) = 9500 and 11100 Da) are slightly higher. Polydispersities of 1.16 and 1.18 confirm that the ROP proceeded in a controlled manner.

The first step of the conetwork preparation was the oxazinone functionalization of PCL(OH)₄ (see Scheme 1). This was performed by conversion of the OH-groups with an excess of CA1-3 in solution. The aromatic sections of the ¹H NMR spectra of the reaction products I1-3 (see **Figure 2**) confirm that the functionalization was successful. Because of the strong electron-withdrawing effect of the polar substituents, the H^2 signals of I2 and I3 are strongly downfield shifted. For I2 and I3, the terminal group signal H^7 of PCL(OH)₄ disappeared completely, showing that the conversion was quantitative. Instead, a new signal was found at 4.41 ppm which could be assigned to the CH₂ group adjacent to the new terminal group. In the case of I1, the conversion was sufficiently high but not complete. Obviously, the reactivities of the carboxylic acid chloride groups of CA1-3 are different.

The synthesis of the conetworks CN1-3 was performed by conversion of I1-3 with PPG-(NH₂)₂ in solution and in the melt (see Scheme 1 and Table 1). During melt synthesis of CN2 and CN3, a strong increase in the viscosity of the reaction mixture was observed within 5 min. A comparable effect appeared for CN1 only after 30 min. The conversion in solution proved to be more difficult. During the synthesis of CN1 and CN2 no gelation was observed showing that complete crosslinking failed. Only for CN3 crosslinking could be evidenced.

The extent of the reaction could be evaluated by the carbonyl IR absorption band of the oxazinone group at 1770 cm⁻¹ (see **Figure 3**). The intensity of the band was normalized to the intensity of the carbonyl band of PCL at 1720 cm⁻¹. The comparison of the spectra (i)–(iii) in **Figure 3a** shows that during the reaction of I2 with PPG-(NH₂)₂ in solution a high

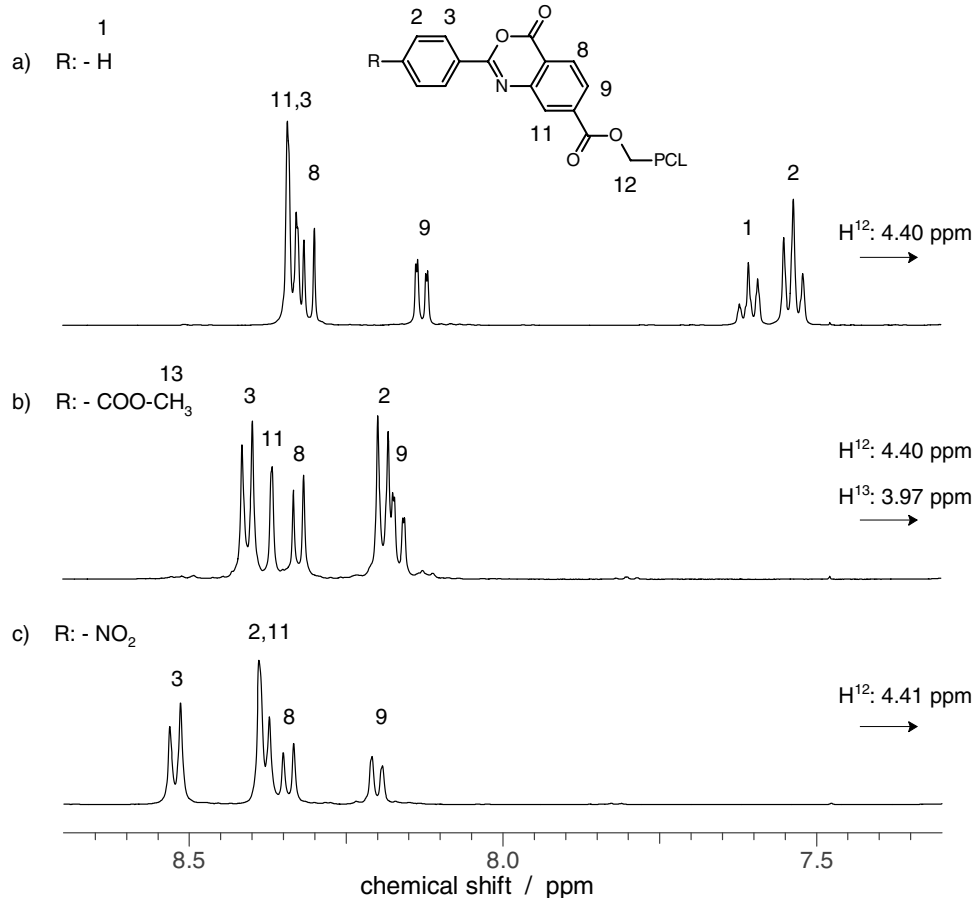


Figure 2. Aromatic sections of the ^1H NMR spectra of the intermediates a) **I1**, b) **I2**, and c) **I3** measured in CDCl_3 .

number of oxazinone groups did not react even after 6 h reflux (iii, **CN2_s**). Similar results were obtained for **I1** (**CN1_s**, not shown). In contrast to this, the conversion of **I3** (iv, **CN3_s**)

proceeded almost completely under the same conditions. Only a weak absorption in the respective range of the spectrum shows that a small number of oxazinone groups did not react.

Figure 3b represents the IR spectra of the intermediate **I1** (v) and the conetworks **CN1_m** and **CN3_m** (vi, vii) synthesized in the melt. In the case of **CN1_m**, a weak absorption of the oxazinone carbonyl band at about 1770 cm^{-1} (vi) indicates high, but not complete conversion, whereas for **CN2_m** (spectrum not shown) and **CN3_m** (vii), quantitative conversion was found within the limits of the measurements.

Both the results of the synthesis in solution and in the melt show that the substituent R exerts a strong influence on the reactivity of the terminal groups of the intermediates **I1–3**. Obviously, the reactivity increases with increasing electron-withdrawing effect of R in the order $\text{H} < \text{COOCH}_3 < \text{NO}_2$ (**I1** < **I2** < **I3**). For all three intermediates, the reactivity in the melt was high enough to obtain conetworks (**CN1_m–3_m**). For the conversion in solution, a network was obtained only in the case of **CN3_s**.

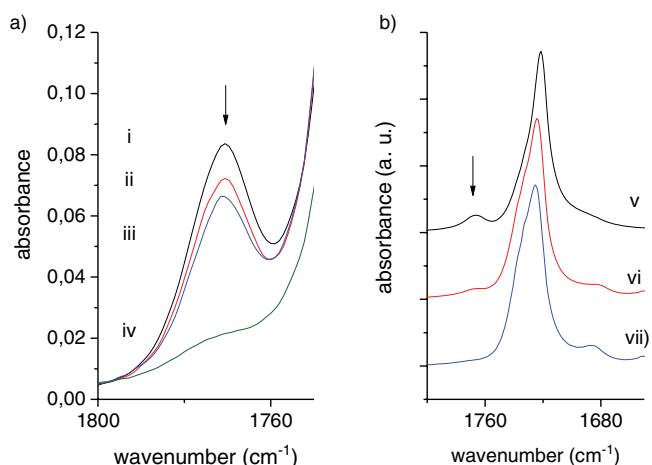


Figure 3. FTIR spectra of intermediates and conetworks. a) Network synthesis in solution: (i) **I2**, (ii) **CN2_s** after 3 h under reflux, (iii) **CN2_s** after 6 h under reflux, (iv) **CN3_s** after 6 h under reflux. b) Network synthesis in the melt: (v) **I1**, (vi) **CN1_m**, (vii) **CN3_m**. The arrow marks the CO vibration band of the oxazinone group.

3.2. Network Characterization

The melt and solution synthesized conetworks **CN1_m–3_m** and **CN3_s** respectively were characterized by swelling experiments

Table 2. Network characterization results.

Sample	Swelling			NMR			
	Q^a	$f_{sol}^{b)}$	$Q^{-5/3}/(1-f_{def,sw})$	$f_{def}^{c)}$	$D_{med}/2\pi$ [Hz]	σ_{in}	$f_{def,sw}^{c)}$
CN1_m	27.4	0.24	0.040	0.15	107	0.70	0.84
CN2_m	21.7	0.12	–	(0.25)	(100)	(0.60)	degr.
CN3_m	14.6	0.15	0.044	0.21	121	0.61	0.74
CN3_s	16.0	0.03	0.039	0.21	125	0.40	0.75

^{a)}volume degree of swelling (after extraction); ^{b)}Extractable fraction during swelling experiment; ^{c)}Defect fraction (proton integral); index sw: swollen state.

in toluene (48 h at RT) and NMR spectroscopic measurements. The results are summarized in **Table 2**.

The degree of volume swelling Q reflects the (inverse) crosslink density ν_c , but since the effective Flory-Huggins interaction parameter χ of the mixed polymer/solvent system is not known, it is not possible to extract an absolute-value estimate. However, since toluene is a good solvent for both components, and since the Q values are large, we can use Flory's scaling relationship^[39] $\nu_{c,app} \propto Q^{-5/3}$. This apparent result has to be corrected for a potentially large fraction of connected non-elastic defect material present in the swollen state, which usually exceeds the sol fraction.^[25,26,33,34] It is important to note that this defect fraction can only be determined by NMR experiments in the swollen state, where topological restrictions (entanglements) leading to transiently elastic behavior, are relieved.^[33] The correction is simply multiplicative,^[34] resulting in $\nu_{c,eff} \propto Q^{-5/3}/(1-f_{def,sw})$.

We note in passing that sample **CN2_m** dissolved partially during the swelling process when it was prepared for the determination of $f_{def,sw}$, pointing to degradation, while the swelling behavior of the other samples was reproducible. Since these experiments were conducted a few months after preparation, and since the bulk NMR experiments were conducted a few weeks after preparation, we hypothesize that the degradation process may have already affected the bulk NMR results for **CN2_m**, explaining its larger defect fraction f_{def} and lower D_{med} —thus the parentheses in Table 2 (equilibrium swelling was measured directly after synthesis). It is not clear whether this is due to some impurities or a chemically more labile linker group.

The bare degrees of swelling (and also the sol and the NMR-determined swollen-state defect fractions) listed in Table 2 nicely reflect an increasing efficiency of crosslinking in the order **CN1_m** – **CN3_m**, as expected on the basis of the reactivities of the intermediates discussed above. After defect correction, the effective crosslink densities $Q^{-5/3}/(1-f_{def,sw})$ (specifying the crosslink concentration relative to the elastic component!) of all samples turn out to be rather similar, which is in fact expected on the basis of the fixed precursor chain lengths, i.e., the pre-determined mesh structure. Therefore, the variation in Q is mainly arising from a variation in the amount of non-elastic defects ($f_{def,sw}$). The latter is actually rather large, which is expected for the given type of A_2/B_4 networks, in particular when the conversion is not close to complete. The reason for the large amount of defects is the high probability for the formation of inactive primary loops. These in turn lead to chain elongation when two out of four star arms are short-circuited, or by decreasing the effective crosslink functionality of

the crosslinks that enters the phantom model of rubber elasticity.^[25,26]

Notably, despite **CN3_s** representing the only case where a network was formed in solution, this network turns out to be as well crosslinked as its bulk counterpart. Note that the comparably low sol fraction is due to the fact that the sol was already mostly removed by the excess solvent during the crosslinking reaction.

Representative NMR results obtained on bulk samples are summarized in **Figure 4**. In part (a), representative MQ NMR signal functions are plotted along with results of their analysis. The $I_{\Sigma MQ}(\tau_{DQ})$ signal function represents the relaxation decay of the total sample signal, which is composed of network

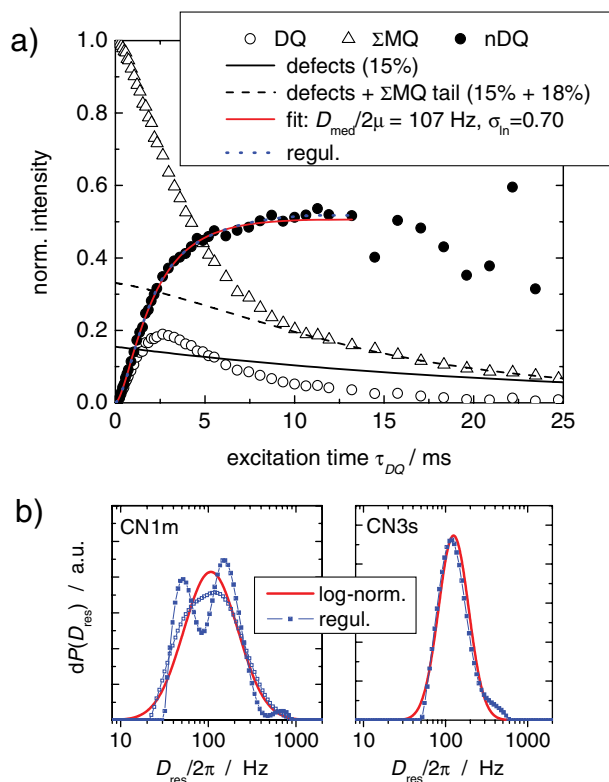


Figure 4. a) NMR results for sample **CN1_m**, b) results of the NMR-based crosslink density distribution analysis (in terms of D_{res}) for **CN1_m** and **CN3_s** comparing the results of fits of the nDQ curves using Equations (3) and (4) (thick lines) with results of a numerical regularization analysis with adapted error parameter^[30] (solid symbols). In the case of **CN1_m** the choice of the latter was not unique, so we also show as open symbols the results using a more conservative value.



components and defects that are elastically inactive in the given physical state. The latter do not have a measurable D_{res} , and they can be quantitatively determined by fitting of the long-time behavior (beyond the shown x axis range), as described previously.^[28] The corresponding exponential signal decay is shown as solid line. For all samples, the associated T_2 relaxation time ranges between 10 and 20 ms, and the corresponding fractions f_{def} are listed in Table 2. These fractions, measured in the bulk state, are expectedly much lower than their swollen-state counterparts $f_{\text{def,sw}}$ because of entanglement effects, which render branched defect structures with high molecular weight transiently elastically active.

The crosslink (better: constraint) density of the network chains is reflected in the $I_{\text{DQ}}(\tau_{\text{DQ}})$ buildup function, which decays at long times and thus needs to be normalized by division through the tail-corrected $I_{\Sigma\text{MQ}}(\tau_{\text{DQ}})$ signal. The resulting normalized $I_{\text{NDQ}}(\tau_{\text{DQ}})$ buildup data rises to reach a plateau value of 0.5, which proves the correct determination and subtraction of the defect tail, and that the merely entangled defect chains do not relax appreciably on the τ_{DQ} timescale. $I_{\text{NDQ}}(\tau_{\text{DQ}})$ is then analyzed according to the procedures outline above, resulting in average (median) crosslink/constraint densities (in terms of D_{med}) and distribution widths σ_{in} listed in Table 2.

Remarkably, after subtracting the defect fraction the $I_{\Sigma\text{MQ}}(\tau_{\text{DQ}})$ signal still appears to consist of two distinct components, and a fit based on a combination of two modified exponentials $\approx \exp[-(t/T_2)^b]$ could be used to roughly estimate their ratio, see also Figure 4a. The significance of this bimodality is presently not clear, in particular in view of the fact that the $I_{\text{NDQ}}(\tau_{\text{DQ}})$ buildup does not visibly reflect different components in a similar ratio. We may hypothesize that the PCL and PPG chains, while being part of a combined network chain, may exhibit distinct transverse relaxation behaviors.

Addressing first the network structure in terms of D_{med} and its distribution, we notice that the average crosslink/constraint densities are all rather similar, with only a weak increase that follow the trend observed in equilibrium swelling. This is expected, as D_{med} is dominated by entanglement effects, noting that the majority of the measured material is just entangled and dangling, and thus not even part of the active network (evidenced by the large $f_{\text{def,sw}}$). Both PCL and PPG at the given chain lengths are in fact well entangled, with similar entanglement molecular weights M_e of about 2–3 kg mol⁻¹^[40,41] (for PPG, only the critical molecular weight, equaling 2–3 M_e , has been estimated to about 7 kg mol⁻¹)^[41]. As to the distribution widths, sample **CN1_m** is overall most inhomogeneous ($\sigma_{\text{in}} = 0.7$), followed by samples **CN2_m** and **CN3_m**, which is again in line with the increasing order of chain-end reactivity. Notably, the solution-crosslinked sample **CN3_s** is the most homogeneous one ($\sigma_{\text{in}} = 0.4$), which is partially due to the lack of a significant sol component in this sample.

Figure 4b shows for two samples (**CN1_m** and **CN3_s**) results of the distribution analysis based the fitting approach outlined above, on the one hand plotting the log-normal D_{res} distributions using the fitted parameters D_{med} and σ_{in} as solid lines. This is, on the other hand, compared with results from numerical regularization analyses^[30] shown as solid symbols. In the case of sample **CN1_m** (and similarly for **CN2_m** and **CN3_m**, which show qualitatively similar results), the actual distribution

shows indications of bimodality. Even though this finding is somewhat on the edge of significance considering the limitations of the regularization procedure, it is not unexpected, as it goes along with the increased width (σ_{in}) resulting from the single-mode fit. Overall, it is seen that the slightly bimodal distribution is still well represented by the single-mode log-normal distribution. In summary, the solution crosslinked sample is confirmed to be dynamically more homogeneous. We remind again that due to the large fraction of dangling defect material, the D_{res} distributions reflect spatial variations of entanglement density rather than crosslink density. We hypothesize that the isotropically mobile defects, that dynamically dilute the entanglements, are probably distributed inhomogeneously.

In summary, the microstructural characterization by MQ NMR has provided results that are consistent with the swelling results, and have revealed the formation of relatively weakly crosslinked and defect-rich networks whose elasticity is dominated by entanglements, with a large contribution from slowly relaxing, dangling and branched, but at long times (and in the swollen state) elastically inactive defect material.

4. Conclusions

Our results show that A_2/B_4 hybrid networks are available by heterocomplementary coupling of an amino-terminated linear PPG and a hydroxy-terminated four-arm PCL star both in solution and in the melt. The extent and the rate of crosslinking have proven to be strongly dependent on the coupling agent used. Especially, the different electron-withdrawing effect of the substituents R at the terminal groups of the PCL intermediates **I1-3** exerts a strong influence on the network forming reaction between the oxazinone group and the amino terminal groups of PPG. Both the macroscopic swelling experiments and the microscopic MQ NMR experiments confirm the formation of relatively well-defined hybrid networks and outline the favorable influence of a rapid conversion in the melt.

Network formation in solution was successful only in the case of the sample with the strongest influence of the electron-withdrawing substituent (**CN3_s**). The better homogeneity (based on MQ NMR) and the small sol content of **CN3_s** emphasize that future synthesis efforts should focus on solution-based crosslinking. Here, longer reaction times and/or the utilization of more strongly electron-withdrawing effects will help to further increase the degree of conversion, resulting in networks with significantly less defects.

A prerequisite for successful conetwork formation is the solubility of the components in a common solvent. This is usually fulfilled for networks with two hydrophobic components as presented here. In case of amphiphilic conetworks, potential solubility and phase-separation issues must be considered, but previous work has shown that this is not necessarily a problem.^[23] Finding a common solvent is likely easier than overcoming the problem of a stronger incompatibility in the melt. Further, in order to increase the homogeneity and the definition of the topological structure, a switch from a linear-chain linker to a second four-arm star linker, in line with the pioneering work of Sakai and coworkers,^[14,15,22,24] will be beneficial. These aspects will be subject of further investigations.



Appendix

Upon fitting nDQ buildup data assuming a log-normal distribution function, Equation (3), the integral given by Equation (4), using Equation (1) as the buildup kernel function, must be evaluated numerically on the fly. This is straightforwardly possible using the non-linear least-squares fitting tool of modern data analysis software such as Origin. In practice, it is sufficient to represent the integral by a summation ranging between $\ln(D_{\text{res}}) - 3\sigma_{\text{in}}$ and $\ln(D_{\text{res}}) + 3\sigma_{\text{in}}$ in 50 equidistant steps. For convenience, we here reproduce the Origin C code for use in a fitting function of OriginPro 7.5 or higher. The fitted parameters are Dmed and sigma, the independent variable (x axis) is tau, and the dependent variable is y :

```
double res,norm,Dtemp;
double lnDtemp,lnDmed;
double gauss,a,b;
int i;
res=0;
norm=0;
a = 2*pi*0.378;
b = 2*pi*0.583;
lnDmed=ln(Dmed);
for(i=0;i<=50;i++){
  lnDtemp=(lnDmed+(i-25)*3*sigma/25);
  Dtemp=exp(lnDtemp);
  gauss=exp(-(lnDtemp-lnDmed)^2/(2.0*sigma^2))/sqrt(2.0*pi*sigma^2);
  res=res+gauss*0.5*(1-exp(-(a*Dtemp)^1.5*tau^1.5)*cos(b*Dtemp*tau));
  norm=norm+gauss;
}
y=res/norm;
```

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The authors thank Dr. Hartmut Komber for the solution-state NMR measurements and signal assignments, and an anonymous reviewer for very valuable suggestions to improve the analyses. Partial funding of this work was provided by the Deutsche Forschungsgemeinschaft (DFG) in the framework of the collaborative research center SFB-TRR 102.

Conflict of Interest

The authors declare no conflict of interest.

Keywords

conetworks, heterocomplementary coupling reactions, hybrid networks, multiple-quantum NMR, network inhomogeneity, swelling

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BOOK CHAPTER

CHAPTER 6

Reactive Inkjet Printing: From Oxidation of Conducting Polymers to Quantum Dots Synthesis

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6.1 Introduction to Reactive Inkjet Printing

In addition to their traditional usage in the production of information displays including newspapers and books, printing technologies have been employed in, and/or enabled, the production steps of other applications in several industries including ceramic/glass tiles and windows, auto and aerospace, circuit boards, RFID labels, and much more.

Recently, various printing approaches have been investigated in research fields such as optics and photonics, electronics, biology and medicine, smart packaging, to mention a few. Printing techniques such as gravure, offset, screen, contact, and inkjet printing have been used in many areas including

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the fabrication of organic solar cells,^{1–4} silicon solar cells,^{5,6} light emission,^{7,8} batteries,⁹ capacitors,^{10,11} sensors,^{12–14} bioapplications,^{15–17} and others.¹⁸

The majority of reported scholarly articles on printed materials and devices, in various areas of research and technology, utilize the printer as a vehicle to place (deposit) a certain amount of given material, at certain locations on the substrate surface, without any chemical reactions taking place. On the other hand, a growing branch of research involving the use of reactive chemical components (inks) in the printing process is finding its way into several areas. This approach, often called “reactive printing”, can be used in any printing technique, as long as certain measures are taken to avoid the reactivity between the ink and any of the printer’s hardware (*e.g.*, corrosion of metallic parts of the printer due to a given oxidizing ink). In what follows, we will focus our discussion on reactive inkjet printing (RIJ).¹⁹ Either thermal or piezoelectric disposal of printed droplets can be used in RIJ. The power of inkjet to accurately control the disposal of inks to extremely small volumes (*e.g.*, picoliters) endows on such approach an attractive feature regarding combinatorial discovery of materials, and optimization of devices and properties. Due to its ability to dispense ultra-small ink volumes, RIJ can then be used as a tool to optimize a certain process. In this case, the knowledge gained and discoveries made can be transferred, and process variables adjusted accordingly, to initiate a roll-to-roll, or any high throughput reactive printing process, thus saving the production process much in materials and development costs, and shortening the time to market.

6.2 Grey Scale Sheet Resistivity *via* RIJ

Perhaps the first report, to the best of our knowledge, on the use of RIJ in device setting was the demonstration of controlled modification of the sheet resistivity of conducting polymer (PEDOT:PSS).^{20,21} In this work, a continuous, and/or digitized, change of sheet resistivity can be obtained through the use of an oxidizing agent as ink, and a color control program (*e.g.* Power Point) to drive the ink disposal onto the substrate. The approach is capable of generating on-demand sheet resistivity values in a thin PEDOT:PSS film. The first demonstration of RIJ sheet resistivity modification was carried guided by grey scale color function to control the placement of the oxidizing agent ink on top of PEDOT:PSS, and thus the term “grey scale resistivity”.²⁰

To formulate the required ink in our case, an aqueous solution containing an oxidizing agent of sodium hypochlorite (2 wt%), DI water, and surfactant was prepared and optimized to yield the required surface tension and viscosity for best controlled wetting over the surface of the conducting polymer film. The ink was injected into the precleaned black cartridge of a commercial desktop multicolor HP printer. The HSL color function was used in this case. Only the luminosity (L) was varied to obtain the required darkness of a given image, keeping the saturation (S) at zero, and holding the hue (H) at a constant value. In other words, the amount of the printed oxidizing ink is











color	No.	luminosity (L)	darkness (%)
	# 1	255	0
	# 2	230	10
	# 3	215	16
	# 4	200	22
	# 5	170	33
	# 6	140	45
	# 7	125	51
	# 8	110	57
	# 9	50	80
	# 10	0	100

Figure 6.1 Values of L used to control ink loading on top of conducting polymer layer. Here $S = 0$, and H was picked arbitrarily. Reproduced from Y. Yoshioka, P. Calvert, and G. E. Jabbour, *Macromolecular Rapid Communications*, John Wiley and Sons, © 2005 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.²⁰

controlled *via* L only. A Power Point program was used to generate various shades on the grey scale, as shown in Figure 6.1,²⁰ which in turn was used to control the amount of oxidizing ink printed per given area.

The oxidizing ink was printed on top of commercially available PEDOT:PSS thin layers precoated on flexible substrates of polyethylene terephthalate (Orgacon™ EL-350- courtesy of Agfa). Upon printing, the ink chemically interacts with the conducting polymer surface. The reaction penetration depth can be controlled by several factors including the number of printed drops (average ink volume per area as controlled by the darkness of the color chosen), the reaction time, temperature, and the chemical concentration of the oxidizing ink. After printing, the substrates were kept at around 40–60 °C, to allow for better and more uniform oxidant-PEDOT:PSS reaction. Subsequently, the substrates were thoroughly rinsed in DI water then dried in an oven.

To determine the end of the oxidation reaction at room temperature, the sheet resistivity was measured over a period of nearly 3 hours, immediately after printing ended. A four-point probe was used to measure the sheet resistivity. Figure 6.2 indicates that a plateau is reached in the measured sheet resistivity of PEDOT:PSS that received oxidizing ink on top of it. This indicates that the oxidation reaction has ended after around 70 minutes at room temperature. In this case, an increase of two orders of magnitude in sheet resistivity (around $7 \times 10^4 \text{ Ohm sq}^{-1}$) was observed, compared to that of pristine PEDOT:PSS layer (around 370 Ohm sq^{-1}). This increase seems to be most rapid in the first few minutes (around 10 min). As time progresses, the remaining oxidant from the printed ink slowly diffuses deeper into the conducting polymer surface oxidizing it even further, which in turn results in less and less effective conducting polymer thickness, thus leading to further increase in sheet resistivity (Figure 6.2).

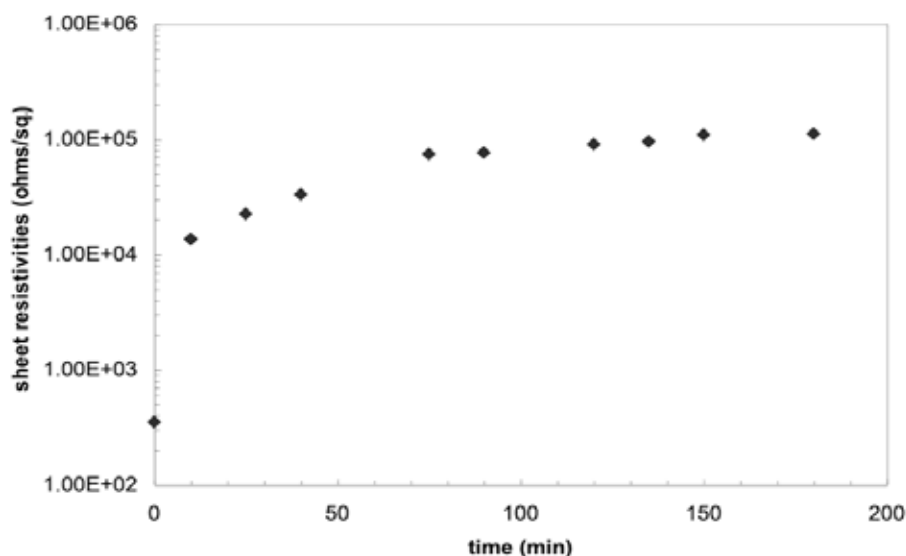


Figure 6.2 Room temperature, four-point probe measurements of sheet resistivity as a function of time for printed areas having $L = 0$ and darkness values shown in Figure 6.1. Reproduced from Y. Yoshioka, P. Calvert, and G. E. Jabbour, *Macromolecular Rapid Communications*, John Wiley and Sons, © 2005 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.²⁰

A judicious increase in temperature of the substrate during (or after) the printing processes is expected to lead to an accelerated oxidation process reaching to more depth within the conductive polymer layer, thus resulting in further increase in sheet resistivity of the PEDOT:PSS film.

The different ink loadings according to the values of L shown in Figure 6.1 yield different values of the sheet resistivity. In this case, an increase in sheet resistivity can be seen with increasing darkness values (ink drops per area). The values reported in Figure 6.3 were measured 1 hour after printing of the oxidizing ink.

One benefit of color inkjet printing technique (*i.e.*, multi-cartridge or multi-ink compartments) is the facile and highly controlled combinatorial experiments it allows for given inks. To demonstrate the power of such an approach, a simple experiment was carried by placing in the pre-cleaned yellow (Y) cartridge an ink made of a mixture of deionized (DI) water and 0.05 wt% surfactant, and an ink of DI water and 5.6 wt-% sodium hypochlorite mixture in the pre-cleaned cyan (C) cartridge.

The dispensing of respective ink droplets was controlled using the Cyan, Magenta, Yellow, and Black (CMYK) color model. In our case, only the two colors Y and C are mixed as indicated above. For each color, a value between 0 and 100 was chosen. These values can be obtained using PPT software. The experiments were carried out with the DI water/surfactant printed first (Y color cartridge), followed by printing of the oxidizing agent ink (C color cartridge). Printing C ink first results in rapid oxidation of the conducting polymer surface, and hence limits the effects of the second ink.

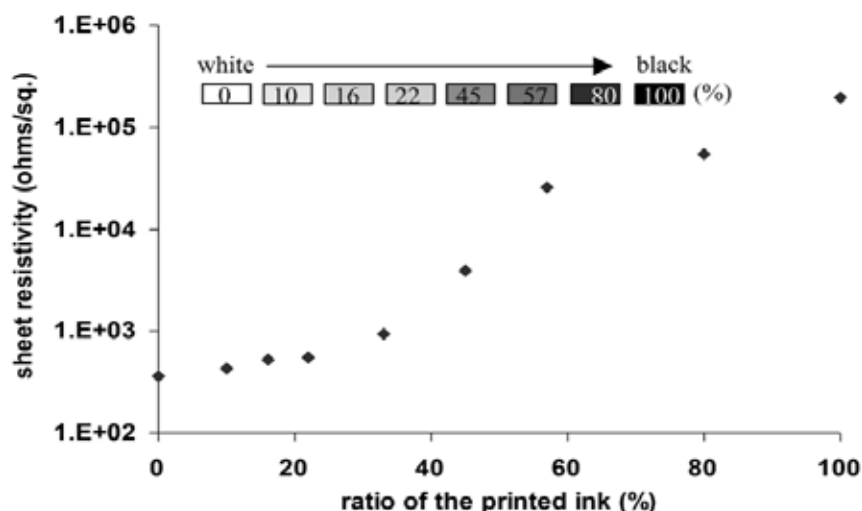


Figure 6.3 Sheet resistivity of PEDOT:PSS at 8 printed locations where $L = 255$ is for white (pristine surface), and $L = 0$ is for black (maximum ink per printed area, resulting in a fully oxidized surface). The four-point probe measurements were done in air, around 1 hour after the printing. Reproduced from Y. Yoshioka, P. Calvert, and G. E. Jabbour, *Macromolecular Rapid Communications*, John Wiley and Sons, © 2005 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.²⁰

By adjusting the experimental conditions, it is possible to obtain uniform mixing of the two inks as dictated by the C–Y combined color given by the PPT program. A representative set of rectangular areas each having a defined value of C and Y is shown in Figure 6.4. The figure also shows the respective color resulting from mixing of the various values of C and Y. The printed library of Figure 6.4 was dried in air for 3 hours, at a temperature of around 55 °C, followed by a DI water rinse to remove any residual oxidant material.

After processing and drying, the sheet resistivity of each of the oxidized PEDOT:PSS areas corresponding to samples 1–18 was measured, and the resulting values are shown in Figure 6.5. Very high sheet resistivity ($\gg 10^7$ ohm sq⁻¹, not shown) was measured for samples 1, 2 and 3, which have a common C value of 100%. This indicates a complete passivation of the thin layer of PEDOT:PSS. A constant Y value of 100, *i.e.* full DI water/surfactant coverage of first printed layer, results in a sharp rise in sheet resistivity for printed samples having C value between 22 and 29.

Figure 6.5 shows that sheet resistivities of 10^3 ohm sq⁻¹ and 10^5 ohm sq⁻¹ are obtained for samples having (Y100, C9) and (Y100, C25–C29), respectively. For the printing process using a single pre-mixed ink of DI water/surfactant/2 wt% oxidizing agents, similar sheet resistivity values are obtained for samples having (L170, darkness 33) and (L50, darkness 80), respectively, as shown in Figure 6.3. The agreement in the measured values indicates successful mixing of the two inks over the PEDOT:PSS surface during printing. The attraction of using the CMYK color model (with two inks in our case) allows us to access a myriad of sheet resistivity values not possible with single ink component printing approach using the grey-scale model.

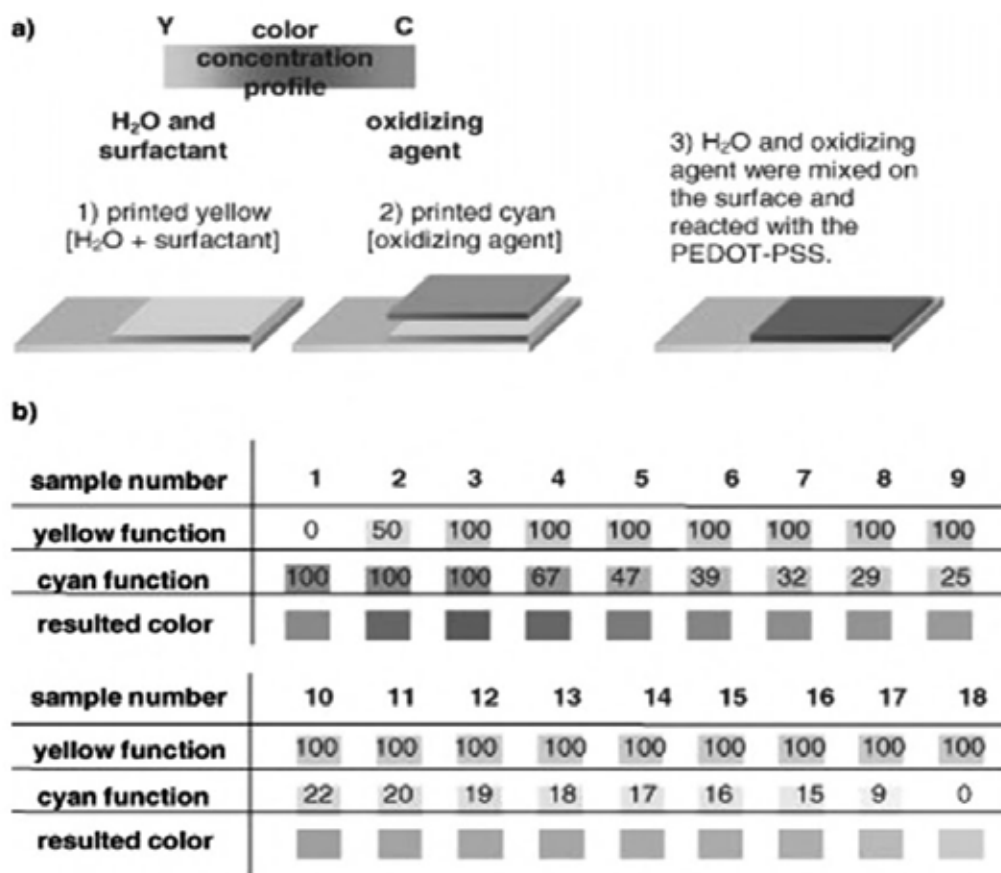


Figure 6.4 (a) A representative color concentration profile obtained by mixing C and Y colors upon printing on the substrate. Y was printed first, followed by C to yield the mixed layer. (b) A library of C and Y values used to produce various sheet resistivities over the surface of the PEDOT:PSS. In all of these experiments, M was set to 0. Reproduced from Y. Yoshioka, P. Calvert, and G. E. Jabbour, *Macromolecular Rapid Communications*, John Wiley and Sons, © 2005 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.²⁰

6.3 Transitioning to Tool Friendly Oxidizing Agent

The significant corrosive ability of sodium hypochlorite, when used at high concentrations, has detrimental effects on printer metallic parts and cartridge electronics (*e.g.* corrosion), leading to frequent costly maintenance and replacement of parts. Although the diluted oxidizing ink (*e.g.* 2 wt%) resulted in an on-demand control of the sheet resistivity of conducting polymer layer, above its pristine value, several experimental aspects might not be conducive to full industrial scale operation. These include the corrosion factor mentioned above, the relatively long processing time (up to 3 hours) needed for reaction completion between oxidizing ink and the polymer, and the extra DI water rinse step needed to remove residual crystals of sodium hypochlorite left behind on the polymer surface. In this regard, we turned our attention to a search for milder oxidizing agents. While several candidates

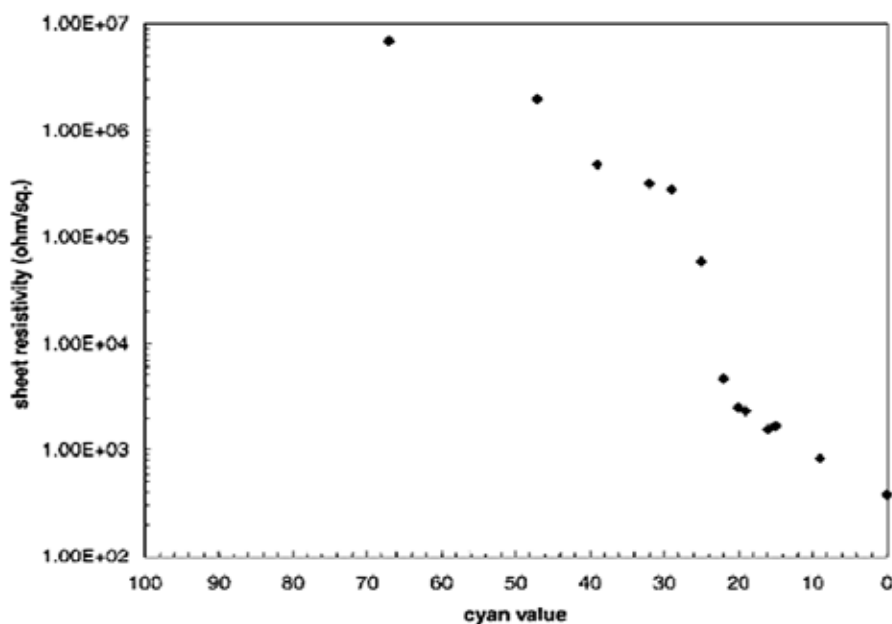


Figure 6.5 Sheet resistivity values for printed color combinations of Figure 6.4. Note the sharp increase in sheet resistivity appears around C values of 22–29. Reproduced from Y. Yoshioka, P. Calvert, and G. E. Jabbour, *Macromolecular Rapid Communications*, John Wiley and Sons, © 2005 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.²⁰

were experimented with, we will present here results pertaining to the use of hydrogen peroxide as an oxidizing agent.

In addition to being more environmentally friendly than sodium hypochlorite, an aqueous solution of hydrogen peroxide evaporates, depending on the concentration, completely at temperatures as low as 115 °C, without leaving any chemical powder residues. This is an attractive feature as it eliminates the DI water rinse step needed in the case of sodium hypochlorite ink. Furthermore, it is also possible to increase the concentration of the hydrogen peroxide ink without causing damage to the cartridge or the printer parts. In fact, an ink of 50 wt% hydrogen peroxide did not cause any observable damage to the inkjet cartridge or printer parts during repeated printing experiments, thus leading to less frequent need of replacement parts, and reducing the down time of the process.

To demonstrate the feasibility of using high concentration of hydrogen peroxide as an ink, we present the results of a similar inkjet printing experiment using the HSL model as described earlier, but with an aqueous ink 50 wt% hydrogen peroxide loaded in the cartridge. By setting the value of S to 0 and holding H constant, we varied L over 9 different values (255, 230, 215, 200, 170, 140, 110, 50, and 0), as shown in Figure 6.6, each used in printing of a rectangular feature over the PEDOT:PSS layer (Figure 6.6 insert).

Although the boiling temperature of the ink used is around 126 °C, heating the sample up from room temperature to 50 °C is found to decrease the sheet resistivity. However, the change in sheet resistivity with decreasing L

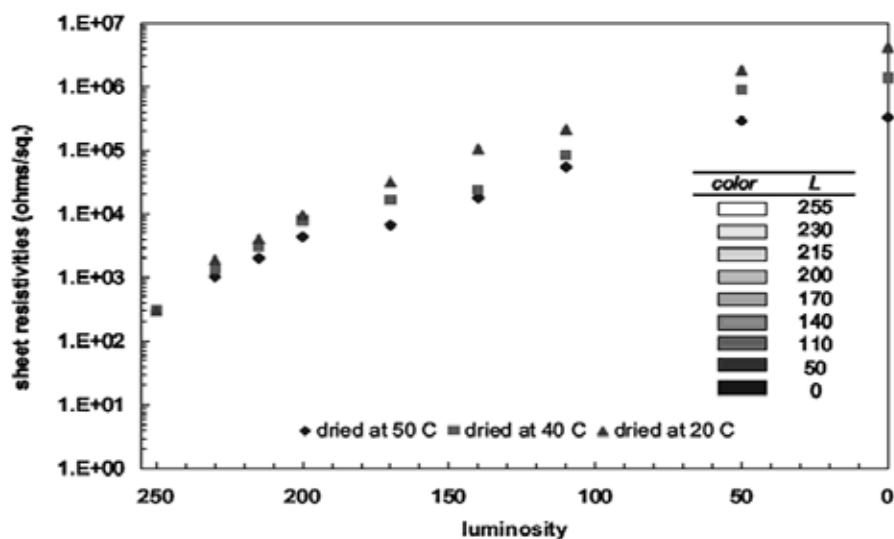


Figure 6.6 Values of sheet resistivity for various L obtained from four-point probe measurements at 3 different temperatures of 20 °C (triangle), 40 °C (square), and 50 °C (diamond), respectively. Reproduced from Y. Yoshioka and G. E. Jabbour, *Advanced Materials*, John Wiley and Sons, © 2006 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.²¹

values is highest at 20 °C, followed by 40 °C and 50 °C, respectively. At 20 °C less ink is leaving the substrate in the form of vapor and thus more oxidation can occur than is the case at 50 °C, resulting in increased sheet resistivity (Figure 6.6). A gradual increase in sheet resistivity with decreasing L values is observed for each temperature.

We also generated a rectangular strip of continuous color change (grey gradient with white and black) using the “Fill Effect” capability of the software. Over this strip, the L values varied gradually from black ($L = 0$) to white ($L = 255$). The values of sheet resistivity measured at various locations on the strip are depicted in Figure 6.7. In similar fashion to the discrete prints above, the sheet resistivity increases with decreasing L values, reaching a maximum around 10^6 ohm sq⁻¹. at $L = 0$.

A current was passed through a 4 inch long oxidized strip of PEDOT:PSS, shown in the inset of Figure 6.7, and the temperature was measured at several locations on the strip, as shown in Figure 6.8. As anticipated, the differing sheet resistivity values for the various oxidized regions gave rise to increasing temperature with increasing sheet resistivity, Figure 6.8 (samples dried at 50 °C). A gradual increase in temperature can be seen along the length of the strip starting at 21.5 °C for the non-oxidized PEDOT:PSS surface, and ending with 25.5 °C for the mostly oxidized location of the conducting polymer layer surface (*i.e.*, at $L = 0$). Such a moderate increase in temperature along the length of the strip can find applications in several areas including biology, body heaters, window heaters, defense, IR maps and embedded images, to mention a few.

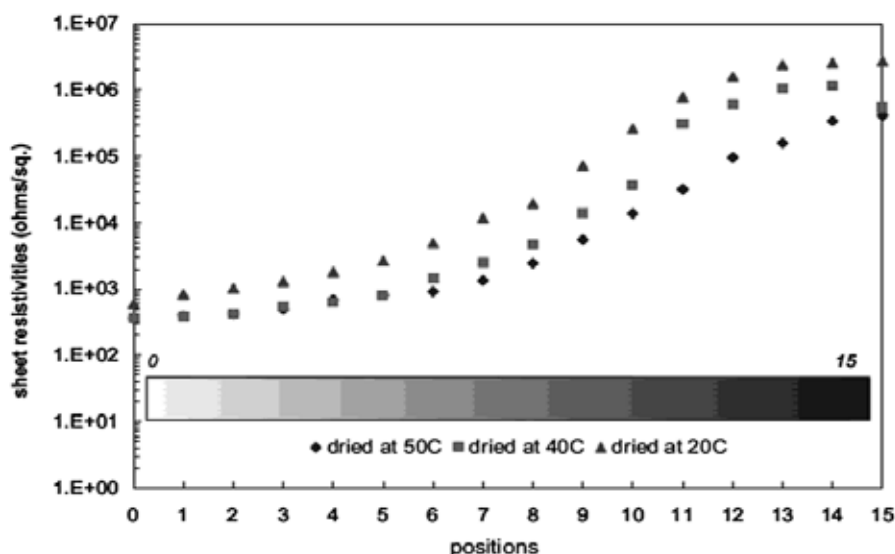


Figure 6.7 Sheet resistivity measurements for gradually changing L values (insert), over a 4 inch long strip, taken after reaction between hydrogen peroxide ink and PEDOT:PSS at different temperatures of 20 °C (triangle), 40 °C (square), and 50 °C (diamond), respectively. Reproduced from Y. Yoshioka and G. E. Jabbour, *Advanced Materials*, John Wiley and Sons, © 2006 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.²¹

6.4 Reaction Mechanism and Characterization of Oxidation Process

6.4.1 Sodium Hypochlorite Case

A possible reaction route between PEDOT:PSS and sodium hypochlorite is shown in Figure 6.9. The oxidizing agent acts on converting the thiophene (part (A) of Figure 6.9) group of the PEDOT to thiophene-1-oxide (B). Thiophene-1-oxide (B) is effortlessly transformed to thiophene-1,1-dioxide (C). Thiophene-1-oxide (B) is recognized previously as an intermediate prior to the formation of thiophene-1,1-dioxide (C).^{22,23} The loss of SO_2 occurs as a result of further oxidation of thiophene-1,1-dioxide (C) accompanied nucleophilic attack that results in the linkage of hydroxyl groups (due to the presence of water), thus producing the structure shown in (D).

FTIR spectroscopy was performed on an oxidized PEDOT:PSS sample and pristine one (Figure 6.10). The measurements depict a slight difference in relative band intensities. The vibrational mode due to asymmetric and symmetric stretching of the S–O sulfonic group is shown at wavenumber of 1343 cm^{-1} and 1132 cm^{-1} , respectively.^{23–25} The absorbance resulting from the symmetrical stretching of sodium sulphonate group (PSS-Na) is depicted at 1044 cm^{-1} .^{24,25} To take a closer look at the conclusion of the oxidation reaction, we synthesized structure (D) from a dried sample (powder) of diluted PEDOT-PSS dispersion (Baytron P, Bayer) overloaded with NaOCl aqueous solution. A FTIR study was carried on this powder sample along with a separate powder sample

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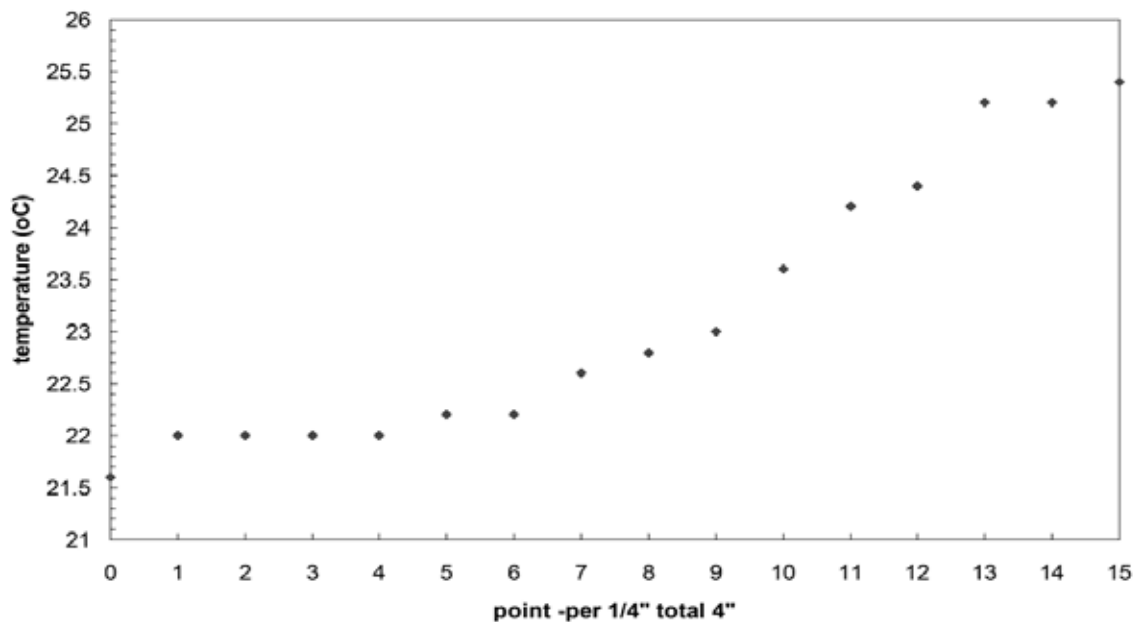


Figure 6.8 Gradual temperature increase across the continuously changing L values. Data shown for PEDOT:PSS treated at 50 °C after printing of hydrogen peroxide ink. Measurements were taken at 1/4 inch intervals over the 4 inch long strip, with $L = 0$ being the highest sheet resistivity (pt 15 on scale).

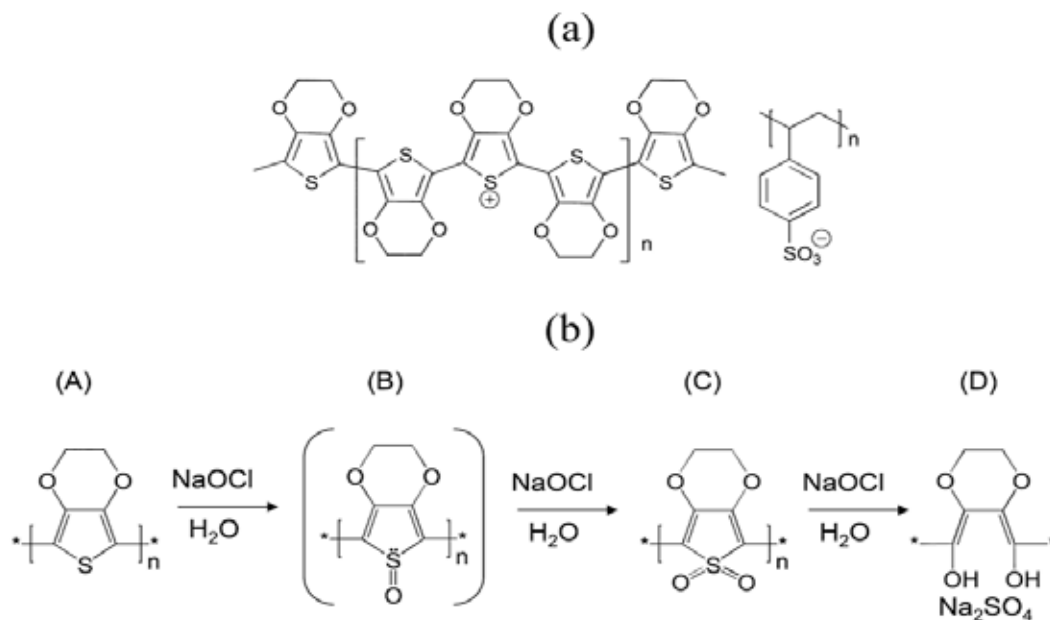


Figure 6.9 (a) Chemical structure of PEDOT:PSS, and (b) candidate oxidation route of PEDOT:PSS reaction with sodium hypochlorite ink. Reproduced from Y. Yoshioka, P. Calvert, and G. E. Jabbour, *Macromolecular Rapid Communications*, John Wiley and Sons, © 2005 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.²⁰

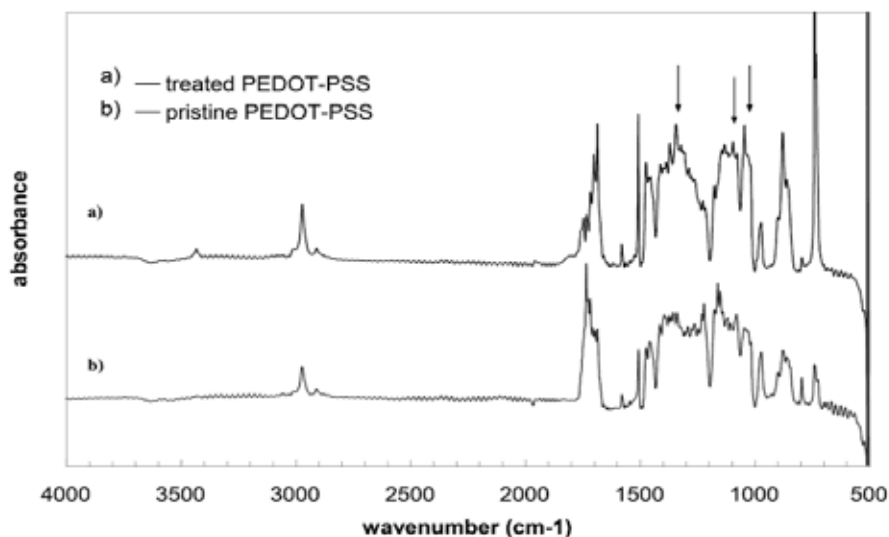


Figure 6.10 FTIR spectra for oxidized (treated-a) and pristine (b) PEDOT:PSS layer. Reproduced from Y. Yoshioka, P. Calvert, and G. E. Jabbour, *Macromolecular Rapid Communications*, John Wiley and Sons, © 2005 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.²⁰

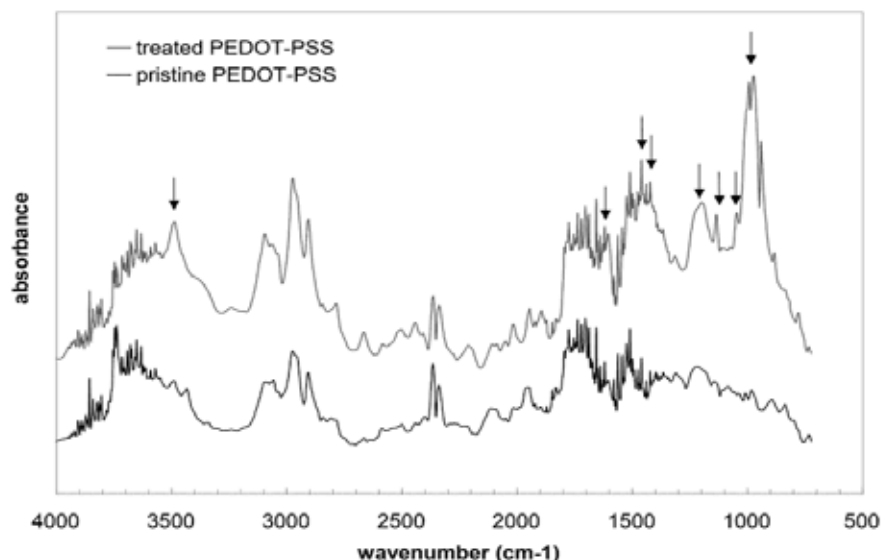


Figure 6.11 FTIR spectra of a dry sample of fully oxidized PEDOT-PSS (a), and a dry sample of pristine PEDOT-PSS (b), mixed with KBr and pressed into pellets. Reproduced from Y. Yoshioka, P. Calvert, and G. E. Jabbour, *Macromolecular Rapid Communications*, John Wiley and Sons, © 2005 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.²⁰

of pristine PEDOT:PSS. Each of the powders was mixed with KBr and pressed into pellets. In both cases, resolutions of 4 cm^{-1} and 128 scans were used.

The results are shown in Figure 6.11. As shown in the figure a noticeable difference in band intensity can be seen. The stretching and bending of O–H, and stretching of C–O bonds are clearly visible at 3493 cm^{-1} , 1410 cm^{-1} , and 1201 cm^{-1} , respectively. The stretching of C–C bonds can be seen at 1616 cm^{-1} . SO_4

stretching mode gives rise to the absorbance at 1134 cm^{-1} .²⁵ An O–Cl vibrational band is seen at 974 cm^{-1} , which arises from non-reacted sodium hypochlorite.²⁶

6.4.2 Hydrogen Peroxide Case

A possible chemical reaction between hydrogen peroxide and the conducting polymer PEDOT:PSS is shown in Figure 6.12. The displayed reaction involves the conversion of thiophene into its oxide version, thiophene dioxide,²⁷ Figure 6.12(a). Hydrogen peroxide can also impact the integrity of oxyethylene rings to result in esters and sulfoxide.²⁸ However, FTIR studies were not sensitive enough to clearly detect this change. This is mainly due to the relatively small number of oxidant molecules compared to that of EDOT monomers in the PEDOT:PSS thin film. Thus, it is not possible to have significant amount of EDOT molecules reacting to yield the needed FTIR signal. To circumvent this, we prepared pristine PEDOT:PSS films, from commercially available Baytron P, on silicon substrates. Some of the samples were fully oxidized by applying excess of hydrogen peroxide. The FTIR of the reacted samples and the pristine ones are shown in Figure 6.12(b). A clear difference between the FTIR spectra of both cases can be clearly seen at 1309 cm^{-1} , 1309 cm^{-1} , and 931 cm^{-1} , respectively. This can be attributed to the partial dissociation and/or protonation of the sulfonate group (in PSS) upon oxidation with the hydrogen peroxide. The dominance of PSS in PEDOT:PSS film²⁹ might overwhelm the spectra, thus making the FTIR data representing mostly that of PSS. The vibrational aspects of the sulfone group are observed at 1360 cm^{-1} and 1182 cm^{-1} , while the bands observed at 1751 cm^{-1} , 1678 cm^{-1} , and 1416 cm^{-1} are those of ester group, which is a product of the oxidation reaction.

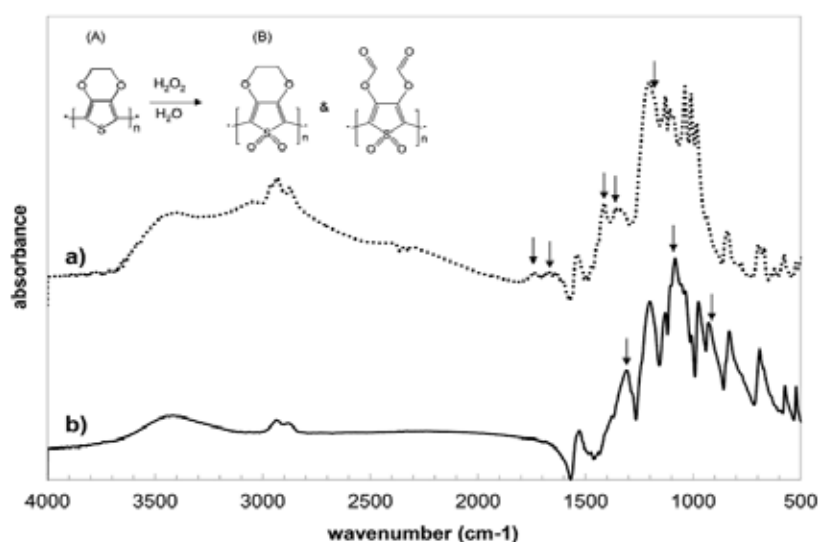


Figure 6.12 A and B represent a possible chemical reaction route between hydrogen peroxide and PEDOT:PSS and FTIR spectra of oxidized PEDOT:PSS using hydrogen peroxide (a), and (b) unoxidized pure PEDOT:PSS. Reproduced from Y. Yoshioka and G. E. Jabbour, *Advanced Materials*, John Wiley and Sons, © 2006 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.²¹

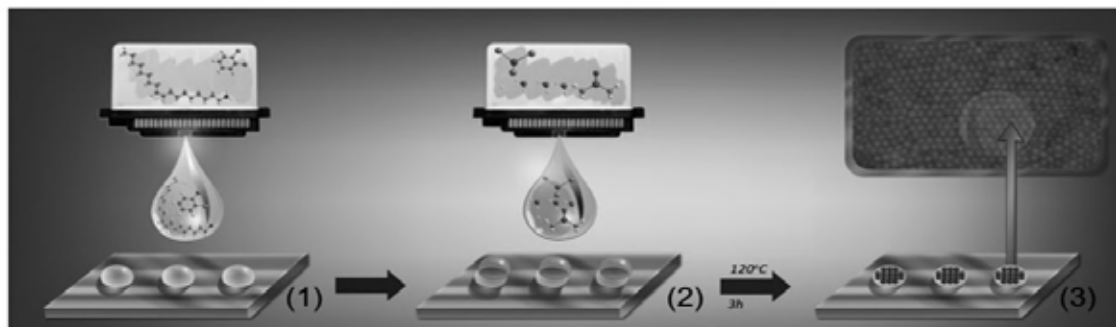


Figure 6.14 Self-assembled Au NPs synthesis using RIJ. (1) Printing of ink A, (2) printing of ink B on top of ink A, and (3) self-assembled Au NPs grown on substrate after heat treatment of printed inks at 120 °C for 3 hours. Reproduced from M. Abulikemu, E. Daas, H. Haverinen, and G. E. Jabbour, *Angew. Chem. Int. Ed.*, John Wiley and Sons, © 2014 Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim.⁵⁷

temperature (around 22–23 °C), and a Kruss Tensiometer (K100MK2/SF/C) was used (at 22.6 °C) to measure the surface tension. The two inks were loaded in separate cartridges. The printing process was carried out by printing ink A first, followed by ink B on top of ink A. A depiction of the experimental process is shown in Figure 6.14.

Ink A and ink B were printed in sequence, with ink B placed exactly on top of ink A printed locations on the silicon substrate. The inks were printed in the form of a square array having 30 μm spacing between adjacent drops. A post printing heat treatment was carried out for 3 hours and at 120 °C.

The substrates were then transported in air and placed in a high-resolution SEM (HRSEM-Nova NANO 600) for imaging and analysis *via* energy dispersive X-ray spectroscopy (EDS). For randomly selected elements of the printed array, the HRSEM inspection revealed a self-assembled layer of NPs having an average diameter of around 8 ± 2 nm. A typical image is shown in Figure 6.15, which indicates a densely packed layer of NPs with relatively uniform spacing between them. Figure 6.16 shows the EDS analysis of the NPs, which reveals the presence of gold and carbon along with a sizable silicon signal originating from the substrate. The uniform distance between adjacent NPs is attributed to the capping ligands of oleylamine attached to the surface of the NPs, which are the origin of the carbon signal in the EDS data. It is worth mentioning that the Au NPs are synthesized and capped with oleylamine in one single step, as opposed to the many steps followed in traditional synthesis approaches! The average length of a free standing oleylamine ligand is around 2 nm.⁵⁹ However, when oleylamine ligands from different NPs are brought into close proximity to each other, an interdigitated structure between the ligands from one NP is formed with those of the adjacent NP, which results in an overall NP–NP distance that is shorter than the length of two oleylamine ligands touching each other in an end-to-end manner. In our case, the average distance between adjacent NPs is around 2.6 nm, as obtained from Figure 6.15.

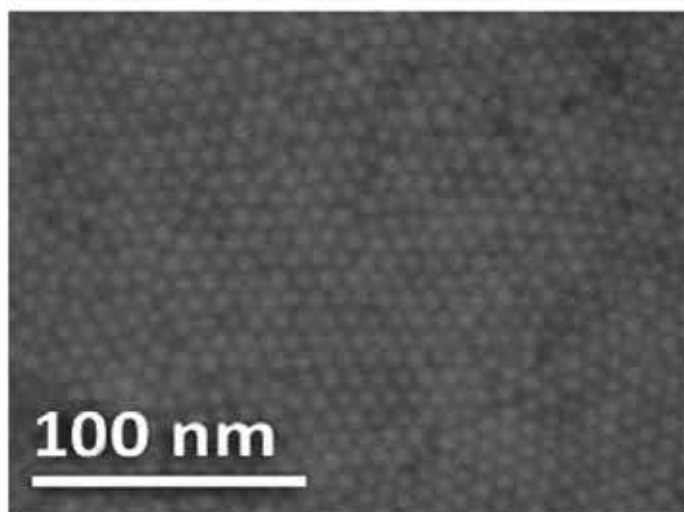


Figure 6.15 HRSEM of heat-treated samples obtained by printing ink A followed by ink B on top. Relatively uniform self-assembled NPs of diameter around 8 ± 2 nm are obtained. Reproduced from M. Abulikemu, E. Daas, H. Haverinen, and G. E. Jabbour, *Angew. Chem. Int. Ed.*, John Wiley and Sons, © 2014 Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim.⁵⁷

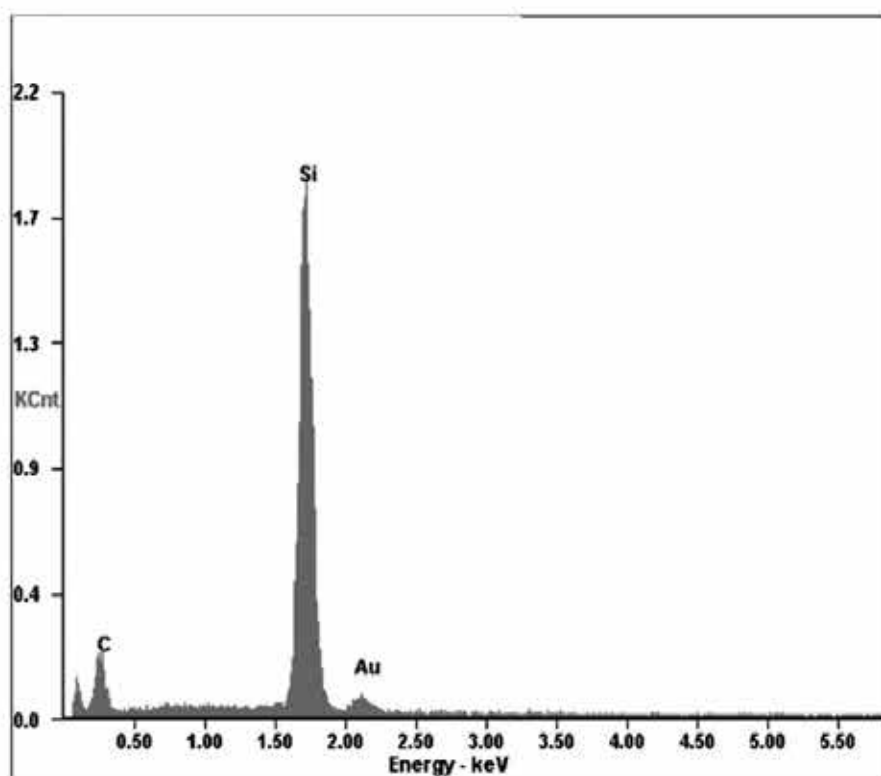


Figure 6.16 EDS analysis of NPs after heat treatment of substrate as described in the text. The metal Au signal in the data originates from the NPs, the Si signal is due to the substrate, and the carbon signal is from the organic ligands surrounding each NP.



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How People Speak about Cultural Differences

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Abstract This study tries to explain and describe reasons that make people from different places react when they experience a new culture. Besides the topic/s they have been interested in talking about, and how they have participated in their discussion i.e., topic and topic change. All these steps are important to show the role of this semi-interculture between people who come from different places, how they react, speak and describe after their interaction with the new culture where they live now. This study also has tried to show which topic/s are the most interesting ones for the participants to discuss and talk in similar situations.

Keywords Inter/Cross Cultural Communication, Grammatical topic, Discourse topic, Topic fragment, Speakers topic and Topic formulation

1. Purpose

The main purpose of the present paper is to show how and the way people talk about cultural differences. More specifically, I will investigate different discourse topics related to cultural differences.

This study will focus on:

- a) As form of the discussion e.g., topic change, and
- b) Its content e.g., cultural differences, topics between Sweden and Middle East / Arabic culture.

2. Mode of Presentation

The style of the present article was described in the theoretical background. We have started by mentioning the main books and articles were used, then a discussion was given and comparison between some selected studies and the present one, analyses with discourse was described as well as definitions for scientific terms i.e.,

Grammatical topic, Discourse topic, Topic fragment, Speakers topic, and Topic formulation including the examples from the topic.

Later, we have generalized the whole conversation under the result's chapter we have given through this study an explicit picture of how this conversation was started, developed and the main points that the participants talked about.

The technique we used in the present study as follows:

1. Before recording, the researcher asked the participants

to speak freely, continuously and were recommended to avoid interruption unless there are significant reason/s

2. The participants were given the following samples: *A, B, C, and D*
3. An interpretation of the present conversation was given in order to make it as clear as possible
4. Under the conclusion, some important comments related to the main topic was given
5. A clear description of what happened in the conversation in sequence e.g., topic change, development, etc).

3. Theoretical Background

We have introduced some important concepts were taken from various and previous writers are: Shi-Xu, Adelswärd, and Brown and Yule in the study of the Intercultural Communication.

Nine different topics was included. Participants have tried to explain some of the main concepts arose for each topic, comparison with their culture and opinions was illustrated. The participants have found themselves changing topics simultaneously. Sometimes they give their evaluations, sometimes they leave it to each other, and sometimes leave it to the interviewer's interpretation.

3.1. Topic Change into Sequence

We have adopted the idea of Shi-Xu's paper '*Discursive Attributions and Cross-Cultural Communication*' of dividing the topics into sequences. The arrows show topic to topic change. Examples for each one of the below items were given, **topic-topic change** will be demonstrated. Sequences as follows:

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Table 1. Topic to Topic Change

Initial topic	Change to --->	New topic
a) the principle of education		
b) social variations	→→→	cultural situations
c) social relationships	→→→	culture considerations
d) discrimination views	→→→	comparison between two cultures

Examples:

Discussed topic (A)

Discriminatory views

Translated examples of the recorded conversation were listed below. Then to continue as sequence of topic (initial topic) - and topic change (new topic).

Example (1)

E: They have said that there are two black players and that one of them scored the goal.

A: and no one tried at least to answer them?

E: no, it is normal, and a while ago they mentioned on TV that we do not want foreigners.

A: I think. the racist phenomenon exists everywhere but it should not cover advertising also, and should not cause many people to react on this bad phenomenon, we are human beings and we live on this planet which is not yours or mine, because you did not choose where are you are going to be born here or there. You might be born in my place or the opposite.

As we have seen the above topic was discussing discriminatory views and below we will see that this topic is changed to:

Talked topic (B)

Comparison between two cultures

Example (2)

B: and this is the difference between us and them // for example now we are playing football anyone would like to share us he or she welcome that beside our religion which orders us to treat everyone the best we can, no difference between black and white or Arab or African or even European. the only difference between me and him is our behaviors (according to our belief) if he/she respects me and I do the same it's OK he/she has the right to be a believer or a non- believer this is his choice, then if he is doing his job well I have to give him or her his right, not to discriminate him otherwise what is the difference between us and the animals in jungles? and I think they have this kind of racists on a high level.

The above example shows how the topic - topic change occurs in the present conversation. We will continue demonstrating and in table the sequence of topic - and topic change:

Table 2. Sequence of Topic and Topic Change

Initial topic	Change to --->	New topic
e) methods of education	→→→	the role of faith
(children) & parents instructions		
f) the positive sides of education		
g) Females' views	→→→	compare it to their opinions and the (real) concept of freedom.
h) the bad impression given from people who come from abroad		
advices from the participants to the listeners	→→→	some of their habits compared with two cultures

3.2. Discourse Topic

Brown and Yule (1983) have explained the "discourse topic" that is distinct from the notion of topic notion used by the grammarians (Keenan and Schiffelin 1976 p:71). We still think that it is interesting to discuss both "grammatical and discourse topic" even though the present study *is to show how people speak about different cultures but not describing the grammatical analysis in Arabic.*

Thus (Brown and Yule P:75) all reasonable judgements according to this point was explained carefully. We have given each topic and topics change its own explanation during changing the topic. This has been done to make the idea easier to understand and for each topic. To follow the main topic of the conversation the data that has been studied in discourse analysis is always a *fragment* of discourse and the discourse analyst always has to decide where the *fragment* begins and ends.

On the other hand there are of course points where one speaker stops and another starts speaking, but every *speaker change* isn't necessary concluding a particular *coherent fragment* of conversation. Which point of speaker change among the many could be treated as the end of one chunk of the conversation? This type of decision is typically made by appealing to an intuitive notion of Topic.

Example (3)

B: I have known some people who've lived here for 30 or 35 years and have forgotten their habits and cultures completely. But this is what I did. I met some people and not all of them they had forgotten their habits and cultures.

A: and do you think after that, the Swedes are going to respect them?

The above example has shown us how speaker A interrupted and continued the speech from speaker B and changed into completely different topic.

We would like to account and identify the following terms as which we have found it is worth to mention here which are related to our topic.

• Grammatical topic

We identify this term as referring to a constituent in the structure of a sentence (or the deep structure analysis, at least). This is also noticeable in the work of grammarians such as Dahl (1969) and Sgall (1973).

Note, according to Hockett, the distinction between a **topic** and the **comment** in a sentence, is that the speaker announces a topic and then says something about it. In English and the familiar languages of Europe, topics are usually also subjects, and comments are predicates (1958 p: 201).

• Discourse topic

Keenan and Schieffelin (1976 p: 380) emphasized that; "*discourse topic*" is not a simple NP (= noun phrase), but a proposition. Maybe because their investigation is primarily concerned with children's speech, but in describing the discourse topic as the "questions of immediate concern", Keenan and Schieffelin appear to replace the idea of a single noun phrase as expressing the topic with the idea of a single correct phrase or, sentence.

Example (4)

A: maybe we can move to another point now// if we tried to know the personal opinions for each one of people who have come to Sweden and changed their habits or cultures or both.

The above example shows how speaker A (as a topics introducer) was very often the responsible of opening and changing the topic/s.

• Topic framework

Is a characterization of 'topic' that would allow each of the possible expressions, including title (for each topic changed), to be considered (particularly), thus incorporating all reasonable judgements of "what is being talked about". In addition, there are aspects of the context that are directly reflected in the text, and which need to be called upon to interpret the text, we shall refer them as *activated features of context* and suggest that they constitute the contextual framework within which the topic is constituted that is, *the topic framework*.

Changing unnecessary behaviors = (the title)

Speaker A pointed out that there are different kinds of behaviors and how it is important to replace a bad behaviour to a good one instead.

Example (5)

A: but I've here pointed out that // it is good to replace some bad behaviors of your culture to a positive one in here.

B: but what happened if this family came (?) more than three generations behind. [no way, the basic is the most important?! a] Yes, but they look at people who lived here for quite long time and became having good positions in Sweden as Swedes even if their grand fathers or mothers are basically from France or Germany, etc.

Speaker B and regarding the above example has shown us

the relation between the title and the topic of the latest conversation.

• Speakers' topic

If we would treat any piece of conversational data as a process in which two, or more participants speak within the topic framework; we should also find in their contributions' elements that characterize their own personal *speaker's topic* on the other hand, there are two points worth noting about the fragment of conversational discourse:

First. It is a feature of much conversation that *topics* are not fixed beforehand, but are negotiated in the process of conversing.

Second. There is a large number of other conversational fragments, where personal topics are frequently introduced through first person reference in one form, or another.

Concerning the above discussion we have observed that none of the aforementioned writers could give an exact definition of the terms they introduced. They gave only explanation/s, besides we think it is still difficult to give a precise definition to any one of these terminologies.

So we should always remember that it is speakers, and not conversations or discourses, who have topics.

3.3. Topic Initiation

People from the Middle East have their own culture which has to be taken into account. When a person speaks the others should listen to him without unnecessary actions e.g., putting their legs on disks, lying down, not giving attention to the speaker, etc. These are important for people who come from this part of the world. On the other hand, we note that, such behaviour/s does not mean impoliteness to the people who live in other parts of the world e.g., Sweden. Because of this it is important to explain this point to the readers or persons who might communicate with person/s from that culture.

In chapter "5" of the present study, Brown and Yule (1983) speak about "Information Units" which are realized phonologically by intonation (B&Y p.155.) In Arabic (any dialects) intonation is very important. Maybe the accent face many differences through the history.

Another reason, Arabic is wide language in dialects, including different sound articulations and synonym words. These are among the main reasons that make this language include number of intonations.

The other point in chapter 5 includes syntactical and structural information.

3.4. Topic Change

The study of Shi-Xu (1994) (*Discourse Attribution and Cross Cultural Communication*) gave an explanation about topic change. The attributions in, or outside communication. He says that, "the notion of attribution is regarded as of great relevance to cross - cultural communication and relations when members of different cultures come into contact, communicative difficulties may arise, because of culturally different ways of explaining beliefs, behaviour and events.

To avoid communicative problems it is considered as crucial to obtain scientific knowledge of culture - bound attributions, which can then be applied to the engineering of cross - cultural communication" (Shi-Xu p:337).

Then, Shi-Xu moves to define these problems by dividing them into two points, and says that, such a conception of attribution is problematical in at least two respects:

Firstly, it neglects the role of language and interaction in constructing and orienting attributions.

Secondly, using attribution as theoretical abstraction, i.e. as culturally shared cognition, in accounting for cross - culture phenomena, or in engineering cross - cultural communication, may involve a risk of ethnocentrism (Shi-Xu p:338).

The analytical preliminaries. Under this title Xu mentions a basic view of language and communication in everyday life, which will be central to the understanding of discursive attributions. This view consists of a number of inter - related components such as language discourse, and the language user. The language user is according to Shi Xu seen primarily as a socially accountable and creative person (Shi-Xu p: 339).

According Shi-Xu's discussion and corresponding to the present data conversation, there is topic change example, will be listed below, is that when the speaker A has created the different topic/s and speaker B who has contributed in language discourse and language user too.

Example (6)

A: // what do you think of education in Sweden, what is the positive and the negative respectively?

B: there is something they have included in their education especially to children's education which they should not give in this age, and of course we do not give these education to the children in early age because this might create problems we do not need and maybe we may lose them.

The cultural attributions as communicative acts.

Shi-Xu says that to understand the nature of cultural attributions, so we must perforce take into account this communicative action dimension. Moreover, he continues that, it is necessary, therefore, to examine people's formulations of cultural and social psychological knowledge regarding to the functional uses to which they are put in everyday life (Shi-Xu P: 340).

Example (7)

A: of course we are with you in this view. Because of the principles of our belief and habits we have observed here that sexual education might be given to the students but gradually (in stages) but not at once; in addition not mix males and females together. Yes // and not to say and show the unlimited which relates to this information. Let me add also that, we have this idea, that it is mothers who supposed to give them this information in detail, rather than their teachers or other sources, because they (the mothers) are the most important members of the society (according to our

concepts), especially when it deals with this type of information.

E: we have private books that have spoken about these things in detail which you can buy or borrow to know these things without putting your sister or mother or even // ?! yourself in an unnecessary situation.

And about the principles of interpretation. Shi-Xu gives two types of meaning - interpretation of attributional discourse:

1. The contextual semantics at the descriptive level, the "saying" of the discourse - to use a metaphor from speech act theory,
2. The cultural pragmatics at the performative level, the "doing" of discourse.

3.5. A Simple Comparison

Below a comparison between Shi-Xu's study and the present study will be given:

1. My interviewees are 4 participants, and Shi-Xu's interviewees are 40 participants which make the present study simpler and much accurate.

2. Xu's study was made in Holland and my present study was made in Sweden. Xu's informants are Chinese, my informants are Arabs came from Palestine.

3. Xu's interviewees, are scholars (students in general). Our participants are almost labors; two students and two labors who came to Sweden as refugees.

4. Both studies use non - questionnaire, and informal style, in order to give participants wider opportunity to speak freely.

5. Shi-Xu's study focused on attributional relationships between propositions, hence sentences because the formulations of the cultural properties are more explicit at this level. However, the present study was focused on how people try to speak about different cultures.

6. Shi-Xu, divided his study into *three parts*, each speaks about different attributional representation as follows:

- a) Implicit, explicit in more, or some such structure.
- b) Attributional discourse, refers to, a belief type of behaviors.
- c) Cultural attribution, which involves a cultural / national group, or characteristics of the cultural / national group, etc.

While the present study was divided into a sequence which includes nine topics, each related to the **topic** (initial topic), and **topic change** (new topic), except two of them: one and six.

3.6. More on Topic Change

Under "**topic change**" some definitions, including the one we are going to present as well, we have realized that it is important and difficult area to discuss, and define. According to Brown and Yule (p: 84), an extreme example of "speaking about a topic" would be in a debate where one participant ignored the previous speaker's contribution on "capital

punishment", for example, and presented his talk quite independently of any connection with what went before".

Regarding the same reference, p: 85 "it is quite often the case that a speaker will treat what he was talking about in his last contribution as the most salient elements, and what the other speaker talked about, though more recent, as less salient".

The second speaker has changed the topic of conversation, the first speaker will get back to the topic of his previous speech again, and this represents a sequence of the *topic change*.

Furthermore, and with regard go "**topics change**", we suggest the following definition; **topic change, is to change the main core of the conversation, in both direct or indirect way/s.**

See the examples below,

1. *The direct way*, is to change and deliberately to another topic during the speech.

Example (8)

A: *did you go to school ?*

B: *I have seen my sister*

As we observe speaker B might has changed the topic of the speech to another topic deliberately.

2. *The indirect way*, is to change to another topic by using, sometimes, idiomatic ways/metaphors, and very much happened with or even without reason.

Example (9)

A: *what do you think of your father?*

B: *I have seen an old man in the street.*

However, the above answer is ambiguous, and has two different interpretations:

1. He meant that he has seen his real father, and he is an old man.
2. Or his real father who was seen, was doing something childish.

The above two cases direct and indirect could depend on the context. Going to see sister may be an indirect way of saying "**no**" to the question.

Another example from the present study is to show a clear case of *topic change*.

Example (10)

B: *for example in Jeddah (Saudi Arabia) there are two universities: one for girls and one for boys /// do you think it is useless? or have they been charged and paid all these amounts for nothing!?*

A: *when the Arabian woman is going to marry // the last, and most important question the judge will ask her/: do you have any condition/s?// Then she has the right to answer him positively or negatively immediately. But there are some people who do not want to know this fact in the world not only in Sweden, but this is a fact.*

The above example has shown us how speaker B has

spoken about the females education, then speaker A has changed the topic to the females marriage, and each topic differs from the other one.

Another question may occur here, how do we know that any person/s has changed topics?

I could say that, it is difficult and might be complicated to know how the **topic** is going to **change** during any conversations, sometimes topic changes even if we agreed that we don't want to. So it can be said that **topic change** is a difficult phenomenon to control.

• Topic formation:

Let us see the following example from the present data conversation,

Example (11)

A: *what do you think is important to your study?*

B: *any open subject, but to be completed.*

C: *you mean our life in Sweden //, or religion/, or even politics*

B: *no, we don't want to dive into religion, or politics.*

The above example has shown us that speaker **B** and from the beginning of this conversation has made a "**topic formation**" and wanted to avoid speaking about religion or politics, and he suggested to influence his suggestion on the others. On the other hand the same speaker during this conversation was the person who spoke about politics, and religion more than the other informants.

Comment,

We think that speaker **B** was affected by the politics and social life of his area, which made it a bit difficult to speak about '*politics and religion*'. Moreover, the stress from this speaker was immediate, and recognized through his loud voice. The observation is that speaker B has found himself forced to speak, explain, defend and even to compare between these two situations, to show his attitudes and beliefs that concern him.

4. Data Collection

A tape recording contains four persons were participated in the conversation. Name of participants: A, B, C, and D. All of them are Arabs of Palestinian nationalities, educated, and between 22 and 30 years old. The tape was recorded in a private house and by the end of the year (1993), in Gothenburg city, Sweden.

5. Results

5.1. General Comments on the Present Study

Three steps has been listed:

1. The sequences of speech which the informants have talked about will be shown in the table below:

Table 3. Sequence Based Subjects are Talked

Initial topic	Change to →	New topic (2)
a) the principle of education		
b) social variations	→	cultural situations
c) social relationships	→	cultural considerations
d) discriminating views	→	comparison between two cultures
e) education methods: children) & parent rules	→	the role of faith
f) positive sides of education:	→	
g) Female views	→	compare their opinions and the (real) concept of freedom
h) the bad impression given from people who come from abroad		
i) advices from participants to the listeners	→	some of their habits compared with two cultures

2. The arrows show the transition from topic to topic changes, the person who plays the main role of changing most of these topics was speaker A. How each topic change has happened will be described below;

- a) Education principle, C speaker discussed the reason behind supporting their home education then speaker A started to speak about the difference between the two societies.
- b) Social variation, speaker B has discussed the differences between the two societies (Swedes and Arabs), then speaker C has taken the floor and changed the topic to describe the situations in each culture.
- c) Both culture situations, speaker D has ended this topic by giving an example to support his claim, then speaker A has taken the floor and changed the topic by simply giving a simple picture friendship in Sweden through the topic (social relationship).
- d) Social relationship, speaker B concluded this topic by giving his view according to his own experiences, and speaker A has changed again the topic to discuss the cultural roles.
- e) Discriminating views, speaker B has given his view and supported his opinion with examples which goes against the Swedish people, then speaker D agreed with him and suggested more examples and changed the topic to the comparison between these two cultures.
- f) Education’s method, speaker B has changed the topic with motivation. He has also mentioned the reason behind all problems related to the educational system, relationship. etc.

Speaker A has taken the floor again and changed the rest of this topic to discuss the positive and negative sides of

education in the Middle East.

3. What topic/s they didn’t speak about?

This is more hypothetical question, however, based on their conversation there have been some topics were not completed and/or did not suggest the solutions:

- a) Problem solving instead of listing them only
- b) Future expectations about Sweden
- c) Development of technology and it affects on people’s social life

If we have discussed some points regarding the following discourse; we will say that each participant has given his view based on his particular experience, however, we have found that most of the analyses of these experiences is connected to their culture, habits and belief.

For example, their topic "education principle" includes important parts related to their belief, tradition and their role in the society.

The interesting observation here is that such comparison between Middle East and Western society require the informants to gain more experiences before understanding lots of behaviors, habits, etc. of the Western culture.

Moreover, since we have concentrated on people from the Middle East, we have realized that they are between 'two difficult choices' are:

1. To accept this change, or
2. To refuse it

Then they have to choose between, living in Europe or to move back to their homes. Of course this also is a difficult choice. To risk with your principles and children's future is a price you might pay. These principle/s (according their belief) is important to keep their dignity. Yes many of them are looking to this choice as destroying the family connection and their identities as well.

Example (12)

B: // Swedes think that we do not allow our women to have a job because they are illiterate no this view is wrong, we look at women // as great mothers who deserve to be in their right place between their families and society, not to spend her night everyday with one man and to go to the night club to let this or. that person touch her, where is the clean life then? would this also be a freedom? God, I and We refuse this opinion from this point of view.

C: then we can say that the mother (woman) is the root and the greatest school to generation/s in the world if she has used her role in the society as we have explained above.

D: the woman in Europe is a device//

B: she looks like a man from home to work and from work to home yes!.

The example above shows both: the way of looking to women and respect.

5.2. The Difficult Choice

Some groups in the world have their own strategies to educate their children, and to build their children's future etc.

If this strategy has been related to their belief, it will be hard to find a solution that makes these groups satisfy to stay in a place where it contradicts some of their principles e.g., behavior, religion, or culture in general.

5.3. Society and Relationships

Viveka Adelswärd book (1988) "*styles of success*" has also distinguished the need of the job and what is the best way to find etc. This article has been useful and very helpful to make the present study more systematic, point by point. The topic of the present study is different from Adelswärd's studies by: topics she has discussed however the similarity between her and the present study was in giving the right to everyone to explain his/her views freely.

The participants in the present study tended very much to move to work topics related to social relationships (we can say that, 95% of the speech topic was focused on this point).

Furthermore, we can not blame the participants at all, why?

Most of people who came to Sweden have their own reasons which forced them to leave their places. They noticed that many Swedes think that they were happy to come to Sweden and to live in different place and to experience different culture even though they miss their homelands.

Example (13)

E: the difference between us and them as they have seen it that we have come to their place as refugees and emigrants, but if they come to our place they come as visitors, then we came for an important reason and they came for another, then how we are going to treat them as the same as they do here?

B: yes, my brothers but why have we come to here? Because of war what happens to them if there was a war in their country?

D: now a days no one would stay at home?!

B: because they did not experience any wars or suffer, people used to live always in safe, wants to live although they have money, for example I came here during the war time but before this I have lived a great life in my country, I didn't need anything, they have not felt that because as we have said they have not had any wars, I want them to put themselves in our situations then to judge, look for instance at many foreigners how did they reach here? yes there are people who came for money and to sleep without doing anything but of course not all.

Example (14)

B: some of them yes?! because some of them wanted people who come from abroad to forget their cultures and habits and may be their history too

A: and most of Swedish //

B: I believe most of them prefer those and few only respects people who still preserve and proud of their identities, but the first group I mean the majority, wanted the Arabs or the rest of foreigners to forget their cultures and

even their languages anywhere they have come from never mind.

A: and later on if I have become like them how do you think that they are going to consider me? as Swedish, or what am I going to be considered here?

B: no, I think.// at the same time you won't be considered as Swedish.

Corresponding to the above conversation we have seen that participants have been disagreed on certain changes, because of this they would like to preserve the minimum degrees of their *identities'* as possible. They got surprised and shocked from the Swedish society. They think that it is fine to keep and show some of their behaviors without neglecting the Swedish social life. This may assist them to protect their identities on the one hand, and to take into account the main characteristics of Swedish social life on the other hand. This is difficult, but as soon as they chose to leave their homelands they have to accept the new life change.

In along with the above explanation, it is not wrong for the Swedes or any European to listen to these people and show them some concerns, also to try to consider their past life, background etc as well. Because they did not mean to ignore the Swedish culture, no, however it is very difficult to forget theirs as well.

5.4. The Culture

The informants have been talking about their culture and how its affected by the people who live in Scandinavia. Some of them have given up and agreed to change their identities, and the other group have objected to change their identities and preferred to try to live with this situation for some time. The question here, which type of these two groups deserve to be more accepted? It is not *easy* to judge here which one of them.

We think that we may accept the first group if and only if they have *taken away* the negative behaviors of the new society. However, we can accept the second group if and only if they could hold the stick from the middle, we think they have to make the balance between reserving their culture, identity's etc. and showing appreciations with respect to the other culture and try to live with this new situation as much as possible.

The questions have arisen of the "interviewer who is the responsible alone for doing the beginning and the ending of the interaction, for introducing new topics and ending existing ones and for formulating the talk" (*Silverman & Jones, 1976:146 p: 10*).

Moreover, we may add that speaker A was the most active informant who has controlled and led many topics in the conversation more than the other informants.

This article as far as I have explained is to show how several topics has been changed throughout the conversation which based on the speakers background, knowledge and information.

I see the present article as useful for several reasons:

1. In providing an interesting discussion to the reader
2. It followed, as possible, the main points were discussed by several writers regarding topic and topic-change, etc.
3. It shows randomly of how the sequence of speech may occurred through similar conversations

6. Conclusions

We need to remind you of the participant A who was the one who suggested most of the topics were discussed. Participant B was eager to participate by giving his views very often, and he has given several opinions that offered wide information related to their culture and in comparison with the Swedish culture. Participants C and D were very often play the role as listeners in the conversation. We think that means they agreed with the other informants' opinions and views. Otherwise they would have interrupted the conversation so often. The general atmosphere of the conversation was normal. One of the main characteristics for people who come from this area is to interrupt and to show their views especially if they disagree on certain point.

The other interesting observation is that all participants have been very happy to discuss these variations and to speak about the different cultures from their points of views, nevertheless they have known that people from the Swedish culture have their own thoughts of life and thinking. They would like to transmit their message to the public if possible.

Several points we need to list:

1. Not all subjects were demonstrated in the conversation.
2. Subjects e.g. grammar, phonetics, semantics etc. were avoided to discuss
3. Sometimes the participants have used a metaphorical/idiomatic styles, but it was clear, and not ambiguous.

Finally, not covered all topics were covered. Topics are vast, several points from each culture were discussed and we try to make things clear and as coherent as possible to the reader. We hope that we have succeeded in presenting useful information and added new cooperation in the linguistic field, showing how people speak about different cultures.

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Appendix

I have used symbols referring to a speaker's reaction in this text. However, I have noticed that, there is some difference (by using the same variables between different articles).

...	= Sentence final.
?	= Question mark.
....	= Same words of redundancy.
..	= Pause of less than 2 seconds.
CAPITAL'S	= Stress on the entire word of phrase.
[]	= Overlapping and (FBA) action.
//	= Repair
()	= Explanation as additional information.
*****	= Laughter.
?!	= Utterances in ironic tone.
[.....]	= Omission by transcriber (me)

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