

# UBT

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UNIVERSITY OF BUSINESS AND TECHNOLOGY

 **RCC**  
Research & Consultation Center  
مركز الأبحاث و الاستشارات





Research & Consultation Center(RCC)  
University of Business & Technology (UBT),2016  
P.O.Box 110200 Jeddah 21361  
Kingdom of Saudi Arabia  
[rcc@ubt.edu.sa](mailto:rcc@ubt.edu.sa)



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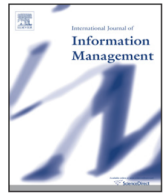
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## Review

## User resistance in IT: A literature review

Mahmood Ali<sup>a,\*</sup>, Li Zhou<sup>b</sup>, Lloyd Miller<sup>b</sup>, Petros Ieromonachou<sup>b</sup><sup>a</sup> College of Business Administration, University of Business and Technology, Jeddah 21361, Saudi Arabia<sup>b</sup> Faculty of Business, University of Greenwich, London SE10 9LS, UK

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## ABSTRACT

User resistance is a complex phenomenon long viewed as a major constraint in successful information technology implementation. User resistance, which can vary between passive and active, could be a source of guidance towards reducing problems associated with organisational change. However, rather than embracing user resistance and seeing it as a learning opportunity and a tool for managing current and future difficulties around user resistance, organisations fear it. There exist a wide literature on user resistance spanning decades; focusing separately on user resistance, and various related factors. However, there is no comprehensive overview of the research work published. This study presents a comprehensive literature review to gain a better understanding of the contents of the current user resistance literature. Based on the findings from the literature review, areas of concern and the impact of user resistance on the development of new information technology are identified and how to overcome the resistance is suggested.

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## 1. Introduction

User resistance issues are of primary focus in information technology (IT) related projects. In today's business environment, technology is playing a critical role in improving organisational effectiveness and is being implemented extensively, understanding user resistance has gained considerable attention in the literature (Dickson & Simmons, 1970; Keen, 1981). Goodhue and Thompson (1995) argue that not understanding user resistance may lead to

less productivity, which in turn can create serious problems for businesses. Hill (2003, p.1) asserts that user resistance must be understood since it has been found to be "at the root of many enterprise software project failures." Gravenhorst and Veld (2004) suggest that change and resistance go hand in hand; accordingly, change suggests resistance, and resistance imply change. For such reasons, Doppler (2004) advises against ignoring the causes of user resistance, and suggests that recognising and taking appropriate action will reduce enduring problems.

The user resistance literature covers a wide range of area such as various reasons, outcomes, and list of factors relating to user resistance. Markus (1983) states that IT development is a political beast as well as a technological animal where resistance is not a problem

\* Corresponding author.

E-mail address: [m.ali@ubt.edu.sa](mailto:m.ali@ubt.edu.sa) (M. Ali).

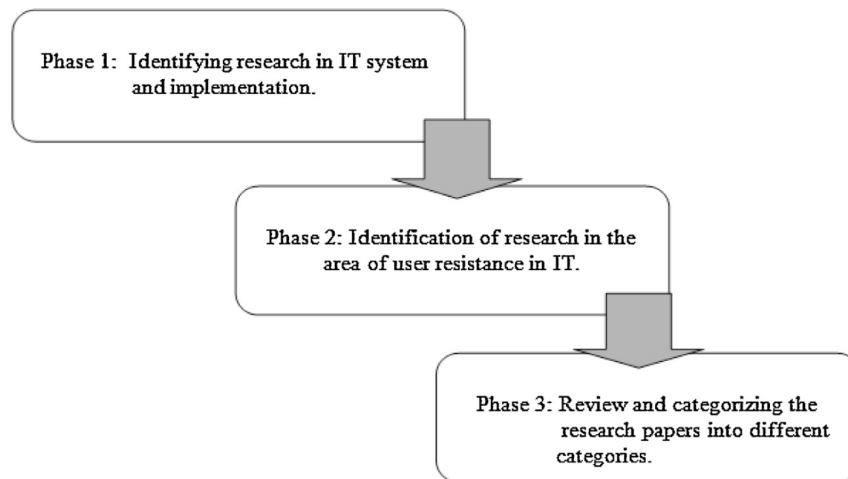


Fig. 1. Research framework.

to be solved, but more a useful clue as to what went wrong. King and Anderson (1995, p. 168) describe user resistance as a “complex kaleidoscope of interrelated factors.” While Jiang, Muhanna, and Klein (2000) conclude that user resistance problems are wide and pervasive and no single feature can describe the phenomenon entirely. There are several examples of user resistance in the industry such as ‘user resistance extended the duration of a US \$6.9 billion defence intranet project by eightfold (Verton, 2002); underutilisation of new implemented enterprise system at a soft drink maker (Barker and Frolick, 2003); a company was forced to redevelop customer relationship management system when employees refused to use the original version (Kim and Pan, 2006); and research fieldwork undertaken in China in July 2015 by the authors witnessed that in logistics companies majority of drivers refused to use transport monitoring system because they can be tracked and felt being watched by management all the time’. These examples indicate the need of getting a better understanding of IT user resistance, and therefore, motivate us to undertake a systematic review of the causes of IT resistance and other issues relating to user resistance, and explore the strategies to overcome these barriers.

The purpose of this study is threefold. Firstly, to overview research in the area of user resistance. Secondly, to overview the causes of user resistance. Finally, based on the findings from the study, we suggest the strategies to overcome user resistance, and offer recommendations for future research in this area.

The paper is organised as follows: Section 2 describes the definitions of user resistance in the literature. This is followed by a general discussion on user resistance in Section 3. Section 4 describes the methodology we adopt in the literature review. The theories of user resistance are discussed in Section 5, followed by an examination of user resistance in Section 6. In Section 7, the strategies of how to overcome resistance are reviewed. Finally, Section 8 concludes and provides future research direction.

## 2. Definition of user resistance

In the management literature, resistance is defined as a multifaceted phenomenon which brings forth unanticipated delays, costs and instabilities into the process of strategic change (Ansoff, 1988, p. 207). It is any conduct that serves to maintain the status quo in the face of pressure to change it (Zaltman and Duncan, 1977, p. 63).

Resistance to change is the intentional acts or commission that defy the wishes of others (Ashforth and Mael, 1998; Newman, 1988). Kim and Kankanhalli (2009) define user resistance as oppo-

sition of a user to changes associated with a new IT implementation. Klaus and Blanton (2010) classify user resistance as the behavioural expression of a user’s opposition to system implementation and during implementation. User resistance is therefore a reaction to present on-going situations, perceived as a negative or stressful feeling (Ang and Pavri, 1994; Maraks and Hornick, 1996). It appears when users perceive changes as ‘unfair’ in regards to their or group workloads (Joshi, 1991).

In the IT sector, user resistance is defined as behaviour intended to prevent the implementation and use of new systems, or to prevent system designers from achieving their objectives (Markus, 1993). Such resistance to a proposed change is an adverse reaction, which may manifest itself in a visible and overt fashion (such as sabotage or direct opposition), or in a less obvious and covert action (such as inertia) to stall and ultimately kill a project.

## 3. Framework of the literature review

The introduction of new technology frequently involves varying levels of change to business processes and how employees carry out their daily job functions. This change can be as minor as a simple modification in the user interface, or installing a new application. Equally, it can be as complicated as implementing a complete enterprise system, such as SAP, Oracle, Lawson, MS Dynamics, etc. which requires a complete business transformation. Users react differently to these changes. Their responses can range from partial to complete acceptance of the changes, to absolute rejection of the new system, which in many cases may lead to project failure (Nov and Ye, 2008). In a summary of 13 recent studies by Jain (2004), in using IT as a tool for reform or change, at least six of the failures are attributed to employee’s resistance to change.

Kling (1980) views resistance from three perspectives: people oriented, system oriented, and interaction theories. People oriented theory suggests that resistance to a system is created by factors internal to users as individuals or groups (Jiang et al., 2000), similar to Mumford and Banks (1967). This is consistent with Sacks, Bellisimo, and Mergendoller (1993) who explains that a user’s individual beliefs, values and understanding contribute to individual’s attitudes to new systems. The system oriented approach posits that resistance is induced externally by factors inherent in the design and introduction of a new system. Finally, interaction theory analyse the interaction between the user and the system. It is based on the premises that systems acquire different political and social meaning in different settings, whilst different users perceive the effect of the same system differently (Joshi, 1991; Kling, 1980).



**Table 1**  
Bibliographical database included.

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<i>Behaviour and Information Technology</i>
<i>Business Process Management</i>
<i>Communications of ACM</i>
<i>Database for Advances in Information Systems</i>
<i>Decision Sciences</i>
<i>European Journal of Information Systems</i>
<i>Harvard Business Review</i>
<i>Information &amp; Management</i>
<i>Information System Management</i>
<i>Information System Research</i>
<i>Information Systems Journal</i>
<i>International Journal of Human-Computer Interaction</i>
<i>International Journal of Information Management</i>
<i>Journal of Business and Psychology</i>
<i>Journal of Computer Information Systems</i>
<i>Journal of Enterprise Information Management</i>
<i>Journal of Information Technology Case and Application Research</i>
<i>Journal of Information Technology Management</i>
<i>Journal of Management Information System</i>
<i>Journal of Organisational Change Management</i>
<i>Journal of System Management</i>
<i>Management Informatics</i>
<i>Management Science</i>
<i>MIS Quarterly</i>
<i>Organisation Science</i>
<i>Strategic Management Journal</i>
<i>The Computer Journal</i>

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Given these three perspectives are commonly accepted, this paper adopts it as the framework of the literature review.

#### 4. Research methodology

In this section, the research methodology used for conducting the literature review is presented.

Due to the volume of literature under study, the research methodology is divided into three phases (see Fig. 1). The first phase involves a search of the inventory of research journals to locate studies on IT systems and implementation using the Swetwise, ProQuest, EBSCO, Emerald, ScienceDirect, Wiley Interscience, and ACM Digital library databases (see Table 1). The keywords used in the database searches are: implementations, IT and user resistance. The selected journals (Table 1) represent the group of major scholarly journals in the area of user resistance and are extensively cited. In addition, they represent wide spectrum of the research area (such as human behaviour, communication, decision sciences, human and computer interaction, psychology, change management, organisation science and strategic management) besides field of IT; thus, enriching this literature review.

The second phase involves the identification and review of papers exclusively on user resistance. As a part of the selection process, the research papers focus on abstracts, keywords, research findings, etc., which enables us to identify and select the papers only on user resistance.

In the final phase, the papers identified and reviewed are categorised. For this study, the classification proposed by Esteves and Bohorquez (2007) who reviewed the literature based on ERP life-cycle framework is adopted.

In an attempt to focus and understand user resistance, we classify the literature into different sub categories—theories of resistance, followed by examining user resistance classified as system oriented, people oriented, and interaction oriented resistance. To gain in-depth knowledge, content analysis is adopted to enhance classification and provide rigour process (Cumbie, Jordan, Peachey, Dugo, & Craighead, 2005). For the content analysis, we focus on the abstracts of the papers to gain an understanding of the research topic. This results in better categorisation and creates a positive impact on the analysis.

#### 5. Major sources of resistance

Val and Fuentes (2003) extend the work of Rumlet (1995) by dividing sources of user resistance into five groups relating to formulation and implementation. The five groups are explained in the following sections. The first three groups deal with sources of formulation, and the last two groups deal with implementation.

i **Distorted perception:** Val and Fuentes (2003) termed the first group, distorted perception, interpretation barriers and vague strategic priorities. It includes

- Myopia, or inability of the company to look into the future with clarity (Barr, Stimpert, & Huff, 1992; Kruger, 1996; Rumlet, 1995).
- Denial or refusal to accept any information that is not expected or desired (Barr et al., 1992; Rumlet, 1995).
- Perpetuation of ideas, the tendency to go on with present thoughts although the situation has changed (Barr et al., 1992; Kruger, 1996; Rumlet, 1995; Zeffane, 1996).

ii **Low motivation for change:** this includes

- Direct cost of change (Rumlet, 1995).
- Cannibalisation costs, changes which bring success to the project but may bring losses to others, so it requires some sort of sacrifice (Rumlet, 1995).
- Past failures.
- Different interest level among employees and management (Waddell and Sohal, 1998).

iii **Lack of creative response:** this includes the main reasons for diminished creativeness in the search for appropriate change strategies.

- Fast and complex environmental changes, which do not allow a proper situation analysis (Ansoff, 1990; Rumlet, 1995).
- Reactive mind set, resignation, or tendency to believe that obstacles are inevitable (Rumlet, 1995).
- Inadequate strategic vision or lack of clear commitment of top management to change (Waddell and Sohal, 1998; Rumlet, 1995).

iv **Political and cultural deadlock:** this results from following:

- When there is a negative relationship between implementation climate and change values and organisational values, resistance and opposition to change will result (Klein and Sorra, 1996).
- Departmental politics (Beer and Eisenstat, 1996; Rumlet, 1995).
- Incommensurable belief, or strong and definitive disagreement among group members (Klein and Sorra, 1996; Rumlet, 1995; Zeffane, 1996).
- Deep rooted values and emotional loyalty (Kruger, 1996; Nemeth, 1997; Strebel, 1994).

v **Other sources of resistance:** other sources of resistance include

- Leadership inaction, sometime due to fear of uncertainty or changing the status quo (Beer and Eisenstat, 1996; Rumlet, 1995; Kruger, 1996; Maurer, 1996).
- Embedded routines (Hannan and Freeman, 1984; Rumlet, 1995; Starbuck et al., 1978).
- Collective action problems (Rumlet, 1995).
- Lack of necessary capabilities to implement change (Rumlet, 1995).
- Cynicism (Maurer, 1996; Reichers, Wanous, & Austin, 1997).

**Table 2**  
Summary of the causes of resistance.

Change of status quo	Ginzberg and Reilly (1957)
Uncertainty	Hirschhiem and Newman (1988), Jiang et al. (2000), Krovi (1993), Sanders (1974)
Lack of involvement in the change	Eveland (1977), Hirschhiem and Newman (1988)
Redistribution of resources	Hirschhiem and Newman (1988)
Organisational mismatch	Hirschhiem and Newman (1988), Markus and Robey (1983)
Lack of top management support	Krovi (1993), Hirschhiem and Newman (1988), Martinko et al. (1996), Sohal (1998), Rumlet (1995)
Reliability issues	Hirschhiem and Newman (1988), Venkatesh and Bala (2008)
Lack of interaction between system developers and user	Chreim (2006)
Lack of training for the new system	Lucas (1973)
Lack of education about the system being introduced	Heany (1972)
Cognitive style	Huber (1983), Mason and Mitroff (1973), Zmud (1979)
Changes in job contents	DeSanctis and Courtney (1983)
Rigidity, perpetuation of ideas	Barr, Stimpert, and Huff (1992), Kruger (1996), Maraks and Hornick (1996), Rumlet (1995), Zeffane (1996)
Net inequity	Joshi (1991, 2005), Keen (1981), Markus (1983)
Role conflict and role ambiguity	Joshi (1989)
Lack of communication	Lewis (2006), Nah, Tan, and Teh (2004), Oreg (2006), Wanberg and Banas (2000)
Subjective norms	Schepers and Wetzels (2007), Thompson, Higgins, and Howell (1991), Venkatesh, Morris, and Davis (2003)
Switching costs, transition and loss costs, sunk cost	Kim and Kankanhalli (2009), Kim (2011), Rumlet (1995)
Myopia	Barr et al. (1992), Kruger (1996), Rumlet (1995)
Denial	Barr et al. (1992), Rumlet (1995)
Variation in interest level	Waddell and Sohal (1998)
Fast and complex change environment	Ansoff (1990), Rumlet (1995)
Reactive mind set resignation	Rumlet (1995)
Negative relationship between teams	Klein and Sorra (1996), Rumlet (1995)
Departmental politics	Beer and Eisenstat (1996), Rumlet (1995)
Incommensurable belief	Klein and Sorra (1996), Rumlet (1995); Zeffane (1996)
Deep rooted values and emotional loyalty	Kruger (1996), Nemeth (1997), Strelbel (1994)
Lack of leadership	Beer and Eisenstat (1996), Kruger (1996), Maurer (1996), Rumlet (1995)
Embedded routines	Rumlet (1995)
Lack of necessary capabilities	Rumlet (1995)
Cynicism	Maurer (1996), Reichers et al. (1997)

In addition, among the measures to evaluate expected resistance, [Joshi \(1991\)](#) proposes an equity implementation model (EIM). It suggests that users evaluate change relating to new IT implementation is based on net equity. The net equity is estimated as the differences between changes in outcomes, i.e. increase or decrease in outcome, and changes in input, i.e. increase or decrease in input. If the net equity is perceived, users will be resistant to changes. Similarly, [Kim and Kankanhalli \(2009\)](#) propose a cost-benefit analysis of change where switching costs play a central role in increasing user resistance. Switching costs also mediates the relationship between several factors, such as user's opinion, user resistance and so on. [Kim \(2011\)](#) adds that uncertainty and sunk costs directly increase user resistance, while transition and loss costs indirectly increase user resistance by reducing the perceived value of switching ([Table 2](#)).

## 6. Examining user resistance

[Nodeson, Beleya, Raman, and Ramendran \(2012\)](#) conclude that the effectiveness of an organisation requires a strong sense of direction, building and transforming capabilities while minimising user resistance. Research suggests that among the factors associated with IT project failures, user resistance is one of the most significant causes ([Jiang et al., 2000](#); [Meissonier and Houze, 2010](#)). In the following sections, a review on user resistance is presented, based on the [Markus \(1983\)](#) classification as derived from the work of [Kling \(1980\)](#). The classification is based on the premise that better understanding of user resistance will lead to better implementation strategies and better outcomes for the organisations in which IT systems are installed.

### 6.1. System oriented

The system oriented approach suggests that resistance occurs because of technology-related factors such as user interface, per-

formance security, ease of use, and degree of centralisation which may not be as user friendly or easy to interact with as intended ([Markus, 1983](#)). Likewise, if the system reacts too slowly, crashes frequently, is unavailable at critical times, has data quality issues, or the quality of output information is not valid, it can generate negative user attitude towards new technology, which in turn can lower usability ([Dickson and Wetherbe, 1985](#); [Markus, 1983](#); [Martinko, Henry, & Zmud, 1996](#)). Similarly, after implementation, if the system is not reliable, or technical quality is unsatisfactory, users are unlikely to welcome the new system and will avoid it ([Hirschhiem and Newman, 1988](#)).

[Markus \(1983\)](#) argues that people resist new IT systems because of their own internal factors, poor system design and interaction of specific system design features with respect to the organisational context of system use. [Markus \(1983\)](#) terms this political variant of interaction theory (PVIT) and explains it as group resistance in terms of the interaction between IT and the context of its use. The model's primary assumption is that an IT system embodies the distribution of power among the actors that it affects. The degree to which intended users feel the ease of using new system frequently determines the level of resistance ([Dickson and Wetherbe, 1985](#)). If users see the new system as being unfriendly and difficult to use, they will tend to avoid it. However, if the system improves the user's task performance or decision quality, then they are more likely to use the IT, otherwise, they may refrain from adopting to new technology ([Lapointe and Rivard, 2005](#)).

[Ives and Olson \(1984\)](#) suggest that during system development, if users are not involved, then there can be a disparity between the aims of system developers or implementers and users. It is due to these reasons that system developers are mostly concerned with the technical aspects of IT systems, whilst users are mostly interested in the new technology to the extent of its impact on their jobs ([Table 3](#)).

Further analysing users acceptance or rejection of new systems, [Tzeng \(2011\)](#) proposes that users perception of a system's value rest



on their practical experience with the system. These experience-based perceptions provide clear clues for users to decide whether to use the system or not (Carney, 2002; Venkatesh and Davis, 1996, 2000).

## 6.2. People oriented

The people oriented approach suggests that user resistance occurs because of individual or group factors such as background, traits, attitudes and experience towards technology (Markus, 1983). Individual's level of interaction with new IT system is based on internal and external influences, which in turn directly impact the level of IT usage (Martinko, Henry, & Zmud, 1996). In addition, it leads to outcome and efficacy expectancies, while the negative expectancies among them lead to user resistance. Positive expectancies and user evaluation of systems encourage user acceptance (Bukhari, 2005; Norzaidi, Chong, Salvani, & Rafidah, 2008).

Users frequently become accustomed to the system they are using for years, and do not understand the business needs of new advanced systems and therefore resist them. Sometimes, resistance is higher at group than at individual level suggesting that groups are more likely to resist any changes introduced by IT systems (Lapointe and Rivard, 2005). Markus (1983) find that group level resistance is often socio-political, whilst at the individual level it is psychological, and therefore, each scenario requires a unique strategy to minimise resistance.

People oriented factors are also related to the required skills a user must achieved to qualify for the job and the changes introduced by new technology (Markus, Axline, Petrie, & Tanis, 2000; Besson and Rowe, 2001; Jiang et al., 2000; Krovi, 1983). Jiang et al. (2000) note that changes in job content have been shown to underpin resistance in adopting new technology. This may be overcome by incorporating training to minimise resistance. Henry (1994) proposes that special attention should be given to users to reduce their anxiety through special training programs which will give users a sense of participation and feeling of "vested interest" leading to reduction of anxiety and negative attitudes towards new IT systems (Table 4).

Selander and Henfridsson (2012) defined cynicism as cognitively distanced resistance that constitute negatively towards IT implementation, and manifest a perception of seeing through the espoused goal of the implementer. Similarly, Stanley, Meyer, and Topolnytsky (2005); Gabriel (1999) identify relations between organisational change, cynicism and resistance.

Waddell and Sohal (1988) identified resistance as a function of a variety of social factors, including:

- **Rational factors:** resistance can occur where an employee's own rational assessment of the outcomes of a propose change differ with the outcomes envisaged by management. Such differences of opinion cast doubt in the employees' mind as to the merit or worth of the changes, and thus they may choose to stand in opposition or voice concern (Ansoff, 1988, p. 211; Grusky and Miller, 1970, p. 63; Kotter, Schlesinger, & Sathe, 1986, p. 352).
- **Non-rational factors:** the reaction of an individual worker to a proposed change is also a function of predispositions and preferences which are not necessarily based on an economic-rational assessment of the change. These may include for instances workers who simply do not wish to move offices, prefer working near a particular friend, or are uncertain of the outcomes of implementing new technology (Judson, 1966, p. 19; Kaufman, 1971, p. 15; McNurry, 1973, p. 381; Sayles and Straus, 1960, p. 305).
- **Political factors:** such as favoritism or "point scoring" against those initiating the change effort (Ansoff, 1988, p. 212; Blau, 1970, p.135; Grusky and Miller, 1970).

- **Management factors:** inappropriate or poor management styles also contribute to resistance (Judson, 1966; Lawrence, 1954).

Eveland (1977, p. 4) note that user 'resistance to change is not so much resistance to changing itself; as it is to being changed by others.' This could be avoided by further establishing a line of communication during the implementation process. Pieterse, Caniels, and Homan (2012) find that a successful implementation requires a good line of communication, which should be clear, explicit in definitions, assumptions, beliefs and expectations from the group of professionals involved in the project. They also stress upon the need for paying attention to the language used during process change which should be easy for user to understand.

The literatures suggest that user's response to new technology could be directly correlated with following personality factors:

**User age:** is generally observed that younger users tend to be more flexible and accommodating with changes in comparison with users from other age group (Fuerst and Cheney, 1982; Lucas, 1973).

**Educational level:** in comparison with less educated users, higher educated users are more willing to accept and utilise new IT systems (Fuerst and Cheney, 1982).

**Perceived need:** there is likelihood of increased acceptance if users perceive a need for a new IT system (Dickson and Wetherbe, 1985).

**Degree of expected use of IT:** if users feel that IT systems will contribute to their performance and improve work productivity, they are more likely to adopt the new IT system (Zmud, 1979).

Ginzberg and Reilley (1957, p. 9) conclude that resistance to change is frequently derived from user reluctance to change the *status quo*, as they 'prefer to stay with the work they know, rather than take on new assignment.' Samuelson and Zeckhauser (1988) propose a status quo biased theory, which explains people's preference for maintaining their current status or situation. This includes users who seek routines, have negative reactions to announcement of change with a short-term focus and possess a rigid or dogmatic point of view.

## 6.3. Interaction oriented

Markus (1983) suggest that interaction oriented approach is related to people resisting a new system because of interaction between characteristics related to the people and the characteristics related to the system. It is not the same as a simultaneous belief in system and people oriented theories. Central to this perspective is the notion that a system acquires different political and social meaning in different settings and that different users perceive the effect differently (Jiang et al., 2000). The interaction-oriented approach suggests that perceived social losses caused by interaction among people and technology, such as changing power relationship, social structure, and job structure affects resistance (Markus, 1983). Such changes accompanied by new IT implementation bring changes in resources distribution across the organisation. These changes can include departmental budgets, equipment, staff and territory, individual authority, status, role and salary (Hirschhiem and Newman, 1988).

Davenport (1998) suggests that new IT systems can give more power to key users by allowing them to access real time data. However, IT systems can reduce the autonomy of employees, which in some cases lead to increase user resistance (DeSanctis and Courtney, 1983; Dickson and Wetherbe, 1985; Husain and Husain, 1984; Joshi, 1991; Jiang et al., 2000; Krovi, 1993; Lapointe and Rivard, 2005, 2007; Markus, 1983). This may also lead to the feeling of loss of power, which is when users believe that IT involves a power shift which will undermine their power and/or position,

**Table 3**  
Summary of user resistance examined in three areas mentioned below.

System oriented	People oriented	Interaction oriented
User interface, ease of use (Markus, 1983)	Background, traits, attitudes and experiences (Markus, 1983)	Perceived social loss caused by interaction between people and technology (Markus, 1983)
System reliability and data quality issues (Dickson and Wetherbe, 1985; Hirschhiem and Newman, 1988; Markus, 1983; Martinko, 1996)	Impact of internal and external influences (Martinko et al., 1996)	Increased access to the data but lesser autonomy (DeSanctis and Courtney, 1983; Dickson and Wetherbe, 1985; Husain and Husain, 1984; Jiang et al., 2000; Joshi, 1991; Krovi, 1993; Lapointe and Rivard, 2005, 2007)
Ease of using a new system (Dickson and Wetherbe, 1985)	Positive expectancies (Bukhari, 2005; Norzaiddi et al., 2008)	Psychological contract and new technology (Klaus and Blanton, 2010)
Improved task performance and decision quality (Lapointe and Rivard, 2005)	Individual vs group level resistance (Lapointe and Rivard, 2005)	Lack of organisational fit (Meissonier et al., 2013)
Users involvement (Ives and Olson, 1984)	IT Skills (Besson and Rowe, 2001; Jiang et al., 2000; Krovi, 1983; Markus et al., 2000)	Social influence (Eckhardt et al., 2009)
Experienced based perceptions (Carney, 2002; Venkatesh and Davis, 1996, 2000; Tzeng, 2011)	Changes in job content (Jiang et al., 2000)	Uncertainty (Jiang et al., 2000; Waddell and Sohal, 1988)
	Special training programs to reduce anxiety and negative attitude (Henry, 1994)	
	Cynicism (Selander and Henfridsson, 2012)	
	Personality factors (such as age, education, needs, communication, training) (Dickson and Wetherbe, 1985; Fuerst and Cheney, 1982; Lucas, 1973; Sander and Courtent, 1985).	

thus resulting in resistance behaviour (Lapointe and Rivard, 2005; Kim and Kankanhalli, 2009).

Psychological contract between employees and an organisation usually influence user behaviour towards new technology. Klaus and Blanton (2010) propose twelve determinants that can affect the psychological contract and the level of user resistance. Deriving four categories from these determinants, namely individual, system, organisational and process issues, they devise a framework to analyse and develop strategies to minimise resistance and suitable relationship between the psychological contract and employees.

Meissonier, Houze, and Bessiere (2013) analyse user resistance from the perspective of cross-cultural frictions. Studying the ERP implementation process, they observe that lack of organisational fit, and consequently resistance resulting from cultural misfit, often leads to a failure. They find that value conflict usually arise from inconsistency between the cultural principles of users, and perceived underlying objectives assigned to ERP implementation. In addition, perceived value and organisational support for change reduce user resistance. Other commonly observed issues include systems not 'fitting with individuals and groups work patterns, or with the structure of the organisation' (Hirschhiem and Newman, 1988; Markus and Robey, 1983).

Eckhardt, Laumer, and Weitzel (2009) study the role of social influence on different workplace groups, and their intention to adopt new technology. They conclude that there is a significant impact on social influence from workplace experiences on IT adoption, such as social influence in the same department will be different for adopters and non adopters.

It is observed that people are generally averse to uncertainty in their decision making and behaviour because of feelings of incompetence in uncertain situations, which in turn causes negative psychological reactions. It bias users toward the status quo (Brown and Venkatesh, 2005; Kim and Kankanhalli, 2009; Samuelson and Zeckhauser, 1988). Similarly, Jiang et al. (2000) conclude that although reasons of user resistance usually differ from system to system, uncertainty and changes in job content are common causes of user resistance. Waddell and Sohal (1988) conclude that people do not resist change per-se, rather they resist the uncertainties and potential outcomes that change can cause. Indeed, Lin (1994) finds that users in Taiwan have more tolerance towards uncertainty and human relationship is a primary catalyst during IT implementation.

## 7. Overcoming resistance from the users

The issue of overcoming the resistance from the users has been a subject of several studies (Kim and Kankanhalli, 2009; Somers and Nelson, 2001; Umble and Umble, 2003). By using empirical studies, case studies and surveys, the authors have identified different strategies to over user resistance. Applying the change management model, the strategies can be identified into four approaches: directive, participative, supportive and coercive (Shang, 2012). Directive approach refers to the use managerial authority to implement changes. Proper training (Sander and Courtent, 1985), rewarding ideas for business improvement, documentation of new processes are essence of directive approach (Umble and Umble, 2003; Somers and Nelson, 2001).

Participative approach refers to involving people in change management process. This can performed by vision sharing (Dong et al., 2009), empowering users (Kotter and Schlesinger, 1979), involving users in system development process (Mumford and Weir, 1979), communication and feedback channel (Chang, Walters, & Wills, 2013; Magal and Strouble, 1991), participation (Chang, 2013) and information sharing about new system Chang et al. (2013) study the development of frameworks in the area of cloud computing, implementation and services. Using case studies to present the validity of the model, they suggest that through positive feedback and involvement from the user community and evidences of presenting deliverables could lead to overcoming the user resistance.

Waddell and Sohal (1998) suggest that participative techniques are the best method of handling resistance. Through carefully managed process of two way communication, information sharing and consultation, employees tend to become more committed to the change effort rather than a compliant to it. Similarly, Jiang et al. (2002) find participative strategies playing critical role in system acceptance supported with user training, orientation session and retraining employee have been observed to reduce the resistance.

Next, supportive approach concerns with moral aspect of the employee during the change process. Kim and Kankanhalli (2009) find that perceived value and organisational support for change can reduce user resistance. Other support such as employees participation and empowerment (Sagie and Koslowsky, 2000), orientation sessions (Dong et al., 2009) and staff appreciation (Lim et al., 2005) can useful in minimising the resistance.



**Table 4**  
Strategies to minimise resistance in the literature.

Training	Aggarwal (1998), Chang (2013,2014,2015)
Establishing user support services	Rousseu (1998)
Hands-on	Chang (2014), Chang and Wills (2013), Zuboff (1988)
Appreciating new system usage	Klein, Hall, and Laliberte (1990)
Encouraging communication	Jager (1994)
Involving user in design process	Baroudi, Olson, and Ives (1986) and Mumford (1979, 1981, 1993)
Documenting standard for new system	Nord and Tucker (1987)
Positive feedback and involvement	Change et al. (2013)
Counseling	Holmes and Holmes (1970)
User right directives	Karat (1998)
Role modification	Klein et al. (1990)
Interactive learning	Chang (2015)
Ease of use and usefulness	Davis (1989)
Job reassignment	Klien and Hall (1990)
Providing financial incentives	Lawler and Mohrman (1991)
Participation	Chang (2013)

Davis (1989) finds that ease of use and usefulness of the system impact the level of resistance offered by the users. This is supported by Chang (2014), who by using business intelligence as a service in the cloud enabled ordinary users power to compute, visualize and analyse the risk and the prices of the stock. This empowerment enables them to make their investment decision without any IT resistance.

In contrast, coercive approach claims that forcing or imposing the change on employees is the most effective way managing resistance. It may include firing or transferring people or threatening of job promotion possibilities (Kotter and Schlesinger, 1979).

Chang and Wills (2013) study the implementation of cloud computing as education as a service model in a UK university. By adopting strategies, such as, learning by doing it, they observe 15% increases in user satisfaction with minimal resistance. They argue that in order to minimise the resistance, experienced IT personal should show user how to do it, train them with right skills which ensuring that they understand the process. This is often also called action research. E-learning could play essential role by providing staff training and executive education which in turn enhance the user acceptance. Chang (2015) find significant role played by e-learning in several organisation such as Royal Bank of Scotland, Cisco and Cap Gemini Earnst and Young. He identifies interactive learning as another essential tool to minimise user resistance. Interactive learning is the combination of both e-learning and face-to-face learning. It has played critical role in increasing motivation, learning interest and efficiency.

## 8. Conclusion

Understanding user resistance is critical to ensure successful implementation, and therefore, to reap the benefits of new technology. This study shows that user resistance is a primary concerns in any new IT implementation. The literature often suggests that user resistance is a reaction to changes and uncertainty. However, as also observed in the literature, it is a far more complex phenomenon involving various players and factors demanding a comprehensive understanding of the issue. The result of this review suggests that there is not a tactic or 'silver bullet' which can avoid user resistance, rather it is a product of a variety of factors inside the organisation which contributes towards user resistance. These are uncertainty, loss of power, lack of involvement in the change process, and reluctance to change. Several strategies are proposed to overcome user resistance. These are, training, increasing user involvement, incorporating their feedback in decision making, communication and job reassignment.

The contribution of this paper is twofold: from practical point of view, the systemic review of IT user resistance enhances managers' awareness of the issues relating to user resistance and viable strate-

gies to overcome these barriers. This would help the managers making right decision in the process of IT development and implementation to ensure the success of IT projects; from academic point of view, apart from a better understanding of existing research in the subject, this review also provides a future research direction for researchers to follow. In turn, this would further enrich research in the area of IT user experience and behaviour.

User resistance offers several potential areas for future research. It is due to its pervasive nature that user resistance is focused of research originating from diverse areas such as human resources, organisational culture, to organisational behaviour. This suggests that user resistance related research should be interdisciplinary. In our opinion, research in the area of user resistance will continue to grow for the foreseeable future, since there is a continuing need for greater and better understanding of the phenomenon due to evolving nature of IT. After rigorous review of the literature, we propose the following areas for further research to enhance the understanding of user resistance:

- i. further research on formulating the theories of user behaviour and resistance in the context of new technologies such as cloud computing, enterprise system, etc.
- ii. A comprehensive study to identify the factors contributing towards resistance particularly in context of current IT trends and users capabilities.
- iii. A study on the user expectations and fears from introduction of new IT system to minimise user resistance.

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## Promoting a culture of innovation & entrepreneurship in Saudi Arabia: Role of the Universities

NADIA YUSUF

Faculty of Economics and Administration  
King Abdulaziz University, Jeddah, K.S.A

HUDA M. ATASSI

University of Business and Technology, Jeddah

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*Saudi's mission to diversify its economy depends heavily on innovation and entrepreneurship. The discussion evaluated the role of universities in building a culture of innovation and entrepreneurship in Saudi Arabia, employing a literature review and gap analysis method to design an approach for universities to play the aforementioned role. The literature review reveals that the role played by universities entails providing entrepreneurship education, providing support resources, and partnerships with non-academic institutions, while the gap analysis undertaken reveals that Saudi Arabia has made significant strides towards equipping its universities to contribute to innovation and entrepreneurship, but lags behind the top ten leaders.*

*The proposed initiative model entails seeking strategic alignment between university contributions and local and national economic goals, collaborating with international institutions to replicate best practices in Saudi Arabia, and establishing formal frameworks for partnerships with relevant stakeholders in innovation and entrepreneurship. Upon evaluation, the main arguments for the model rest on its focus on strategic alignment and partnerships, while counterarguments involve bureaucratic restrictions on innovation and entrepreneurial spirit owing to formal frameworks with the government, as well possibilities of exportation of ideas and benefits away from Saudi Arabia through international partnerships. To address the aforementioned concerns, the stakeholders will need to address bureaucracy, allow inclusive participation, and strengthen implementation of intellectual property rights.*

### Introduction

Saudi Arabia has recently sought to diversify its economy in a bid to transform it from being heavily natural resource based, with a focus on improving human capital and creating a knowledge-based economy being a mainstay for Saudi economic planners and leaders. Salem (2014A) argues that innovation and entrepreneurship are pertinent factors behind Saudi Arabia's ambitions in economic diversification, besides noting that the country has established over 65 tertiary education institutions since the mid twentieth century. The rationale for such expansion in higher education lies in the need to develop human capital and stimulate innovation and entrepreneurship. Today, the goal is to transform Saudi Arabia into a global innovation and entrepreneurship leader in preparation for the eventual depletion of oil

resources. However, the country still lags behind current global innovation and entrepreneurship leaders despite opening many tertiary education institutions (Mehta, Vaidya, Chaudhary, Ramamrajan, & Ranjan, 2014). In light of this observation, research into how universities can contribute to innovation and entrepreneurship in Saudi Arabia is necessary. The present investigation seeks to establish the role that Saudi universities should play in promoting a culture of innovation and entrepreneurship in the country, exploring the curricular developments and partnership models necessary. The undertaking entails a literature review leading into a methodology for the role of universities in promoting an innovative and entrepreneurial culture, which then allows designing of an initiative model for education alongside accompanying arguments and counter-arguments that help generate crucial recommendations.

### **Literature Review**

A number of scholars have examined the role that universities have played, can play, and should play in promoting innovation and entrepreneurship in societies and economies. The analysis of literature entails thematic categorization into the role of universities in undertaking entrepreneurship education, providing support infrastructure and resources, and establishing partnership models with non-academic institutions.

### **Entrepreneurship Education**

One of the crucial ways in which universities can contribute to a culture of innovation and entrepreneurship is through undertaking entrepreneurship education, with the knowledge spillovers into society then helping stimulate entrepreneurial spirit and innovation beyond the educational setting. A study by the Organization for Economic Co-operation and Development (2009) explores entrepreneurship education in institutions of higher learning, employing a case study approach to evaluate the contribution of universities in the field of entrepreneurship. According to the study, several universities have established centers for entrepreneurship and technology transfer centers that seek to stimulate entrepreneurship and innovation within and beyond the universities. In such centers, the purpose of entrepreneurship education entails training students and other interested parties in entrepreneurial skills, such as creativity, problem-solving abilities, conflict management, communication, and negotiation, employing lectures and business simulation games in such education. The entrepreneurship courses and workshops exist as course modules in such universities. Entrepreneurship education is a core part of curricula in some courses, such as business administration and other business-inclined courses. However, the approach taken by some universities in offering entrepreneurship education outside business courses demonstrates how they help nurture entrepreneurship and innovation in the wider population. In this case, some universities offer all modules as elective units open to all students, as exemplified by the approach in the University of Applied Sciences Jena.

In another study, Vicens and Grullón (2011) explore how some universities have approached education in entrepreneurship and innovation, citing some institutional approaches as models that can be replicated elsewhere in the world. For instance, Stanford University employs a Design Thinking approach to train students in entrepreneurship. Design Thinking



approaches entrepreneurship education from the perspective of principles that can be tutored to and utilized by people from diverse academic levels and backgrounds. Irrespective of academic level and background, Design Thinking centers on employing the individual's sensibility and methods to match people's needs and wants with products that are technologically feasible, and for which a viable business strategy can convert into customer value and accompanying market opportunity. Ultimately, this approach links innovation with viable entrepreneurship, besides applying to individuals from diverse backgrounds in a way that promotes entrepreneurial and innovation culture. Meanwhile, entrepreneurship education at Babson College emphasizes holistic and integrative learning in a way that makes entrepreneurship a lifestyle, demonstrating contribution to entrepreneurial culture.

A study by Efi (2014) explores the various ways through which universities and other tertiary institutions of education promote entrepreneurship in society. In the study, the scholar observes that entrepreneurship education in universities can enable a society develop and produce more entrepreneurially inclined individuals. Universities play a crucial role in providing the much needed entrepreneurial knowledge and skills necessary for enterprise growth, as well as equipping individuals with adequate knowledge, skills, and capabilities in proper business management. However, the role played by the universities in promoting the culture of education not only concerns the education aspect, but also changing the mindset of individuals regarding the place of entrepreneurship in society. Here, universities also help change the attitudes of individuals in ways that create positive perceptions toward self-reliance and self-employment. In addition, universities help create awareness of entrepreneurship as a career option for individuals, helping promote entrepreneurial spirit in society.

### **Providing Support Infrastructure and Resources**

Universities can help promote a culture of innovation and entrepreneurship in an economy through providing supportive infrastructure and resources. The Organization for Economic Co-operation and Development (2009) notes that universities can offer important resources that support innovation and entrepreneurship, beyond education and research in the two fields. The Organization provides examples of the infrastructural and resource support that universities can offer, including providing support to startups establishing business incubators. In addition, universities can establish support programs and create access to networks for future, emerging, and existing entrepreneurs. Establishing entrepreneurship research centers also provides another way through which universities can employ their resources in helping build a culture of innovation and entrepreneurship. Support may also be through providing a network and contacts to business support providers and financiers.

Wells' (2014) study also observes that universities play crucial roles in supporting innovation and entrepreneurial spirit through establishing business parks or incubators in which individuals within and outside the university can access a collaborative and conducive environment for business creation and technological development. In such business and technology incubators, individuals can access resources that may be unavailable to them outside large corporate organizations with massive research budgets. In addition, universities can aid promising individuals and startups with seed money to pursue their projects. Through

expanding the number of people accessing innovation and entrepreneurship development opportunities, universities help widen the culture of innovation and entrepreneurship beyond traditional boundaries.

### **Partnership Models with Non-Academic Institutions**

Noting that research in entrepreneurship may not necessarily translate to supporting entrepreneurship in society, Wells (2012) proposes more emphasis on contract research approaches that have a direct link to entrepreneurs and innovators in society. Here, the scholar observes that many universities have research labs capable of undertaking research for the direct benefit of startup businesses. At the same time, many universities have departments and centers devoted to excellence in industrial design and prototype development, underscoring their high potential for innovation. Meanwhile, startups may be missing key or final pieces to complete innovation puzzles, or may be limited in capabilities in areas such as prototype development and industrial design. As a result, universities can establish direct partnership arrangements with such startups, enabling collaborative processes that allow startups to benefit from the opportunities, resources, and human capital present in universities. Such actions would help accentuate entrepreneurial and innovative capabilities in society.

Tornatzky and Rideout (2014) indicate that universities can promote innovation and entrepreneurship in society through undertaking boundary-spanning entrepreneurial activities and technology transfer through establishing community and industry partnerships. The aspect of moving beyond university boundaries entails instituting policies and practices that move research and action beyond traditional disciplinary structures, crossing the boundaries that exist between universities and the private sector world. Meanwhile, boundary-spanning technology transfer involves universities participating in the translation of innovative research into commercially viable intellectual property through collaborating with startups and pursuing industry partnerships. According to the Organization for Economic Co-operation and Development (2009), universities establish partnerships to external startup and nascent companies, cooperating with national commerce ministries and agencies to help nurture innovation and entrepreneurship.

### **Methodology**

The proposed methodology for exploring the role that Saudi universities can play in promoting a culture of innovation and entrepreneurship in the country entails using the findings from the literature review and undertaking an audit of the current role played by Saudi universities in nurturing societal innovation and entrepreneurship. The next step entails exploring the current state of innovation and entrepreneurship in Saudi Arabia and the country's goals, alongside the strengths and areas in need of improvement in innovation and entrepreneurship in Saudi Arabia. The aforementioned activities help identify gaps and opportunities in present efforts, which then enables the discussion of a model for the role of universities in promoting a culture of innovation and entrepreneurship in Saudi Arabia.

### **Current State and Emerging Trends in Saudi Arabia: Innovation and Entrepreneurship, Role of Universities**

The National U.S.-Arab Chamber of Commerce (2010) explores developments and promise in entrepreneurship in Saudi Arabia, noting the realization of the importance of an entrepreneurial culture in the growth of the economy. Entrepreneurship promises to be crucial to the Saudi economy, as small and medium-sized enterprises (SMEs) already constituted 92% of businesses in the country and employed over 80% of the workforce. Supporting their growth through furthering innovation and entrepreneurship will only translate to a more vibrant economy, which is a pertinent factor for success in Saudi Arabia's ambition to diversify its economy. National U.S.-Arab Chamber of Commerce (NUSACC) observes that Saudi Arabia aims to become one of the top ten most competitive nations in today's, an ambition that necessitates developing a vibrant knowledge-based economy. NUSACC indicates that the Saudi administration and policymakers are aware of the need for a new generation of creative individuals and forward-looking entrepreneurs in attempts to become a top economy that does not rely on natural resources. As a result, the country has established universities aimed at promoting innovation and entrepreneurship, chief among them the King Abdullah University of Science and Technology. This university is a graduate-level state-of-the-art research university that bears an Innovative Industrial Collaboration Program (KICP). The KICP seeks to foster partnerships among local, regional, and global organizations interested in nurturing entrepreneurship. In addition, the university aims at strengthening the link between academic research and economic growth, underscoring Saudi Arabia's awareness of the need to harness tertiary education in boosting innovation and entrepreneurship. Salem (2014B) agrees, observing that Saudi universities are creating a network of research centers, besides producing, spreading, transferring, and utilizing knowledge, and collaborating with local and international businesses.

However, some observers indicate that Saudi Arabia needs to do more to reach its ambitions in diversifying the economy through entrepreneurship and innovation. Rahatullah (2013) undertook a study to map the entrepreneurship ecosystem in Saudi Arabia, appreciating the efforts undertaken by the government, learning institutions, and the private sector in stimulating entrepreneurship. However, he also established that the country still has significant room for improvement in entrepreneurship and innovation. The scholar concludes that Saudi Arabia needs to start new study programs aimed at supporting entrepreneurship throughout the kingdom, develop and strengthen more enable entrepreneurship institutions, and develop heightened awareness of entrepreneurial activities and entrepreneurship in the Kingdom. Such recommendations point to a need for more involvement in innovation and entrepreneurship promotion by universities.

Mehta, Vaidya, Chaudhary, Ramamrajan and Ranjan (2014) also observe that Saudi Arabia is pursuing a heightened role of innovation and entrepreneurship in the economy, but note that the country is at crossroads today. The scholars indicate that most of the countries occupying the top ten competitive innovator positions have achieved strengths in human capital, research, strong institutional frameworks, and high quality output, depicting well-developed entrepreneurship and innovation ecosystems. The scholars provide a comparison of Saudi Arabia's innovation ecosystem with that of other regions from which the top performers in innovation exist (Figure 1). Although Saudi Arabia's highest score (40/100) is in institutions, this aspect is also where the country lags the top performers farthest (over 90/100), with Mehta,



Vaidya, Chaudhary, Ramamrajan and Ranjan (2014) calling for improvements in the institutional framework for innovation. Such findings indicate gaps in the role played by universities in contributing to a culture of innovation and entrepreneurship in Saudi Arabia.

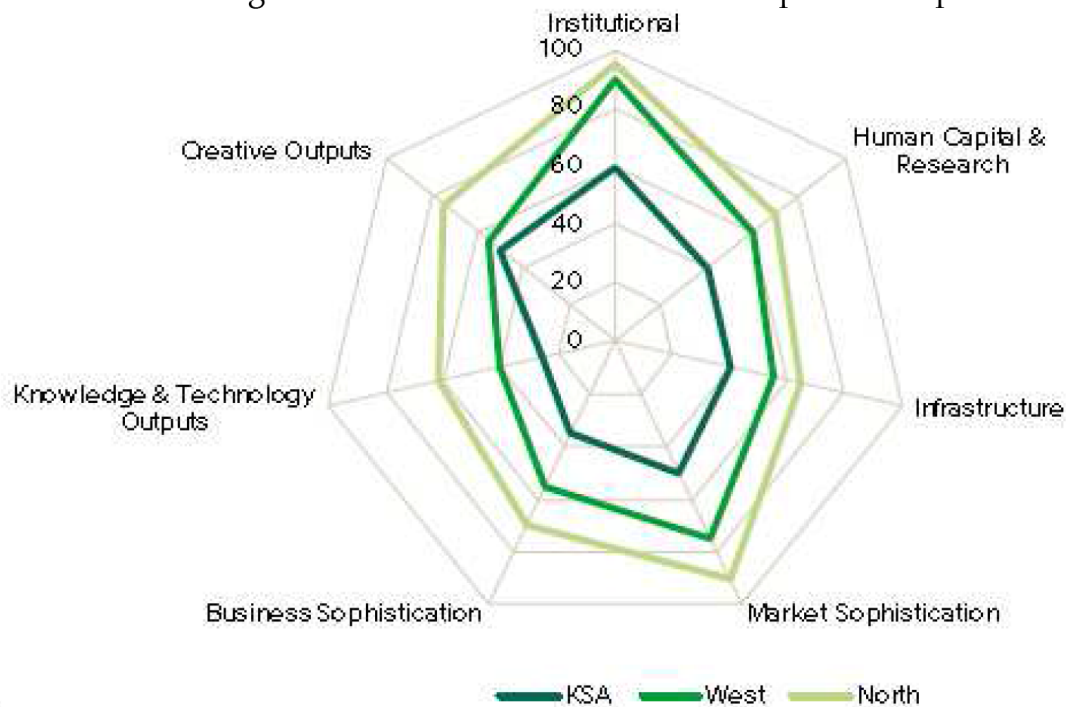


Figure 1: Saudi Arabia's innovation ecosystem, demonstrating room for improvement before the country can catch up with the top performers (Mehta, Vaidya, Chaudhary, Ramamrajan & Ranjan, 2014).

### Initiative Model

The discussion indicates that Saudi has already established many universities with the potential to stimulate innovation and entrepreneurship in the country. However, there are gaps in the role played by such universities in promoting an innovative and entrepreneurial culture. The proposed model entails three parts, namely, strategic alignment, collaborating with international universities to establish and meet best practice standards, and formal frameworks for external partnership and networking.

#### Part 1: Strategic Alignment

This aspect concerns the need to align university innovation and entrepreneurship initiatives with the economy's mission and objectives. In this case, one of the reasons behind the observed gap between establishing universities and gaining from them in sparking entrepreneurship and innovation may arise from the lack of strategic objectives. As a result, a core part of the model should entail linking university innovation and entrepreneurship activities with local and national economy goals, all aimed at transforming Saudi Arabia into a top ten innovator. Such strategic alignment should also involve linking the role of universities with other aspects of the national strategy towards diversifying the economy.

#### Part 2: International Collaborations to Replicate Best Practices

The initiative model also entails establishing collaborations with international tertiary institutions that provide state-of-the-art examples and proven practices through which universities have been able to stimulate and support entrepreneurship and innovation in communities. For example, Stanford University and Babson College among other higher education institutions drawn from the developed and developing world can offer ideas that Saudi universities then localize to the country to great effect.

### **Part 3: Formal Frameworks for External Partnership and Networking**

The last part of the proposed model entails the establishment of formal frameworks that ease and encourage partnership and networking with external non-academic entities. Formal frameworks will specify channels, provide linkages, and enable support of cooperation and collaboration between universities and external parties such as startups, established business, government agencies, and non-governmental organizations.

### **Arguments and Counterarguments**

The main argument for the initiative model revolves around how it addresses current gaps in how Saudi universities contribute to innovation and entrepreneurship. In this case, pursuing a strategic fit between university efforts and local and national economic ambitions gives direction and strategic goals towards which universities can work. In addition, pulling in the same general direction through the proposed strategic alignment will enable concerted efforts and gains rather than dispersed efforts that contribute less to the desired knowledge economy. Another argument for the model arises from how the proposed partnership with foreign institutions will enable leapfrogging towards current best practices in how universities can contribute to an economy's innovation and entrepreneurship ecosystem. Further, the strategic alignment and formal frameworks for external partnerships will enable the country to benefit from existing resources in Saudi universities, bridging the institutions with the national economy.

One of the major counterarguments to the initiative model arises from the view that establishing formal frameworks and policies for strategic alignment may restrict innovation and entrepreneurship through introducing government bureaucracy in the system. In addition, the measures may result in curtailing of freedom of thought, which is pertinent for the creative process behind innovation and entrepreneurship. At the same time, collaborating with foreign institutions may result in ideas and inventions being exported through partnerships with such international universities, benefitting other economies rather than Saudi Arabia.

### **Conclusion**

In a bid to create a knowledge-based economy, Saudi Arabia has invested in many universities recently. Scholars indicate that universities can help nurture a culture of innovation and entrepreneurship through entrepreneurship education, providing support infrastructure and resources, and establishing partnership models with non-academic institutions. An analysis of the state of Saudi Arabia notes gaps in innovation and entrepreneurship that translate to opportunities for universities to contribute in establishing the desired culture and ecosystem. The gap analysis undertaken helps generate an initiative model that prescribes strategic

alignment between university activities in innovation and entrepreneurship and local and national economic goals, collaborations with international universities to establish and meet best practice standards, and establishment of formal frameworks for external partnership and networking. The following suggestions will help address the counterarguments identified in the initiative model.

- The concerned stakeholders should establish modalities that ensure bureaucracy and other hindrances to creative processes do not accompany the strategic alignment sought between university activities and broader government economic ambitions.
- The stakeholders should strengthen intellectual property practices to protect against loss of ideas and products through the foreign partnerships formed through the initiative model.
- The implementation of the measures proposed to make universities more useful in promoting a culture of innovation and entrepreneurship should be participative and inclusive, enabling the stakeholders to own the process outside the formal structures established.

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## A historical analysis of the theories of money

Farah Durani

Mewar University, Chittorgarh Rajasthan, India

Faculty of Finance, University of Business Administration, Jeddah, Saudi Arabia

Ishtiaq Qureshi

The Business School: University of Kashmir, India

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### Keywords

Money, Monetary Theories, Classical, Neo Classical, quantity theory

### Abstract

*Money, the most complex idea to understand is labelled a subject of disagreement and a thorough confusion among economists. "Money" has been fortunate enough a topic to receive ample attention from the philosophers. Economic literature is replete with theories concerning the understanding and behavior of money from different historic eras. The present day knowledge of money is very limited when it comes to understanding what actually it can be. Most of the common strata of people believe that the money is something that is determined by the governments. People generally hold the view that citizens have a legitimate duty incumbent upon them to honor the payment systems stipulated by the authorities. This Research Paper aims at bringing together most of the prominent contributions of greatest philosophers of money and clearly demarcates various schools of monetary thought be it the Classical, Neo-Classical or the Heterodox. The aims of this chapter are to review the relevant theories concerning the understanding of money, to present the monetary dogmas of historical times in a proper chronological order, to establish a link between the predecessor and the successor, to elaborate on the most obscure confusions and their causes in an easy to understand parlance and to deviate from the mainstream to discuss the Heterodox yet appealing school of thought.*

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### Introduction

Most of the monetary theories are written in inexplicit language, which not only restricts this discipline to the so called Politico-Economists of the country, but also keeps it hidden from the masses. The inability to understand the complexity of theories has misleadingly led many to believe that money originally started as a government initiative rather than a market phenomenon. It was the "forces of market, its discipline and needs" that led to the invention of money and eventually the evolution got kicked in by the same forces. However this auto evolution came to a halt when governments actively started interfering with respect to what money actually should be. The role of authorities itself changed from "the regulator of the money approved by the markets" to "the creator and issuer of the money coerced upon the markets". Very rarely do we see a reckoning done in this direction by a common man. The literature that should serve as a guiding torch remains blurred with difficult jargon. It is ironic that most reputed text books on money do not touch upon the theories of money; readers are kept off the track by only mentioning "what money can do" rather than "what money is". This has to do with the confusions that interlaced the monetary economics and its theories in the past century. A misunderstanding of the ailment, therefore an incorrect diagnosis and prescription is made. It has never been an easy task for scholars to evaluate monetary theories objectively as the context remains obscure due to lack of clarity, however many attempts have been made to explain the work of monetary theorists, to criticize them and then finally to produce the critique to the criticism. This research paper attempts to list down and explain the monetary theories from Classical to Neo Classical Eras.

### Classical Monetary Theories

Classical Economics is understood as the first modern school of economic thought; its developers include Adam Smith, Jean Baptiste Say, David Ricardo, Thomas Malthus and John Stuart Mill. This thought of economics had evolved as knowledge against feudalism into the capitalism that got triggered by industrial revolution. One cannot discuss the Classical economics without delving into its core theory of value. The theory of value recognized that the prices of goods should be derived from the wages to labor that went into producing those products. While Smith called it a Labor theory of Value, Ricardo went even further with some modifications to call it Cost of Production Theory of Value. The monetary aspect discussed by the Classical economists remains no different from that of value theory of commodities. The money to most of the classical economists was a commodity (any good used as money, widely gold and silver) and its value was derived by the same methodology as the common goods traded on the market.

Before presenting Adam Smith's contribution which is considered to be the very first in the time line, a serious urge to report the writings of a not so widely referred to philosopher namely Ibn Khaldun, is felt. This philosopher though long forgotten in the clouds of history had a vivid ideology of what constitutes money and how it can be valued and produced. Ibn Khaldun (A.D. 1332 - 1406) in his Prolegomena (The Muqaddimah), recognized that money served as a standard of value, a medium of exchange, and a preserver of value (Weiss, 1995). To him the exchange value of a good is derived from the value of labor effort (and natural resources) that goes into the production of the good. He emphasizes the value of labor in determining the exchange value of a good (Khaldun, 1377), though not giving his theory a name yet his philosophy of valuing goods goes in symphony with "labor theory of value of money". The money serves purely as the medium of exchange; however the exchange can take place by way of barter also which requires the parties to establish the exchange ratio in accordance with the ratio of labor effort that created the goods. Ibn-Khaldun's era did not see the emergence of paper money; hence he neither commented on the legitimacy nor anticipated the possibility of fiat money. The money that was used to support the payment system existed as Gold and silver, nonetheless Ibn Khaldun clearly outlined the role of the mint to standardize the value of coins by marking them with authentic stamps to guarantee their weight and purity. Ibn Khaldun's writings clearly anticipate the tendency of governments to debase currencies to finance their extravagant expenditures on building castles and funding mercenary armies, therefore he subscribes to the macroeconomic objective of preserving Purchasing Power of Money i.e. Fighting Inflation. This concept emanates from his quantitative philosophy of money which he states as "*the quantity of money is of no significance for a country's wealth*". For this reason he postulates the preservation of currency's value by mint to be the main economic objective. Therefore Ibn Khaldun's monetary theory essentially remains a theory of value and the Quantity theory of money.

Centuries after Ibn Khaldun, Adam Smith in his book, *An Inquiry into the Nature and Causes of the Wealth of Nations* developed further the theory of money. Adam Smith clearly defined the limitations of barter in trade which gave birth to the use of an intermediate commodity in economic exchange (Smith, 1776). However the problem with such a medium was its value being subject to variations. How would a scale be used to measure value of goods, when its own value was not a fixed parameter? Adam Smith clearly indicated the prime function of money as the medium of exchange. Experiences stood witness to the stability of the value of precious metals, to the favorable physical properties of theirs due, and hence Adam Smith vouched for their use as better money material. Regarding the employability of twin

metals in monetary system, one was labeled as a standard and the ratio of other to the former was fixed either by law or by market forces. The famous Gresham's Law is also touched upon by Adam Smith, as he stipulates that exchange value of the coin is established by its intrinsic value and not the nominally designated face value. It is practically impossible for two classes of money with varied quality to exist in circulation, as people tend to hoard the better kind so the inferior kind would drive the better kind out of the market. Adam Smith's *Wealth of Nations* also referred to the relationship between money and price, "*the value of standard money varies directly with the number of exchanges to be made and the frequency with which they are affected, and inversely with the whole quantity of money in use and the rapidity of circulation*" (Holander, 1911). Regarding the attempts to artificially alter the stock of money, Adam Smith labels the act as useless and mischievous. The variations in the value of money benefit different classes of society differently. The undue appreciation of the currency harms the debtor segment and the depreciation harms the creditor segment of the society. Concerning paper money, Adam Smith's views were no less vivid, as his doctrine outlined that the substitution of paper for gold and silver replaced an expensive with much less costly instrument of which promissory bank notes payable on demand are best known and adapted for the purpose (Smith, 1776).

Another Classical Economists who deserves a mention here is Jean Baptiste Say; Say's law remains a very famous assertion of classical times i.e. aggregate production necessarily creates just equal quantity of aggregate demand. *A product is no sooner created, than it, from that instant, affords a market for other products to the full extent of its own value* (Say, 1834). Say's notion comes from the principal that the producing of goods creates aggregate income that makes an equal way to seek aggregate demand. Say argued that economic agents produced goods and services so that the money earned in producing them is spent on other goods desired by the same agents. His assertion is usually phrased as "*Supply creates its own demand*", though Say did not phrase it this way. A quote from his book explains his claim to a great deal, "*It is worthwhile to remark that a product is no sooner created than it, from that instant, affords a market for other products to the full extent of its own value. When the producer has put the finishing hand to his product, he is most anxious to sell it immediately, lest its value should diminish in his hands. Nor is he less anxious to dispose of the money he may get for it; for the value of money is also perishable. But the only way of getting rid of money is in the purchase of some product or other. Thus the mere circumstance of creation of one product immediately opens a vent for other products*" (139).

David Ricardo: His entire life as economist, Ricardo delved into the theoretical and practical problems relating to the Banking Restriction Period of 1797-1821 and most of his theoretical works are his views in various forms (Sato, Takenaga, 2013). Ricardo's monetary theories though quiet voluminous remain under estimated in comparison to his theories on real economy and international exchange. Ricardo's monetary remarks are considered of temporary nature as these came in response to the peculiar economic conditions of that time. However generalizability from his work can be extended by discussing two major contributions (rather controversies) to monetary economics. Ricardo's monetary theory encompasses two essential aspects of money, one being the value and quantity theory of money and the second the central banking. According to Ricardo, money essentially is a commodity, a precious metal which is directly exchanged with the other commodities. This function of commodity money is because of the perceived stability of the value of precious metals that money maintains the appropriate function of the measure of value (Ricardo, 1951a). Apart from the role of money as a measure of value expressing the value of commodities in common unit, Ricardo appears to be a proponent of commodity exchange through barter where each good is exchanged with the other without intervention of any payment system. Many allege Ricardo of propagating inconsistencies and



contradiction for determination of money prices, as Ricardo argued that both the quantity of money and the value of money derived from the value theory are the determinants of money prices in the economy. Though the underlying assumptions to Ricardian monetary theory that money does not depreciate and the value of the standard is constant, refer to the variations in money prices caused only by the irregularities in conditions of production or income distribution; these assumptions are applicable to only a specific economic condition. It is important to understand that Ricardo's value stands different for gold and for money, as he renders gold not as just money but the standard of money, i.e. a way to measure the value of money.

When Ricardo talks about value of gold, it follows the value theory and cost of production analysis. However the value of money is determined by its quantity and is measured as purchasing power of money over gold, in other words how much gold can a unit of circulating money buy? It is imperative that Ricardo rendered it immaterial whether the circulating medium comprise of whole weighed gold coins, or debased coins or convertible or inconvertible paper money, his theory rendered value of money always determined by the quantity of gold that each monetary unit could buy on domestic and foreign markets, which eventually depended on prices of gold and exchange rates (Marcuzzo, Roselli, 1991). Ricardo has been thought to represent the neutrality of money position i.e. a thought which says that changes in the nominal quantity of money will impact the nominal variables like wage rates, exchange rates, prices only and not the real variables. He held the view that the increase in the quantity of money would have no permanent impact on production employment and interest rates. These variables are determined by the level of capital accumulation and rates of profit of the economy. Though Ricardo strongly backed the opinion of quantity of money being responsible for changes in the prices, the reverse was not considered true. He never thought that any changes in prices necessarily implied the changes in the quantity of money. Price increases could be initiated by other factors like decrease in the value of the standard, a rise in wages or tax increases (Ricardo, 1951b). Ricardo stressed proportionality only between the quantity of money and price of gold, as any increase in the quantity of money above natural level (the level at which money specie is exactly backed by the gold i.e. mint par) would result an exactly equal decrease in its purchasing power in terms of gold. Ricardo has stressed at many places that the existing price of gold compared to the mint par could act as a barometer to evaluate the reduction in the quantity of money needed to bring the price of the gold back to the par level (Vol III, P 123).

John Stuart Mill: Mill is credited with contributing a profound economic analysis to classical monetary theories. His monetary theory remains clear and simple; he regarded money as commodity whose value could be found like any other commodity in the market. His main distinction was the value determined temporarily by demand and supply forces (in the short run) and the permanent value which resulted from the cost of production (in the long run) (Mill, 1848a). Mill explicitly contributed to the theory of money supply, which has a greater similarity with the modern theory of money supply, even though his theory remains restricted to monetary gold only. The supply theory of money given by Mill was the first theory to identify the public's demand to hold gold in non-monetary forms. According to Mill it is the labor and material cost expended in producing the commodity of money that makes up its cost. This is equally applicable to countries which acquire money not by producing but by acquiring through trade with the rest of the world. In that case the cost of money would be the cost of labor and material expended in producing goods that are exchanged against it (pp 498-506). Mill recognized that the value of money like any other commodity varies in the short run from

its value in the long run. Mill explained the short-run fluctuations in the value of money by virtue of Quantity theory. Mill's supply of gold in the short run was not fixed as per the existent gold stock (p554). He identified that gold had varied usage other than money. It was also hoarded as a store of value; therefore the stock of gold could be affected either by melting or exporting it. As market value of money increased in the short run, non-monetary hordes of gold were melted down to convert them to the monetary stocks of gold.

### The Neo-Classical Monetary Thought

The line that demarcates Classical Economic Theory from Neo-Classical one is the value determination itself. Classical economists rendered the value of goods as the value of inherent property in them, but many economists at different places realized simultaneously that value of goods in markets differ from the value of the matter they hold. The value of goods depended more on a network of relations between its cost of production and a much subjective interplay of marginal utilities, called the demand and supply forces. This is referred to as the Marginality revolution in the history of economic thought. The monetary theory of classical era remains essentially a theory of value and the quantity theory of money. Both of the classical monetary theories endeavored to explain the value of money; however the approach adopted was different by different economists. Before we discuss how the Neo-classical faction of monetary theories came into being, it becomes imperative that an elaborate explanation of Quantity theory and its evolution of thought is presented.

### Quantity Theory of Money

The theory that implies that the prices move directly and proportionately with money supply is called the Quantity Theory of Money. As the money supply increases, it leads to the proportionate increase in prices. Quantity theory's origin dates back to early thinkers like Copernicus, Ibn Khuldun and Henry Thornton who realized the increase in the price level of a country with the import or influx of gold and silver coins used as money coins from other parts of the world (Volkart, 1997). Developed from Hume, John Stuart Mill first time advanced the concept for equation of exchange. He explained the vivid difference between money and price, which was a concept usually confused among other Classical economists. He clearly explained that any increases in the money can lead to proportionate increase in prices (Mill, 1848b). Though Mill laid the foundation for equation of exchange, it was Fischer who for the first time developed a mathematical equation of the same. The main idea behind Fischer's quantity theory was that the inflation is primarily caused by the expansion of money or credit by banks (Fischer, 1922). He took the equation of exchange developed as an accounting identity by Simon Newcomb in 1885 and turned that into a theory. The equation in its original form was

$$MV = PT,$$

$M$  = Quantity of money in circulation

$V$  = Velocity of money, or annual turnover of money

$P$  = General Price Level

$T$  = Total number of transactions of goods and services during the year.

The given equation of exchange developed initially as an accounting relation between money and real side of the economy. The right hand side of the equation shows the money transfer and the left hand side shows the goods transfer in an economy. The total value of transactions, which is given as the product of *price* and *total number of transactions* should be equal to the product of the *quantity of money* and the *velocity with which money changes hands*. The dollar amount of goods and services produced and sold in an economy should be equal to the money usage for the same. Fischer developed this equation of exchange into a theory, by

assuming  $V$  (velocity) and  $T$  (Transaction number) to be stable. This introduction of constants establishes a direct and proportional relationship between the quantity of money and price. His theory stipulated that changes in the prices are directly caused by changes in the money supply. As Fischer stated: *"The level of prices varies in direct proportion with the quantity of money in circulation, provided the velocity of circulation and volume of trade which it is obliged to perform are not changed"*.

Another assumption of Fischer's Quantity theory of money is that money supply is determined irrespective of the aggregate income ( $PT$ ). So, there exists only a one-way causal relationship between  $M$  and  $PT$ . Money supply ( $M$ ) is rendered exogenous, it does not get affected by the changes in  $PT$ . In other words, changes in money supply cause changes in nominal income and not the other way round. Mises' approach to explaining Quantity Theory of money was different from that of Fischer, he contended that the variable  $M$  (Quantity of Money) is a culprit and is an exogenous variable that not only drives changes in  $P$ , the price level but also brings variations in  $V$  and  $T$  ( $V$  and  $T$  were rendered stable by Fischer). Therefore he thought that money is a variable that is likely to create havoc in the economy by not just raising prices but also creating structural imbalances in the economy. Mises said that money is never neutral, a change in quantity of money affects all other variables in Fischer's equation (i.e.  $V$ ,  $T$  and  $P$ ) therefore the relationship between  $M$  and  $P$  might be direct but is scarcely proportional. Mises wrote *"Fischer's proposal of stable price index could not in any way ameliorate the social consequences in the value of money"* (Mises, 1953a). Mises and other Austrian Economists were the adherents of Gold standard and their contribution is widely discussed in other section of this paper; however their approach to deal with the crises was to "Wait" until economy corrects itself. This approach was not feasible for coming out from the grips of Great Depression of 1930s as it was taking too long, a revolutionary economist namely John Maynard Keynes approached Quantity Theory from a different perspective. Keynes strongly refuted the extreme monetarism of Irving Fischer that claimed monetary inflation has no ill effects in the long run, it only raises prices. Keynes said, *"Now in the long run this might be true, but this long run is misleading guide to current affairs. In the long run we are all dead"* (Skuosen, 2006).

Keynes is said to have turned the classical quantity theory of money upside down, his economics rejected the orthodox understanding of money. Keynes rejected the very famous classical dichotomy that said the nominal variables in an economy are determined by nominal factors and real variables by real factors. This dichotomy essentially was between the relative price level (determined by demand and supply of goods) and the absolute price level (determined by demand and supply of money). Keynes argued that the velocity of transactions given stable in classical economics is not constant. In times of economic slowdown, the money changes hands very slowly, as people are less willing to spend due to low incomes, especially during the Great Depression. Therefore, Keynes was of the view that velocity of transactions cannot be a fixed variable. Consumer and business confidence, seem to influence the velocity to a great extent, however these variables themselves are highly volatile.

The notion that turned Quantity theory of money upside down was Keynes' reasoning on Output ( $T$ ). Keynes argued that it is not reasonable to assume output ( $T$ ) to be constant. As opposed to the classics who believed that output of a country is determined by the level of employment used in producing the output, and since the economy is always at full employment, the output level can be treated as constant. Keynes believed that it is possible for equilibrium to exist even when resources are not fully employed. Therefore, Keynes's analysis was a complete reversal of the causal relationship that employment determines output and took the form for him output determines employment. Since the economy is not always at full



employment, which shows that output levels are unstable and not constant. This was the first time to look at the output of an economy from Demand side as opposed to supply side (Trevithick, 1992).

Keynes also argued that people tend to hold money not just for transactions only. He put forward his theory of Liquidity Preference. Liquidity preference theory states that money is a store of value, a standard of deferred payment and the usual medium of exchange. Apart from transactions need, people hold money for precautionary purposes also. Precautionary needs come into play when people are uncertain about the future, expect lower levels of income in future due to economic slowdown, will tend to save and hold more money balances as a security for bad times in future. Additionally, Keynes believed that people also hold money for speculative purposes. And for this Keynes introduced role of interest rates in determining the speculative holdings of money. He explained that the expectation of future interest rates are key to determining the current demand for money as economic agents tend to get rid of their bond holdings as they expect rise in the interest rates (which may be due to low current interest rates). As rising interest rates deteriorate the value of bonds so the investors are more likely to sell their bonds and increase the current liquidity i.e. money. The classical dichotomy was rendered irrelevant, as Keynes related a real variable (interest rate) in determining a monetary variable (money demand) (Johnson, 2001).

Presenting a rebuttal to Say's law, Keynes argued money could be hoarded. Rather than investing money in interest bearing assets, people may choose to hold idle balances of money based on their speculative needs. The speculative demand for money is an unstable function of the interest rate. Keynes was of the view that consumption and savings are not the determinants of the interest rate, Instead the interest rates are determined by the money market. Keynes reformulated the Classical Quantity Theory and laid down new assumptions, which stipulated that the relationship between Money Supply is neither direct nor proportional, instead money changes affect the prices indirectly by changes in interest rates. According to him when Quantity of Money increases the first impact is felt by interest rates which are going to fall. The falling interest rates will spur Investment activity which will tend to kick in the multiplier hence affecting the effective demand thereby increasing income, output and employment. Output and employment tend to increase in the same proportion as effective demand, and the effective demand also increases in the same proportion as the quantity of money. But, once full employment is reached, output refuses to respond at all to changes in the supply of money. The elasticity of supply of output in response to changes in the supply of money, which was infinite when there was unemployment, falls to zero. Therefore the supply of money exerts its pressure in entirety on prices, which tend to rise in exact proportion with the increase in effective demand. Keynes' Quantity Theory says, *"so long as there is unemployment, output will change in the same proportion as the quantity of money, and there will be no change in prices; and when there is full employment, prices will change in the same proportion as the quantity of money"*

Milton Friedman a relatively modern economist in 1956, in his article, *"The Quantity Theory of Money: A Restatement"*, shifted the focus of the quantity theory of money, though he tried to incorporate the major developments carried forward by Keynes and post-Keynesians. Friedman argued that the changes in the money supply can cause changes in the nominal variables as well as the real variables like output and employment sometimes. Friedman's restatement of the quantity theory was essentially a theory of demand for money, where money is treated like any other asset (Handa, 2009). Economic agents (individuals, firms, governments) tend to hold a specific quantity of money in real terms called as real money balances. During times of higher inflation the purchasing power of the unit of account gets eroded, economic



agents will adjust the nominal balances of money to maintain the same quantity of the real balances, keeping real balances constant. Friedman argued, the level of real balances held by people depended on permanent income (the Present discounted value of all expected future income), the relative expected return on bonds and stocks versus money, and expected inflation. Therefore Friedman's equation of exchange can be expressed as a demand function of money given as:

$$M_d/P: f(Y_p <+>, r_b - r_m <->, r_s - r_m <->, \pi^e - r_m <->)$$

Where

$M_d/P$  = demand for real money balances ( $M_d$  = money demand;  $P$  = price level)  $f$  means "function of",  $Y_p$  = permanent income  $r_b - r_m$  = the expected return on bonds minus the expected return on money,  $r_s - r_m$  = the expected return on stocks (equities) minus the expected return on money,  $\pi^e - r_m$  = expected inflation minus the expected return on money

<+> = increases in

<-> = decreases in

*"So the demand for real money balances, according to Friedman, increases when permanent income increases and declines when the expected returns on bonds, stocks, or goods increases versus the expected returns on money, which includes both the interest paid on deposits and the services banks provide to depositors"* (Wright, 2009).

The modern quantity theory formulated by Milton Friedman is considered superior to Keynes's liquidity preference theory because of its inclusion of other asset types like bonds, equities, goods as opposed to just one asset (bonds). Friedman did not assume that the return on money is zero, or even a constant. In Friedman's theory, velocity is no longer a constant; instead, it is highly predictable and, as in reality and as formulated by Keynes velocity is procyclical meaning rising during expansions and falling during recessions. Finally, unlike the liquidity preference theory that claimed a huge impact on money demand due to changes in interest rates, Friedman's modern quantity theory predicts that interest rate changes have meagre effect on money demand. The reason for this is that Friedman believed that the return on bonds, stocks, goods, and money are usually positively correlated, they move together leading to little or no relative changes of  $r_b - r_m$ ,  $r_s - r_m$ , or  $\pi^e - r_m$  as both sides would rise or fall about the same amount. This very insight essentially reduces the modern quantity theory to  $M_d/P = f(Y_p <+>)$ .

The very premise that sets Friedman's quantity theory apart from Keynes' is his assertion that both money demand and velocity are very stable and could be easily predicted. This went opposite to Keynes view who thought velocity and money demand are very volatile and unpredictable. This difference of opinion had a significant policy implication, as Friedman's analysis supported monetary policy to be an effective tool to gear the economy. While Keynes due to his view of unpredictable money demand and velocity thought that Fiscal policy was the most appropriate and reliable stabilization policy.

### **Economic Analysis of Classical and Neo-Classical monetary thought**

**The analysis of Classical Monetary theory:** The classical monetary theory essentially was an extension of classical value theory, with no doctrinal dichotomy what so ever. Since money was a commodity in classical analysis, therefore its value was simply explained by the same value theory that explained the prices of other commodities. As John Stuart Mill observed, *"The introduction of money is a mere addition of one more commodity, of which the value is regulated by the same laws as that of all other commodities"* (Mill, 1871a). The difference that sets the classical money theory apart was mainly in the peculiarity of supply and demand functions of money. Classical

money supply function as in modern times was directly related to its value ( $1/p$ ) and was quite inelastic. Mining gold, which otherwise was an unprofitable business, gained momentum when gold money's value rose in terms of buying goods and services, i.e. the price of all other goods and services declined in terms of gold. Both the elasticity and location of the money supply curve in classical monetary thought are accounted for by the real adjustments to real changes.

The elasticity of the classical money supply function was due to two factors that brought changes in the value of money (reciprocal of the price level): (1) conversion of money into plate and vice versa, and (2) expansion and contraction of marginal domestic mining of precious metals, if any. Having explained the elasticity, the position of the implicit classical money supply curve, was accounted for by the cost of producing the metal specie from mines or acquiring it through trade. A positive shift in the money supply curve resulted due to the reduction in the cost of producing the precious metals, or the increase in exports by which they might be obtained. Similarly, the unitarily elastic demand for money shifted directly with the output of domestically used goods (due to the reduced cost of production of domestic goods) and inversely with the volume of credit (including the substitutes for "money" in the performance of its medium of exchange function) (Mill, 1871b). What makes Classical Monetary Theory unique is the inclusion of cost of producing things other than money in positioning of money supply function. Further to clarifying the uniqueness of classical monetary theory, the following elaboration may suffice. The demand function for money in classical monetary theory, shifted simultaneously, and in the same direction, with the changes in the money supply function. For instance, positive movements of the money supply function that could result from improvements in the productive capacity of domestic gold mines (if any) or of other commodities including agriculture. Such a technological improvement would result in a significant concurrent rise in both the demand for money (through increased aggregate production of goods exchanged for money) and the supply of money (through the increased inflow of gold corresponding to export balance of trade initiated or augmented by the innovation) (Mill, 1871c).

**The analysis of Neo-Classical monetary theory:** Neo-classical monetary theorists are the Anglo Americans who professed to interpret the classical monetary theory but inadvertently turned it upside down, without even realizing or detecting the inversion they caused to the doctrine. The commodity and quantity theories of money complemented each other in explaining the value of money in classical monetary analysis; however these theories were presented as competing theories in neo-classical analysis, interpreted as half-truths. The controversy that initiated between the commodity and the quantity schools of monetary theory in post classical era, originated due to the ignorance of the classical distinction between the long-run and short run values of money. Post classicals tried to incorporate one aspect of classical monetary theory, while excluding the other (Agger, 1941). The clashes associated with the Bimetallic controversy basically witnessed the annihilation of the commodity theory faction of the neoclassical school that happened to succumb to the Quantity theorists, who in their attempt to preserve and explain classical quantity theory inverted it (Mason, 1963). Neo classical monetary theory emerged as a quantity theory which was very different from its classical counterpart. This inadvertent inversion resulted from extending the application of classical short run analysis of Quantity Theory to the long run, and then burying its short run formulation forever.

The exclusive emphasis on long run relevance of Quantity Theory was conserved due to the negligence on part of the neo classists regarding *ceteris paribus*, who failed to recognize this

as an abstract methodological condition rather than a necessary condition that must be fulfilled in practice. Fulfillment of this condition was achieved by rendering the velocity of money constant, which is a condition that could be accomplished only in the long run, hence the long run garb was given to the otherwise short run implication of the Quantity Theory. This morphisms in methodology contributed generously in blurring the line of discrepancies between classical and Neo Classical monetary doctrines.

**The Austrian School of Monetary Economics: A Heterodox Economic Thought:** Austrian School of Economic thought originated in Austria in late 19<sup>th</sup> century; its early contributors remain of Carl Menger, Eugen von Böhm-Bawerk, Friedrich von Wieser, and others (Schumpeter 1954). Austrian Economics is credited with contributing important theories to early economics, which include the Subjective Theory of Value, Marginalism in Price Theory, and the Formulation of the Economic Calculation Problem, these contributions remain an integral part of mainstream economics (Birner, Van Zijp, 1994). Mainstream Economists are critical of Austrian economic thought, for reasons related to Austrian rejection of Econometrics and other macroeconomic analysis and consider them outside the mainstream economics, hence heterodox (Boettke, Peter, 1994). Of all the theories and explanations of money that various Economists brought forward, none served as a clear guideline to a statesman. Professor Ludwig Von Mises of Vienna, in his book, "*The Theory of Money and Credit*" (1912) has done justice to a greater extent by systematically dealing with the major propositions of theory of money and credit, by establishing its relationship with main analytical economics and with the major problems of contemporary economic policy structure

In the very first chapter "the Functions of Money", of his book, Mises provides a step by step process of the origin of money. Mises significantly acknowledged the contribution of his reference Carl Menger 1871, who is designated as a founder of Austrian Economics and gave for the first time a satisfactory explanation on the origin of money. Menger contrived a step by step evolution of money rather than assuming it a decree or an edict from a king or a government (Mises, 1953b). Mises and his Austrian predecessors, whom he refers to generously, worked out a logical explanation to the measurement of value. Referred to as Subjectivist/Marginal Revolution, Mises and others explained the prices of commodity goods by the interplay of subjective valuations in the market, which in turn explained the prices of producer goods that are required to produce them. This was a breakthrough in valuing commodities as it negated the classical economists' labor theory of value, which explained the price of a good by the amount of labor used in its production or cost of producing that good.

Mises goes forward in explaining that a government can never force a particular good (be it the commodity money or fiat money) to command a specific purchasing power in the market. If the government alters the value of the circulating money, the market will react by altering prices in the opposite direction (Mises, 1953c). Mises was the first one to discuss the social consequences of changes in the value of money, he discussed that inflation or monetary value reduction can make businesses overestimate their profits which eventually lead to *Capital Consumption*. The increased influx of money of any kind (be it gold or fiat currency) does not make the society richer, its circulation spreads unevenly, benefiting only certain circles of the society which remain primary beneficiaries on whom the money is spent first of all. Other segments of society stand at the losing end, as they do not directly see increase in the income instead the value of their savings is already deteriorated due to falling value of the money (Mises, 1953d).

Mises a strong opponent of the inflationism; dedicated his career to make its ill effects evident to the rest of the world. He stressed that the only technical definition of inflation is the increase in the supply of money. The consequences that follow the inflationism like Price



Controls and Currency Speculation are well tackled by Mises. He clearly demonstrates how price controls are an ineffective measure to keep masses unaware of the consequences of inflation. This leads to either shortage or removal of goods from markets that are price controlled (Mises, 1953e). The most valued contribution of Mises is his explanation related to expansion of fiduciary media causing Business Cycles. Mises relied on Bohm-Bawerk's capital theory to explain the boom bust cycles. Böhm-Bawerk viewed interest rates as a reflection of the community's preferences for the consumption and its timing. Not only that, it also reflected the technical opportunities available for increased output resulting due to lengthening of the methods of production. Mises explains how banks by issuing fiduciary media artificially lower the interest rates, which in turn induces entrepreneurs to believe that subsistence fund has increased, when in reality it has not. Entrepreneurs tend to borrow more at the suppressed rates. Businesses in an attempt to invest in their so perceived productive ventures hire workers, and try to bid away resources from others to begin longer-term processes. This period of optimistic economic sentiment is called a boom and is believed to be the period of prosperity. Yet because the society did not become rich actually due to the issue of fiduciary media, the boom eventually meets its end. The reality is that there are physically not sufficient savings to help society go forward, until the time when these investment projects start yielding their final consumption goods. A bust or recession sets in, when the output of consumption goods declines pushing their prices up. Entrepreneurs come to their senses, realizing their mistake; they discontinue the projects that had appeared profitable to them due to the false interest rate. In reality the bust is triggered by bank's lowering the rate of credit expansion causing the money rates to rise towards their appropriate level. The growing supply of money pushes the prices up, and lenders tend to demand higher inflation premiums in the contractual rate of interest. No matter how long banks try to hold the money rates below the natural rate, eventually a worse crisis becomes inevitable (Mises 1953f). Mises stands as a strong proponent of the gold standard; he argues that the long term woes of inflationism outweigh its short term apparent benefits. He strongly believed that governments caused the failure of gold standard and continuously stand to object the common man's choice of sound money.

Fredrick. A. Hayek: It would be unfair to conclude the Austrian school of Economic thought without making any mention of Fredrick. A. Hayek, his contributions added a profound insight to the Austrian economics. Hayek puts the Capital theory, the monetary theory and the price theory together to formulate the Austrian Theory of Trade Cycle. Hayek believed that changes in prices communicate information which eventually leads economic beings to co-ordinate their plans (Skuosen, 2006). Hayek is of the view that the increase in money supply (mainly due to credit expansion) can lead to inter-temporal dis-coordination of economic activities initially characterized by a boom, which eventually turns into a bust and necessitates certain adjustments by money induced disco-ordination which is called the recovery. Hayek used from Bohm Beware of the idea of interest rate being the reflection of saving propensities which affects not only the magnitude of investment but also its pattern. A lower interest rate is said to encourage a longer term investment which might not have taken place, had interest rates remained a little higher. Therefore, under normal circumstances, it is the interest rate that sets the preferred time pattern of consumption activity which gets translated into a corresponding time pattern of investment activity. That is why interest rates are said to coordinate the two kinds of activities inter-temporally. The inter-temporal coordination is disturbed when interest rates are artificially lowered due to injection of money. The misleading interest rates let capital goods be invested for a relatively longer or time-consuming structure of production. This happens at the expense of capital goods which are



more compatible with the current, less time consuming, structure. A net increase in economic activity led by credit financed capital structuring comes into being, which is very well mistaken for a boom. As time passes, the capital restructuring which is not yet complete does not conform to actual resources available. The resources that are not yet contracted for still are needed for capital restructuring, get scarce and hence pricy, requiring a further demand for credit. These increased costs lead to the liquidation or abandonment of misallocated capital. Labor units which were complementary to the misallocated capital, once abandoned become unemployed. The result is a bust a sluggish economic activity, which is followed by a recovery in terms of market adjustments in relative prices and wages, which eventually leads to the reabsorption of unemployed capital and labor into the structure of production (Garrison, 1986). Hayek said, "The past instability of the market economy is the consequence of the exclusion of the most important regulator of the market mechanism, money, from itself being regulated by the market process" (Hayek, 1932).

### Conclusion

Money remains the most talked about and discussed entity of the historic times; however its value determination theory took a roller coaster ride from Classical to Neo Classical eras. Though there is no universal taxonomy to separate the two, however an attempt is being made here to follow what majority of scholars have to prescribe with respect to the same. It is an established fact that the models vary mostly in assumptions and implications, hardly have they showed any variations in interpretation. This research paper has established a clear delineation between the assumptions, implications and interpretation of Classical and Neo-Classical monetary thoughts. Classical monetary economists rendered value determination purely based on cost of production in the long run and by the forces of demand and supply in the short run. Neo-Classical in an attempt to interpret the classical monetary thought turned it upside down by extending the short run application of Quantity theory to the long run and excising its actual applicability. Neo-classical monetary theory remains essentially a quantity theory in a long-run context and this is the theory that dominates the mainstream economics now a days. While Fischer, Keynes, and Friedman all recognized the importance and implication of Quantity Theory, they each placed different emphasis as to which variable was the driver in changing the prices. Fischer emphasized Money and credit, Keynes income and demand, and Friedman the quantity of money (but with a different Causality). In contrast to mainstream monetary economics a heterodox school of economic thought, the Austrian School considers the in elastic nature of gold and commodity money, a virtue and not a vice and vouches for the gold standard as the most preferred money standard to achieve economic stability. The economists of this school explain how trade cycles are exacerbated by the extension of endless credit. The only way trade cycles can be nipped is to curb the credit expansion, which definitely would limit the booms but would also free the economies from ugly busts. They propose the return to the gold standard.

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## CONSTRUCTION PROJECT FAILURE IN SAUDI ARABIA, CAUSES AND SOLUTIONS

Dr. Mohammad Saleh Miralam\*<sup>1</sup>

<sup>1</sup>Assistant Professor, University of Business and Technology, Jeddah, Saudi Arabia.

### ABSTRACT

The aim of this article is to find out the causes of construction project failure in Saudi Arabia and how can be avoided by using semi-structured interviews. Semi-structured interviews were found to be the most appropriate method of data collection in such paper because they enabled the researcher to gather valid and reliable data. Ten project managers in major construction sector companies have been interviewed. The article gives a valuable resource and rich information for those interested to know more about the project in Saudi Arabia or those wishing to invest in construction field. All interviews were conducted with project management department managers by using semi-structured interviews. The study found that there are many causes of project failure in construction sector in Saudi Arabia. Some of them have been mentioned in the literature and some have not as discussed in the following paragraphs.

### INTRODUCTION

Companies work hard to success in their project, so project management tools and techniques should be understood to avoid the project failure or delay causes. The aim of this paper is to understand the causes of project failure in construction sector in Saudi Arabia and how can be avoided. The researcher found that construction sector is the most rapid growing and developing sector in Saudi Arabia market. For collecting the data, the researcher set the following question to be asked for the interviewers:

- (1) From your perspective, what are the causes of project failure or delay?
- (2) How can you overcome these causes?

This article represents an important contribution to the project in construction sector field in Saudi Arabia by providing a valuable resource for those interested to know more about the construction project in Saudi Arabia. In addition, this one has been conducted in specific sector (construction field) thereby providing rich and concentrated information from one perspectives, which can be more specific. Finally, this study also provides useful information for researchers interested in the same subject area, because it is a rich source of project failure causes information which could be applied in other countries around the world. In other words, the study could be generalized to other countries.

To achieve the research objectives, the researcher decided to choose and use semi-structured interviews, to give the researcher the ability to change interview direction, and to open up

new aspects of the subject during discussions.

The data was analyzed personally using a number of steps. The first step was to transcribe the data collected and the second step was to translate this data from Arabic into English as the interviews had been conducted in Arabic. Subsequently, the researcher classified all the data into categories and units. Finally, the all data were discussed and numbers of recommendations and suggestions were written

## **BACKGROUND AND LITERATURE**

A project is defined as a temporary group activity designed to produce a unique product, service or result (PMI, 2015). A project needs planning and organization of an organization's resources in order to achieve goals by completion specific project tasks. In another word, the project needs to be succeed a good management to achieve all set project objectives in spite of risks. Success in project management field is defined "the accomplishment of an aim; a favourable outcome."(Canadian Oxford Dictionary, 1998) so if the project objectives could not be achieved, it means that the project fails. All companies and organizations seek to be successful in their projects and avoid failure causes, so to understand the failure causes, success factors should be understood first. In the literature, many studies have talked and discussed the factors of project success and failure.

Slevin and Pinto (1986) proposed ten key success factors: project mission, top management support, project schedules/plan, client consultation, personnel, technical tasks, client acceptance, monitoring and feedback, troubleshooting, and communication. Then, they extended this list with four additional factors considered outside the project implementation process and therefore outside the team's control: characteristics of the project team leader, power and politics, environmental events, and urgency (Slevin and Pinto, 1988b). According to these authors, in the project design phase, project mission and client consultation would appear to be the most important factors. In the project planning phase, the key success factors are project mission, top management support, client acceptance, and urgency. During project execution, the key factors are project mission, characteristics of the project team leader, troubleshooting, project schedules/plan, technical tasks, and client consultation. Finally, at project closing phase, the key success factors are technical tasks, project mission, and client consultation (Ika, 2009).

In contrast, Nielson (2014) stated in his article the top five causes of project failure. These causes are poor planning, disconnected tool, lack of visibility, poor resource allocation and lack of measurement and correction. In addition, shaker (2010) represents the reasons of project failure in his article, which are poor alignment between project objective and organization's vision, bad planning, a gap between project managers and executives (lack of executive support), incomplete requirement, unclear expectation, scope creep, lack of resources, selecting wrong technology, lack of education or experience.

## **RESEARCH METHODS AND DESIGN**

There are three types of interviews: structured, semi-structured, and unstructured (Saunders, Lewis, & Thornhill, 2003). A structured interview (also known as a standardized interview) can be used within a quantitative or qualitative questionnaire. The aim of using the structured

interview is to ensure that each interviewee is presented with exactly the same questions and this ensures that answers can be reliably aggregated. The researcher should read out questions exactly as they appear in the survey and in the same tone of voice, to give all interviewees the same opportunity and freedom to answer each question (Kvale, 1996).

A semi-structured interview is considered as a two-way communication and can be used both to give and to receive information. Unlike the structured interview, where details of questions are prepared ahead of time, semi structured interviewing starts with more general questions or topics. Not all questions are designed and phrased ahead of time. The majority of questions are created during the interview, allowing both the interviewer and the person being interviewed the flexibility to probe for details or discuss issues. Although the researcher has a list of themes and questions to be covered, interviews may be varied from interview to interview, which means that the order of questions is not fixed and the researcher may omit some questions in particular interviews, depending on the flow of the conversation. The responses received from such interviews are usually recorded by note-taking or tape-recording (Saunders et al., 2003).

Unstructured interviews are used when researchers wish to explore a general subject in depth. There is no specific set of questions asked in a predetermined order although the researcher needs to have a clear idea about the subject. An unstructured interview can go in any direction depending on the conversation flow, so it gives interviewees the opportunity to talk freely about their opinions and beliefs in relation to the subject, with guidance from the interviewer (Easterby-Smith, Thrope, & Lowe, 2002).

The researcher therefore decided to use semi-structured interviews to collect the research data. A semi-structured interview was deemed as the most appropriate type of interview because it is flexible enough to give the researcher the ability to change interview direction and to open up new aspects of the subject during the discussion. Questions (see introduction) had been set in advance to guide the interview. Interviews (semi-structured interviews) found the best method of data collection to gather valid and reliable data. A semi-structured interview is considered as a two-way communication and can be used both to give and receive information.

The researcher found that the most appropriate interviewees for such study were people responsible for project management department managers because they had full information about projects and projects' history.

To find out the causes of project failure, the researcher has interviewed ten project managers in major construction sector companies. This sector (construction sector) has been chosen because it is found that this sector is the most rapid growing and developing one in Saudi Arabia market.

In 2010-2014, the Kingdom's Cabinet has approved to invest SR 1.4 Trillion in many development and infrastructure projects. This amount reflects the keen of the Government on development to push all productive and service sectors forward (Saudi, 2014). Examples for the most important projects in Saudi Arabia in this period are:



### **King Abdullah Financial Center**

The center will be the first in the Middle East in terms of size, organization, technical standards and equipment. The constructions started since 2007 and is expected to be completed on several stages. When completed, the Center will enhance the position of the kingdom –World's Oil Capital and provides the most up-to-date working climate that is equipped with the latest international standards.

### **King Abdullah International Gardens**

This is one of the biggest three botanical gardens in the world. The total area is about two million square meters and it consists of a range of global iconic gardens with particular scientific, cultural and environmental features, as well as water, ice, desert and aquariums, waterfalls, children parks, birds, butterflies, reptiles, flowers, and integrated services (markets, theaters, meeting halls coffee shops, playgrounds and other services). This project is expected to enhance tourism, and it is a huge leap in the concept of a very large tourism and recreation in the Kingdom.

### **King Abdullah University for Science and Technology**

This University becomes an International research university in post-graduation studies. It is dedicated to start a new era of scientific achievement in the Kingdom, and benefit the region and the world. The University is supported by an Endowment of several billion dollars, and governed by a Permanent and Independent Board of Trustees, with Eligibility as the basis of its work and it welcomes men and women from all over the world. The University seeks to implement its research plan through strategic research themes that focus on areas of science and technology of interest to the Kingdom and the Region and the World in general. The main campus occupies an area of more than 36 million square meters at Thuwal

### **Economic Cities**

A number of economic cities are being established in the kingdom to activate regional development in industrial and business as a long-term investment in the kingdom. The economic Cities will support the expansion of the growing non-oil economic activities in the Kingdom. There are many cities around the kingdom as follow:

#### **King Abdullah Economic City**

It is considered as the largest architectural construction projects in the Kingdom, and one of the most important economic cities in the world. The City will embrace nearly two million people, and it will take about 20 years beginning from the year 2006 until the year 2025. The city includes a seaport, an industrial zone, central business district, resorts and facilities area, the residential neighbourhoods, and the scientific and research institutions.

#### **Jazan Economic City**

The project is in a strategic location along the red sea. The City is expected to attract over one hundred million Saudi Riyals of private investment from various sectors, and it is focusing on heavy industries with energy-intensive, and providing all the needs for establishing various secondary industries, especially in the area of agricultural support and fishery industries. The city consists of integrated elements that include: the port, Industrial Estate, logistics services,

power station, water desalination and refrigeration, residential area, island business center civilization center Cornish, the Sea Front district and maritime.

### **Abdulaziz Bin Musa'ed Economic City**

The total area of the City is 156 Million Square Meters and will be constructed at a total cost of 30 billion Saudi Riyals. The project will provide about 30,000 jobs for Saudi youth in Ha'il, and it will contain an international airport, railway, and land-port.

### **Economic Knowledge City**

The aim of the city is to establish a foundation for economic development based on knowledge industries, support tourism and also the establish of a commercial area with modern infrastructure to serve residents and visitors to reduce pressure on the Central Area of the city, in addition to the development of a distinctive residential area for those wishing to work, invest and stay next to the Prophet's Mosque - peace be upon him-. The city is expected to attract investments worth 30 billion Riyals and provide more than 20000 new jobs. City Website.

### **King Abdullah Sports City in Jeddah**

The project comprises unique sport facilities that will enhance sport skills in Saudi Arabia. With several associated halls and training playgrounds. The project capacity is 60 thousand spectators with a fancy design, and the 3 million square meter area playground, that meet FIFA standards.

The playground consist of business enterprises, HD monitors, TV studios overlooking the playground, famous world and local brand restaurants, a separate Olympic athletics playground, closed sport halls that accommodate 10 thousand spectators, festival and conference halls, big mosque, sport academies and car parks that accommodate 8,000 vehicles.

### **King Abdulaziz New International Airport**

It consists of three phase projects, and it will be completed in 2035 with 70 -80 million passengers capacity per year using existing three runways. The project comprises the following main facilities: Passenger terminals that are built on 670m2 area and 46 boarding gates that are connected to 94 boarding tracks and waiting terminals designed, a hotel, shopping centers, the most recent air traffic control system, and modern transportation center that comprises the latest transportation systems including a railway station.

After the researcher had collected the data, he started to analyze the data personally. The first step was to transcribe all the data. The second step was to translate the transcribed data from Arabic into English because Arabic was the main language of all the interviews. After all the data had been translated into English, the researcher classified all the data into categories. The researcher found that there was valuable data to assist in the understanding the causes of project failure.

The researcher regarded ethical issues as an important success factor for the research process. First of all, privacy was given full consideration during the research process. The interviewees' names were kept anonymous, as most of them had requested. Secondly,

anything that interviewees said or gave (documents) during the interviews was not used out of the research. All data was used only for the research purpose. Finally, all interviewees knew about the tape recorder before the interviews began.

## **FINDINGS AND DISCUSSION**

The study found that there are many causes of projects failure or delay. These causes are discussed in the following paragraphs.

### **Materials Supply Delays**

Three construction companies mentioned that sometimes the custom delay to clear the material from the port, which causes a delay to accomplish the project. The researcher found that the reason of this cause comes from either no good communication between the company and the custom or the shortage of custom employees. Thus, from the company side, the company should open and develop the communication way with the custom. One of this ways is ensuring of preparing all shipments' document as one of a project manager said preparing the necessary document that could facilitate the clearance of arrived material is important to avoid any delay, whether you need it or not". At the same time, the project owner should talk and explain to the custom the importance of the project such as haram expanding project, and tell him that the holding of material long time will cause a delay in the project. From the custom side, the custom should reevaluation and reconsiders the number of its employees depending on the job capacity especially on vacation season.

In addition, three project managers mentioned that there is limited number of qualified suppliers in the market. These interviewees noticed that some suppliers do not supply materials on time because of their weaknesses in the market, which cause also a delay in a project. Therefore, the company should choose well-known suppliers who have a good experience in same project and they should apply penalties on the suppliers if they do not provide material on time. The study found that a good forecasting from the suppliers side gives the contractors the ability to accomplish the job, and the project owner should have more than one well-known suppliers or subcontractor to provide the same materials or equipment.

In addition, the study found that sometimes because there is no open purchase order between purchasing team and the supplier (it takes time to do it), this leads to delay in requesting main necessary equipment or material, which delays the project. Four project managers represented that purchasing team should and open purchase orders with the supplier regularly to assure the availability of the orders on time.

The study found also that booming in projects in many countries give the contractors and manufacturers a chance to deal with more than one project, which causes long lead material delay in delivery. This cause has not been mention in the literature.

### **Scope creep**

Scope creep has been mentioned in the literature (shaker, 2010). Seven project managers represented that some owners tend to request several changes even if they are not stated in the contract, which cause delay to the implementation. So, Before starting the project, all parties



should agree on a final plan and design. Frequent changes could harm the project as three of project department managers mentioned that changes should be controlled to protect the project's budget. The project manager should make a culture of change management, protect the project from frequent changes and insist to work with the project charter. For example, for any changes, the project managers should send and forward change form to be approved from the concerned department. In addition, a project manager should have a good speaker Engineer available to overcome any disputes with the client (owner). That is why, the trouble maker owners should be identified from the beginning of the project and during the implementation. Additionally, the specification of the project should be very clear from the beginning. At the same time, there is no matter if there are minor changes in the project scope not in schedule. All project parties should work together under one roof, and take their time on agreeing to a final plan and design to avoid any project creep.

### **No top management support**

Sometimes the project managers find themselves alone, especially if there is conflicts between stakeholders or lack of cooperation from the other department managers such as resources manager or support department (shaker, 2010). Generally, the study found that middle managers think that the project is not important to the organization, so they redirect resources to activities, which top management support. Five project managers represented that top management should support project managers during all stages of the project continuously. One of this supports it could be by attending and participate in major meeting. If they do not do so, it means that the project is not a high priority for them. Two of them said that "top management should know and understand all project charters and empower project manager". This cause has been mentioned in the literature.

### **Weak project manager, team and consultant**

The researcher found that the weakness comes from the lack of education, experience or authority. Project managers should be a good planer and decision maker and he has the ability to coordinate activities rather than perform an effort. Six managers mentioned that sometimes the project is led by only engineering Department that is not enough for project to be succeeded. Due to the lake of experience, the project manager could not manage the integration between the program phases, Also, sometimes concerned people who are in charge of critical responsibilities and positions cannot take decisions because of centralization of the project system (the decisions must get approval from top of the hierarchy. As a result, the action will be affected and late). In addition, sometimes decision makers are afraid to receive any negative feedback of their decisions since it may affect their positions so, they tend to do only the minimum of work only and afraid to take decisions. Three of project department managers said "project managers should be followed continuously to make sure that they are using contract statements, related to the concerned subject, perfectly, and put them under pressure of finishing works needed as fast as they can". Six project department managers mentioned that project owner should empower their project managers, and, give them full authorizations to deal with the project with, monitoring.

The researcher found that project team should be selected carefully and all necessary information should be provided to them to avoid lack of visibility (Nielson, 2014) . Eight

managers said that “when the contractor, project manager, organization selects or recruits competent people to perform the job for the project, be sure you select the right people to be succeed”. One of the common cause of project failure is that the project team do not have skills or resources that the project needs. The study found that if the project objectives was against the team interests, the team would lose the commitment toward the project.

From the beginning, the top management should choose the project consultant carefully. Six managers have represented that If the consultant was changed during the same project, the bad selection of the first consultant from beginning give an excuse for the new consultant to complain every time about the wrong specs from the previous one. The study noticed that the good relationship between the consultant of the project and the contractors could affect the project negatively. For example, a good relationship between the consultant of the project and the contractors could lead to some changes in of the scope without restrictions because the contractor can apply the work without approval. Two project managers said “the key for our companies is using competent partners and right people at the table”. The study found that contractor such as consultant or supplier try to win as much projects as they can at the same time, without paying attention to their ability of mastering projects fairly. As a result, shortage of sources and equipment will occur which will affect the project time and budget negatively. Therefore, strong penalties from client side must be applied, and better evaluation must be done before choosing any contractor.

#### **Poor planning (unrealistic Planning)**

Project manager should specify and identify the project scope, time cost, risks, communication, quality and dependencies. It says, “If you fail to plan, you plan to fail”. Poor project planning is the concern of eight project department managers. They mentioned that sometimes the planning section, project owner or top management does not give the project activities proper time although, the planning stage is the most important stage in the project cycle. In addition, the researcher found that bad coordination inside the contractor (who is doing the job) delay the project. Moreover, it is found that the project will delay long time if there was an overlap between the projects’ activities. For example is that one project has been delayed long time because there was a huge defect (planning defect) in the civil work from the contractor because of the bad planning; there for this defect creates huge delay since the correction would need a very sensitive work to overcome the issue. Furthermore, seven project managers mentioned that the wrong estimated budget or cost of the project from the project owner or main contractor in the beginning of the project leads the project to fail. In addition, the study found that sometimes the no feeling of time and responsibility toward the importance of the project from project team, manager or consultant leads to project delay. It is noticed that because of lack of attention of time, sometimes the project team makes poor estimation of time in planning, which leads to change the triple constraint of any project (Time, scope, and budget), which is leading to waste of resources. Six project department managers suggested that first, planning period should be extended. Secondly, the targets should identified and tied them with specific time. Then, stakeholders should be informed and take their approval for plans and goals. Finally, plan should be followed up and reviwed by taking feedback continuously.

Poor planning cause has been mentioned in the literature Slevin and Pinto (1986), Nielson (2014) and shaker (2010).

### **Bureaucracy and some governmental Policies**

The study found that some government offices should review their procedures and policies to support projects to be succeed. Four managers represented that sometimes they face difficulties to issue the municipal permits on time to start the work, which affect the project negatively (delay the project). One of the interviewees said, "Sometimes the municipality doesn't even issue the permits and the process from their sides is a mystery and takes a long time". Three of interviewees said, "Sometimes we build the sites without permits and then we try to use our relationships and connections to have it"

In addition, the researcher found that the new regulations, which were set by Ministry of Labor, affect the work force of the project vendors negatively. In a result, a shortage in the teams (workers and labors) and delay in the works project occur. Three managers represented that after the ministry of labor issued that each corporation should localize a given percentage of manpower, many big running projects are delayed, because most of the manpower in the site is foreigners and it is not easy to localize (Saudis) some jobs (low level or high expertise job). That is why some contractors provide visit visa for some workers to work temporary which is against the law. Four project department managers said, "The ministry of labors should understand our job and needs".

Moreover, if there are many parties in on project, especially in governmental big projects, it is not easy to get approvals for any required changes because of different views regarding the project or fearing to take a decision, which leads to delay. The study found all parties should meet together regularly to solve any problems immediately and to align their view toward the project.

In addition, materials Payment Authorization one of the reasons which causes a delay in the project. This is because the procurements team needs a high-level approval for each material purchasing even for small items.

Additionally, Sometimes the ministry of finance does not pay the contractor on time, therefore the contractor covers the project needs from others project cash flow. Therefore, the practice of bureaucracy in Saudi Arabia fails to provide the flexible level of support, and the researcher found that the people who in charge from the government side are afraid to improve procedure of performance and develop better strategies because they are fearing from the negative effects which may be could happen to their position. It is so difficult for governmental system to cope with demand of project under this situation.

Furthermore, sometimes the small margin of profit, which given by the government, leads the project to delay. Four project managers mentioned that the small margin of the project affects the worker enthusiasm to complete the project on time.

Moreover, the study found that because of starting many projects at the same time, the contractors, manufacturers and subcontractors cannot concentrate and follow many project at the same time especially there are no enough number of contractors to do the same work in the market.



All previous reasons represent good opportunities for private sector to expand projects duration in order to delay finishing of projects. As a result, companies will have the legal reasons to expand projects timing, which will cost clients to pay extra money as per their contracts. This cause has not been mentioned in the literature.

### **Expropriation**

The study found that it is hard to find big large area (land) in big cities such as alriyad, Jeddah, makkah or almadinah because its cost. A lot of times, the project face conflict with another project conducted by other firms at the same time because of project location area. Expropriation is one of the most important factor that affect many projects in Saudi Arabia especially for big governmental project. Landowner can delay a huge project because his/her land or house located within the project area. At the same time the government regulations do not assist the project to not delay. For example, four project managers said that “The land compensation is not fare enough to encourage the land owner to waive which cause a huge delay of the project, and if tis fare the government does not pay on time”. Moreover, government regulations take long time to fix such an issue. In addition, sometimes for renting land, signing the contract with selected site is taking long time because the land owner fears from any lose that may happen to him because of singing long term contract. This cause has not been mentioned in the literature.

### **Personal relationships**

In Saudi Arabia, personal relationship is playing a big role in social life. That is why, sometimes evaluation from the government side toward the private sector is not implemented and practiced as it has to be because, in somehow, there are personal relationships between private sector and governmental representatives who are in charge of projects. Two project managers said “Poor evaluation occurs by accepting the amount of contractors’ work (not enough) because of personal relationships”. That is why, contracts between private and governmental sectors must be very clear and well revised by specialized experts in this field. This cause has not been mentioned in the literature.

### **Bad human resources behaviors or activities**

The study found that because of bad human resource department behaviors or activities, it is noticed that a lot of employees’ turnover and resignations from the company. This cause affects the company performances, which leads the project to be delayed at any phase. Four project department managers mentioned that human resource department is one of the most important department in the company to keep and encourage the employees to stay in, especially for expertise. It should work had to reserve good employees. Seven managers have stated that human resource department should give attention to employee turnover and resignations from the company because it is for sure will affect the company performance negatively due to loss of professional employees. Therefore, the project could delayed in any phase of projects. This cause has not been mentioned in the literature.

### **Weak outsourcing and foreigner experts**

The study found that many foreigner companies are less than the required level of experience and practice. In governmental big project, sometimes because of politics force, decision

makers accept hiring foreigner companies to improve the relationships with countries and to obtain other objectives (not clear to project managers). This affects the projects in terms of quality. Six project department managers said, “Outsourcing should be helpful for us and we should take advantage from it, in many cases, we teach and foreigner outsource show to work”. This cause has not been mentioned in the literature.

### **Contract manipulating**

The researcher found that because of the manipulating in the contract word, sometimes companies tend to take advantage of some statements in contract in order to win more money and time. This is can happen between all project parties (contractors and consultants) against the client. Seven project department managers said, “A few words can play an important factor or reason of delaying huge projects and cost a large amount of money”. That is why the contract statement should be clear. This cause has not been mentioned in the literature.

### **SUGGESTIONS AND RECOMMENDATIONS**

- All goals and targets should be identified and tied to time, and higher management should follow the plan.
- It is very important coordination department should be established from consultant’s side of the project.
- In big project managers should be evaluated regularly. At the same time, they should be honest and brave to say NO when they need.
- Applying penalties for any delaying in the project delivery.
- The owner and the consultant should be so accurate in selecting the contractor who have a good history and reputation, and they should not stick in one consultant or contractor. At the same time, they should block contractors, who did not finish his scope of work in the specified time, to take any projects in the future, and add them in a black list.
- It is better if the project owner distributes the big projects to different qualified consultants instead of one consultant.
- Government should reconsider and improve the bureaucracy procedures by, making the relationship between top management and private sectors more flexible (open new communication channels), and developing new systems, methods in order to improve the performance and old regulations such as expropriations procedures. For example, Government should contact the property’s owner in early time and explain that the property location is in the expanding the Project, and the government should pay the fair financial compensation early.
- The government should support the local contractors by qualifying more number of local contractors, at the same time, if it is necessary, the government could invite international contractors to enter the market, especially from the far east countries such as south korea, china.
- Contracts agreements between stakeholders must be very clear and reviewed be experts before signing to avoid changes, and auditors should monitors and reviews the whole procedures regularly.

- Each project should have Projects Office to keep the projects documents and records. This will help the future projects team to learn from the previous mistakes and were the solutions
- Infrastructure new districts should be planned and designed very well. It is recommended that building underground tunnels can have all services such as electrical cables, communication cables, and sewage pipes, so no need to dig for each project, and the maintenance will be easier
- The ministry of education should pay a lot of attention for training to improve the technical skills for Saudi employees.

## CONCLUSION

Finally, the main objective of this article was to find out in-depth the causes of the project failure in construction sector and how can be resolved in Saudi Arabian. The article's significance derives from the following main factors. First factor is that this article represents an important contribution to the construction project field in Saudi Arabia. Second factor is that this one is conducted in specific sector (construction) which providing rich and concentrated information which could be generalized to other countries.

The study found that there are many causes could affect projects negatively in Saudi Arabia. These causes are Materials Supply Delays, Scope creep, No top management support, Weak project manager, team and consultant, Poor planning (unrealistic Planning), Bureaucracy and some governmental Policies, Expropriation, Personal relationships, Bad human resources behaviors or activities, Weak outsourcing and foreigner experts, and Contract manipulating.

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# A Study of State of Food Retail Supply Chain in Saudi Arabia: A Conceptual Framework

Salah Mahmoud Abunar<sup>1</sup>, Mahmood Ali<sup>1</sup>, Mohammed Fazelrabbi<sup>1</sup> & Hosam Ismail<sup>2</sup>

<sup>1</sup> College of Business Administration, University of Business & Technology, Jeddah, Saudi Arabia

<sup>2</sup> University of Liverpool, Liverpool, UK

Correspondence: Mahmood Ali, College of Business Administration, University of Business & Technology, Jeddah, Saudi Arabia. Tel: 966-2-215-9161. E-mail: m.ali@ubt.edu.sa

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## Abstract

Supply Chain Management has been playing a key role in food retail business in the developed countries by providing various segments of customers with quality products in a highly-efficient manner. The Kingdom of Saudi Arabia (KSA) is following the lead of the developed countries through a rapid growth trend in super and hypermarkets. However, the role of supply chain management in proposing products which meet customers' needs has not, up to now, been definitely-set, well-established or thoroughly investigated because of a lack of readily-made-available data. There is an obvious need for an appropriate framework for KSA's food retail sector for the purpose of studying the roles and impacts of the various divisions of the supply-chain process. This paper describes a conceptual framework that researchers can utilize to further study the current conditions of supply-chain and its impacts on the food retail sector in Saudi Arabia.

**Keywords:** retail sector, supply chain management, supermarkets, Kingdom of Saudi Arabia

## 1. Introduction

The Kingdom of Saudi Arabia (KSA) is a major emerging economy in the Middle East. A good part is owed to its Government's drive in supporting the economy of the Kingdom, coupled with boosting the spending power of the Saudi citizens. This has significantly contributed towards a growth in the dynamic food retailing sector, including the grocery industry in both: super and hypermarkets. However, out of the developing countries, the Saudi retail sector ranked 16<sup>th</sup> in retail expansion according to Shabat and Moreiarti (2012). Moreover, Swartz (1997) described the Middle East, inclusive of KSA, as a "potential franchising hotspot" pertaining to an intense competition amongst its businesses to attract foreign investors. Whilst, Young (2001) concluded that there is a long-term potential in the Middle East market as the region has been adapting to new circumstances, and henceforth, is likely feasible and more tolerant for adjustments. For instance, the Saudi household unit is enormous when compared with that of a typical Western family. Hence, Saudis have a tendency to buy large quantities of consumer products and food stuffs (Culpan, 1985). Of course, such expenditure helped the super and hypermarkets expand and flourish all throughout the Kingdom, increasingly contributing to its overall economic activity.

In addition, the Saudi government's plan to inject SR 100 billion during the next 5 years in support of its economy has also definitely and positively stirred up its markets. In return, this has contributed to a current 40% increase in consumer shopping at major retailers, in contrast to Al Kathery's (2011) anticipated 60% growth (Al-Rajhi Capital, 2010).

The area of information sharing in the retail industry and the advantages of collaborative supply-chain activity between suppliers and retailers has been a subject of several studies (Inc, 1993; Cachon & M, 1997; Clark & Hammond, 1997). These studies have highlighted the importance of implementing these concepts through the introduction of new technology, collaboration and information sharing with upstream and downstream partners. Cachon and Fisher (1997) suggest that sharing information and real time demand are important factors for improving supply chain performance. Whilst, Lee and Moinszadeh (1986) found that sharing information in the grocery sector could lead to 23 percent reduction in cost.

The review of the literature and the current state of the Saudi food retailing sector, evident in a lack of research in this area, suggest a huge gap in the literature covering the supply chain in Saudi food retailing sector. The statistical data, be it from governmental or private associations, is very limited, and where it is available, it is ambiguous and loosely covers the entire retailing sector. The structure and nature of the relationship between the KSA's supermarket and its suppliers, the degree of supply chain integration, as well as the conflicts within the sector have not yet been discussed in the literature of supply chain industry. Among the few studies in this area, Al-Sudairy and Tang (2000) identify the extent of information technology used in the supermarket chains in Saudi Arabia. While, in a recent research, Qureshi, Ansari and Sajjad (2013), investigate the contemporary issues faced by human resources management in the KSA's retail sector. In research, it is concluded that due to the active growth in the retail sector, human resources management has become eminent in relation to other managerial initiatives and plays a critical role in the retail industry. Mahfooz (2014) focused on the relationship between service quality and customer satisfaction in hypermarkets in Saudi Arabia. It's also worth noting that, in this study, data was collected using questionnaires carefully composed based upon "convenience sampling" techniques. It does not, however, cover the particular issues with the food supply chain in the country.

The work described in this paper evaluates the current state of supply chain retail industry and examines the nature of the collaboration between the supply-chain partners involved in the trading process in the Kingdom of Saudi Arabia. This paper addresses the next stage in improving the understanding the state of the retail supply chain by proposing a conceptual framework which encourages further studying, evaluating and then offering strategies to enhance the collaboration and integration between supply chain partners in KSA. Therefore, this study is structured as follows: the first part review the literature on the supermarket industry in developing countries and KSA supermarket context. The second part presents the conceptual framework. The third part highlights the research questions which this research is seeking answers, followed by a conclusion and the future work.

## 2. The Supermarket Industry in Developing Countries

Remarkably but not surprisingly, the natures of developing countries appear to vary in many ways from those of developed countries in terms of economic stability, cultural considerations, industrial resources and technological reliability (Goldman, 1974). Consequently, developing countries, particularly those in Latin America, Asia, Central Europe, Eastern Europe, and parts of the African continent, as had been foreseen, lagged behind in introducing retail services into their markets, that which has notably affected the subsequent development of these services. In fact, food retailing in developing countries was traditionally limited to supplying customers with basic-life provisions such as sugar, eggs, oil and rice. Similarly, meats and poultry were usually sold in special shops.

Literature suggests that the growth of the number of supermarkets from 1950 to 1980 was not only very slow, but had also concentrated in big cities, as it was particularly there where customers of higher-incomes settled (Holton, 1953; Galbraith & Holton, 1965; Goldman, 1974; Findlay et al., 1990). Goldman (1974) argued that the slow growth in developing countries occurred for a number of reasons. One reason was that of the richer classes' lack of interesting actually buying retail products, a second was the high cost of transportation to and from supermarkets, and a third was that the prices of goods were higher than it were in traditional groceries and food corner-shops. It's worth noting, however, that buying from a supermarket was still a new concept at the time. Therefore, getting customers to break their traditional and social habits or contradict their social norms and cultural teachings, especially in their everyday practices, of course, entailed devising effective marketing plans. In response, supermarkets had to reduce their selling prices so as to attract their intended consumers. The growth which then followed, as Reardon, Henson and Berdegue (2007) argue, was the result of the change in shopping habits of the female shopper and that in the social attitude of high-income earners. This contributed to the largest increase in the number of supermarkets in the developing countries in the 1990's.

According to Reardon et al. (2007), the transformation took place due to different reasons. One is the fact that consumers were increasingly becoming able to afford the equipment, such as refrigerators to store and sustain foods for longer times. In addition, improvement in the transport infrastructure allowed for easier and more efficient means for transporting goods to and from supermarkets by their suppliers/manufacturers (Reardon et al., 2003a; Wrigley, 2000). In the US, for instance, the supermarket share of the retailing sector ranged between 75-80 percent in 2005. While, in some developing countries such as in most of South America, East Asia, Northern Europe, Eastern Europe, Baltic, the approximate value of supermarket share of retailing revenues increased from 10-20 percent in 1990 to 50-60 percent in the 2000s.



### 3. The Saudi Arabian Supermarket Context

The first supermarket in the KSA was established in the Eastern region in Al-Dahran in 1974. Originating in 1974, it was run by British management and was later owned by AL-Souk Company Limited. Since then, the retail market in Saudi Arabia has undergone rapid transformation due to rationalization and modernization combined with huge expansion (Rossides, 1994). The retail food industry has grown vastly during the last ten years in KSA. These outlets are most popular among the Saudi consumers and have resulted in a rapid increase in the number of supermarkets in the last ten years (Leonidou, 1991).

Previously, Rossides (1994) observed, the corner shop was the dominant form in the Saudi retail market. There were very few modern self-service stores or supermarkets offering wide ranges of goods to customers. Alawi (1986) stated that the emergence of supermarkets in KSA was motivated by various factors. One, for instance, is the Government's incentives to encourage trades men to practice and apply the newly implemented and desired ways to business. Another factor lies in the general rise in customers' incomes, the readiness of the traders, and the availability of start-up funds offered by the government. Supermarkets initially started in the Kingdom's bigger cities such as Riyadh and Jeddah. The sizes of stores at the time were limited and managed to sell a relatively small number of groceries' items. By the 1980s, there was a major change in how supermarkets did their business. Simply put, the markets adopted high pricing strategy while targeting affluent customers to increase profit margins. This strategy was very successful at the beginning in attracting middle and high-income earners because of the features of the stores being generally clean, organized and air-conditioned. However, later supermarkets reviewed their pricing strategy to target more customers to compete against other stores. Let alone, customers in the region started expecting much more than quality and low prices, and customer loyalty was becoming even harder to retain (Alshaya, 2001). The supermarkets responded by enhancing their services through opening new sections inside their stores to provide a variety of products to their customers (Alawi, 1986; Al-Sudairy & Tang, 2000). Supermarkets who had previously sold 12,000 items increased sales up to 50,000 items within a short time. At the present, there are 21 large supermarket chains in KSA. The size of the supermarket depends on the number of chains or the size of the store (Al-Sudairy et al., 2000).

### 4. Previous Studies on Measuring Supply Chain Collaboration

Literature review suggests limited research in the area of retail-supply-chain. Lawson (2001) analyse the operational strategies of retailers in the both of USA and Europe, and conclude that retail supply chain managers employ a broad array of strategies to overcome the operational challenges. Adopting those strategies, Morrison and van Assendelft (2002) find that top-performing retailers held one-third less inventory when compared with average ones. In addition, top retailers hold more than the double revenue growth and one-third higher operating income margins than average retailers. In other studies, researchers focus on the micro perspectives. For instance, Hines et al. (2006) study a single product's link between suppliers and retailers, Fernie, Pfab and Marchant's (2000) studies on grocery supply chain in Spain, while Mejias and Prado's (2002) studies on that of the UK's retail supply chain. Mukhopandhyay and Setaputra (2006) suggest that the value of outsourcing on retailers cost reverse logistics activities. Kent and Mentzer (2003) developed a concept of relationship strength using retailers as part of the sample.

Al-Falah et al. (2003) find a lack of Supply Chain Management (SCM) awareness in Saudi manufacturers and a need to integrate the supply chain with the suppliers. Rather, it is observed that Saudi manufacturers view supply chain management as part of a traditional inventory management system. Simatupang and Sridharan (2005) propose an instrument to measure the extent of collaboration in a supply chain, based upon suppliers' and retailers' use of information sharing, decision synchronization, and incentive alignment. Ramadas and Spekman (2000) studied the collaborative practices of high performers in innovative product supply chains and high practice performance in functional-product supply chain.

### 5. A Conceptual Framework

Indeed, literature on the matter suggests a lack of research in the area of retail food supply chain in the KSA. Therefore, we present here a comprehensive conceptual framework for analyzing the state of food retail supply chain in the Saudi Arabian supermarket sector. In order to have a comprehensive understanding of the current state of the retail food supply chain, this study proposes an analysis of all the factors involved in the supply chain using the qualitative and quantitative methodology as shown in Figure 1.

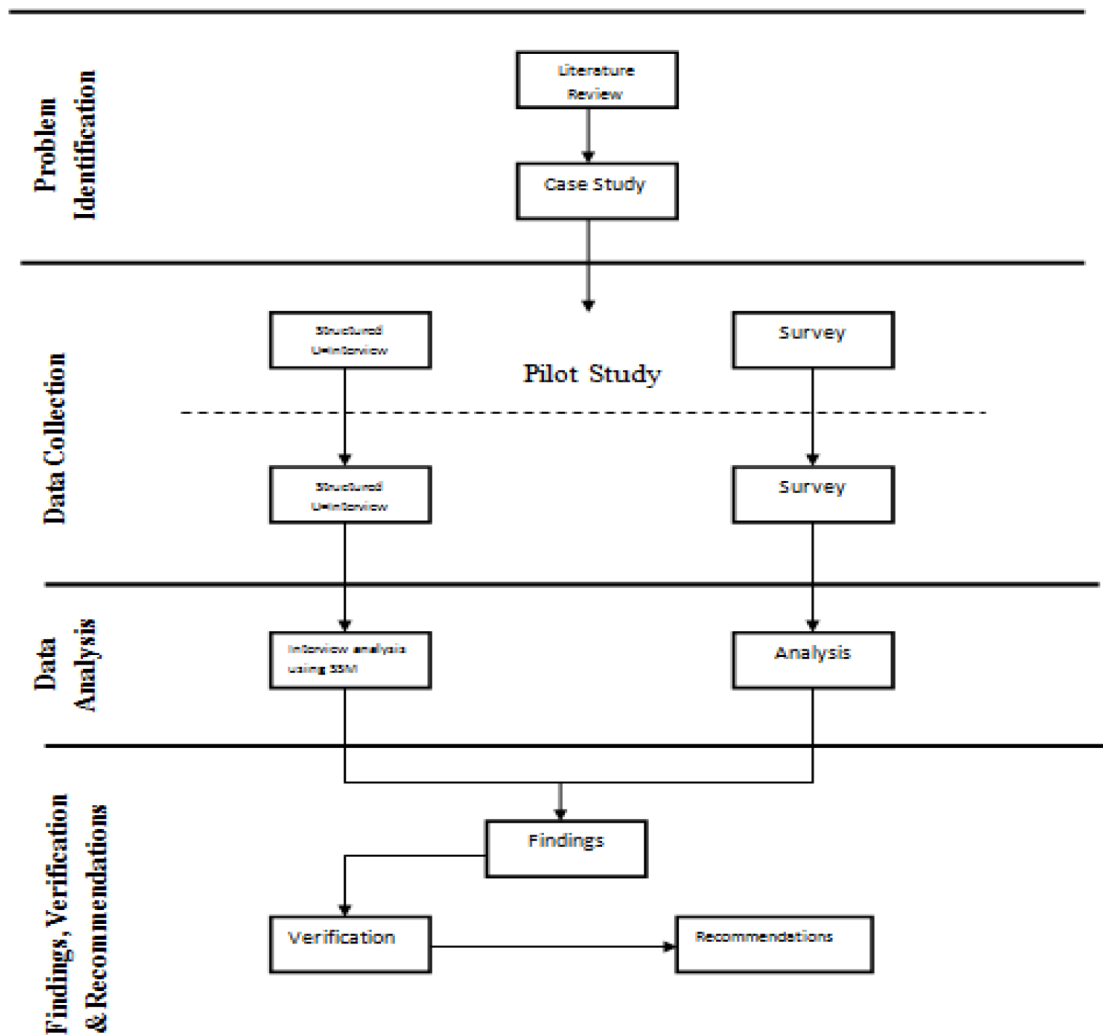


Figure 1. Research framework

The general methodology for a critical assessment of framework consists of the following steps:

#### 5.1 Literature Review

A comprehensive literature review will be performed gain the understanding of the area of supply chain. The literature review will cover supply chain management, its benefits and challenges, and the collaborative role of IT in the supply chain activity. Next, the supermarket industry in developed countries such as the USA and the UK's will be examined. It will be followed by a review of the supermarket industry in the KSA to offer a better understanding of the Saudi market, underlying cultural issues, economic factors, IT usage and human resources. The focus of the literature review will be the articles, research journals, conference proceeding papers and news' articles. To gain a comprehensive understanding of the matter, the review will not be limited to one specific subject, but will rather cover the topic in its broader sense.

#### 5.2 Case Study

Next, a qualitative case-study approach shall be adopted and two case studies are to be conducted to better answer key "why" and "how" questions. Yin (2003) suggests that such an approach is an ideal method, especially when a "how" and "why" question is being asked about a set of events over which the investigator has little or no control over. As a matter of fact, the "how" questions are usually associated with describing relationships, while the "why" questions tend to explain the reasons why those relationships exist (Yin, 2003). Two organizations, one from the UK and another from the KSA, will be selected for the case-studies. This will

allow for an in-depth analysis of the cases studied and a better understanding of the behavior of the retail sector, comparing the SCM practices between the UK and the KSA.

### *5.3 Consumers Survey*

Once the two markets are compared, in the next phase, this research shall conduct a quantitative consumer survey to illustrate how consumers' shopping preference and satisfaction are influenced by the collaboration between suppliers and retailers. In addition, the way the nature of the relationship between suppliers and retailers affects the consumer's shopping decision and level of satisfaction at the services' level in the Saudi supermarket shall be discussed. The sampled population in the survey shall consist of a wide and diverse variety of Saudi consumers in society.

### *5.4 Structured Interviews*

The structured interviews will be carried out with key suppliers or retailers in the Saudi organization. Based on the fact that the relationship between retailers and their supplier have a profound impact on the consumers, the primary purpose of the interviews is to extract information on the procedures and the processes adopted in their daily operational activities. Besides acquiring more information about the retail supply chain in the KSA, which suffers from a lack in literature, the structured interview could assist in identifying internal difficulties faced by Saudi supermarkets from different perspectives. This could include gaining further insight into the technology used to test the quality of the products inside the organizations, the mechanisms employed to identify expired goods, and the stages of the supply chain process from order placement up to successful delivery. Therefore, a detailed investigation shall be carried out encompassing the major actors, retailers and suppliers.

### *5.5 Data Analysis and Proposed Model*

In the next phase of this research, the collected data including data analysis tools and Soft System Methodology shall be analyzed. The derived findings will be used to propose a model to examine the state of retail supply chain and propose recommendations to enhance the collaboration between the suppliers and retailers for a more effective and integrated supply chain.

### *5.6 Verification of a Model*

The last phase of the research involves model verification. Model verification is an essential part of any model development since it ensures and validates the basic construction and performance of the model. According to Sargent (2011), the developers and users of these models, the decision makers using this information obtained from the results of these models, and the individuals affected by decisions based on such models are rightly concerned with whether a model and its results are "correct". Therefore, the model verification process is intended to ensure that the model does what it is intended to do. Usually, in model verification purposes, there are acceptable ranges and a model is considered "valid" if the results it produces are within these ranges (Ali, 2013).

Therefore, to verify the validity and practicality of the recommendations, this research will present its findings and some useful recommendations of professionals working in the supply chain of major retail supermarkets in the KSA to seek their opinions on the various matters in discussion. In addition, the value of these findings and its practical application shall also be verified.

## **6. Development of Research Framework**

The proposed framework discussed and shown in Figure 1 has yet to be developed. Once the data is collected and analysed, it can assist in gaining an insight into the current condition of the supply-chain in the KSA, and thereafter, specific & required changes can be recommended. The proposed framework should assist in identifying and evaluating the following:

- To identify the level of information sharing between the retailer and supplier.
- To discover how supermarkets deal with the quality of the products once they receive them from suppliers and if they use certain checking procedures.
- To find out how the retailers check the stock, and what is the behaviour of inventory management in Saudi supermarkets.
- To identify how they are processing the orders and the procedures suppliers follow in order to get orders from supermarkets.
- To evaluate the effectiveness of communication in enhancing the supply chain performance.
- To evaluate the impact of suppliers and retailers relationship on the services provided to the customers.



Furthermore, different strategies can be analyzed and implemented to ensure a reliable and efficient supply chain system.

## 7. Conclusion and Future Prospects

This paper proposes a conceptual framework which opens a way for a precise and factual evaluation of the state of the retail food supply chain in the Kingdom of Saudi Arabia. Responding to an evident lack of research in this area, this study aims at filling the gap in knowledge by evaluating the current state of the retail supply chain in the Kingdom and the circumstances which bound it. The retail supermarket sector of the KSA is fortunately still at its outset. Even though major supermarkets, local and foreign, are heavily investing in setting up new distinguished businesses, surprisingly, however, they are hardly applying the appropriate strategies and schemes underlying the supply chain system. This, in turn, causes operational difficulties, which inevitably lead to financial losses and a significant drop in customers' loyalty. Therefore, findings and recommendations drawn from this framework could enable the practitioners and researchers to gain further insight into the condition of the supply chain industry in Saudi Arabia, and its effect on the food-retail process in particular. More importantly, the viewpoint of incorporating "proper" strategies into their operations could evidently make organizations in the supply chain system more efficient and responsive, especially to external environments.

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## A Study on Consumer Perception towards E-Shopping in KSA

Mohammad Zulfeequar Alam<sup>1</sup> & Sheriff A. Elaasi<sup>2</sup>

<sup>1</sup> Department of Marketing, College of business Administration (CBA), University of Business & Technology (UBT), Kingdom Saudi Arabia

<sup>2</sup> Head of marketing department, CBA, UBT, Jeddah, KSA

Correspondence: Mohammad Zulfeequar Alam, Department of Marketing, College of business Administration (CBA), University of Business & Technology (UBT), P. O. Box 110200, Jeddah 21361, Kingdom Saudi Arabia.  
E-mail: zulfeqarm@ubt.edu.sa

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### Abstract

Marketers are facing new challenges of marketing in the new millennium due to the changes in the consumer buying behavior associated with disruptive innovation, virtual communication, purchasing habits and consumption pattern. The rapid rise of online marketing has captured the attention of marketers and consumers nowadays. At present online shopping became the ideal for the people in the world. In Saudi Arabia most of the citizens having the access of internet facility and good purchasing power however still e-shopping are not in trend of Saudi Arabian consumers; around 62% of the population of the country did not even shop online by Al-Salamin (2014). The objectives of the study are to provide an in-depth understanding regarding customer perception on e-shopping, payment method were used; the risk factors involved and the preferable devices were utilized for e-shopping. For the study a survey of 128 respondents of Saudi Arabia were conducted during the period of 3 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 suitable statistical tools. It was investigated that the majority of the respondents had involved in e-shopping, 73% of respondents are feeling e-shopping as easy shopping, 44% consumer use credit card as a payment method and 40% of the respondents preferred to buying product/ services through laptop when buying online. The quality of product was reported as a highest worrying factor by the majority of respondents.

**Keywords:** E-Shopping, consumer perception, online shopping, e marketing, Saudi Arabia

### 1. Introduction

In the past individuals used to buy their needed product or services from stores and traditional market. It was the only option to fulfill their needs. With the rapid development of the new trend in e-shopping has shown positive results in buying habits to the consumers. However, this seems to be able to access without the physical location is the most useful methods to buy goods and services. With increasing use of internet trend by consumer and their purchasing power they are willing to shop virtually. This is the reason that number of enterprises has developed commercial sites and portals for e-shopping.

As indicated in several research that "Internet technology growth in the Kingdom of Saudi Arabia has enormous prospective as it decreases the price of goods and amenities, and expand the geographical boundaries of market. Technology and the emergence of the Internet, not only allow persons to make purchases virtual, but also it improve the economy and promote worldwide trade" Alden et al. (2006); Al-Somali et al. (2009); Alied F et al. (2009).

Due to high need of shopping retailers wanted to improve the quality of the online shopping experience for customers. However, the level of confidence in making payments online is still not developing fully. In a euro monitor report in 2012 indicated that "with the expansion of the Internet, e-shopping is growing rapidly in the country, and is currently at 60% of the consumer using it, due to reason many online retailers trying to recover the excellence of the virtual marketing involvement for the shopper.

Online business or online shopping has brought big changes in the opportunities and challenges for the business houses. From customers' perspective, the line of demarcation between local and global business firms and/or products has narrowed down where quality, value, time, convenience, style etc. matters a lot. For example,



reduce the buyer's evaluation time for purchase, good decision after evaluation and in order to resolve invoice discrepancies and spend less time and ultimately increase the chances for the purchase of substitute products. In addition, customers can appreciate online shopping 24 hours a day from everywhere. Particularly customers of Saudi Arabia with high disposable incomes are willing to spend on online shopping these days but, the self-confidence of payments through Internet have not been fully developed and its need to adopt market driven strategy to achieve the better performance and value .

### *1.1 Scope of the Study*

The area of this study covers all industries and marketers within the KSA. However the study is specially focused on the retailers who trade their products and services through online or having intention to sell in future.

### *1.2 Significance of the Research*

- This study will be helpful to a number of business groups in KSA.
- Another set of interest group that will be benefited from the findings of this research will be Government, marketer in general and particularly retailers who approach online business in KSA.
- The beneficiaries of this study is the international community particularly in the area of related field of study
- This study will be helpful for researcher for further in depth study.

## **2. Literature Review**

Progress of Internet and e-commerce has border trade shrank, leading the company to create opportunities and accomplish modest consumers, directly across the globe. As per the study by Griffiths et al. (2006) the economy and social science research now focuses specifically on Internet marketing and transnational and intercultural issues on eshopping.

As per the study of Alsomali et al. (2009) “the growth of Internet technology in the Kingdom of Saudi Arabia has a huge potential because of the less cost of products, services and escalation of environmental boundaries reduces the limitations to meet purchasers and vendors together. Advent of equipment and the Internet not simply permit persons to online shopping, but also to make to develop the economy and to promote global business through worldwide trade, international companies and local alternatives consumption worldwide.

It was also indicated in a report in April 2012 by Master card.com “46% of buyers of Saudi Arabia, that internet access for online shopping are progressively gaining popularity in the Kingdom of Saudi Arabia”. Internet tools leads to on-line activities, the purchase of goods and payment on shopping sites with laptops at any time wherever that showed online shopping growth on a remarkable scale in these days (Shim et al., 2001).

According to a study Saudi Arabia was one of the most important markets in the developing Arab world with respect to the foreign E-retailers, despite the widespread use of Internet in this country, the relatively low rate of 5% the population in 2003 were estimated to be around 1.4 million Internet users, Sandhu (2010); Sait, et al. (2004). Besides it Al-Somali et al. (2009); Eid, M. I. (2011) also reported that “the use of internet encourage the adoption of online banking by customers in Saudi Arabia”. In one study it was noted that, “the Saudi Arabia E-Commerce spending is 12 billion, Saudi Riyal (SR) in 2010; however, only 14.26% of the Saudi population was involved in E-Commerce activities” AlGhamdi et al. (2012).

Changes in lifestyles of consumers and demographics also contribute to changing consumption patterns, satisfaction and loyalty. The large increase in the number of population, improving education, increasing expectations and urbanization of rural areas in the country could play a vital role in the pattern of behavior to current purchase. And it also changed the Saudis customers for grooming, clothing, leisure habits, savings, investment, and communications facilities, transportation, and travel & tourism sectors. Berry et al. (2002), in his study raveled that the side of the interaction of e-commerce applications it is closely linked to customer loyalty. The interest in cultures and confidence in e-commerce is important for the buyer. In this study it highlights the three different aspects depending on their importance can detrainments the use of electronic commerce: complexity, privacy and compatibility were among of them. The complexity (privacy) has proved the most important element in terms of the extension of electronic services easy or difficult to use by the consumer (Kushchu et al., 2004).

On the other hand, compatibility is one of deterrence key factors consumers' use of e-transaction, due to the extent that electronic transactions related to language, culture and values of consumers (Asianzu, 2012). The success of e-shopping factors is based on influencing, satisfaction trust and loyalty as indicated by (Srinivansan, 2002). In one study it was found that a higher proportion of spending in the Internet was music download sites, instead of

traditional sales. And other major categories of computer programs, airline tickets and products / services online games in the virtual world (Wei et al., 2010).

In addition, researcher stressed the importance of issues that touching the achievement of wired shop comprise timely delivery of products. In addition, there was a comprehensive study of the attitudes of online buying habits in currently to recognize aspects that touch purchasing choices toward e- shopping (Zhang et al., 2002). Captivating into reflection those virtual supply qualities and the important in selecting a Website design dramatically affects attitudes and buying behavior in the purchase and repeat purchase decision. Internet use in recently not only restricted to the nets of media, but also extended to be used as a treatment method for consumers in the world market (Childrs et al., 2001; Delafrooz et al., 2010). The researchers discuss in their study and concluded that “security problems in conducting online transactions and the reliability and credibility of online merchants have a direct impact on consumer confidence in making online purchases” (Wei et al., 2010).

Moreover, clients require the elasticity, the broadest variety of goods; they remain capable to take a percentage of info from diverse bases, relate values and do purchase with their own convenience and create greater opportunities for the transformation of the various electronic retailers and suppliers. Therefore, by shopping online customers have access to a wider product range conveniently without limitations (Brynjolfsson et al., 2000). A study done by mastercard.com also supported the above study (Master card.com. 2008). Hereafter, it encounters to retain and attract customers to online retailers. To achieve it is significant for virtual venders to comprehend the features that inspire customers to works virtual which will chief them to whole their automated spending acceptably (Celik, 2011). According to the (Eid & Talal Maghrabi, 2010) the major key success factors for e-shopping were safety threat, and privacy perception or customer satisfaction to motivate shop online. E-commerce customer loyalty in Saudi Arabia is strongly influenced by customer satisfaction but weakly influenced by customer trust (Eid, 2011). According to the press release “Online spending is attractive in KSA-showed by the great level of customer satisfaction among those who have made a purchase online, the major categories of products that were purchased online via mobile phone included airline tickets, phone apps, toys, gifts, clothing, accessories, home appliances and electronic products” (master card.com).

A research report indicated that “Saudi market share in e-commerce is expected to top out at \$13.3 billion by 2015, with 25 percent of that figure coming from Internet users in the country who routinely make online purchases” (PixHeart, 2015). All told, e-commerce in Saudi Arabia is expected to have a valuation worth 8 percent of the country's total retail sector. This is expected to surpass countries such as France, the U.S. and Japan who are already very active when it comes to making online purchases. As per the report by Alzazirah “KSA has the second largest e-commerce market in the GCC with an estimated \$520 million and the sales will reach about SR 50 billion in 2015” (Al Jazirah, 2013). According to the report it was indicated that “Saudi Arabia is the late adopter online shopping compared with industrialized countries” (arabnews.com, 2007).

### *2.1 Research Gap*

Although, many research has been done in the region and as well as worldwide to understand the e-marketing perceptions. But there is still a need to determine and measure the factors of e-shopping that will create the greater values for e-shoppers in fast competitive and dynamic environment of market. To give more value product and services to the consumer it is always recommended that marketer's should have customer driven market strategy. Therefore, the present study is an attempt in this direction. As well as the paper will focus on the perception of customers towards online purchase and its marketing practices.

### *2.2 Objective of the Study*

The major objectives of the present study are to recognize the Saudi consumers' buying perceptions and preferences for shopping in the region. However the specific objectives of the study are as follows:

- i) To understand at which level consumer feel convenience to e-shopping.
- ii) To identify the preferable payment method they prefer to e-shopping.
- iii) To investigate the risk factors involved in e shopping.
- iv) To explore the preferable devices were utilized for e-shopping.
- v) To determine the preferred website for e-shop in the region.
- vi) To explore the types of products they prefer to buy through online.

## **3. Research Methodology**

The main purpose behind this research was to know the respondents' thoughts, preferences and perception of

Saudi customers' towards e shopping. A convenience sample survey has been conducted of 128 respondents through online and offline (in Jeddah City, KSA) during the period of three month from September to November 2015. The close ended questionnaire was used for the purpose. Special 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 analysis descriptive statistics (frequency distribution) were used and result findings were interpreted.

#### 4. Findings/Discussion

##### 4.1 Demographic Information

Table 1. Demographic information of respondents

Variables		Frequency	Percentage
<b>Gender</b>	Male.	63	49.21%
	Female.	65	50.79%
<b>Age</b>	Less than 20.	12	9%
	20 - 30	95	74%
	30 – 40.	10	8%
	40 and above.	11	9%
<b>Family Monthly Income</b>	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%
<b>Profession</b>	Student.	79	62%
	Privet Sector worker.	21	16%
	Governmental employee.	10	8%
	Unemployed/ house wife.	13	10%
	Business Man/Women.	5	4%
<b>Education level</b>	Less than high school	6	5%
	High School.	22	17%
	Under graduate.	85	67%
	Post-graduate and more	15	11%
<b>Total</b>		<b>128</b>	<b>100</b>

The respondents were classified on the basis demographic factors such as gender, age, monthly income, education and profession. From the above Table 1. We can see that male and female are almost equally representing the sample. About 74% of the respondents were between the age groups of 20-30 years. This age range broadly reflects the profile of the young Saudi population. In the sample 83% of respondents representing their monthly income within the group of less than 10,000/- SR and profession wise majority are students that is 62% of total sample size followed by privately employed 16%, Government employee 8%, 4% businessmen/ businesswomen and unemployed/ housewife were 10%. Majority of the respondents are having under graduate degree i.e. 67% followed by high school 17%, post graduate and more 11% and less than high school representing 5% of the total respondents.

##### 4.2 E-Shopping Motivational Factors

The Figure 1 provides the information regarding the motivational factors that motivate to shop online. It reveal that saving time is the most important reasons for choosing online shopping i.e. (37%) followed by convenience (24/7) 29%, easy to evaluate and compare 27% and 7% affirm other reason of choosing e shop.



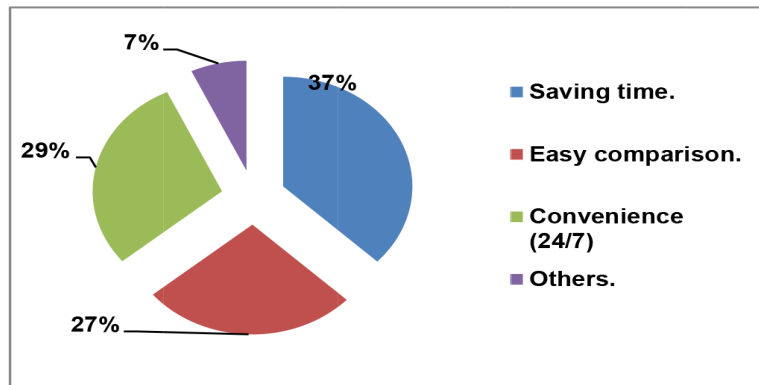


Figure 1. E-Shopping motivational factors of respondents

#### 4.3 Handling/Surfing and Understanding of E-Shop Websites

As indicated in the Figure 2. majority of the respondents (73%) do agree that handling and understanding the e-shop websites are easy, 20% of the respondents feel it neutral and 7 % respondents affirmed that it is not easy to handle and do shop through online. The reason behind it was that many times during shop they session expired, server slow and faced problem in payment.

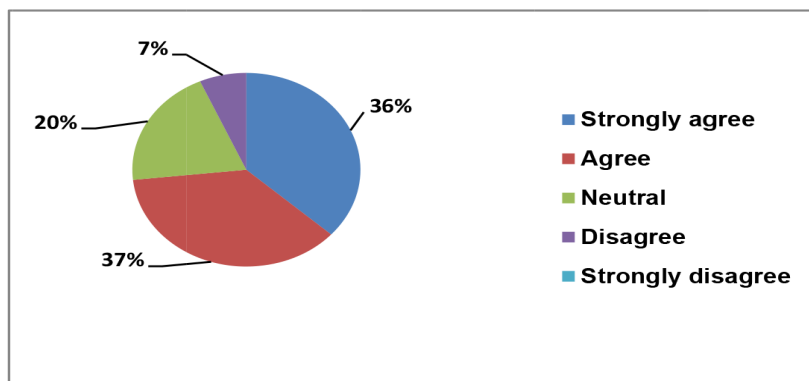


Figure 2. Handling and understanding of e-shop websites

#### 4.4 Mode of Transaction

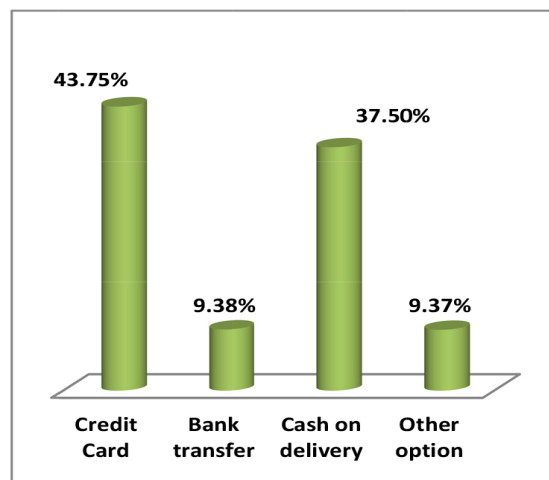


Figure 3. Preferred mode of payment

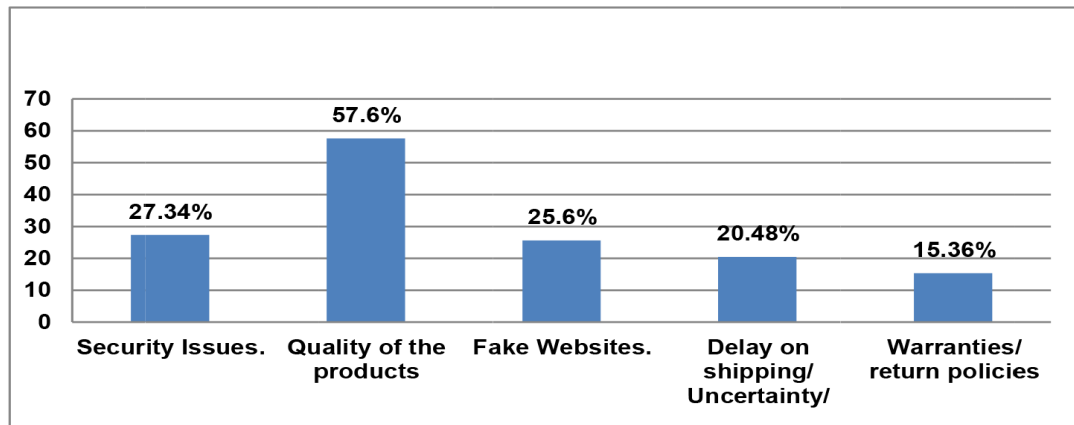


Figure 4. Risk factors associated with e-shopping

When respondents were asked regarding the mode of transaction they chose to pay at the time of e shopping majority affirmed (Figure 3) that they do transaction by credit card that is around 44% of respondents preferred mode, 37.50% of respondents indicated that they prefer to pay cash on delivery facility while bank transfer (9.38 %) and other mode of payment (9.37%) were less preferred mode for e shopping by the respondents.

#### 4.5 Risk factors

On the other hand, when respondents were asked what are the risks you feel when you do shop through online? The answer were in this order; the quality of products were the most important factor followed by security issues, fake websites, delay on shipping/ uncertainty of delivery and warranties/ return policy respectively 57.6%, 27.34%, 25.6%, 20.48% and 15.36% (see the figure.4).

#### 4.6 Devices Used for E-Shopping

From the figure 5, reveal that most preferred device for e-shopping are laptop/ tablet which is 40% of respondents sample after that smart phone (35%) were second preferable device for e-shop and desktop (25%) were less preferred device to shop online by the respondents in the region.

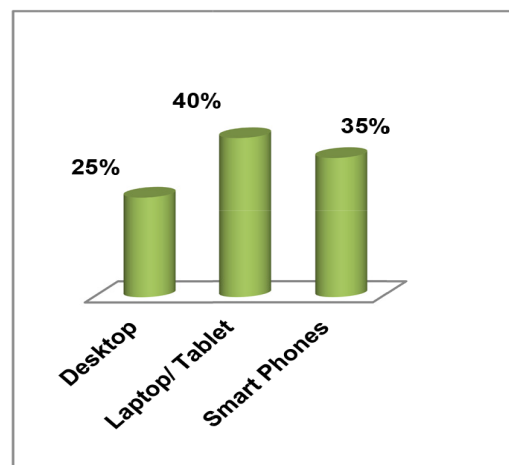


Figure 5. Preference of device for e-shopping

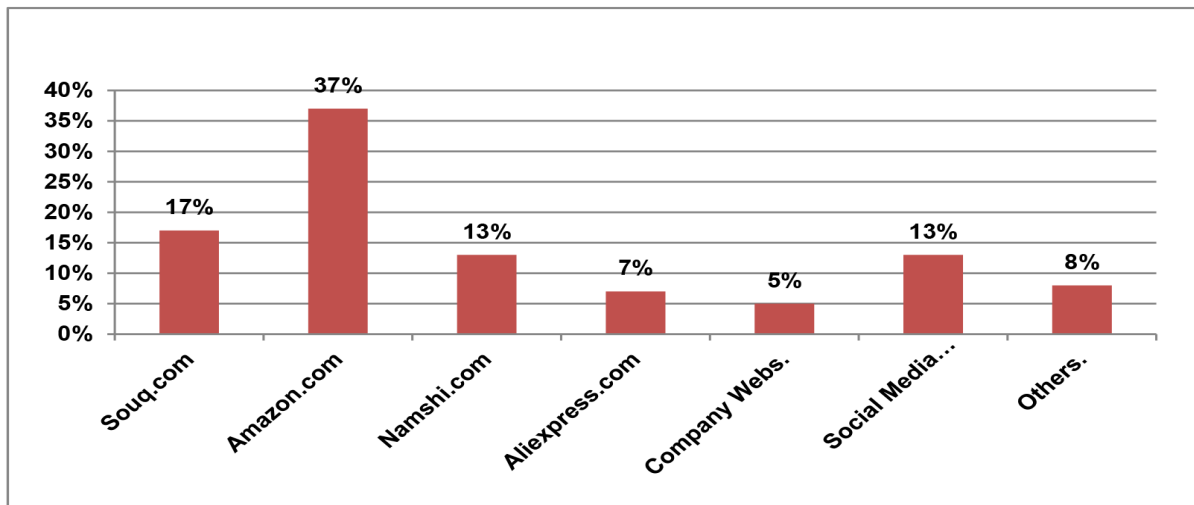


Figure 6. Preferred e-shopping websites by consumers

#### 4.7 E-Shopping Websites

When the respondents were asked to give their opinion on preferable e-shop website for online shopping the result indicated that amazon.com is highest preferable websites for e-shopping i.e. 37% of total respondents of the sample opinion. After that souq.com (17%) has second preferable choice for it. Namshi.com (13%) and shopping through social media (13%) were third preferred place to e-shopping. Aliexpress.com, other websites and company own websites respectively were 8%, 7% and 5% respondent choice for online shop (See the figure 6).

#### 4.8 Product Preferences

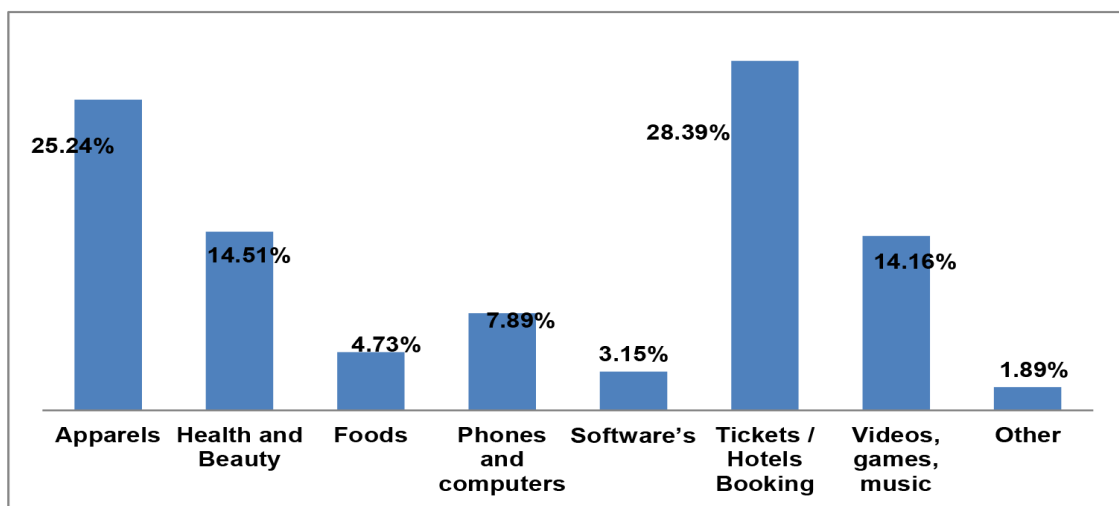


Figure 7. Product buying preferences through e-shopping

From the Figure 7, it can be observed that tickets and hotel booking (28.39%) were the most preferred buying after that apparel (25.24%) has second choice through online shopping. After that the choices of products they prefer to buy online were health and beauty (14.51%), videos, games and music (14.16%), phones and computers (7.89%), foods (4.73%), software's (3.15%) and other item (1.89%) respectively.

#### 5. Conclusion

With high rapid growth of online shopping or e-shopping at present many retailers selling products or services through online which is the important channel to expand their market locally and globally. The study reveals that



saving time is the most important motivational factor to buy online, second important factor is convenient (24/7days available) and comparing and evaluating the product are one of the important factor that make them to buy product online. Majority of respondents feel that online shopping is easy shopping than traditional one. It is obvious that online shopping consumes less time as compared to traditional shopping stores because it does not need more time to shop as well as taking less effort to evaluation of alternative products or services. The survey reveals that credit card has the strong image for online shopping followed by cash on delivery, bank transfer and other tools of transaction. Respondents feel that quality of product is the most risky factor followed security issues, fake websites, delay on shipping/ uncertainty in delivery and return policies / warranties associated with e-shopping as a risky factors when they shop online.

Laptop/ tablet has the most preferable devices to e-shopping after it smart phone has the second choice to shop online in the region. When the respondents were asked to give their opinion on preferable e-shop website for online shopping, result indicates that amazon.com having the highest preferable place for e-shopping that is an international online marketer followed by souq.com, namshi.com, shopping through social media were preferred place to shop online. Tickets and hotel bookings services have the most preferred buying through online after that apparel, health & beauty, videos, games & music, phones & computers, foods, software's etc respectively.

Finally, the researcher hopes the results and outcomes of this study might be significant helpful to e-retailers, online consumers and other researcher of this field. May e-retailers should be benefited greatly by understanding the most important factors of online purchasing behavior of consumers. And it will also be helpful to develop strategies to serve customer as per their buying needs. After knowing the important and preferable factors the e marketer can modify and adopt the way which may be helpful to serve better to the customer and to be a successful marketer in this area. However, e-retailers should keep in mind that consumer behavior might change in time to time especially in online market so the e-retailer should investigate the consumer behavior always and adapt the products and services to serve them as per the customer current requirements. Last but not least, this study is useful for the academicians where current study could serve as a reference and may provide some guides for the future researchers who would like to study about the same topic.

## 6. Limitation of the Research

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:

- Scarcity of time and cost
- This study could not cover all products and services of online shopping as only few products or services have been selected.
- The sample size was limited due to time and cost concerned.

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# Corporate Governance in the Banking Sector (Empirical Study on the Effect of Separating Chairman and Chief Executive Officer (CEO) Positions on Financial Performance)

Ayman Mohamed Zerban<sup>1</sup> & Wael Bahaa El Din Ateia<sup>2</sup>

<sup>1</sup> Department of Accounting, College of Business Administration, University of Business and Technology, Jeddah, Saudi Arabia

<sup>2</sup> Commercial International Bank, Alexandria, Egypt

Correspondence: Ayman Mohamed Zerban, Department of Accounting, College of Business Administration, University of Business and Technology, Jeddah, Saudi Arabia

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## Abstract

The subject of corporate governance has brought great attention to global business in developing and developed countries after a string collapses of high profile companies. The failure of Enron Corporation in 2001 for example shocked the investment community in its very core. Banking sector is a critical sector in any economy. A well-developed corporate governance system with clear authorities and responsibilities can contribute in advancing economic welfare. Good corporate governance enhances real investments. At the core of corporate governance lies the importance of transparency, monitoring, responsibility and accountability.

Egypt is one of the most important Arab countries. Now the Egyptian uprising has to bring into attention economic as well as political reform. The failure of the privatization program together with the lack of rules governing organizations and institutions stress the need for reform. Effective corporate governance practices are essential for achieving and maintaining public trust and confidence in the banking system.

The objective of this study is to investigate and explore the effect of separation the positions of CEO and Chairman on the financial performance of banks in Egypt. We believe that this research could be beneficial as it sheds light on new, empirical knowledge on the effect of separation positions of Chief Executive Officer and Chairman on a developing country such as Egypt struggling to achieve high rates of economic growth by creating a well-developed legal, political and economic infrastructure. The empirical study on Egyptian commercial banks measures financial performance by return on assets (ROA) and return on equity (ROE) since both ratios summarize the final results of the bank performance.

**Keywords:** Corporate governance, Banking Sector, Egypt

## 1. Introduction

The failure of Enron Corporation in 2001 was the fuel that inflamed the importance of corporate governance in developed and developing countries with different degrees. It showed the flaws of our accounting and auditing systems as well as shortages in rules governing organizations with the greed of corporate managers.

Corporate governance of banks in developing countries such as Egypt is important as banks have a great role in developing economy financial systems, and are extremely important engines of economic growth. Financial markets in developing countries are usually underdeveloped, banks are typically the most important source of finance for the majority of companies. Banks are usually the main depository channel for the economy's savings. Many developing countries have recently liberalized their banking systems through privatization and reduce the role of government in financial regulation. Consequently, managers of banks in economies such as Egypt have obtained greater freedom in how they run their banks.

Banks are different from that of non-financial institutions. Banks have many stakeholders which creates more challenges than non-financial institutions. Business of banks is complicated and can shift rather quickly due to many factors. Stakeholders in a bank include debtholders, the majority of which are the depositors. The failure of banks can create huge consequences to financial system of the country concerned as a whole (Mehran et al., 2011). As pointed



by Narwal and Jinda (2015, p.81) "Poor corporate structure results in discipline, both on the part of management and workers. Poorly governed corporations not only pose a risk to themselves, but they also cause barrier to others and could indeed pull down capital markets". The collapse of banks creates social costs to stakeholders and sometimes bank managers in their desire to satisfy shareholders can bear more financial risk which exposed stakeholders to financial disasters (Marcinkowska, 2012). The objective of this study is to investigate and explore the effect of separation the positions of CEO and Chairman on the financial performance of banks.

### 1.1 Problem Statement

The duality of Chairman/CEO is considered a debated area in research (Narwal and Jindal, 2015). The CEO a leader is responsible for implementing short and long term plans as well as the effective running of business. On the other hand, the chairman is responsible for ensuring that the board works as it should in monitoring the CEO to ensure that shareholder interest is well protected. As stated by Tonello (2011, p.1), "In light of required disclosure about board leadership structure, the decision of whether or not to separate the chairman and chief executive roles remains a hot governance topic for public companies, boards and shareholders". Since the chairman performs important control functions, it is often suggested that a separate person apart from the CEO should occupy this position. The Chairman/CEO duality can create obstacle for the board's ability to perform its monitoring functions over CEO. Likewise, Jensen (1993) argues that separating the two positions is required for board effectiveness. According to stakeholders theory which provides theoretical framework for analyzing relations between companies and society, companies should design their strategies considering their stakeholders. This contrast the shareholders perspective which implies that managers should be controlled by the board to act on the owner's interest. While the mode of governance according to stakeholders perspective is to maintain more coordination, collaboration and conflict resolution in order to distribute value among stakeholders (Ayuso and Argandona, 2007).

This research thus seeks to investigate and explore the effect of separation the positions of CEO and Chairman on the financial performance of banks measured by return on assets and return on equity in Egypt by examining the following research question:

- Is the separation positions of Chief Executive Officer and Chairman has an impact on the financial performance of Egyptian banks?

### 1.2 Literature Review

Banks are essential for the effective functioning in any economy. Effective corporate governance practices are necessary. Banks failure is inevitable with poor corporate governance (Bank for International Settlements, 2006). Black et al., (2006) provide evidence that corporate governance is an important factor in explaining the market value of Korean public companies, and that this effect is likely causal. Companies' having higher governance scores have a high market value. According to Russell Reynolds Associates survey (2012) recent corporate financial scandals have created a need for intensifying corporate governance, including calls for the separation of CEO and chairman positions. Indeed, from 2001 to 2005 companies included in the Standard & Poor's 500, and NASDAQ 100, started to separate the Chairman and CEO positions.

The concept of corporate governance takes into consideration the relationship between stakeholders and management of companies. This relationship has to be based on trust and credibility and to be sustainable. The overall objective for the shareholders is to have adequate return on their investments. Therefore, the owners must be sure that management are going to work in their best interest since they are the ones operating their investment. It is the management that are managing the owners' capital and are in some ways responsible for making sufficient return. Shareholders' interests may differ from those of other stakeholders, especially on risk tolerance (Mehran et al., 2011). Macey and O'Hara (2003) argue corporate governance mechanisms for banks should include depositors and shareholders. The complexity of banks operations also makes it very costly for depositors to control managers. Depositors need to be sure when the deposit their money in banks. Governments through insurance and regulations can encourage depositors and make them safer. According to (Bank for International Settlements, 2006) the effectiveness of the board of directors require identifying lines of authority, responsibility and accountability for managers and be able to oversight their decisions. The relationship between management and owners are discussed in the agency theory. The agency theory, developed by Jensen and Meckling (1976), highlights the existing conflict of interests between the owners of a company and its management. Agency theory suggest that CEO duality may limit board's ability to monitor management and thereby increase the agency cost. As a result, splitting the titles of CEO and Chairman of the Board will improve firm performance. On the other hand, Dahya et al., (2009) conducted a study to examine the performance of UK public listed companies after the issuing of Cadbury Committee's Code of Best Practice. They found no significant improvement for companies separating chief executive officer and chief of the board positions.

Corporate governance is a mechanism through which shareholders are assured that managers will act in their interests. Sometimes managers do not always act in the best interests of shareholders. Suppliers of finance control managers in order to ensure that their capital is not going to vaporize and that they earn a reasonable return on their investment. Nevertheless, even if the government provides deposit insurance, bank managers may be involved in risky projects with the aim of high return. Regulations are necessary to limit bank manager's strive for high returns. Therefore the special nature of the banking industry requires protection of depositors from bank management (Capiro and Levine, 2002). Shareholders may want managers to take more risk than is socially optimal, whereas regulators have a preference for managers to take substantially less risk due to their concerns about financial stability. Good corporate governance can help to prevent corporate scandals. It enhances image and reputation of financial institutions and makes them more attractive to stakeholders. The implementation of corporate governance principles such as disclosure of information, protection of shareholder rights and equal treatment of shareholders, can ensure safeguarding of investments (Todorovic, 2013). Usui (2003) argued that both American and Japanese bank regulators have high authority to supervise and inspect banking organizations. Sarbanes-Oxley Act and new provisions in Japanese Commercial Code have a common trend in which they all consider the oversight of the board of directors and senior management as the key to the improvement of corporate governance. Both were enacted with the purpose of protecting investors and are applicable not only to banking organizations but to all businesses. In addition to the enactment of the corporate governance laws, American and Japanese bank regulators are continuing to create new regulations and guidelines on banking organizations' corporate governance. Arun and Turner (2004) argued for the need of corporate governance in the banking sector to protect depositors. It is necessary to have supervisor authority and to work closely with bank's management. One of the most hotly issues in corporate governance is the question of whether the chief executive officer (CEO) should also serve as the chairman of the board of directors. Tonello (2011, p.1) argued that "when, as after the recent financial crisis, public corporations come under fire from activist shareholders, institutional investors, proxy advisory firms, and regulators, the issue of separating the Chair/CEOs roles is often front and center, with a view to achieving independent leadership in the board". Recent corporate scandals created debates on the effectiveness of corporate governance and the accountability of corporate executives. The CEO is a corporation's chief strategist, responsible for initiating and implementing company-wide plans and policies. The Russell Reynolds Associates' Survey New York (2012) highlighted that board members are concerned about their independence from the Chief Executive and are increasingly promoting that the chairman and CEO roles be separated to have a balance of power. While this trend is more established in Europe, data indicates that companies in the United States are imitating. While the trend toward separating the roles gains prominence, not all directors are in favor. According to survey, 41% percent of board members feel the chairman/CEO position should be one person.

Kang and Zardkoohi (2005) concluded that the relationship between CEO/Chair is complex due to turbulence in the external environment and if such duality exists as a reward, it might result in positive performance. But if the reason is to increase the CEO's power than it may have a negative effect on the performance of the firm. If duality contributed to corporate scandals, it is not the only reason to cause corporate failure.

The evaluation of the Egyptian financial sector before 2004 urges the need for reforming financial sector regulation and supervision. The Program was approved in September 2004, and is currently under implementation. According to African Development Bank Group (2012, p.4 emphasis added) case study about Egypt financial sector reform program:

The development of secondary capital markets will improve price discovery and valuation of financial assets and productive activities, and will improve liquidity by facilitating efficient capital entry and exit. ***The buildup in regulatory and supervisory capacity with enhanced corporate governance will ensure market integrity and instill investor confidence.*** The creation of a mortgage market will serve as a market mechanism for mobilizing medium-term funding from capital markets for residential housing while increasing access to finance and affordability.

As a further step to strengthen the banking sector, the Banking Reform Unit (BRU) –a unit reporting to the Deputy-Governor– was established at the Central Bank of Egypt (CBE, hereafter). The Banking Reform Unit worked out on a basis of four pillars (CBE, 2007):

- Privatization and consolidation of the banking sector;
- Streamlining the financial and managerial structure of State-owned banks;
- Addressing the issue of non-performing loans;
- Upgrading CBE banking supervision.

The CBE works on deepening and developing the concept of risk-based supervision, in order to assess banks' ability to identify, measure, control and manage current and future risks. The CBE also examines the adequacy of procedures and internal control systems applicable at banks to determine, measure and control the information technology related risks. During the financial year 2005/2006, examinations covered 16 banks. To effect the provisions of Article 133 of Law No. 88 for 2003, of the Central Bank, many settlement cases are studied, and their settlement reports are documented. In addition, the CBE co-operates with any investigation entities that need banking expertise and know how assistance to decide on the relevant technical banking issues. In addition, the CBE studies customers' complaints to verify them. Moreover, the CBE's Board approved in its session on February 7, 2006 Decision No. 305 regarding the maximum limits of a bank's investments with a single customer and the connected parties (CBE, 2006).

Banks' aggregate financial position during 2005-2007 shows an increase over the three years following the implementation of the reform program.

Table 1. Aggregate Financial position of Banks (CBE, 2007)

<b>Aggregate Financial Position of Banks</b>			
<b>End of June</b>	<b>2005</b>	<b>2006</b>	<b>(LE mn)</b> <b>2007</b>
Cash	6594	6813	7705
Securities and investments	170659	193965	176098
Balances with banks abroad	51204	72554	124366
Balances with the CBE	109773	109597	199542
Balances with local banks	15213	12098	17821
Loan and discount balances	308195	324041	353746
Other assets	41990	42494	58645
<b>(Assets = Liabilities)</b>	<b>703628</b>	<b>761562</b>	<b>937923</b>
Capital	22949	27112	33037
Reserves	12419	13418	12552
Provisions	49541	54950	53469
Bonds and long-term loans	14254	17526	26351
Obligations to banks abroad	12262	8770	10006
Obligations to the CBE	8011	10379	66485
Obligations to local banks	14660	11109	16134
Deposits	519649	568841	649953
Other liabilities	49883	49457	69936

Source : CBE (2007)

As per Central bank of Egypt Annual Report 2007, the level of profits realized by a bank reflects its ability to strengthen its capital (equities) and to distribute dividends among its shareholders. A follow up of the levels of banks' profits reveals that public sector banks' net profits amounted to some LE 2204 million for the year ending June 30<sup>th</sup>, 2006, (mainly due to the profits of selling some of financial investments held with the Bank of Alexandria) compared with LE 714 million for the previous financial year. The ratio of public sector banks' average return on equity was 11.6 percent for the year ending June 30<sup>th</sup>, 2006, against 3.9 percent for the preceding year (CBE, 2007).

We believe that this research could be beneficial since it provides new, empirical knowledge on the effect of separation positions of CEO and Chairman on the financial performance of the Egyptian banks. The objective of this study is to investigate and explore the effect of separation the positions of CEO and chairman on the financial performance of banks in Egypt. The main objective is to find out whether there is a correlation between separation of the two positions Chairman and CEO's in achieving better financial performance reflected in better financial ratios of return on assets (ROA) & return on equity (ROE).

### 1.3 Hypotheses

This research will take both an explorative and a descriptive approach. It will take an explorative approach because it provides basic knowledge concerning the concepts of corporate governance as well as special aspects of corporate governance for banking sector. The descriptive approach is based on a description of how the financial performance of banks in Egypt affected by separation CEO and chairman positions, thus we took the descriptive approach to gather data, analyze it and interpret it. We proposed the following hypotheses for the concern of this research:

H1: There is a positive correlation between separation chairman & CEO positions and enhancing return on assets (ROA) & return on equity (ROE) in Egyptian banks.

## 2. Methodology

Our empirical study data collection and analysis was built on 3 years period financial statements (2005, 2006, and 2007) of the sample selected banks. In September 2004 the Government of Egypt launched a comprehensive reform programmer for its financial sector. It is, Financial Sector Reform Program, planned to run from 2005 through 2008. In our opinion, this period was very critical as it witnessed the starting of reforming financial sector as well as by its end



the global financial crises hit the world. The researcher selected 8 major banks in Egypt that represent public, private sectors and foreign international banks. The 8 banks were selected for the following reasons:

- 1) The 8 banks all combined capture about 60 % market share of the total Egyptian banking sector based on total assets (CBE, 2007).
- 2) The sample includes the biggest 2 public sector banks (National Bank of Egypt and Banque Misr).
- 3) The other 6 banks represent the biggest 6 ranked among all private sector banks based on market share and total assets.
- 4) Availability of the financial statements and figures.

The banks sample are National bank of Egypt ( NBE ), Banque Misr, Arab African international bank (AAIB), Barclays, HSBC, CIB, NSGB, and Piraeus Bank. The study differentiated between the selected banks based on the nature and structure of the board and existing of the CEO/ Chairman positions, accordingly, study divided the 8 banks into 3 groups. The first Group A, (where the title of CEO is not exist in structure of the said banks), includes National Bank of Egypt and Banque Misr. The second Group B, (where no separation as Chairman serves as CEO –duality), includes NSGB, CIB, and Piraeus Bank. The third Group C, (where CEO and chairman positions are totally separated – non duality), includes Arab African Bank, Barclays, and HSBC.

In each group we gathered and analyzed 3 consecutive years (2005 to 2007) related financial reports, we calculated the ROA & ROE for each bank separately, then we conducted an average for the entire group for each year and then for the whole 3 years period respectively, finally a comparison between the 3 categories was conducted to reach the final conclusion if separation positions of chairman and CEO would enhance the ROE & ROA and respectively the financial performance of banks in the Egyptian banking sector. The study samples average total assets represents about 60 % market share of based on total assets of banking sector in Egypt as per CBE 2007 annual report, however number of total banks was limited to only 8 due to the reasons mentioned before.

Group A encompassed 2 major public sector, The National bank of Egypt and Banque Misr, both banks sharing the fact that no CEO position exists in bank structure. Total assets combined for 2 banks amounted LE 367,399 billion representing 39.2 % of total banking sector in Egypt in 2007. As shown on the above table the 3 years average ROA & ROE for the entire group A were respectively 0.20 %, and 6.49%.

Table 2. Average financials for the National bank of Egypt and Banque Misr (Group A, 2005-2007)

Bank Name	Total Assets	( Market Share )	Total Equity	Net Profit	ROA	ROE
NBE	177,716	23.3%	6,446	415	0.23%	6.44%
Banque Misr	126,034	16.5%	3,377	221	0.18%	6.54%
<b>Total</b>	<b>303,750</b>	<b>39.9%</b>	<b>9,823</b>	<b>636</b>	<b>0.20%</b>	<b>6.49%</b>

Source: Authors (2016)

Group B encompassed 3 private sector banks Commercial International Bank (CIB) National Societe Generale Bank (NSGB), and Piraeus Bank. They have combined total assets LE 96,483 billion representing 10.3 % of total banking sector in Egypt in 2007. The 3 banks shared the fact that its chairman serves as CEO as well. Meaning that chairman combined both authorities of being a chairman and CEO as well (duality). As shown on table 3 years average ROA & ROE for the entire group B were respectively 1.24 %, and 16.89%.

Table 3. Average financials for the Commercial International Bank (CIB) National Societe Generale Bank (NSGB), and Piraeus Bank (Group B, 2005-2007)

Bank Name	Total Assets	( Market share )	Total Equity	Net Profit	ROA	ROE
NSGB	31,855	4.2%	2,066	248	0.78%	12.01%
CIB	38,582	5.1%	2,859	955	2.48%	33.41%
Piraeus Bank	6,516	0.9%	585	31	0.47%	5.27%
<b>Total</b>	<b>76,954</b>	<b>10.1%</b>	<b>5,509</b>	<b>1,234</b>	<b>1.24%</b>	<b>16.89%</b>

Source: Authors(2016)

Group C encompassed 3 private sector banks which are Barclays, HSBC and Arab African Bank. Combined total assets for the 3 banks amounted LE 89,455 billion representing 9.5 % of total banking sector in 2007. The 3 banks have separated the clearly the positions of CEO and chairman (non-duality). As shown on table 4 ROA & ROE for the entire group C were respectively 2.48 %, 44.43%.

Table 4. Average financials for Barclays, HSBC and Arab African Bank (Group C, 2005-2007)

Bank Name	Total Assets	( Market Share)	Total Equity	Net Profit	ROA	ROE
Arab African Bank	30,094	4.0%	1,183	474	1.58%	40.08%
Barclays	12,795	1.7%	679	326	2.55%	48.04%
HSBC	19,572	2.6%	1,441	651	3.33%	45.17%
<b>Total</b>	<b>62,460</b>	<b>8.2%</b>	<b>3,303</b>	<b>1,451</b>	<b>2.48%</b>	<b>44.43%</b>

Source: Authors (2016)

### 3. Results and Discussion

In order to examine the relationship between Chairman/CEO position and the financial performance of commercial banks in Egypt, Pearson Correlation Coefficient testing was conducted to ensure that study findings are statistically significant. The alpha level  $\alpha$  equals 5%. The null hypothesis and the alternative hypothesis were set as following:

- The (non-duality) was set as independent variable; ROA & ROE were set as 2 dependent variables.
- Null hypothesis  $H_0$ :  $r = 0$  (no positive relationship between separation chairman & CEO positions "Non-duality" and enhancing ROA & ROE in Egyptian banks.)
- The alternative hypothesis  $H_1$ :  $r > 0$  (There is a positive correlation between separation chairman & CEO positions and enhancing ROA & ROE in Egyptian banks).
- The value of the Pearson Correlation Coefficient ( $r$ ) was calculated. The Pearson correlation coefficient is a measure of the linear correlation between the two variables which are Chairman/CEO position and the financial performance of commercial banks in Egypt, giving a value between +1 and -1 inclusive, where 1 is total positive correlation, 0 is no correlation, and -1 is total negative correlation. It is widely used as a measure of the degree of linear dependence between two variables. Also, the statistical test was conducted and the results were:
- $r = .70$  for variable ROA and  $r = .79$  for variable ROE
- Decision rule for rejecting the null hypothesis.

To write the decision rule we had to know the critical value for  $r$ , with an alpha level of .05 (two-tailed test) as we are not previously sure of the results, and critical value was found .404.

Reject  $H_0$  if  $r \geq .404$

Since our calculated value of  $r$  and were respectively (.70 and .79) for ROA & ROE both are greater than the critical value of .404, so we reject the null hypothesis and accept the alternative hypothesis. Hence, the positive correlation between the separation of Chairman /CEO position and enhancing the ROA & ROE is statistically significant. Based on the findings, the empirical study showed that there is an obvious link and correlation between Non-duality (separation positions of the CEO and chairman) and enhancing ROA & ROE of the Egyptian banking sector, since in Group C where clear separation between the two positions was exist, the Group C performed almost 10 times better the Group A where no CEO position exist in bank's Group, and almost double times better than Group B where chairman serves as CEO. Moreover Group B results where CEO title is exist but occupied by the Chairman were remarkably better than Group A where CEO title is not exist at all. All public sector banks do not have a CEO position in its hierarchies. The study shown that the far and deepening we go towards the full separation between chairman and CEO titles (non-duality) the better ROA & ROE were conducted.

### 4. Conclusion

Researchers recommends and urges the banking sector to take proper actions to apply and implement a full separation between Chairman and CEO positions in addition urging the central bank of Egypt as the responsible entity for banking sector in Egypt to take necessary actions to direct Egyptian banks to implement full separation between the two posts, as per the study findings this will support enhancing banking corporate governance that most probably will lead to better financial results. Due to the size of the sample the study results should be taken with caution, it is recommended

for further studies to enlarge and expand the number of banks sample size, additionally more deep financial analysis to examine financial performance since it was limited in this study to ROA & ROE.

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## Social media as a tool in learning and social behavior in Saudi Arabia

NADIA YUSUF

Faculty of Economics and Administration  
King Abdul-Aziz University, Jeddah, K.S.A

RANDA AL-MADAH

University of Business & Technology (CBA), Jeddah, KSA

MOHAMMAD ZULFEEQUAR ALAM

University of Business & Technology (CBA), Jeddah, KSA

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*Social media tools have become universal because the majority of population worldwide tend to use diverse social media applications. The advancement of technology has provided a chance to accommodate the needs of individuals to stay connected with each other. This paper explores the importance of social media tools perceived as essential learning resources in the contemporary educational field (Alwi, Mahir, & Ismail, 2014). It has been argued that technology has advanced the static information and provided viable opportunities for individuals to increase their learning skills and enrich their learning horizons. Technology is not only one-time investment, but is progressively advancing day by day by introducing different types of infrastructure expansion and growth in social media applications.*

### Introduction

Research shows that a substantial number of individuals are involved in using Youtube, Facebook, Blogging, and Twitter for learning purposes by making groups based on specific interests and following certain discussions (Nookhong & Wannapiroon, 2015). Technology has provided a different type of medium for individuals so as to increase their learning resources through the implementation of social media and exchange of information within seconds. The increased social media adoption has led to a significant impact on social behavior, which is not only related to learning purposes but also to business investment. The fast emerging social media has shifted patterns of social behavior, which has gradually led to the integration of social media tools in a wide range of learning and teaching activities. This paper mainly focuses on the Kingdom of Saudi Arabia (KSA), stressing on social behavior dimensions and how it has impacted local society, through social media as a promising tool of learning.

In recent years, online social network sites like MySpace, Face book, and Twitter have become the most popular sites on the Internet, especially for college students who have been enticed into spending longer hours using social media technologies, thus redefining their interpersonal communication and study dynamics. (Junco, Merson & Salter 2007). University students' communicative capacities have been transformed by these systems that dramatic and irreversible changes to the very shape and structure of their academic and social behavior, along with their cultural disposition have necessarily followed.

## Literature Review

Technology has shown tremendous diversity in recent years; however, social media is one of the significant elements of technology in the internet-driven world. It has provided more knowledge to workers, students, clients and facilitates individuals as a learning tool (Nookhong & Wannapiroon, 2015). Due to the fact that a significant proportion of the world's workforce is connected to social media, most individuals tend to adopt social media as a marketing and learning tool. Scholars have argued that social media is an internet-driven tool, which has provided a medium to individuals to share, create and transfer information such as data, ideas, pictures, videos, voice messages, etc. in virtual communities.

Moreover, social media is also defined as a group of internet-based applications, which have created user friendly content for people to exchange data with each other. It depends on individuals how they use social media and for what purposes. It has provided numerous benefits such as quality, frequency, outreach, usability, proximity and durability. Nowadays, the learning environment is also created on social media using different platforms, which have the same characteristics as the system of the bygone ages (Mao, 2014). It can be said that with the explosion of the internet world, learners are revolving around social associations and tools to learn. There are different types of social media platforms to include LinkedIn, Chat/Messaging, Facebook, Twitter, Youtube, Instagram and Blog.

Other popular social media platforms in the context of Saudi Arabia refer to Whatsapp and Dropbox, as they find proper application in academics. Students tend to utilize Whatsapp as a relevant tool to exchange important information about certain topics they explore (Nookhong & Wannapiroon, 2015). This aspect allows them to focus on the limitless possibilities of expanding their learning to new horizons. Moreover, Dropbox has become a popular learning tool recently, considering its capacities to facilitate document sharing among students. In this way, they can have access to vast information on the web, as the respective social media platform is quite flexible and efficient.

These are the most popular tools used by individuals as a learning tool to achieve multiple objectives, not particularly in the business field but in informal learning experiences as well. Youtube provides video content to spread learning content, whereas messaging has given a leverage for rapid communication to transfer data. These tools are well-recognized and are deployed as a vital element of the successful implementation of social media for learning purposes (Mao, 2014). As social media have been considered a learning tool, this aspect has also affected the social behavior of individuals.

Social behavior is defined as a behavior of individuals linked with society, or between members of society in terms of how they communicate with each other. However, social behavior is both considered to be social meaning and social context by focusing on social actions of individuals (Sun, Chen, & Fan, 2014). Due to exponential development and proliferation of social media as a learning tool, this has revolutionized the global world by increasing the demand of technology. The internet now permeates the daily activities of individuals all around the world. Research has shown that the Kingdom of Saudi Arabia has more than 10 million online users, implying that almost half of the population is into social media through different platforms, for the vital purpose of learning experience (Mao, 2014). The main purpose of this

study is to focus on social media as a learning tool and social behavior of KSA, with the idea to show that the effect of adoption of technology has increased the extension of social media. From this perspective, it has been indicated that KSA's social behavior is dependent on social media as well because of diverse factors, such as immediate communication medium, cultural and region diversity.

Another study by Abero and Marin (2013) indicates that students surveyed had positive attitudes towards group work and considered that it did not have a negative impact on learning outcomes. Group work could be considered a strategy for overcoming one of the variables of failure in learning of this type: the students' socio-cognitive isolation. Students who participated in the study perceived that group work was one of the ways of working in the knowledge society.

On the negative aspects of SM use, Wang, Chen and Liang (2011) report that most college students spent vast hours checking social media sites. Ninety percent of students surveyed spent their time on entertainment. There were not too many college students who preferred using social media to deal with their homework. Eighty percent of the sample admitted that they posted or responded while completing homework which had definitely affected their efficiencies and their grades. Considering the data collected, there was a negative attitude towards social media when college students used them. The research also indicates that an approach is needed to better balance the relationship between social media and academic study. Therefore, college students should think more about the balancing equation of social media and academic.

The frequent use of Facebook could cause addiction toward the site and influence students' daily life at large. A study by Zainudin, Omar, Bolong and Osman (2011) was done to identify the relationship between female students' motives for Facebook use and Facebook addiction. Five motives identified were social interaction, passing time, entertainment, companionship, and communication. The findings of the study showed that there are significant relationship between female students' motives for Facebook use and Facebook addiction. As a conclusion, social interaction, passing time, entertainment, companionship and communication motives were among the major contributor to the addiction of Facebook site.

## Methodology

Methodology refers to a systematic, analytical and statistical approach of study to drive specific results. The main objective of this study is to examine the potential of social media as a learning tool and social behavior of KSA. This paper will perform research using a quantitative approach, with survey as a data collection method (Maxim, 1999). The survey was conducted at King Abdulaziz University amongst faculties and students of the different colleges at random. The method of carrying out a survey will be based on a Likert scale rating from 1-5, which will highlight how participants support certain assumptions related to the study. A quantitative method strategy may enable the researcher to uncover the perception of random participants to fill out the survey form; this method is useful because it provides statistical data to evaluate the results. This method will provide clear results with proper analysis using the frequency and



percentage method. The sample of this study will consist of 100 participants who need to respond to 10 questions.

One section will be divided into demographic, while the second one will be about social media and social behavior. The survey will be designed using an online survey tool identified as [www.surveymonkey.com](http://www.surveymonkey.com), as it will be sent to random participants in the KSA (Balnaves & Caputi, 2001). This online survey tool will be utilized to accumulate important information with significant implications for practice. With the help of the respective quantitative method, this study will find out the knowledge of how KSA's social behavior has been changed due to social media.

### Research Limitations and Directions for Further Research

A limitation of the research is related to the inadequate number of participants, as this may prevent generalizability of research findings. The short duration of the study may prevent the researcher to gather relevant data. This paper can be further extended to analyze each social media tool and how they are used in learning procedures by focusing on specific demographic area rather than focusing on every age group (Maxim, 1999). It would be helpful to properly analyze the data in a valid form. Moreover, further research can be performed on a specific KSA institution from the student population rather than selecting random participants online.

### Results

In this research, only selected information was reported and covered important aspects which are linked with social media and learning outcomes. The demographic statistics offers a relevant account of the participants. The idea of social media presents the information on student knowledge of social media approach and learning tools. Social media acceptance and its reputation received significant popularity among Saudi education specialists and Saudi students. Social media and its connection with student performance, learning tendency and attitudes were found in result findings. The survey gathered relevant information in regard to participants' gender, age and education background with the purpose to discover if these variables would influence student views and attitudes toward social media and their utilization of social media as a learning tool. Approximately 2000 participants took part in this survey, as 50 per cent of the participants were education specialists working in the education sector of Saudi Arabia, while 50 per cent of the participants were students enrolled in higher education courses, as shown in table 1.

**Table 1: Participants**

Participants	Percentage
Education specialists	50%
Students in higher education courses	50%

Approximately 75 per cent of the respondents were male and 25 per cent were female. In addition, 60% of students were in the age category of 18 to 24, 40% belonged to the 25-34 age group, while 70 per cent of education specialists were in the age category of 30 to 35, while 30 per cent belonged to the age category 35-40, respectively. Most of the education specialists hold

Bachelor's and Master's Degree, while students were actively involved in pursuing higher education in various Saudi universities.

The research examined education specialists' ideas and student knowledge about the approach of social media as a learning tool, as 94 per cent of participants were familiar with the fact that social media approach differs at different levels; only 6 per cent of participants were not well-informed about social media approach. It is evident that almost one third of the participants were very well-informed with the approach. There were roughly 7 social media tools identified by participants in the survey. They were Bulletin board, Blogging, Facebook, LinkedIn, Twitter and Youtube. The result findings showed that Facebook and Twitter were the most widely used tools in Saudi Arabia's education sector. Frequency table 2, shows the responses for the most common Social Media tools used in learning by students under social network category. It was a multiple response question. Whereas, frequency table 3 shows the responses for the most common Micro blog tools used in learning by students. Whereas, Table 4 shows the responses for the most common SM tools used in teaching by instructors.

**Table 2.** Responses for Social Media tools under Social networks category

Social network	Multiple Responses		% of Cases
	F	%	
Face book	1669	84.2	90.1
My Space	181	9.1	9.8
Others	132	6.7	7.1
Total	1982	100.0	

From Table 2, we note that a very high majority (90.1%) of students are using Facebook for learning.

**Table 3.** Responses for the Social Media tools under Micro blogs category

Micro blog	Multiple Responses		% of Cases
	F	%	
Twitter	1902	96.4	98.3
Meme	50	2.5	2.6
Others	21	1.1	1.1
Total	1973	100.0	

From Table 3, we note that a very high majority (98.3%) of students are using Twitter for learning purpose in micro blogs. This indicates that Twitter is the most commonly used micro blog.

**Table 4.** Responses for SM tools under social networks category

Social network	Multiple Responses		% of Cases
	F	%	
Face book	301	88.3%	92.9%
My Space	18	5.3%	5.6%
Others	22	6.5%	6.8%
Total	341	100.0%	

From Table 4, we note that a very high majority (92.9%) of instructors are using Facebook for teaching.

Before this survey was carried out, there was an expectation that most participants knew about twittering, but the findings indicated that there were 25 per cent of participants who did not have awareness about it at all, and 75 per cent of participants had awareness and knowledge about it. One of the questions was about social media adoption and use of social media for education purposes.

Table 5 shows the responses for blogs tools used in learning by students. The survey also discovered participants' perceptions about social media acceptance. Table 6 shows the responses for the slide sharing tools used in learning by students. It was a multiple response question. The understanding helped relevant authorities design learning activities significantly and utilizing social media tools efficiently.

**Table 5.** Responses for the Social Media tools under blogs category

Blog	Multiple Responses		% of Cases
	F	%	
Blogger	368	57.1	59.6
Word press	265	41.1	42.9
Others	12	1.9	1.9
Total	645	100.0	

From Table 5, one can note that (59.6%) of students are using Blogger in blogs. This indicates that Blogger is the most commonly used blog.

**Table 6.** Responses for Social Media tools under Slide Sharing category

Slide Sharing tool	Multiple Responses		% of Cases
	F	%	
Slide share	347	63.7	65.5
Prezi	183	33.6	34.5
Others	15	2.8	2.8
Total	545	100.0	

Table 6, shows the majority (65.5%) of students are using Slide share for learning purpose. This indicates that Slide share is the most commonly used slide sharing tool.

It has been indicated that 25 per cent of the participants affirmed that social engagement is the top rationale for social media acceptance followed by direct communication for education purposes, quick feedback and results. Yet 20 per cent of the participants used social media for relationship building and to reach new friends as indicated. Table 7 shows the distribution of student's sample as per the most common reasons. It shows entertainment with the highest (78.8%) usage level. Second highest is information searching with 66.9% and the third highest is exchanging ideas with 59.6%. It is also worthwhile to note that the responses for searching for information and learning are both above 60%. This indicates that a high percentage of students use Social Media for learning. The survey question was of multiple response type. Though, 55



per cent of the participants (education specialists and students) strongly affirmed that they used social media tools for academic purposes.

**Table 7.** Distribution of student's sample as per the most common reasons

Reason	Multiple Responses		% of Cases
	F	%	
Making Friends	1333	12.6	52.6
Exchange ideas	1509	14.3	59.6
Entertainment	1997	18.9	78.8
Sharing Resources	525	5.0	20.7
Community discussion	1107	10.5	43.7
Searching for information	1695	16.0	66.9
Learning	1565	14.8	61.8
Professional Networking	732	6.9	28.9
Others	102	1.0	4.0
Total	10565	100	

Table 7, shows the results on reasons that students use Social Media for.

Other reasons have also been considered such as low labor cost, gain understanding, capability to enhance education practices, public research/polling, controlled system, and reliability. In education specialists' free input, being able to connect with other colleagues is another strong rationale for social media tool acceptance. Education related advertisement has enhanced the utilization of social media tools to reach more potential users. Table 8 presents responses from students on preference to integrate Social Media as a tool in learning. It shows that the majority (66.1%) of students prefer to integrate Social Media as a tool in learning. This indicates to a certain extent the interest and readiness of students to adopt Social Media into their learning environment.

**Table 8.** Distribution as per opinion of integrating Social Media as a learning tool

Would you like to integrate Social Media as a tool in your learning?	F	%
NA	65	2.5
Yes	1721	66.1
No	362	13.9
I don t know	457	17.5
Total	2605	100.0

Table 8, indicates to a certain extent the interest and readiness of students to adopt Social Media into their learning environment.

Few students pointed out about the academic use for research projects, learning sources, and helped to work as a team to complete group projects. There are interesting facts in the findings. Saudi students had certain issues when they were utilizing social media tools for education purposes (30 per cent), but there were roughly 70 per cent of students who considered that most individuals in online communities were willing to find social media help for learning purposes. Roughly 70 per cent of participants would prefer to follow standards, procedures and

opinions of others when they were utilizing social media tools. Almost 80 per cent of Saudi students felt that they were acknowledged by online community members, while 20 per cent of students reported that they received helpful information from social media resources.

In both cases, when they corresponded with their class-mates and tutors, they received more supportive information about their studies (70%) and tried to persuade more as well (30%). It can be observed that participants corresponded at different levels with different target users. The social media approach has been an effective social learning tool. There are numerous social networking communities with immense interests such as politics, education, profession, recreation, etc., and in different arrangement such as government, organizations, corporations, membership, clubs which ultimately provided extended resources to students.

### Evaluating Attitudes of Students

The remaining portion of the questionnaire was designed to evaluate attitudes covering the following:

- Rating statements in terms of the positive impacts (advantages) of SM on social behavior and attitude
- Rating statements in terms of the negative impacts (disadvantages) of SM on social behavior and attitude

In this research, when evaluating attitudes, a 5 point Likert scale was used to acquire respondent's opinion. The weights used were as follows:

**Table 9.** Likert scale weights

Weight	Response
1	Strongly Disagree
2	Disagree
3	Unsure
4	Agree
5	Strongly Agree

Since these variables are considered to have ordinal weights, the weighted mean for all respondents may be computed for each variable (and for the whole factor) and is used to reflect the respondents' opinions (attitudes).

Table 10 shows results obtained when using the Likert scale to check the students' attitudes to answer the questions related to advantages of using SM in Social behavior of students for all questions at once. It shows that the overall attitude is 'agree' with an average weighted mean of 3.79. This indicates agreement with outcome obtained through the question by question approach.

**Table 10.** Results of students' attitudes on advantages of SM on social behavior and attitude of students - by clustering

Strongly Disagree		Disagree		Unsure		Agree		Strongly Agree		Weighted Mean	Attitude
F	%	F	%	f	%	f	%	f	%		
1444	4.0	2597	7.1	6610	18.1	17252	47.3	8567	23.5	3.79	Agree

Table 11 shows results obtained to answer the questions related to disadvantages of using SM on social behavior and attitude of students for all questions at once. It shows that the overall attitude is 'unsure' with an average weighted mean of 2.83. This indicates agreement with outcome obtained through the question by question approach.

**Table 11.** Results of students' attitudes on disadvantages of SM on social behavior and attitude of students - by clustering

Strongly Disagree		Disagree		Unsure		Agree		Strongly Agree		Weighted Mean	Attitude
F	%	F	%	F	%	f	%	f	%		
3936	18.9	5051	24.2	4723	22.7	4983	23.9	2147	10.3	2.83	Unsure

## Discussion

Social media tools are advancing their momentum at an inconceivable speed in Saudi Arabian education sector. The study demonstrated that people, as social beings, need reliable association with each other and with the globe. The world is advancing at a faster pace and it is clear than ever before that it provides incredible opportunities for sharing ideas, experiences, and intelligence due to the fast development of technologies. Social media established its way rapidly into the education world; at the same time, Saudi educators are seeking opportunities of leveraging social media tools in the educational field.

Social media approach offers students with new possibilities to become self-regulated in their study and research. They persuade an extensive range of communicative capacity. The current study indicated that the use of Facebook and Twitter is increasing and has become very accepted by Saudi students. There are different methods to utilize social media tools for educational objectives. One approach is to incorporate social media tools into the current academic system as a teaching and learning source to help the progression of curriculum completion.

## Conclusion

Utilizing social media tools in education sometimes can be very demanding and challenging to educators. Students can become a superior consulting source because they have skills and they have a better awareness of the tools. The future advanced technology and integration with education should emphasize on what students utilize instead of what the school wants them to utilize to assure maximum effectiveness, as indicated in this study. When students become core stakeholders of their own education, learning will be truly modernized through the efficient teamwork between instructors and students.

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### ***Authors and submission details***

#### ***Dr. Nadia Yusuf***

Associate Professor, Faculty of Economics and Administration, Jamia Street, P.O. Box 42795, King Abdul-Aziz University, Jeddah-21551, K.S.A  
E-mail: [nadiayusuf112@hotmail.com](mailto:nadiayusuf112@hotmail.com) (Correspondence author)

#### ***Dr. Randa Al-Madah***

Assistant Professor, University of Business & Technology (CBA), Jeddah, KSA  
E-mail: [randa.almadah@hotmail.com](mailto:randa.almadah@hotmail.com)

#### ***Dr. Mohammad Zulfeequar Alam***

Assistant Professor, University of Business & Technology (CBA), Jeddah, KSA  
E-mail: [zulfeqarm@ubt.edu.sa](mailto:zulfeqarm@ubt.edu.sa)

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## Consumer Buying Behavior towards Organized Retailing: An Exploratory Analysis of Saudi Arabian Supermarkets

Dr. Salah Abunar<sup>1</sup> and Dr. Mohammad Zulfeequar Alam<sup>2</sup>

<sup>1</sup>Assistant Professor of Supply Chain Management, Dean, College of Business Administration (CBA), University of Business & Technology (UBT), KSA. Email: [salah@ubt.edu.sa](mailto:salah@ubt.edu.sa)

<sup>2</sup>Assistant Professor of Marketing Department, College of Business Administration (CBA), University of Business & Technology (UBT), KSA. Email: [zulfeqarm@ubt.edu.sa](mailto:zulfeqarm@ubt.edu.sa)  
[smabunar@gmail.com](mailto:smabunar@gmail.com)

**Abstract:** Retail sector in Saudi Arabia is growing very fast. It started making its presence felt nearly a decade after the first lot of retail hypermarket introduced in KSA. Developments in the food retailing industry have led to growth of shopping malls, particularly in the large cities of Saudi Arabia. As a consumer play an important role in any business. Therefore understanding consumer buying behaviors are important to success of super or hyper market business. For the purpose an exploratory study with structured questionnaire was developed and online survey with 244 Saudi customers were conducted to identify and explore their satisfaction regarding super/ hyper market services provided by these sectors in the region. After analysis it was found that there were significant differences in their opinion towards organized retailing among the super market shoppers in the region.

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**Keywords:** Super Market, Hyper Market, Consumer Behavior, Retail Sector, Consumer Satisfaction, Saudi Arabia.

### Introduction:

Kingdom of Saudi Arabia (KSA) has a population of more than 27 million people, a growth rate of 1.49 percent and an average age of 26.4 years (CIA World Factbook, 2014). The customer base includes KSA locals who are more eager consumers in the world, and the Emigrants (more than 30 percent of the population) who have a wish to spend for convenience and shopping products (AT Kearney, 2013; CIA World Factbook, 2014). The largest size of the population, a high percentage of young population and high disposable incomes offers an eye-catching chance and it has focused growth in the retail sector.

Retail and food industries, which consist of hypermarkets, supermarkets and corner shops (Bagalas), are gradually growing in Saudi Arabia as a result of the state of the economy driving assist to support it. According to a report Shabat, *et al.* (2012) in the Saudi retail area placed the 14th place in 2011. In addition, supermarkets and super stores Arabia Market will play an increasingly important role as a major basis for shoppers to shop in the future. Al Kathery (2011) claims that the Saudi shopper behavior is different now than it was, and it is expected that 60% of consumers buy from hypermarkets and supermarkets, and the purchase of 6% compared to the corner shop, often defined as Bagalas that defined also small shop, which sells mainly to the corner of the street, and the common foodstuffs and other stuffs that are in the House use. In addition to the extraordinary swift development of online shopping or e-mail

shopping at the present time many of the traders try to use online sales trading for retail products or services, which is an important channel to increase their markets locally and globally aware, (Alam & Elaasi, 2016).

The supermarkets in Saudi Arabia are currently engaged in the major cities such as Riyadh, Jeddah, Mecca, Medina, Dammam, but getting higher in other parts of the province and growing populace, with a variety of needs and faiths makes it a very competitive to the sector.

Saudis and foreign residents regularly visit supermarkets that are significant not only for shopping, but also perceive this as a chance to meet people and entertainments. The people who visit supermarkets come often for social upbringing and window shopping as a substitute of the actual shopping too. Thus the significance of shopper behavior research in the field of retail cannot be ruled out.

Customer satisfaction is a utility of the difference between customer expectations prior to purchase and their insight of agreement they received from the goods and services they received it (Oliver, 1977, 1980; Anderson & Sullivan, 1993).

An enduring affiliation is probable if they can assess the retail customer purchasing behavior and insights with the excellence of services and their understanding to the business. Commercial Companies need to create a better image of the service quality in

order to satisfy existing customer loyalty and attract new one (Dabholkar et al. (1996).

#### Review of Literature:

Supermarket industry had a significant impact on overall economy in most of the countries. McCarthy (1981) recognized supermarket as a large business specializing in the provision of food self-service, retail market mainly sells foodstuff and everyday goods. The first supermarket in the Kingdom of Saudi Arabia had worked in the eastern region in Dhahran. Established in 1974, it was under British administration, and was part of AL-Souk Company limited. Rossides (1994) observed that the corner shop was the prime form in the Saudi retail market. There were very few modern shops, self-service or supermarkets which offer a wide range of goods to customers. Alawi (1986) pointed out that the appearance of supermarkets in Saudi Arabia was motivated by several aspects, the utmost significant was that the government stimulated to start dealing with this new concept, the way of state, and escalation in income of customers make them relax. In Saudi Arabia classification of retail business are such as hypermarkets, supermarkets and department stores and traditional markets. They offer more than 55,000 items, including food, clothing, tools, toys and electronics.

The retail sector in Saudi Arabia is one of the freshest and fastest growing sectors of the demand for consumer goods revealed by (Zawya, 2006). Consumers now prefer the supermarkets for different reasons for shopping. First, young people and put the country in general and Western-style shopping from the supermarket shopping stores. Second, older people prefer supermarkets, because it is convenient. Thirdly, it is considered a place for the whole family engagement because of the old-school nature of Saudi society as parents will be engaged to buy, while children will be entertained (Al Rajhi Capital, 2010). In addition, it was noted in the report that the main source of entertainment and culturally acceptable in the form of shops and restaurants in shopping malls. Hypermarkets/ supermarkets with access to the facilities for relaxation were the ideal sites for the families of Saudi Arabia as reported in Al Rajhi Capital (2013). On the other hand, the corner shops in the number of Saudi approximately 200,000 companies. Corner stores are also called (Baqalah) in Arabic (Al-Eqtisadiyah Newspaper, 2011) especially for low-income service people (Leonidou 1995). According to Al-Rajhi and the Euro Research observer to the annual growth of Bagalas, hypermarkets and supermarkets in 2010 was 3.2%, 4.4% 7.2% respectively (Al Rajhi Capital, 2010).

Customer satisfaction is a utility of the difference between customer expectations prior to purchase and

their insight of agreement they received from the goods and services they received it (Oliver, 1977, 1980; Anderson & Sullivan, 1993), and it will be important for them if the perception at the highest level compare to the expectation placed. Customer satisfaction is and the quality of service-based client, has one of the tools for customers to increase the value (Sivadas & Baker-Prewitt, 2000), highest value means customers having more satisfaction, which will benefit the retail organization in the long term (Zeithaml, Berry, & Parasuraman, 1996; Cronin, Brady, & Hult, 2000), and it will generate higher returns (Aaker & Jacobson, 1994). The main challenges of service industry are the quality of service and customer to be satisfied (Anderson & Sullivan, 1993; Hung et al. 2003). Consumer satisfactions and intangible assets are as powerful as the quality of service that will lead to meet the hopes of consumers (Oliver, 1980; Boulding, 1993; Bahia, 2000; Homburg, 2006; Jayasankaraprasad & Kumar, 2012). Researchers had emphasized the significance of relationship between service quality and customer satisfaction (Cronin & Taylor, 1992).

As investigated by Nisha Rathore (2012), that the main drivers of the revolution of retailers announced in increased the motivation of customers to dispose their income, infrastructure development and changing customer choice of middle-class. Bernadette (2010), stated that, consumers are quite influenced by the visibility, advertising and attractive bumper offers on the product. Veerapong and Wuttisak (2002) suggested that supermarket retailer's management strategies should be different, depending on the nature of the supermarkets. Moreover, it was analysed that customers generally prefer shops that offer a reasonable price of the product and sales promotions to them. Researchers also had other dimensions of value, such as shopping fun (Downs, 1961 and O'Guinn and Faber, 1989), Quality of Services (Zeithaml, 1988), and shopping convenience (Mazursky and Jacoby, 1986).

A number of previous studies had determined the core values shopping in mall that was the enjoyment from shopping (Shim and Eastlick, 1998, Winyard, 1998, Thompson and Chen, 1998, Erdem *et al.*, 1999 and Stoel *et al.*, 2004). However, few have studied systematically how these values Mall shopping behavior affect the consumer choice stated by (Cai and Shannon, 2012). The quality of service and customer satisfaction are different constructs, but the relevant (Brady *et al.*, 2002; Ranaweera and Neely, 2003). Moreover service quality and customer satisfaction to be the consequence of customer experience during service encounter as well as the quality of service to consumers oriented knowledge, as well as a series of emotional consumers to be a prelude to customer



satisfaction. (Brady & Robertson, 2001; Jayasankaraprasad & Kumar, 2012). The investigation also identified customer satisfaction as a function of perceived quality and the extent of disconfirmation—that perceived quality expectations prepurchase (Olsen, 2002; Gustafsson, 2005; Rigopoulou, 2008; Cerri, 2012; Kitapci *et al.*, 2013), it is also a debatable matter said by researcher (Bahia *et al.*, 2000) and Intentions of buying were affected more to shop than quality of products or services itself (Anderson & Sullivan, 1993).

#### **Research Gap:**

In several studies, customer satisfaction was found an important factor to achieve the goals of business. The supermarkets are striving to develop new effective strategies for satisfying the needs and wants of their consumers these days. Despite the implementation of many researches in the area inside as well as around the world towards the consumer shopping behavior of supermarkets there is still a need to identify and measure the purchasing power of the consumer and its success factors, which manages to be the leading company in the market, and it will be the largest values of the organization retail traders. In fact there are consumer research gap from Saudi Arabia and their preferences for shopping hyper / supermarket in the literature and it does not covered yet for deep study. Therefore, the present study is an attempt in this direction. In addition the paper will focus on customer behavior towards super / hypermarket and marketing practices.

#### **Scope of the Study:**

The area of this study covers all industries and marketers within the KSA. However, the study is particularly focused on retailers and organized retail, supermarket, etc., dealing its products and services, or the intent to sell them in the future with this platform.

#### **Significance of the research:**

- This study will be useful in a number of business groups in Saudi Arabia.
- Another set of interests that will benefit from the results of this research is government groups, and marketers in general, especially retailers, which aims for retail organization in the Kingdom of Saudi Arabia.
- This study will be useful to researchers who want to do further research in this area.

#### **Objective of the study:**

The objectives of the investigation were to investigate the customer behaviour on super/ hyper markets shopping experience in Saudi Arabia in general and in particular the present study focuses to recognize the Saudi consumers' buying perceptions and preferences for super/ hyper market shopping in the region are as follows:

- To investigate the customers experience with the products quality, when buying from super/ hyper markets.
- To identify the most preferable attributes they look for when buying products.
- To find out the respondents attitudes regarding the elements they need to confirm before the selection of the products.
- To recognize the attitude about repeat shopping behaviour.
- To understand the behaviour of respondents about the action taken by him when they cannot find the required product in the store.
- To study the behaviour about the awareness of checking the damaged product during the shop.
- To analyse the feelings of respondents in regards to changing the supermarket and availability of alternative product.
- To distinguish the respondents perception regarding the availability of supermarkets nearby their locality.
- To know the important reasons for they visit the supermarket to shop.
- To investigate respondents preferences for supermarket those having the space for family and childcare facilities.

#### **Research Methodology:**

The main purpose behind this research was to know the respondents' thoughts, behavior: preferences and perception of Saudi customers' towards super, hyper market (mall) shopping. For the purpose a two stages survey was carried out to investigate and examine the importance of service quality provided by supermarkets in KSA. In the first phase a pilot study was conceded among the Saudi families. For the purpose 26 respondents comprised both male and female shoppers were contacted to take their feedback to reduce the error for further (main) study. The modifications were made in the questionnaire as per the feedback of respondents' and the previous version of questionnaire was improved. In second phase (final version) convenience sample survey has been conducted electronically through e-messages among the 244 respondents of Saudi Arabia, out of which 227 respondents completed the survey and its took about a period of 2 month to complete. The close ended questionnaire was used and the software had been used to ensure that only one survey response could be submitted from a single PC. This was to avoid duplication in the results. And special 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 analysis descriptive statistics (frequency distribution) were used and result findings were

interpreted to achieve the above objectives and to know the consumers shopping trends and their behavior regarding the organized retailing sectors in general and particularly for the Saudi Arabian super/hypermarkets.

#### Result findings and Discussion:

The respondents were classified here on the basis demographic factors such as gender, education and monthly income. And as well as their geographical

area where they belong. Majority of respondents were male 164 (72.25%) and 63 (27.75%) female representing the sample. The Figure 1 shows the educational level of respondents that were master degree holders 97 (43%) at highest representation followed by 67 (30%) holding a bachelor's degree, 17% (39) of respondents having PhD degree, very few had high school / or diploma degree qualification and other educational background.

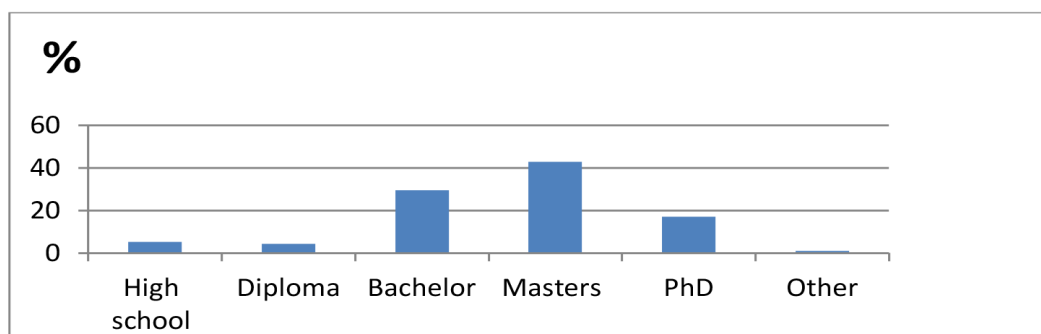


Figure 1 Educational level of respondents

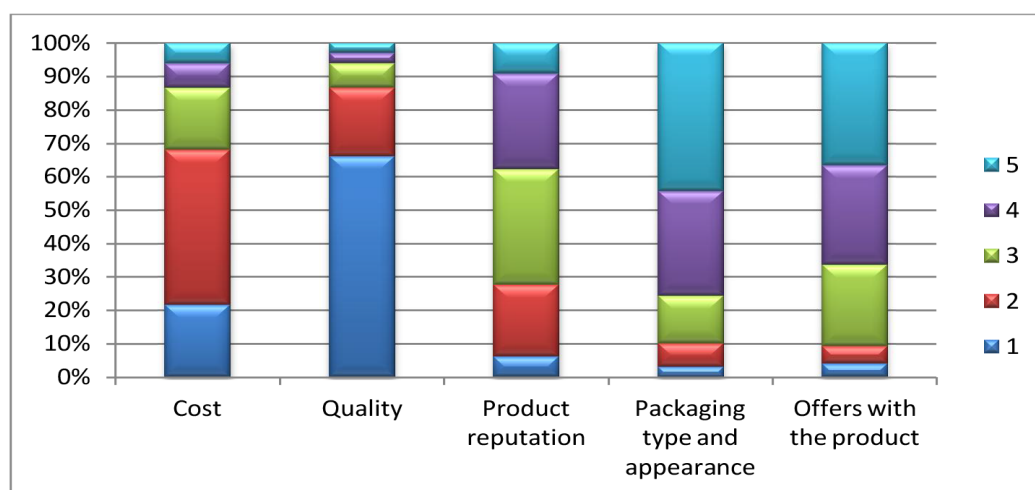


Figure 2: Important factors consideration when buying the products

Table 1 monthly income of respondents

Monthly income in SR	N	%
Less than 5000	35	15.42
6000-8000	58	25.55
9000-11000	48	21.15
12000-14000	38	16.74
15000-17000	21	9.25
18000-20000	14	6.17
More than 20000	13	5.73
Total	227	100

The table 1 shows the income level of the respondents. In the sample more than 60% of the respondents representing their monthly income within the group of less than 10,000/- SR. and less than 40% of the respondents belong to the monthly income of

more than 10,000 SR per month. It means that majority of the population belongs to middle income group.

Table 2: Location of Respondents

City	N	City	N
Riyadh	85	Dahran	6
Jeddah	58	Najran	1
Madinah	4	Jubail	2
Makkah	11	Alhasa	3
Haffouf	5	Safwa	2
Tabouk	2	Hafr Albaten	1
Abha	4	Zulfi	1
Alkhobar	9	Kharg	5
Dammam	10	kateef	5
Qasim	10	Hail	1
Jazan	1	Dawadmy	1

Table 2 provides the full detail of respondents' location they belongs. It can be seen in the table that the largest number of respondents belongs to the capital city Riyadh (85) followed by Jeddah (58). The other 101 participants came from the remaining 22 cities. The both cities are having the good representation for business as compare to the other cities in the region.

The Figure 2 reveals the most important factors they consider when buying the products from super/hyper markets, 64% of respondents agreed that the quality of the products are their primary concern

followed the cost of the product at 45%, packaging and product offers/special deals and product reputation were at 44%, 36% and 34% respectively.

From the figure 3 it was found that only 6% strongly agree that supermarkets attempt to satisfy consumer needs. Most respondents either agree (37%) or are neutral (38%) only 11% of respondents disagree- that supermarkets are not interested in satisfying the product quality needs of its customer. From the result it can be concluded that majority around 80% of respondents were agreed and happy that they are having positive level of satisfaction with the services they received from Saudi supermarkets.

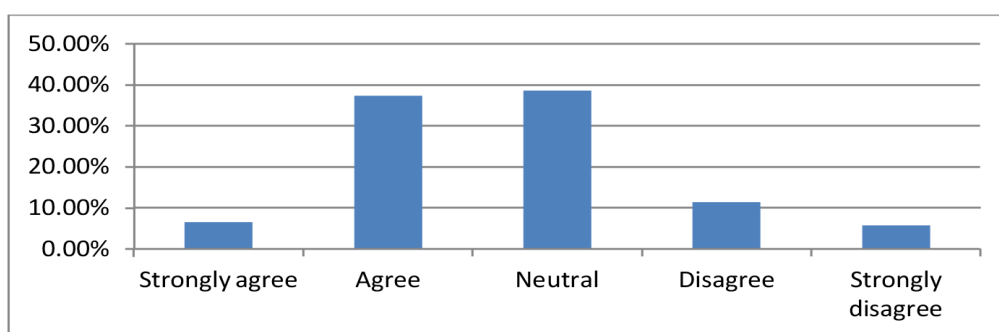


Figure 3: Respondents satisfaction with product quality.

Table 3: Responds' attitudes regarding the elements they need to confirm when selecting the products:

PhD holders	Always	Some times	Never
Check quality	70%	30%	0
Check expiry	80%	20%	0
Check price	68%	29%	3%
High school and Diploma holders	Always	Some times	Never
Check quality	79%	21%	0
Check expiry	70%	16%	14%
Check price	100%	0	0

When looking for the checking process itself in general, the respondents from the lower educational level do more check regarding the quality of the product, expiry of the product and the price checking. According to the researcher, the reason behind this checking is the income level is much lower than the PhD holders (See table 3). Furthermore, some regions such as the Central one has the big cities such as the capital of the country, and the Eastern region has Two big cities Dammam and Al-Khobar, the Western region has Makkah and Jeddah. All of the previous cities are the largest in the Kingdom of Saudi Arabia. The Northern and Southern regions has the smallest population and the cities are small. This could give us another indicator is that the crowded city the people want to finish quickly from the shopping to do

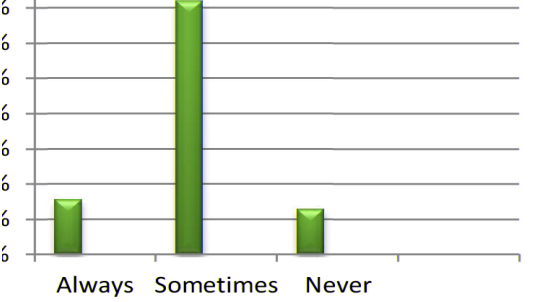
something else therefore they do not have the same ratio of checking comparing the South and North.

Moreover, when coming to the different regions in the country, the choices are different in the Eastern, Western, North, South and the central region. 72% of the respondents from Eastern region always check any sign of damage to the product, whilst less than 1% of the respondents said they never check any sign of the products. The Southern region, 80% of them always check any sign of damage and 100% of the respondents check the price. Furthermore, regarding the quality issues, 80 % of the respondents from Central region check the quality of the products, 66% from the respondents from the Northern region always check the quality, on the other hand, 20 % of the respondents from the Western region check the quality that is the lowest among others. Regarding expiry date

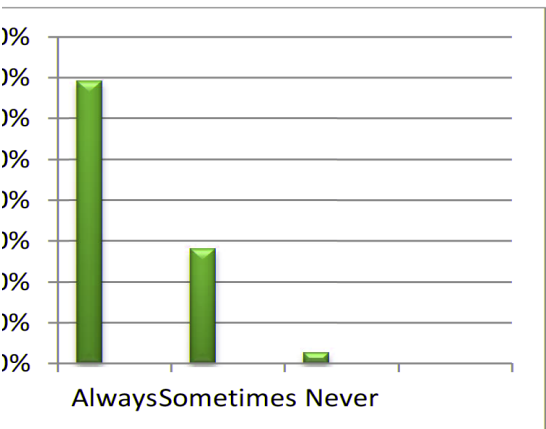


checking, the respondents from Central region 71 % check the expiry date, the response from the Western region was not far from the Central, it was higher by 5 %. In comparison with those two regions, 100 % of the Northern region respondents check the expiry date.

Figure 4 showed the respondent attitudes in respect of their willingness to repeatedly visit the same



Behavior of respondents towards the action taken when they cannot find the required product in the



Respondents awareness of checking the damaged product using the shop

will occasionally check. Less than 3% never check for signs of damage. The figure also indicates that majority are more concern regarding to check the quality of product and packaging etc.

branch of their chosen supermarket. We can see that 22% will buy from the same supermarket again, 49% might buy from the same branch again. Almost 30% will never visit this branch in the future.

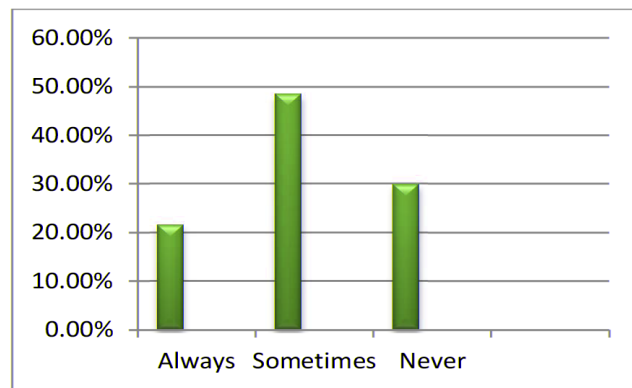


Figure 4: Respondent attitude about repeat shopping in the same branch

The study also indicates that majority more than 80% of the sample population visiting the repeatedly if they do not find the required product first in first visit followed by the less than 20% never visit the super market to get the such product (see the Figure 5).

We can analyse this behaviour further by investigating whether consumers on not finding a product switch to an alternative supermarket. Moreover, from Figure 6 we can observe that a majority of respondents check for signs of damage to the product always. Just over a quarter of respondents

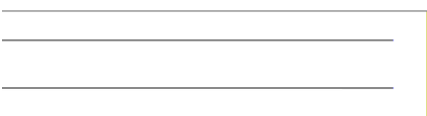


Figure 5: by him v store

Figure 6: product d

From figure 7 it was indicated that the majority answered either ‘‘sometimes’’ (37%) or occasionally (21%). 32% rarely changed supermarket (7%) or never changed supermarket (4%) were in above order.

Figure 8 showed that 26% of respondents are always able to find alternative products or visit another supermarket to satisfy their need and wants. Nearly 70% respondents find that they can obtain an alternative product or visit another supermarket sometimes. And only 10% of respondents agreed that they fail (or refuse) to get alternative product and visit another supermarket. Therefore, from the result it can be concluded that if customers are unable to find the products what they needed and when choice is limited they will often go to an alternative product as well as another supermarket to fulfil it.

To look at the availability of supermarket near by the respondents’ location (which also allows us to investigate concentration and competition) it was seen that the number of supermarkets located within a 2 KM<sup>2</sup> range of the respondents residence. Figure 9 indicated the detail. 13% of the respondents had only

one supermarket available nearby their location. At the other end of the scale 70% of the respondents had 3 or more supermarkets available nearby their location. From this, it can be concluded that there is a high level of competition among supermarkets in the region.

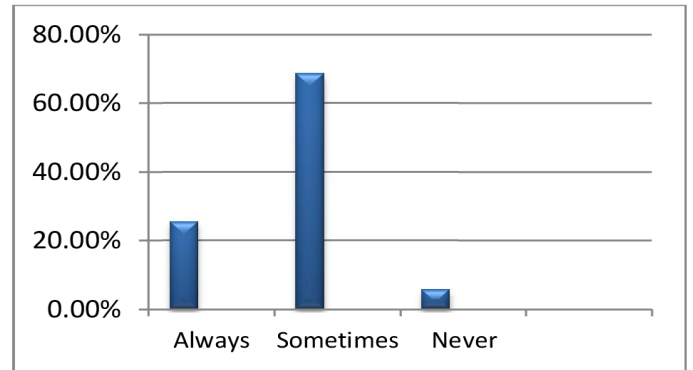


Figure 8: Respondents perception regarding to find alternative products

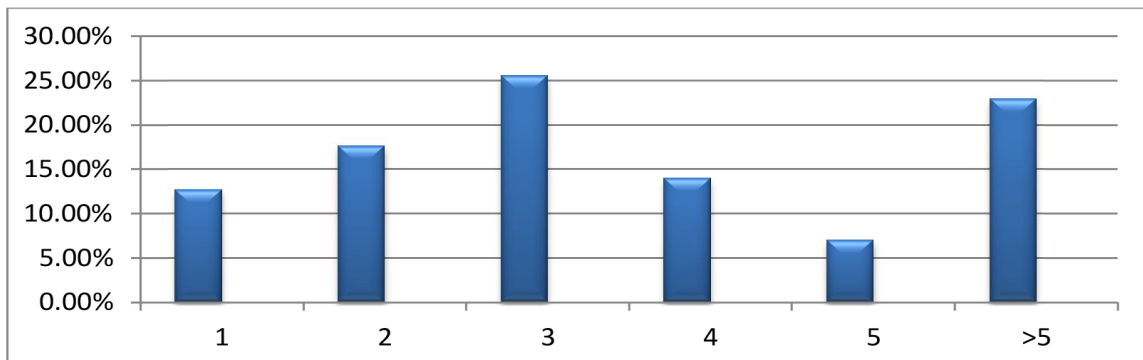


Figure 9: Availability of supermarkets nearby the locality of respondents within 2 KM<sup>2</sup>

In the next question participants were asked why they chose a particular supermarket. They were asked to assess a number of factors using a simple ranking system. A rank of 1 indicated the factor was the most important factor in the eyes of the respondents. A rank of 5 indicated the factor was least important. The

results presented in Figure 10 showed that the most respondents chose a supermarket on its proximity and ability to supply all the needs of the respondents. The Least interest and perhaps most surprising were price competitiveness and selection of goods on offer.

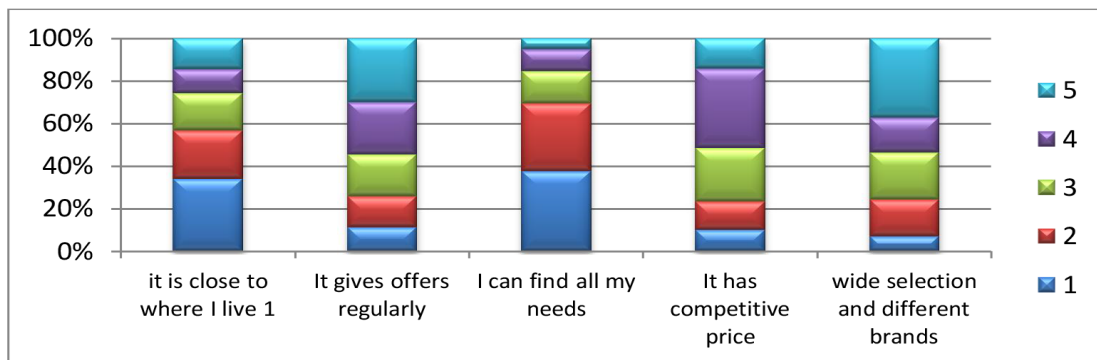


Figure 10: Reasons for choice of supermarket among respondents

From the data provided in Figure 11 we revealed that 44% of respondents prefer a luxurious supermarket. It means that most respondents would be willing to change the supermarket they usually shop

at. 17.1% of the participants answered always they prefer the luxurious places, and 10.1% and 7% they rarely and never prefer the luxurious places respectively.

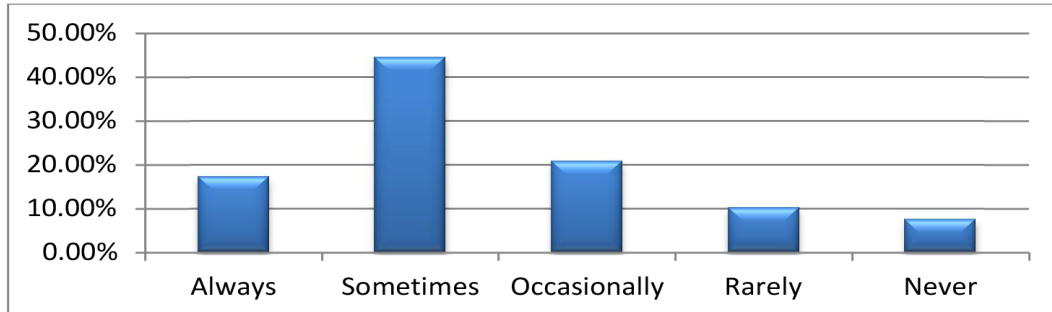


Figure: 11. Preferences and choice of luxurious locations and facilities inside the supermarket

From figure: 12, it was investigated that whether family and child care facilities influence choice of supermarket. 22% of respondents chose a supermarket on this basis. Not surprisingly, 34% of respondents

said that these facilities sometimes influenced their choice. Only 9% argued that these factors had no influence on their choice.

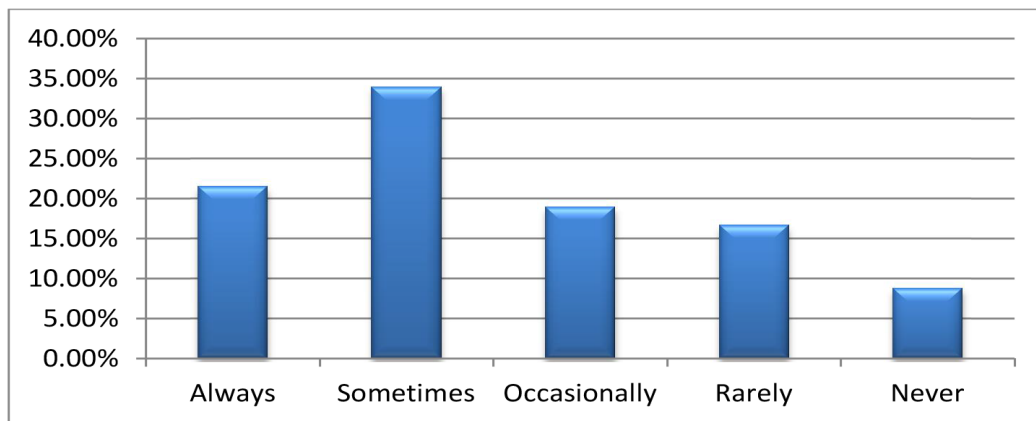


Figure: 12. Respondents preferences regarding the selection of supermarket that having family and children facilities

**Discussion and Conclusion:**

Retail sector in Saudi Arabia is growing very fast. Developments in the food retailing industry have led to growth of shopping malls, particularly in the large cities of Saudi Arabia. As a consumer play an important role in any business. Therefore understanding consumer buying behaviors are important to success of super or hyper market business. The results indicates that the quality of the product are their primary and most important concern when they consider to buying the products from super/hyper market followed the cost of the product packaging and product offers/special deals and product reputation. Most respondents either agree (37%) or are neutral (38%) on that supermarkets attempt to satisfy consumer needs. The worksproposes a agreement on the association of better service quality toward higher customer satisfaction. The results are

stable with studies which found the significance of better service quality to rise of customer satisfaction (Dabholkar *et al.*, 1996; Gomez, 2004; Jayasankaraprasad & Kumar, 2012).

From the result it can be concluded that highest number of respondents are agreed and happy and having positive level of satisfaction with the services they received from Saudi supermarkets. This is the very positive sign for organised retailers. When looking for the checking process itself in general, the respondents from the lower educational level taking care of the quality of the product, expiry of the product and the price checking. This is the indication that the consumer are now more health concern as compare to past so the marketer should always be concerned of it. Regarding willingness to visit frequently to the same branch it is clear from the result that highest number of respondents visits reputedly if they do not find the



required product in first visit. Moreover, it is observed that a majority of respondents check for signs of damage to the product always. And they are more concern about to check the quality of product and packaging too.

Highest figure of respondents report that they usually change the super market for shop if they do not get desired product, they go through with an alternative product or visit another supermarket sometimes to find it. It is advised to the marketer that they should make sure that the entire product should be available and logistic problems should fix to satisfy the customer in this regards. Highest number of the respondents indicate that more than 3 supermarkets available nearby their location. From this result, it can be concluded can that there is a high level of competition among supermarkets in the region and it should be the concern of marketer to take comparative advantage.

Distance of supermarket and ability to supply all the needed items to the respondents has given more attention to visit for shop as compare to the price competitiveness and selection of goods are secondary factor to them. Majority of them prefer a spacious supermarket and furthermore family and child care facilities influence the consumer to visit supermarket. Thus it can be suggested that marketer should give the attention to provide more space and family and kids' entertainment facility should be provided so they can get an added advantage on competitors and consumer will be highly loyal to them.

#### Limitation of the Research:

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:

- Scarcity of time and cost.
- The sample size was limited due to time and cost concerned.

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## ROLE OF TV ADVERTISEMENT IN INFLUENCING, PROCESSING & UNDERSTANDING OF ADVERTISEMENT MESSAGE AMONG CHILDREN AND ITS IMPACT ON BUYING BEHAVIOUR

MAQSOOD HUSAIN JUNAIDI<sup>1</sup> & ROHAN SHARMA<sup>2</sup>

<sup>1</sup>Lecturer, College of Business Administration University of Business & Technology, Jeddah, KSA

<sup>2</sup>Research Scholar, Innocent Hearts Group of Institutions, Punjab Technical University, Jalandhar, Punjab, India

### ABSTRACT

*The present research aims to study the children and parents behaviour with respect to exposure of television advertisement. 300 children between age group 8-12 years were taken as sample randomly drawn from various Indian cities. Various aspects of buying behaviour & television viewing pattern were taken into consideration. The result reveals that television advertising makes huge impact on children's buying behaviour. And advertisement music, slogans, celebrity models influences the children buying behavior drastically. The other aspects of children buying behavior were also explored.*

**KEYWORDS:** Children, Advertisement, Buying Behaviour, Parents, Purchase

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### INTRODUCTION

In today's scenario children are most IMPORTANT target market for all companies, it has been observed that they are the future market for many companies. the children market is the new segment which contain lot of potential. Majority of companies somehow are in the business of making products for the children's Atkin (1978); Belch et. al. (1985); Caruana & Vassallo (2003); Ekstrom (1995); Foxman et al.(1989); Jenkins (1979); Lee & Beatty (2002). Behaviour is the complicated concept and can mean many different things to many different people. Hawkins (2009) this means that behaviour is just as much about how we act in certain social position, such as saying "thank you" or letting another person go by as it is about arguing, disturbing other, struggle or using offensive language. Behaviour includes everything that we say or does that can manage or have an impact on another person. Consumer behaviour is a rapidly increasing discipline of study. It means more than just how a person buys products. It is a difficult and multidimensional process and reflects the totality of consumers' decisions with respect to acquisition, consumption and discarding activities. We, as consumers, exhibit very significant differences in our buying behaviour and play an important role in local, national or international economic conditions. It is just a normal phenomena that we all are customer at certain level it does not matter we belong rich, poor, rural urban or from which ever society in the end we are customer. We generally need goods or products to satisfy our need and wants. On the other side companies use different techniques to create a demand by showing their product again and again with new advertisement with new brand ambassador, with new story, with new music's etc. their ultimate goal is to create a demand and people will purchase whatever they show in the advertisement for that they try to understand the customer behaviour. Our burning up<sup>2</sup> related behaviour influences

the development of technology and introduction of new and better products and services (Belch et al., 1985). The children never think about the before demanding anything, if they want something they just say it. I need it, it is not their problem how that thing will come or managed they just need it is parents responsibility to get it done (Beatty & Talpade, 1994); (Belch et al., 1985); (Swinyard & Sim, 1987) and the influence of the children is quite high on their parents and best things is they know how to convince their parents. (Belch et al., 1985, 1980); (Hempel, 1974); (Nelson, 1978); (Shoham & Dalakas, 2003); (Swinyard & Sim, 1987); (Szybillo & Sosanie, 1977). The parents also know how to handle their children if the demand something expensive to fulfill that demand, they want some commitment from their children (Belch et al., 1985); (Jenkins, 1979); (Foxman et al., 1989), Parents are much more concern about the purchasing any product in case of purchasing any product for thir children they do all necessary checking of the product then they buy it, such as brand, manufacturing date, expiry date, colour, model etc. they are very particular regarding purchasing any product for their children's (Belch et al., 1985); (Darley & Lim, 1986); (Jenkins 1979); (Kenkel 1961); (Nelson 1978); (Szybillo & Sosanie 1977).

## REVIEW OF LITERATURE

Ernest (2010) This study explores the influence of directs (parents) and vicarious (celebrities) role models on young consumer's purchase purpose and behavior in Malaysia. The study partially replicates previous studies conducted in the west while exploring the eastern viewpoint. The data was collected using convenience sampling. Respondents were mostly undergraduate students at a public university in Sarawak, Malaysia. Regression analysis was carried out to approximation the impact of role model power on purchase intention and behavior. The results indicate that both direct and vicarious role model significantly influence purchase intention. However finding do suggests that the direct role model does not influence purchasing behavior. The study significantly contributes in understanding the role model influence on ever growing youth market in Malaysia. Panwar & Agnihotri (2006) This study is designed to extend knowledge of cognitive processing of advertising messages by urban children in India. Data were collected from 250 children aged between 7 and 12 years, drawn in the sample from five major towns of the relatively affluent western state of Gujarat (India) by using the cluster sampling approach. It was found that children's skill to make out and process advertising messages and to understand their intents is influenced not only by their cognitive abilities at different age strata but also by their social and personal environments. Social norms related to acceptability and appropriateness of gender behavior also influence the processing of advertisement messages by the children of both sexes. Other fundamentals like likeability of the model, character or endorser, story line, slogan and the music will create liking or disliking for a particular advertisement and hence decoding of its message. Sabat & Dash (2012) The motive of this study is to gain deep understanding of demographic aspect behind company's choice of celebrity endorsement as a part of its promotional strategy while positioning its brand to particular segment. The research result suggests tentatively that the use of celebrity endorsers in TV commercials could be effective in influencing attitudes and purchase intentions. But the success of the use of celebrity endorsers varies across different products. More considerably the success of the use of the celebrity endorsers in the commercials depends on the fact that for which demographic segment the ad was meant—is it meant for the males or else; is it for the teenagers; is it for the white collar workers; is it for the housewives or for the students, i.e. for the financially dependents; or it is for the business personnel, for the reason that demography make a significant difference of the psyche of the consumers. So the marketers should go thoroughly about the mind of the different demographic segment before finalizing the strategies with a long term perspective. Then only the marketing organizations can become able to satisfy their esteem need; fame, prestige in the consumers' society can be gained. And this is the only way to reach at the

top of Self-actualization Mountain—the ultimate destination of individual human being as an organization of diverse activities, the ultimate destination of a group of individuals with a rational perspective.

## OBJECTIVE

- Role & effect of television advertisement on Buying behavior
- Role and Effect television advertisement on the bases of gender.
- To determine whether television advertising elements like music, slogans, endorsers etc. influence, processing and understanding of advertising messages among children.

## METHODOLOGY

### Sample

The present research was conducted on a sample consisting of 300 subjects that were randomly drawn from different Class city of India. The age of children vary from 8-12 years

### Tool Used

The questionnaire by Panwar & Agnihotri (2006) on Impact of T.V Advertising on children’s buying behaviour was used. The scale is having 14 items used, with five point rating. The scoring is done as point 1 for strongly disagree with the statement to point 5 for strongly agree. The scale has the reliability and validity within the acceptable norms.

### Procedure

The questionnaires were distributed to the mothers and they were asked to read the instructions given in the questionnaires. No time limit was given to fill the questionnaire but it was expected that respondents would fill the same within 20-25 minutes. There were several reasons why just mother had been selected as respondent instead of both parents. Firstly, researches demonstrated that mothers seemed to be primary recipients of influence attempt from children and are more familiar with the children’s purchase attempt Cowan (1988).

## RESULTS ANALYSIS

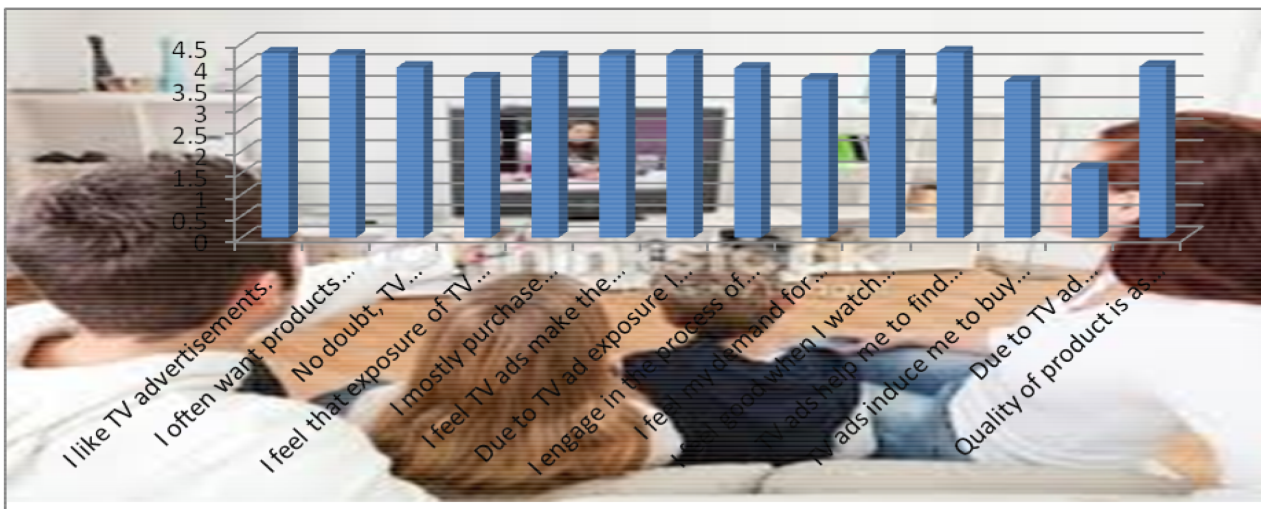
**Table 1: The Mean Value and Standard Deviation of Children Understanding the Television Advertisements**

Sr. no	Variables	N	Mean Value	Standard Deviation
1	“I like TV advertisements”.	300	4.28	0.78
2	“I often want products seen in TV ads”.	300	4.23	0.93
3	“No doubt, TV advertisement increases the frequency of purchase”	300	3.95	0.90
4	“I feel that exposure of TV ads has enhanced my involvement in purchasing”.	300	3.70	0.87
5	“I mostly purchase product shown in TV ads”.	300	4.19	0.91
6	“I feel TV ads make the purchase of product easier”.	300	4.22	0.87
7	“Due to TV ad exposure I have started experimented new products”.	300	4.23	0.93
8	“I engage in the process of buying TV advertised product”.	300	3.93	0.90
9	“I feel my demand for products purchase is influenced by TV ads”.	300	3.67	1.04
10	“I feel good when I watch the ads of products I am already using”.	300	4.23	0.93
11	“TV ads help me to find the best product”.	300	4.30	0.88
12	“TV ads induce me to buy products for enjoyment even though I do not require them”.	300	3.62	1.05



13	“Due to TV ad exposure, my family members collectively decide products to be purchased”.	300	1.59	0.81
14	“Quality of product is as good as expected from TV ads”	300	3.97	0.92

The table shows the mean value and standard deviation of television advertisement and it include number of variables such as children like television advertisement shows the mean value 4.28 and standard deviation of 0.78, it is generally seen that children often want those products seen in TV ads and its mean value is 4.23 and standard deviation 0.93. Television advertisement increase the frequency of purchase its mean value and standard deviation is 3.95 and 0.90. with this it is observed that television ads has enhanced my involvement in purchasing gives mean value with 3.70 and standard deviation of 0.87 Children mostly purchase product shown in TV ads shown mean value and standard deviation 4.1900 and 0.91. With television advertisement make the purchase of product easier with mean value and standard deviation 4.2267 and 0.87. With television advertisement children have started experimented new products with mean value 4.2367 and standard deviation 0.93. Children engage in the process of buying television advertised product with mean value 3.9333 and standard deviation 0.90. Demand of product get increased with advertisement and having the mean value and standard deviation 3.67 and 1.04. Children love to watch the ads of products which they already using and having mean value 4.23 and standard deviation 0.93. Advertisement help in finding the best product mean value 4.30 and standard deviation 0.88. Television advertisement helps in introducing new products or recall different products to us and helps in purchasing them with mean value and standard deviation 3.62 and 1.05. Television advertisement helps family members collectively decide products to be purchased with mean value 1.59 and standard deviation 0.81. Television advertisement provides quality of products and having the mean value and standard deviation 3.97 and 0.92.



**Figure 1: Showing the Mean Value of Children Understanding the Television Advertisements**

**Table 2: Mean Scores & T-Test for the Dependent Variables on the Basis of Gender**

Sr. No.	Variables	Gender		T-Test	Sig.
		Male	Female		
1.	“I like TV advertisements”.	4.25	4.32	0.81	.418
2.	“I often want products seen in TV ads”.	4.29	4.15	1.24	.216
3.	“No doubt, TV advertisement increases the frequency of purchase”	3.94	3.95	.090	.928
4.	“I feel that exposure of TV ads has enhanced my involvement in purchasing”.	3.70	3.68	.187	.852
5.	“I mostly purchase product shown in TV ads”.	4.24	4.11	1.18	.239

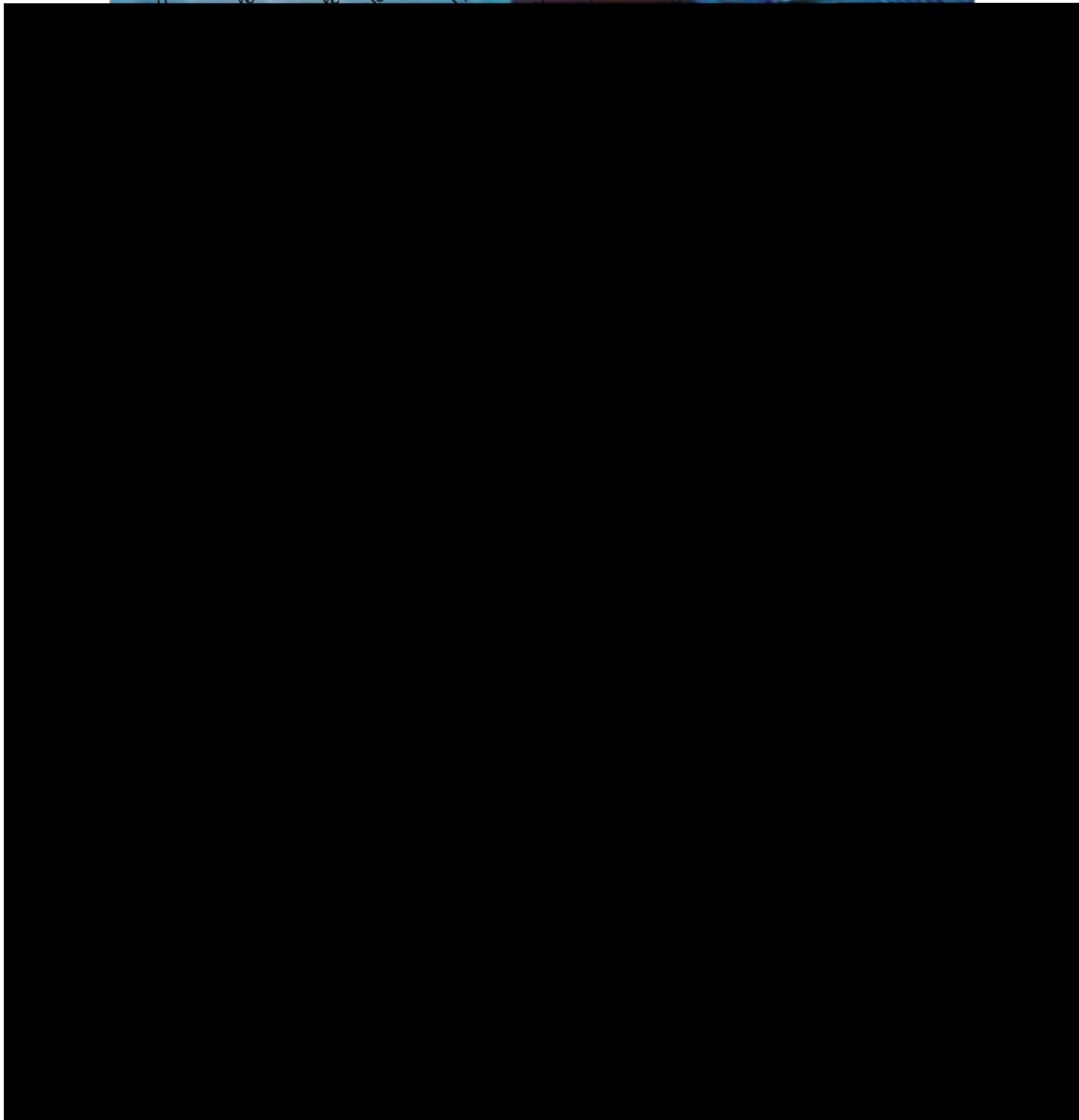
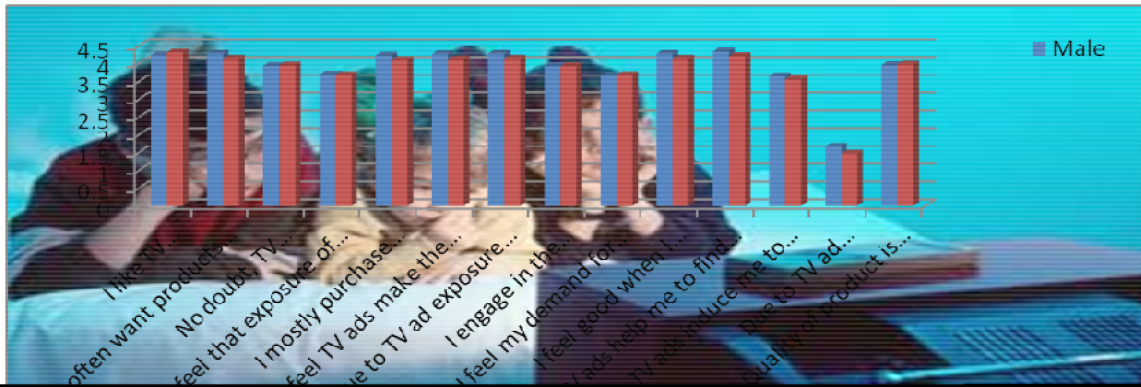
**Table 2: Contd.,**

6.	“I feel TV ads make the purchase of product easier”.	4.28	4.13	1.42	.154
7.	“Due to TV ad exposure I have started experimented new products”.	4.29	4.15	1.24	.216
8.	“I engage in the process of buying TV advertised product”.	3.93	3.93	.017	.986
9.	“I feel my demand for products purchase is influenced by TV ads”.	3.66	3.68	.208	.835
10.	“I feel good when I watch the ads of products I am already using”.	4.29	4.15	1.24	.216
11.	“TV ads help me to find the best product”.	4.35	4.22	1.32	.185
12.	“TV ads induce me to buy products for enjoyment even though I do not require them”.	3.65	3.56	.742	.459
13.	“Due to TV ad exposure, my family members collectively decide products to be purchased”.	1.67	1.47	2.08	<b>.038*</b>
14.	“Quality of product is as good as expected from TV ads”	3.96	3.98	.160	.873

**\*: Significant at.05 level of significant**

It was observed from table that male and females had different mean value regarding television advertisement and out of 14 variables, 6 variables had significant difference such as in case of variable studying advertisement enhanced involvement in purchasing showed the significant difference among males with the mean value as 3.70 and female with the mean value as 3.68 and t value 2.18 (0.05 >.030). Television advertisement made the purchase of product easier also showed significant difference with the mean value of males as 4.28 and female as 4.13 and the t value of 2.03 (0.05 >.043). Due to television advertisement exposure, families started experimenting new products also showed significant difference in the mean value of female and males as 4.15 and 4.29, the t-value as 2.25 (0.05 >.025). Television advertisement made selection of product best also showed significant difference in the mean value of male and female child with values as 4.35 and 4.22 and had the t-value 1.98 (0.05 >.048). Due to television advertisement, product was purchased with family collective decision. This statement showed significant difference with mean value of male and female as 3.96 and 3.98 and t value 2.08 (0.05 >.045).

The overall results show that both male and female child like watching television advertisements. Both love to purchase products shown on television and thus are curious to watch television advertisement and decide to purchase product through television advertisement. Tinson (2005) in terms of children with a more democratic preference consider themselves more involved in all different stages of decision making. If democratic values were spreading within society this would put forward that children were becoming more concerned in purchase decisions. Female child take better decision as compare to male child and good in decision making. Sabat & Dash (2012) also supported the study by understanding of demographic aspect behind company’s choice of celebrity endorsement as a part of its promotional strategy while positioning its brand to particular segment.





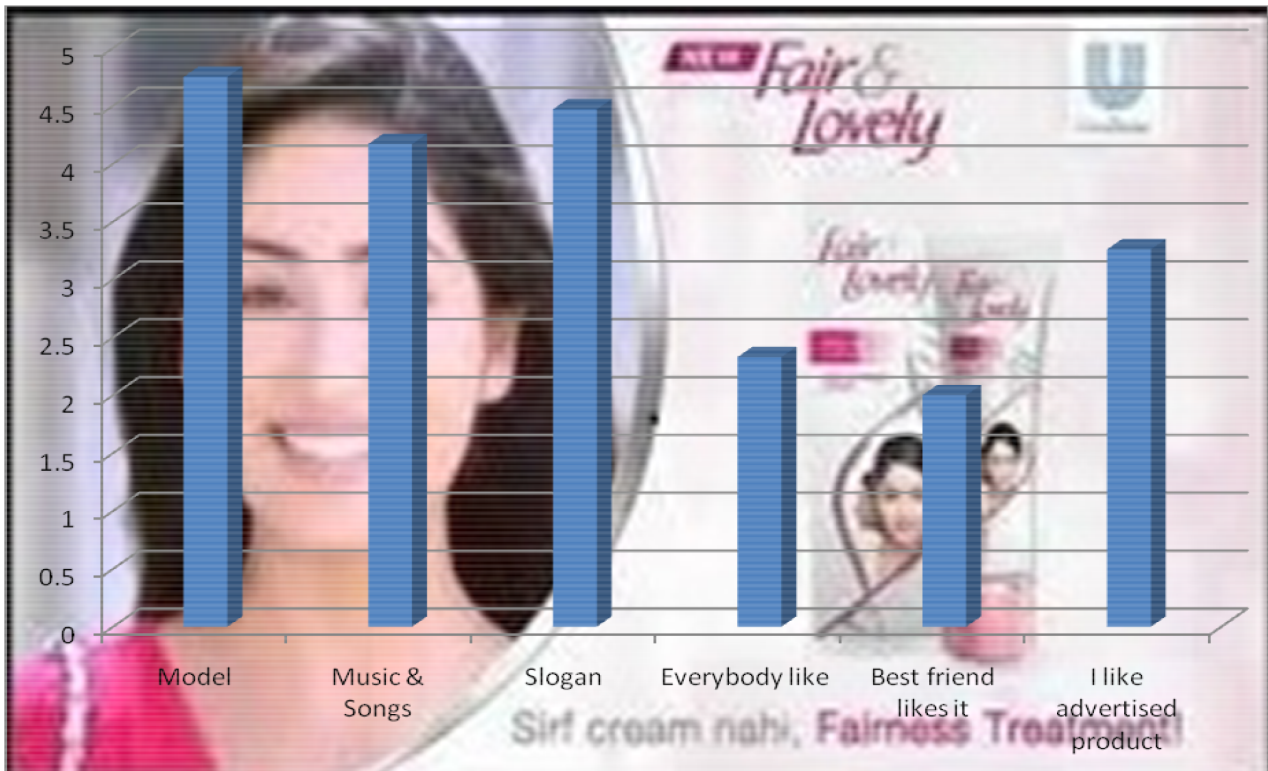


Figure 3: Showing the Mean Value of Children Likeability towards Advertisements

Table 4: Elements Creating Likeability towards Advertisements

Sr. No	Variables	Mean Value	Ranks
1	“The model of the advertisement (like Hrithik Roshan in Coca-Cola)”	4.75	1
2	“The slogan in it (like yehi hai right choice baby, aha!)”	4.47	2
3	“The music and the song of the advertisement (like in Nescafe)”	4.17	3
4	“You like the advertised product and therefore you like the advertisement (like you may be liking all the chocolate advertisements because you like chocolates)”	3.26	4
5	“Everybody in the house likes it and therefore you like it”	2.33	5
6	“Best friend likes it and therefore you like it”	2.00	6

The results shows that children gives priority to those advertisement in which there is celebrity or models, followed by advertisement with any form of slogans, next preference of children is watching the advertisement with slogan or any kind of music followed by watching advertisement because of the liking of advertised product. Another reason of watching advertisement is due to the liking of the product by other family members and least ranked reason is liking of the advertisement due to best friend’s liking. Panwar & Agnihotri (2006) i.e children’s skill to make out that they like those advertisement in which famous celebrates, model or some known person endorsing the product, children believes and trust on them so they love to watch those advertisement again and again. Zubairi et al (2012) also supported the study. The main motive to advertisement companies is to attach the customer by giving the emotional touch to the customers. The marketing and advertising helps in increasing the growth of the economy by increasing sale.

## CONCLUSIONS

The results shows positive impact of television advertisement on children's behavior and it also shows that majority of children enjoy watching television advertisement. No significant difference between male and female were found on behaviour and liking of children's towards television advertisement and result also proves that advertisement help them in purchasing the new product and quality/ branded product. Television advertising makes huge impact on children's behaviour to such an extent that children start demanding for the advertised product. It is also found that children showing more enthusiasm and love to watch advertisements having involvement of models or celebrities.

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## RELATIONSHIP OF JOB BURNOUT WITH DEMOGRAPHIC VARIABLES – A CASE STUDY OF PUBLIC & PRIVATE UNIVERSITIES IN INDIA

SAYEEDUZZAFAR QAZI<sup>1</sup> & TEJBIR KAUR<sup>2</sup>

<sup>1</sup>Professor, HRM Department, CBA, University of Business and Technology, Jeddah, Saudi Arabia

<sup>2</sup>Assistant Professor, School of Commerce & Management, Sri Guru Granth Sahib World University,  
Fatehgarh Sahib, Punjab, India

### ABSTRACT

*The present research paper investigates the relationship of demographic variables like age, experience, gender and designation with Total Job burnout as well as 3 dimensions of Job Burnout i.e 'Emotional Exhaustion', 'Depersonalization' and 'Diminished Personal Accomplishment as given by Maslach and Jackson (1981) Burnout Inventory'. The data was collected and analysed during the time period of 2015 from teaching fraternity working in Public & Private Universities of India. Faculty members from Management, Engineering and Basic Sciences departments with designation Professor, Associate Professor and Assistant Professor were selected as a sample keeping in mind the availability of the data, cost to be incurred and the distance to be travelled for data collection. Only faculty members with more than one year of experience were taken in to consideration. The data were analysed by using mean, standard deviation, t-test & critical ratio method, One way ANOVA. A significant difference was found in Job Burnout levels of faculty teaching in public & private universities of Punjab on the basis of Designation, Experience, Qualification whereas on the basis of Gender there was no significant difference in total Job Burnout & its three dimensions i.e Emotional Exhaustion, Depersonalization & Diminished Personal Accomplishment.*

**KEYWORDS:** Job Burnout, Emotional Exhaustion, Depersonalization & Diminished Personal Accomplishment

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### INTRODUCTION TO CONCEPT OF JOB BURNOUT

Job burnout has come into consideration as a concept in 1970s onwards and something very noteworthy came into limelight which was related to people and their occupation. This is in continuation till date though it's been some 35 years from foundation of this concept to emotional literature and related civilized exchange of ideas. Since then, burnout is known as a concept that is been practised commonly among large number of people. Due to its importance & impact on masses, Burnout has persuaded many experimenters to go deep to the roots, learn it more and try to recognize reasons of its occurrence in a better way. It has also stimulated practitioners to outline ways to deal with it, avert it, or fight with it. Thus, since beginning, burnout as a concept has allured both practitioners & experimenters as a common society problem and so must be given utmost attention in all sectors where human jobs are concerned. According to Sinha V. (2010) Burnout can be defined as the end result of stress experienced, but not properly coped with resulting in symptoms of exhaustion, irritation, ineffectiveness, discounting of self, others and problems of health (Hypertension, Ulcers and Heart Problems).

Maslach et al. (2001) provided a comprehensive analysis about the three stages of burnout: "high levels of exhaustion cause depersonalization; if depersonalization continues, the feelings of accomplishment would then

be reduced.” Although there are various definitions about job burnout, they provide similar explanation that job burnout can be generalized as the negative emotional responses to the job.

### **Emotional Exhaustion**

It is the main factor for burnout and the most distinct level of burnout symptoms. This dimension of burnout signifies the basic response to stress. In fact, emotional exhaustion is a requisite dimension for definition of burnout and without this dimension burnout concept may be incomplete (Maslach and Jackson 1981).

### **Depersonalization (Cynicism)**

In revision of some studies relating to burnout, depersonalization usually emerges after emotional exhaustion and in fact it is a direct response to occupational stress. In other words, depersonalization denotes non-emotional irrelevant and hostile responses to referent people (service receivers) and colleagues etc. with burnout syndrome of negative emotions and attitudes followed by others' reprimand (Maslach and Jackson, 1981).

### **Individual Inefficacy (Personal failure)**

The relationship among individual efficacy is relatively more complicated with two other burnout dimensions. In some studies, it seems that dimension of individual inefficacy is the outcome for two other dimensions of burnout but in some other cases, this assumption has not been approved while it emphasizes that such elements grow in parallel and along with each other instead of placement as a chain side by side of others. In other words, individual efficacy stands for sense of adequacy and successful advance in working with other individuals (Maslach, 1981).

### **Review of Studies Related With Job Burnout and Demographic Characteristics**

Like other phenomena linked to occupation, job burnout has been studied in comparison with individual and demographic features. In terms of gender, the studies of Cordes & Dougherty (1993), Gunes, Bayraktar, & Kutanis, (2009), Kabuoh & Anazodo (2012), Lackritz (2004) found that women are experiencing more often the job burnout syndrome than men.

Cakmberk (2011) in his research that he had done for bank officials he found that among men and women is a statistically significant difference in the variable emotional exhaustion, with men experiencing greater amounts of emotional exhaustion than women. However, it was found no difference in the mean scores of depersonalization and personal accomplishment. It was also found that bank employees that held bachelors and master's degree experienced depersonalization more often compared to non-university degree holders. However, for the variable "personal accomplishment" it was found that there is a statistically significant difference between graduates and non-graduates, with non-graduates experiencing the feeling of personal accomplishment more often.

In contrast, Gorji & Vaziri (2011) study held among bank employees, finds that the factor age affects the amount of burnout that it's being experienced by someone. More specifically, it was observed an increase in the amount of the experienced burnout when there was an increase of age in the sample. Similar results were found in the studies of Tomic, Evers, & Brouwers, (2004), Lackritz (2004) and Ahola et al. (2005), where they found a statistically significant relationship between burnout and the factor age.

Finally, there have been studies in which it was found that the factor sex/gender had absolutely no effect in the experienced amount of job burnout (Lackritz, 2004; Maslach et al., 2001). In the study of a credit institution, it was found

that burnout was higher in employees with more experience and more years of working as bank employees than those with fewer years of work experience (Gorji & Vaziri, 2011).

In contrast, in the research of Kabuoh & Anazodo (2012), also in a financial institution, it was observed that people with 1-15 years of overall experience were experiencing personal accomplishment more rarely. Wofford (2003) found that demographic factors are related to the magnitude of job satisfaction of employees in construction organizations, such as age, gender, tenure and job position.

## RESEARCH METHODOLOGY

### Objective of the Study

To understand the relationship between different demographic variables (Gender, experience, Educational Qualification and designation) with Job satisfaction & Job burnout.

### Hypothesis of the Study

H<sub>05A</sub>= “There is no significant difference b/w Job Burnout level in Public & Private Universities of Punjab on the basis of Gender.”

H<sub>05B</sub>= “There is no significant difference b/w Job Burnout level of faculty in Public & Private Universities of Punjab on the basis of Designation.”

H<sub>05C</sub>= “There is no significant difference b/w Job Burnout levels of faculty in Public & Private Universities of Punjab on the basis of Qualification.”

H<sub>05D</sub>= “There is no significant difference in Job Burnout levels of faculty teaching in Public & Private Universities on the basis of Experience.”

### Sampling & Distribution of Sample

Thorndike (1979) proposed a rule or informal guide that “there should be ten respondent for each variable plus fifty respondents”. And as per the guideline or the rule, in this particular research  $12 \times 10 + 50 = 170$  respondents can be ideal sample.

Also, Malhotra (2009) argues that for studying behaviour/perception/attitude, minimum sample of 300 is required. Here sample size taken for this study is well above that mark. The questionnaire was distributed among 500 faculty members but only 410 filled responses were returned with a response rate of 82%. After scrutiny of the filled questionnaire, 42 responses were rejected because of various reasons like incomplete information, wrong entries etc. The remaining 368 i.e 89.75 % cases were used as sample in this study.

**Table 1: Designation Wise Sample Break-up**

S. No	Designation	Frequency	Percentage
1	Professor	11	3.0
2	Associate Professor	27	7.3
3	Assistant Professor	330	89.7



Table 1 shows that the faculty members contacted for collection of data were of three different designations. There were 11 Faculty members who were working as Professors, 27 faculty members who were working as Associate Professors &

**Table 2: Qualification Wise Sample Distribution**

S. No	Qualification	Frequency	Percentage
1	PhD's	126	34.2
2	Non-PhD's	242	65.7

Table 2 shows the sample distribution on the basis of qualification of faculty members. The qualification of both type of university faculty was further divided into 2 categories i.e the faculty who obtained Ph.D degree & the faculty who is Non-Ph.D & not yet obtained the doctorate degree. It was observed by researcher that there were 126 faculty members who were with Ph.D degree & 242 faculty members were Non- Ph.D who participated in survey.

**Table 3: Experience Wise Sample Distribution**

S. No	Experience	Frequency	Percentage
1	Novice Faculty	206	56.0
2	Mod. Experienced Faculty	91	24.7
3	Experienced Faculty	19	5.2
4	Highly Experienced Faculty	52	14.1

Table 3 shows the sample distribution on the basis of Experience of faculty. The experience of university faculty was further divided into 4 categories i.e Novice faculty members=1 to 5 years of experience, moderately experienced=6-10 years, experienced faculty=11-15 years whereas faculty having experience 15 years & above was given nomenclature of highly experienced Faculty. It was observed that 206 faculty members fall in Novice faculty member category, 91 faculty members fall in Mod. Experienced Faculty category, 19 faculty members fall in experienced faculty member category & 52 faculty members fall in Highly Experienced faculty member category who participated in the survey conducted by researcher from Public/State & Private Universities of Punjab State.

**Table 4: Gender wise Sample Distribution**

S. No	Gender	Frequency	Percentage
1	Male	174	47.3
2	Female	194	52.7
3	Total	368	100.0

Table 4 shows the sample distribution on the basis of Gender of faculty. It was observed that there were 174 male faculty members who participated in the survey & 194 female faculty members participated in the survey when contacted for collection of data from State & Private Universities of Punjab State.

**Table 5: University Wise Sample Break-up**

S. No	University Type	Frequency	Percentage
1	Public/ State	139	37.8
2	Private	229	62.2
3	Total	368	100.0

Table 5 shows that the faculty members who were contacted for collection of data belong to two categories of Universities. There were 139 Faculty members who were working in Public/ State Universities of Punjab whereas 229 Faculty members were working in Private Universities of Punjab

## RESULTS & DISCUSSION OF DEMOGRAPHIC VARIABLES

### (Gender, Age, Educational Qualification and Designation) & their Relationship with Job Burnout

#### Job Burnout Level on the Basis of Gender of Faculty

This section deals with Mean Values and standard deviation for JB level of faculty on Gender basis. Table 6 depicts mean values & S.D Values for all the three dimensions of Job Burnout, According to which there is not any significantly predicted difference in both type of gender.

**Table 6: T Statistics for Total JB, E.E. DEP & Efficacy of Faculty of Public & Private University**

Dimensions	T-test for Equality of Means			
	CR	df	Sig. (2-Tailed)	
Emotional Exhaustion		-.373	366	.709
		-.373	359.704	.709
Depersonalization		1.008	366	.314
		1.004	354.356	.316
Efficacy		.143	366	.886
		.142	338.531	.887
Burnout Total		-.448	366	.654
		-.450	365.716	.653

Sig value-.05

As per the T - significance value shown in Table 6, The Null hypothesis is accepted due to all significant values of  $T > .05$ . In contrast to this result, some studies show that burnout occurs more often in women than in men. The inconsistency of burnout's relation to gender is most likely attributable to role expectations and job level. Nurses are more likely to be women, and police officers are more likely to be men, and supervisors or managers are more likely to be men. Within such groups, gender would have different mediating roles and the impact of gender on burnout would then vary by the group studied. Unmarried people, especially men, seem to be more susceptible to burnout (Maslach & Jackson, 1996; McDermott, 1984).

There have been studies in which it was found that the factor sex/gender had absolutely no effect in the experienced amount of job burnout (Lackritz, 2004; Maslach et al., 2001). The result supports the findings of Kaur T & Zafar (2014) who conducted a study on private universities in Punjab & found no significant difference in burnout levels among faculty on the basis of their Gender.

**Table 7: Comparative Analysis of Job Burnout of Private & Public Universities on the basis of Gender**

Gender	Measure	E.E (Public Uni)	E.E (Private Uni)	DEP (Public Uni)	DEP (Private Uni)	Efficacy (Public Uni)	Efficacy (Private Uni)	Burnout Total (Public Uni)	Burnout Total (Private Uni)
Male	Mean	19.83	21.02	14.52	10.35	34.60	29.61	62.12	61.01
	N	52	122	52	122	52	122	52	122
	Std. Deviation	6.096	7.952	7.855	4.295	13.868	5.334	6.236	10.738
Female	Mean	20.01	21.72	11.89	10.28	32.31	29.90	61.52	62.05
	N	87	107	87	107	87	107	87	107
	Std. Deviation	7.260	7.236	6.977	3.749	9.751	4.926	9.701	11.017
Total	Mean	19.94	21.35	12.87	10.32	33.17	29.75	61.74	61.49

	N	139	229	139	229	139	229	139	229
	Std. Deviation	6.826	7.617	7.401	4.040	11.470	5.138	8.550	10.858

Sig value-.05

Table 7 provides very important finding for variable Job Burnout under study & compares JB level of both Private & Public/ State Universities on Gender basis. Starting from the overall Job Burnout score, The Public university faculty is facing slightly more Burnout as compared to Faculty of Private Universities of Punjab. This is a bit strange result

The reasons can be discussed in the light of study conducted by G. Lokanadha Reddy and R. Poornima (2012) in 9 state universities of south India. “The results revealed that majority (74%) of the university teachers are experiencing moderate and high levels of occupational stress and 86 percent of teachers have professional burnout. Also, the analysis showed strong support for the hypothesis that there is a positive relationship between the occupational stress and professional burnout of university teachers. Stepwise multiple regression analysis shows that the occupational stress has accounted 7.6 percent of variance to professional burnout.”

Furthermore our results reveal that the Private University teachers are suffering from more *Emotional exhaustion* (21.35>19.94) but Public University faculty is having higher mean score in Depersonalization (12.87>10.32) & diminished personal (33.17>29.75) accomplishment as compared to Private University Teachers. The teachers working in Public Universities when get settled in Government Job, they start least bothering about their clients i.e students. This might be due to no fear of losing job whereas on the other hand Private university teacher’s are accountable for uploading attendance online every day, transparency in assignment marks to students and are answerable for even bad results in the subjects allotted to them. If we compare Job Burnout dimensions on the gender basis from the table, there is no significant difference between scores of JB dimensions of male & female teacher’s teaching in Public & Private Universities. Both Male & Female of Private Universities are suffering from moderately higher Emotional exhaustion whereas Male & Female teachers of public universities are suffering moderately higher Depersonalization & diminished Personal accomplishment score.

These findings are in support of Reddy, G. L., & Poornima, R. (2012) which recommends that “the colleagues and the head of the department should be motivated to support the teachers adequately in their teaching and research activities in order to reduce burnout.

#### **Job Burnout Level on the Basis of Designation of Faculty**

This section deals with statistical testing for JB level of faculty for three designations understudy namely; Assistant Professor, Associate Professor & Professor’s using One Way ANOVA test.

**Table 8: Mean & S.D Values for Total JB Level of Faculty on Designation Basis**

Designation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Assistant Professor	330	62.03	9.704	.534	60.98	63.08
Associate Professor	27	59.04	13.668	2.630	53.63	64.44
Professor	11	54.55	5.939	1.791	50.56	58.54
<b>Total</b>	<b>368</b>	<b>61.59</b>	<b>10.037</b>	<b>.523</b>	<b>60.56</b>	<b>62.62</b>



Sig value-.05

Table 8 is showing difference of mean values of faculty members suffering from burnout. The ANOVA Table 9 depicts that the JB level of faculty differs only in two dimensions i.e E.E & Depersonalization with significance values (.000 & .002) respectively & also in Total Burnout level.

**Table 9: ANOVA & F statistics for J.B of Faculty on the basis of Designation**

Categories		Sum of Squares	df	Mean Square	F	Sig
Emotional Exhaustion	Between Groups	845.017	2	422.508	8.124	.000
	Within Groups	18983.785	365	52.010		
	Total	19828.802	367			
Depersonalization	Between Groups	414.363	2	207.182	6.616	.002
	Within Groups	11430.245	365	31.316		
	Total	11844.609	367			
Efficacy/ Self Accomplishment	Between Groups	285.027	2	142.513	2.089	.125
	Within Groups	24900.441	365	68.220		
	Total	25185.467	367			
Burnout Total	Between Groups	785.830	2	392.915	3.963	.020
	Within Groups	36189.387	365	99.149		
	Total	36975.217	367			

Sig value-.05

The researcher interpret from post hoc table 10 that the significant difference shown in previous table 9 lies with designations Assistant Professor with that of Professor & no significant difference in burnout dimensions is shown in case of Associate Professor.

**Table 10: Post Hoc Test & Tukey’s Test Results for J.B of Faculty on the Basis of Designation**

Dependent Variable	(I) Designation	(J) Designation	Mean Difference (I-J)	Std. Error	Sig
Emotional Exhaustion	Asst Professor	Associate Professor	2.468	1.444	.203
		Professor	8.245*	2.210	.001
	Associate Professor	Asst Professor	-2.468	1.444	.203
		Professor	5.778	2.580	.066
	Professor	Asst Professor	-8.245*	2.210	.001
		Associate Professor	-5.778	2.580	.066
Depersonalization	Asst Professor	Associate Professor	1.456	1.120	.396
		Professor	5.930*	1.715	.002
	Associate Professor	Asst Professor	-1.456	1.120	.396
		Professor	4.475	2.002	.067
	Professor	Asst Professor	-5.930*	1.715	.002
		Associate Professor	-4.475	2.002	.067
Efficacy	Asst Professor	Associate Professor	.800	1.653	.879
		Professor	-4.961	2.532	.124
	Associate Professor	Asst Professor	-.800	1.653	.879
		Professor	-5.761	2.954	.126

	Professor	Asst Professor	4.961	2.532	.124
		Associate Professor	5.761	2.954	.126
Burnout Total	Asst Professor	Associate Professor	2.993	1.993	.291
		Professor	7.485*	3.052	.039
	Associate Professor	Asst Professor	-2.993	1.993	.291
		Professor	4.492	3.562	.418
	Professor	Asst Professor	-7.485*	3.052	.039
		Associate Professor	-4.492	3.562	.418

\*. The mean difference is significant at the 0.05 level.

“Depersonalization refers to a negative, callous and detached attitude towards the people one works with”, i.e. students in this case. Here, Researcher can conclude that this negative attitude decreases with increasing designation. This scenario is alarming because assistant professor is the entry level designation in universities now a days and they have more teaching load as compared to Associate Professor or Professor’s which result into their more interaction with the students. When there will be a feeling of detachment with students, the negative impact of such attitude can result into non serious attitude of students, increased conflicts, more political behaviour, Absenteeism in classes and reduced number in admissions in the particular university/ Institution. Reduced personal accomplishment refers to “someone’s negative self-evaluation in relation to their job performance” (Schaufeli et al., 1993).

There is a very strange result interpreted in the case of Efficacy / diminished Self accomplishment component on the basis of designation of teaching fraternity. The Professor is suffering from highest negative self evaluation score as compared to associate or assistant professors. This feeling of evaluating oneself negatively in teaching Career is decreasing as the designation is going downwards. The result supports the findings of Kaur T & Zafar (2013) who conducted a study on selected private universities in Punjab & found a significant difference in burnout levels among faculty on the basis of their designation.

#### Job Burnout Level on the Basis of Qualification of Faculty

This section deals with statistical testing for JB level of faculty for two level of Qualification’s understudy namely; faculty holding Ph.D degree, Non- Ph.D faculty using Mean, S.D values & CR / T statistics Value’s.

**Table 11: Mean & S.D Values for J.B on Basis of Qualification**

	Qualification	N	Mean	Std.
				Deviation
Emotional Exhaustion	PhD	126	19.35	6.765
	Non PhD	242	21.58	7.538
Depersonalization	PhD	126	9.30	4.198
	Non PhD	242	12.31	6.074
Efficacy	PhD	126	30.77	5.994
	Non PhD	242	31.18	9.264
Burnout Total	PhD	126	58.97	8.717
	Non PhD	242	62.95	10.419

Table 11 is showing difference of mean values of PhD & Non-PhD faculty members suffering from burnout & mean values for Non-PhD faculty is slightly more as compared to faculty holding PhD degree.

**Table 12: T Statistics for J.B on the Basis of Qualification**

Dimension	E.E	DEP	Efficacy	Total J.B
T	-2.791	-4.981	-0.448	-3.672
SIG	0.006	.000	0.655	.000

According to the results obtained in T table 12, the significance values of E.E (0.006), DEP (.000) & Total J.B (.000) in case of PhD vs Non PhD's, the null hypothesis is rejected and it is interpreted that there exist a significant difference in various dimensions as well as Total Job Burnout on the basis of Qualification of Faculty members teaching in Public & Private Universities of Punjab. As given by (Maslach, 1976; Maslach and Jackson, 1981), "Emotional exhaustion refers to feelings of being emotionally overextended and having depleted one's emotional resources." After achieving such a highest degree in their subject, Faculty feel a sense of emotional satisfaction due to increased reputation in career & job.

Similarly there is huge difference between feelings of depersonalization i.e feeling of negative attitude towards student's b/w PhD vs Non PhD faculty. Faculty holding PhD degree were found more sincere towards their clients i.e students whereas more callous attitude was measured among faculty not holding PhD degree. This may be due to the reason for being new to the teaching profession or less proficiency or mastery over one's subject.

The result supports the findings of Kaur T & Zafar (2013) who conducted a study on selected private universities in Punjab & found a significant difference in burnout levels among faculty on the basis of their qualification.

#### **Job Burnout Level on The Basis of Experience of Faculty**

This section deals with statistical testing for JB level of faculty for four categories of Experience understudy namely; Novice Faculty, Experienced Faculty, Moderately Experienced faculty & Highly Experienced Faculty using Mean, S.D values & One way ANOVA.

**Table 13: Mean & S.D Values for Total JB Level of Faculty on Experience Basis**

Category	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		
					Lower Bound	Upper Bound	
Emotional Exhaustion	Novice Faculty	206	21.33	7.383	.514	20.32	22.34
	Moderately Exp. Faculty	91	21.32	6.798	.713	19.90	22.73
	Exp. faculty	19	21.84	6.882	1.579	18.53	25.16
	Highly Experienced faculty	52	17.54	7.650	1.061	15.41	19.67
	Total	368	20.82	7.350	.383	20.06	21.57
Depersonalization	Novice Faculty	206	12.36	6.150	.428	11.51	13.20
	Moderately Exp. Faculty	91	10.57	4.771	.500	9.58	11.56
	Exp. faculty members	19	8.37	2.833	.650	7.00	9.73
	Highly Experienced faculty members	52	9.33	4.958	.687	7.95	10.71



	Total	368	11.28	5.681	.296	10.70	11.86
Efficacy	Novice Faculty Member	206	31.03	10.062	.701	29.65	32.42
	Moderately Exp. Faculty Member	91	30.68	5.882	.617	29.46	31.91
	Exp. faculty members	19	<b>31.32</b>	4.295	.985	29.25	33.39
	Highly Experienced faculty members	52	<b>31.58</b>	4.331	.601	30.37	32.78
	Total	368	31.04	8.284	.432	30.19	31.89
Burnout Total	Novice Faculty Member	206	<b>62.11</b>	10.552	.735	60.66	63.56
	Moderately Exp. Faculty Member	91	<b>62.21</b>	8.382	.879	60.46	63.95
	Exp. faculty members	19	61.53	7.582	1.739	57.87	65.18
	Highly Experienced faculty	52	58.44	11.014	1.527	55.38	61.51
	Total	368	<b>61.59</b>	<b>10.037</b>	<b>.523</b>	<b>60.56</b>	<b>62.62</b>

Sig value-.05

Table 14: ANOVA &amp; F statistics for J.B of Faculty on the Basis of Experience

		Sum of Squares	df	Mean Square	F	Sig.
Emotional Exhaustion	Between Groups	656.041	3	218.680	4.152	.007
	Within Groups	19172.761	364	52.672		
	Total	19828.802	367			
Depersonalization	Between Groups	645.042	3	215.014	6.988	.000
	Within Groups	11199.567	364	30.768		
	Total	11844.609	367			
Efficacy	Between Groups	28.149	3	9.383	.136	.939
	Within Groups	25157.318	364	69.114		
	Total	25185.467	367			
Burnout Total	Between Groups	606.189	3	202.063	2.022	.110
	Within Groups	36369.029	364	99.915		
	Total	<b>36975.217</b>	<b>367</b>			

Sig value-.05

The faculty members are divided into four categories on the basis of experience. The categories are: Novice faculty: 1-5, Moderately Exp: 6-10 yrs, Experienced Faculty: 11-15 & Highly Experienced faculty: 15 and above. Table 13 shows mean values and difference of mean values among four categories of experience which is highest in case of faculty members teaching from last 11-15 years for emotional efficacy (**21.84**) & Efficacy or Diminished Accomplishment (**31.32**). ANOVA Table 14 depicts that the difference among four categories exist only for two dimensions of Burnout i.e **EE** & **DEP**. Thus the null hypothesis is rejected and alternate hypothesis is accepted which shows that there exist a significant

difference in the level of Job Burnout on the basis of experience of faculty members.

**Table 15: Post Hoc & Tuckey Test Results for J.B of Faculty on the Basis of Experience**

Dimension	(I)Category 1	(J)Category 2	(I-J)M.D	Std. Error
E.E	Novice F	Highly EXP	3.792*	1.126
	Mod EXP. F.	Highly EXP	3.780*	1.262
DEP	Novice F	Mod EXP. F.	1.788	0.698
	EXP. F	Novice F	-3.991*	1.33
	Highly EXP	Novice F	-3.032*	0.861

Post –HOC test Table 15 shows that the novice faculty members are suffering from high level of Job Burnout and they are highly emotionally exhausted than the experienced faculty members. This result is alarming because there is a need of young faculty in the educational institutions due to increased competition & rising need of innovation & creativity in the higher education sector. But the youth is suffering from high burnout.

The result supports the findings of Kaur T & Zafar (2013) who conducted a study on selected private universities in Punjab & found a significant difference in burnout levels among faculty on the basis of their experience.

## FINDINGS OF THE STUDY

- Job Burnout does not differ in all the three dimensions in Public & Private universities of Punjab on the basis of gender. So male & female faculty in both Public & Private universities suffer from similar level of Burnout.
- Assistant Professors i.e. entry level faculty members are suffering maximum level of total Job Burnout as compared to Associate Professors & Professors.
- Assistant Professors have more detached attitude i.e. are measured high on depersonalization dimension with their students as compared to Associate Professor or Professor.
- Professors are suffering from highest negative self evaluation/ efficacy score as compared to Associate or Assistant professors.
- Young teachers associated with Public University with less experience, agreed to be a sufferer of groupthink.
- The faculty holding a PhD degree seems to perceive less emotional exhaustion as compared to Non PhD Faculty in Universities of Punjab.
- Faculty holding PhD degree were found more sincere towards their clients i.e. students whereas more callous attitude was measured among faculty not holding PhD degree.
- novice faculty members having up to 5 years of experience are suffering from high level of Job Burnout and they are highly emotionally exhausted than the experienced faculty members
- Depersonalization dimension is measured high for novice faculty members with up to 5 years of experience as compared to teachers who have spent 6 years or more in the university teaching environment.

## IMPLICATIONS OF THE STUDY

One of the reasons for no significant difference of job burnout on the basis of gender can be a huge increase in number of dual career couples in the teaching profession. Earlier there were more female in the school teaching and more

male in higher education teaching, but with the passage of time, many female joined into the university & college teaching after pursuing doctoral degrees. In the University system, there is not much difference in the kind of administrative tasks given to male & female teachers. Also, during the survey, researcher met with many female faculties who were co-ordinator for the training & placement cell, admission process, examination as well extra co- curricular activities. So both male & female teachers are working under similar kind of pressure. In opposite to this scenario, there exists strong difference between JB score on basis of designation of teachers. Reasons can include lack of self motivation, fewer amounts of teaching hours spent in classes, reduced student interaction, more involvement in administrative tasks rather than research and physical & harmonically changes happening in oneself due to aging. The researcher during the survey while interacting with the entry level assistant professor's found some interesting facts. The Assistant Professor level faculty agreed that they were attracted to university teaching profession due to their keen interest in academics and wanted to pursue their career in research & teaching and go for further doctoral studies after gaining some experience but after entering into the system, they are overfilled with administrative tasks such as admission targets, training & placement targets, conducting cultural activities, pleasing their HOD's by doing extra work even during holidays. They are suffering from more pressure than any corporate job. Interestingly such scenario was prevalent in both Public & Private universities.

Furthermore, there exists a significant difference in various dimensions of JB as well as total Job Burnout on the basis of qualification of faculty members teaching in public & private universities of Punjab. There is also a huge difference between salary & monetary benefits given to faculty holding a PhD degree as compared to faculty with no PhD degree. This factor makes more qualified teachers emotionally stronger than their less qualified counterparts. On the other hand, non PhD faculty lives & works with a feeling of inferiority and all the time they undergo a pressure to achieve PhD degree so that they can also enjoy good reputation and more monetary increments .While the researcher compares Job Burnout on the basis of experience of teacher's it was found that faculty members up to 5 years of experience are suffering from high level of Job Burnout and they are highly emotionally exhausted than the experienced faculty members. Also, there depersonalization level is very high as compared to teachers who have spent 6 years or more in the university teaching. The reasons can be their involvement in non teaching tasks rather than teaching & research.

## RECOMMENDATIONS

- The apex body responsible for higher education in any country shall make it mandatory to conduct periodical survey in all the types of universities (government, private , deemed ) to check the level of Job satisfaction , stress & burnout level among faculty and on the basis of that rankings shall be provided to universities to promote quality research.
- The workshops, seminars or conferences should not only be conducted by the universities for spreading a good word of mouth or for publicity purpose but to update their faculty so that they shall feel encouraged to learn new things in their particular specialization.
- It shall be mandatory for the senior faculty members to attend at least one workshop on 'how to lead and guide young faculty'/ learning different leadership styles in different situations so that the most appropriate leadership style can be adopted whenever there a need for good leader in educational Institution.
- As there exist a mandatory position/ designation of "Dean student Welfare " in all the universities for handling matters related to welfare of students of a particular university , It is recommended that apex body shall create a

mandatory new designation named ‘Dean Faculty/ staff Welfare’ for every 200 – 300 employees working in a university who will full time work for welfare of university employees and shall be held responsible for maintaining a minimum acceptable level of stress & a moderate level of job satisfaction among university staff/ faculty .

- A performance appraisal plan for career advancement of faculty shall be designed by HR department so that that all academicians gets a fair opportunity for growth on certain parameters like classroom teaching, research done by faculty and its contribution to society, no of subjects taught in a year, teacher student ratio, Critical Incidents handled by the faculty, extra responsibilities handled other than teaching, etc.
- There shall be fixed Job specification & Job description for teaching as well as non- teaching job which must be provided to an employee at the time of joining of job in university. This will reduce role stress prevailing among employees which become burnout in future . Policies regarding career advancement must be communicated to all teaching/ Non- Teaching staff time to time through circular/memos and also announced in meetings to ensure that all employees are well informed in advance about what kind of performance is expected from them.
- The faculty shall be allocated teaching courses as per specialization & according to their skills and preference so that no faculty leave the university/ institution for the reason of being allocated a course in which they were not comfortable.

## CONCLUSIONS

It was concluded that a significant difference is found in Job Burnout levels of faculty teaching in public & private universities of Punjab on the basis of designation, experience, qualification whereas on the basis of gender there was no significant difference was found in Job Burnout & its three dimensions of faculty teaching in both public & private universities.

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## AN EMPIRICAL STUDY ON ORGANIZED RETAIL SHOPPING BEHAVIOR AND ATTITUDE OF CONSUMERS IN SAUDI ARABIA

Salah Abunar, College of Business Administration (CBA), University of Business & Technology (UBT), Saudi Arabia

Mohammad Zulfeequar Alam, College of Business Administration (CBA), University of Business & Technology (UBT), Saudi Arabia  
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### ABSTRACT

*The presence of organized retailing took the entry in KSA nearly more than a decade ago and a speedy growth in this sector has been seen in the region. The development of the food retail industry, especially in the big cities in Saudi Arabia, has leads to the development and growth of the shopping mall and organized retailing sector. Consumers play a very important role in any business to be a successful. Hence, understanding of customer buying behavior will be a great role to the success of supermarkets or hypermarkets. To understand the best customer insight and investigate the issues related to the behavior of consumers towards the services provided by the supermarket / hypermarket in this region a descriptive research with structured questionnaires of 244 Saudi consumers were conducted online and after analysis it was found that buyers having difference opinion towards products availability and price charged by organized retailer during shop.*

**Keywords:** Consumer Behavior, Retail Sector, Consumer Satisfaction, Supermarket, Hypermarket, Saudi Arabia.

### 1. INTRODUCTION

The KSA customer base comprises locals, who are among the most enthusiastic consumers in the world, and expatriates (more than 30 percent of population), who have a willingness to spend on convenience and shopping products (CIA World Fact book, 2014). A wide range of segments like a high percentage of young population, high disposable income will provide attractive opportunities and focus for the growth of the retail sector. In addition, retail and food industries, including supermarkets and hypermarkets, as a result to encourage the government to support the economy it is now increasingly expanding in Saudi Arabia and it is ranked 14th in 2011 (Shabat et al., 2012).

In addition, Al Kathery (2011) expected that the behavior of Saudi Arabia shoppers different from the claim that so far, 60% of consumers purchased from supermarkets and hypermarkets, about 6% of the purchase of the small shop. Currently, in addition to the rapid growth of online shopping a number of retailers that sell goods and services online and it became the important channel to expand the market locally and internationally (Alam and Elaasi, 2016).

Customer satisfaction is a function of the contrast between the recognition of previous customer expectations and then purchases the same service (Oliver, 1977.1980, Anderson & Sullivan, 1993), it is expected if it is placed on the recognition at the highest level as well. The high value of high customer satisfaction, long-term it is possible to benefit the retail sector, and increase revenues (Zeithaml, Berry, & Parasuraman, 1996; Cronin, Brady, & Hult, 2000; Aaker & Jacobson, 1994). The main challenge of the service industry is the quality of service and customer satisfaction stated by Anderson & Sullivan, 1993; Hong, Huang and Chen, 2003.

Customer satisfaction is the most powerful intangible assets similar to the quality of service, and can be achieved by meeting customer expectations (Oliver, 1980; Boulding, Kalra, Staelin, & Zeithaml, 1993; Bahia, Paulin, & Perrien, 2000; Homburg, Koschate, & Hoyer, 2006; Jayasankaraprasad & Kumar, 2012). If the retailer can evaluate the purchasing behavior and its recognition of the client using the experience in the field of quality retail would enable long-term relationship. Retail companies, for the current customer

loyalty will need to create more of a good quality and better services (Dabholkar, Thorpe, and Rentz, 1996).

## 2. REVIEW OF LITERATURE

Organized retailing/ supermarket industry has had a significant impact on the overall economy in most countries. McCarthy (1981) indicates that the supermarket has been a self-service, retail markets, and a large store that specializes in food products, in particular, the sale of food and household goods selected. In order to understand the behavior described by Yavas and Secil, 1984. Saudi Arabia in the retail sector, according to (Zawya, 2006), is one of the areas that grow rapidly and new demand for consumer goods. Consumers now prefer to shop at the supermarket modern shops and supermarkets for a variety of reasons. First, to the young people and the public, it has been developed to shop from the Western-style shopping from the supermarket. Second, older people prefer the supermarket because it is convenient. Third, at the supermarket because there is a playground where parents can make it possible to shop while entertainment for children, because of the conservative nature of Saudi society, has been seen as a place for family entertainment (Al Rajhi Capital, 2010).

In addition, Saudi Arabia population, and growth in the context of a culture that is based on religious principles, described in the report, which has been updated. A major source of entertainment that can be culturally acceptable is in the form of shopping and dining at a shopping mall. Retail store that can be assessed in these facilities' sale (hypermarkets and supermarkets) is the perfect place to Saudi Arabia from the family can relax (Al Rajhi Capital, 2013). On the other hand, shop corner of Saudi Arabia about 200,000 restaurants in the store mainly for low-income (Al Kathery, 2011). According to Al-Rajhi and Euro monitor survey, the annual growth rate of corner shop in 2010 by 3.2%, supermarket 4.4%, and was 7.2% hypermarket. And it has been the market share of supermarkets by 16%, and the share of supermarkets is 24%, and finally corner shop because a large numbers that is 60%. (Al Rajhi Capital, 2010).

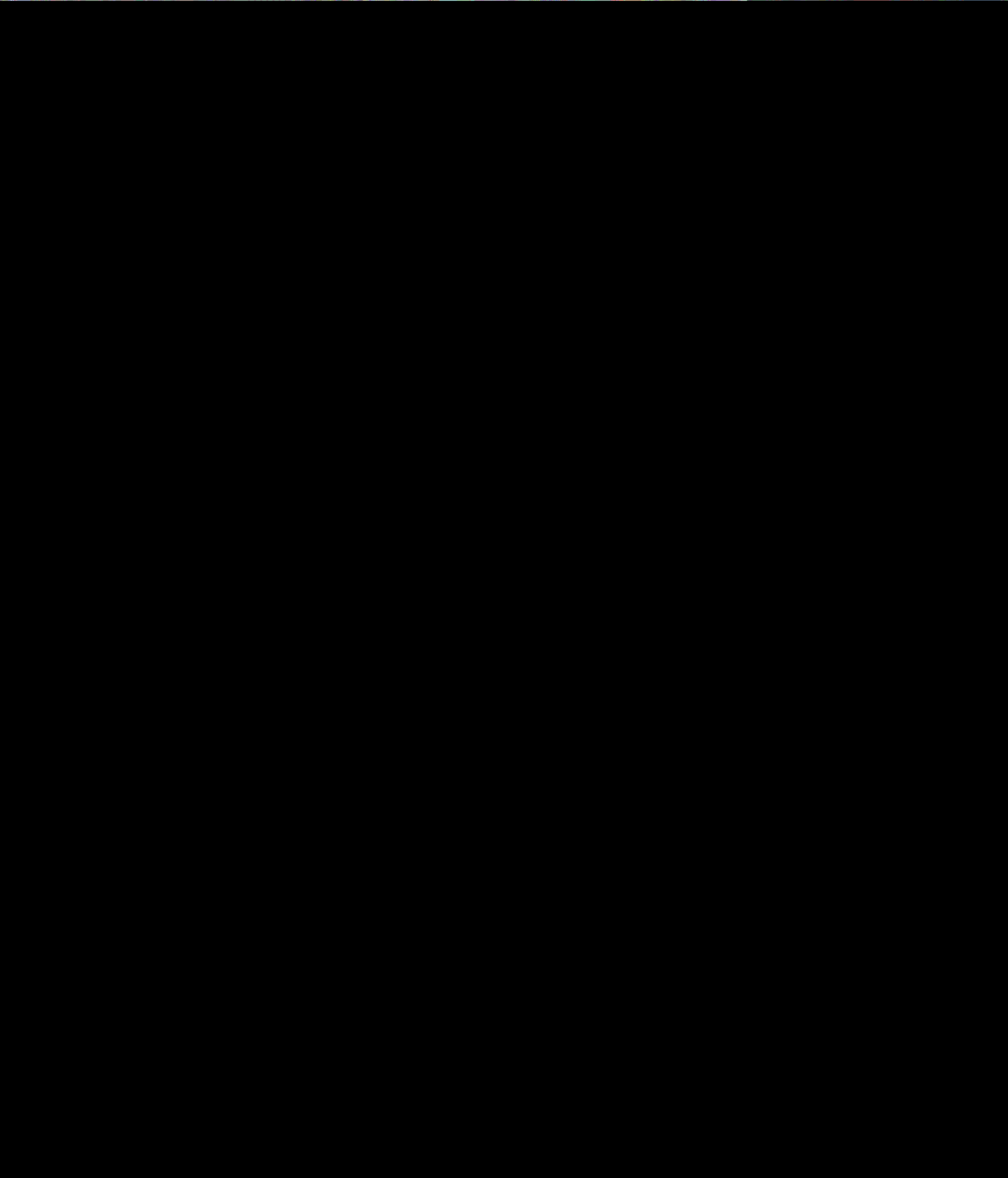
Customer satisfaction is a function of the contrast between the recognition of previous customer expectations and then purchases the same service (Oliver, 1977, 1980; Anderson & Sullivan, 1993). The fact that more and more high-value customers in the long term and will bring great benefits to regulate the retail trade with the largest revenues (Zeithaml, Berry, & Parasuraman, 1996; Cronin, Brady, & Hult, 2000; Aaker & Jacobson, 1994). Customer satisfaction is the most powerful of intangible assets similar to the quality of service, and can be achieved by meeting customer expectations (Oliver, 1980; Boulding, Kalra, Staelin, & Zeithaml, 1993; Bahia, Paulin, & Perrien, 2000; Homburg, Koschate, & Hoyer, 2006; Jayasankaraprasad & Kumar, 2012). Studies have emphasized the importance of the relationship between quality of service and customer satisfaction (Cronin and Taylor, 1992).

The researchers stressed that the importance of the relationship between quality of service and customer satisfaction, it was also found that satisfaction is a result for the service at the time of the customer experience (Brady & Robertson, 2001; Jayasankaraprasad & Kumar, 2012). Quality of service and customer satisfaction, while the structure that is different, associated with it (Brady, Cronin, & Brand, 2002; Ranaweera & Neely, 2003). In addition, a causal relationship between the quality of service and customer satisfaction is the major subject of academic debate (Bahia et al., 2000). In one study it was indicated that perceived quality in advance purchase is expected to be recognized to the extent that it does not match with customer satisfaction (Olsen, 2002; Gustafsson, Johnson, & Roos, 2005; Rigopoulou, Chaniotakis, Lympelopoulos, & Siomkos, 2008; Cerri, 2012; Kitapci et al., 2013). According Abu Nar and Alam, 2016; the Saudi Arabian foreign and large population not only go to shop in malls, they also see it an opportunity to socialize.

In several studies, we found that customer satisfaction is an important factor in order to achieve business objectives. Supermarkets, in recent time are trying to develop a new and effective strategy to meet the needs of the consumer. Although much research have been undertaken to determine the success and strength of consumers' attitudes and it's evolving factors to measure the consumer hypermarket shopping behaviour these days. Despite the implementation of many researches inside the region as well as around the world towards the consumer shopping behaviour of hypermarket there is still a call for to

identify and measure the attitudes of the consumer and success factors to achieve the goals the marketer. In fact there are research gaps on attitudes' analysis of consumers and their preferences for shopping hyper / supermarket in the literature and it does not cover yet for deep study. Therefore, the present study is an attempt in this direction. In addition, this paper focuses on customer behaviour touching the practices of supermarket / hypermarket and its related sectors.





**TABLE 2: LOCATION OF RESPONDENTS**

City	N	City	N
Riyadh	85	Dahran	6
Jeddah	58	Najran	1
Madinah	4	Jubail	2
Makkah	11	Alhasa	3
Haffouf	5	Safwa	2
Tabouk	2	Hafr Albaten	1
Abha	4	Zulfi	1
Alkhubar	9	Kharg	5
Dammam	10	kateef	5
Qasim	10	Hail	1
Jazan	1	Dawadmy	1

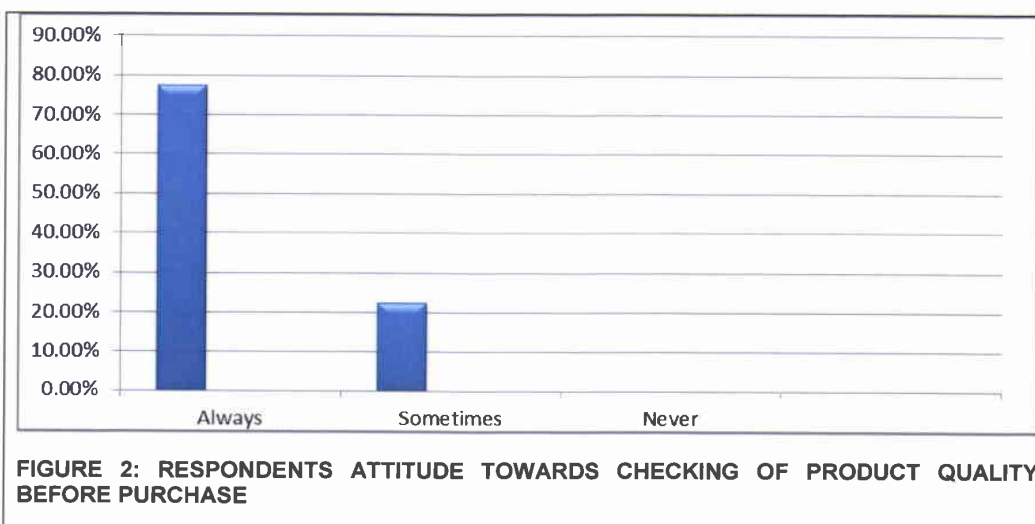
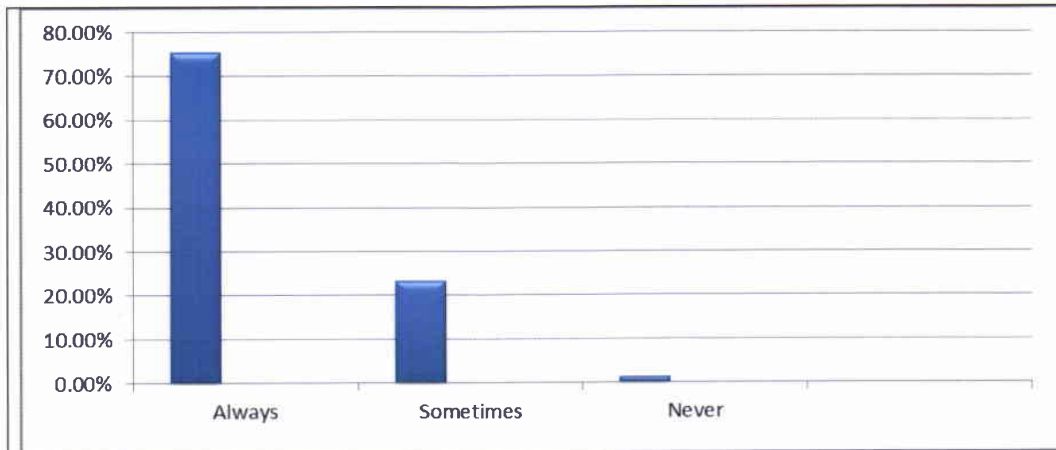


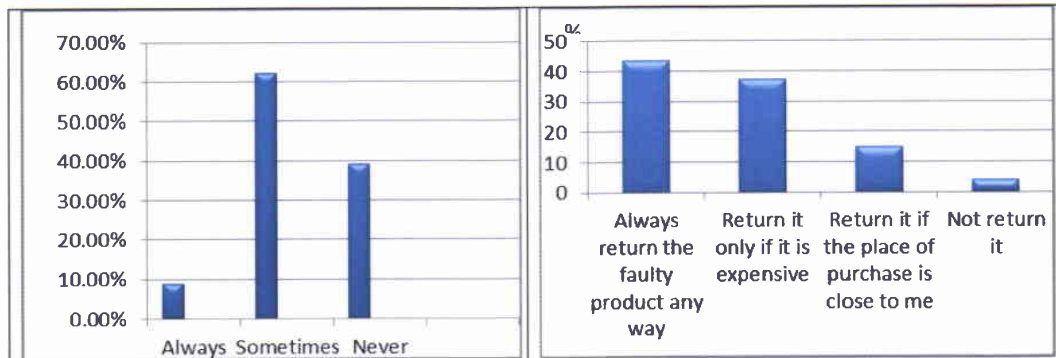
Table2: show the complete details of the respondents of a place to belong. From this table, it can be seen that most of the participants belong to Jeddah (58) after the capital Riyadh (85) and the other 101 people

belong to the rest of the 22 cities. Each of the city, compared with other cities in the region, have a good representation in the business side.

From the figure 2: it can be analyzed that customers check product quality first and foremost. 78% of respondents always check the quality whilst only 22% only check it occasionally. Also, and continuing with the theme of product awareness, we can look at the issue of expiry date. Furthermore, figure 3 also show that 75% of respondents always check the expiry date, 23% do it sometimes, and only very small number (2%) do not check it at all.



**FIGURE 3: RESPONDENTS AWARENESS OF PRODUCT EXPIRY DATE**



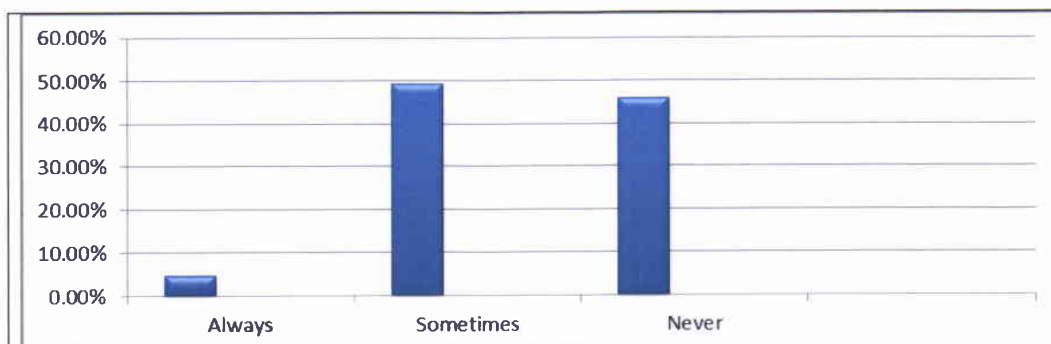
**FIGURE 4: RESPONDENT EXPERIENCE IN GETTING FAULTY PRODUCT FROM SUPERMARKETS**

**FIGURE 5: RESPONDENT ATTITUDE TOWARDS POST PURCHASE AFTER GETTING THE FAULTY PRODUCTS**

Figure 4; It can be observed the frequency with which respondents pick up faulty product. Researcher would expect responses to be small. The detailed figures show that 9% have found a faulty product. On

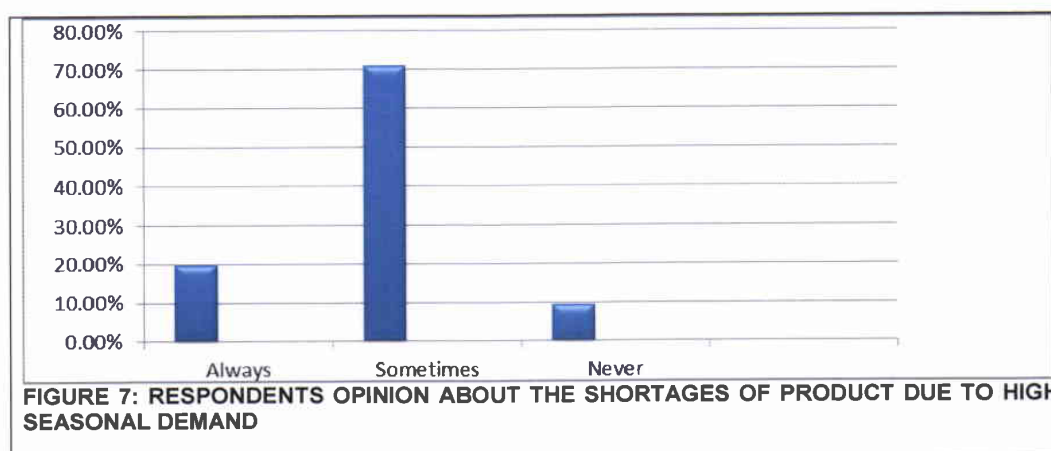
the other hand, 39% have not picked up a faulty product. This result may be considered abnormal as we would expect it to be a lot higher.

When asking them about their reaction on finding a faulty product after buying it, a majority of them reported they would be willing to return the product. Figure 5 show that more than 43% would return the faulty product to the supermarket straight away; and 37% would return it only if it was expensive; and nearly 15 % would return it if the place of purchase was close to their home. Only 4% not return it at all.



**FIGURE 6: RESPONDENT OBSERVATION ON FINDING SHELVES EMPTY IN SUPER MARKETS**

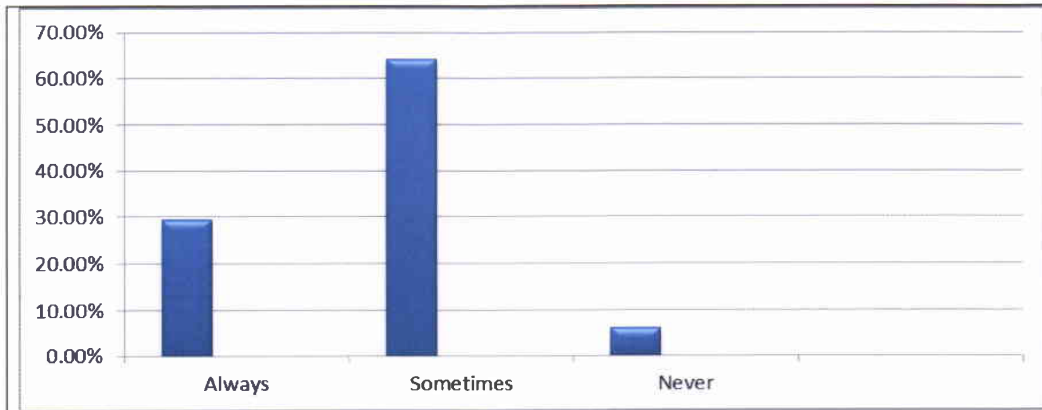
Figure 6: show respondent attitudes towards empty shelves. A very small number- less than 5%- have experienced cases where there are too many shelves empty. At the other end of the scale only 45% of respondent have found that shelves are fully stocked to their satisfaction.



**FIGURE 7: RESPONDENTS OPINION ABOUT THE SHORTAGES OF PRODUCT DUE TO HIGH SEASONAL DEMAND**

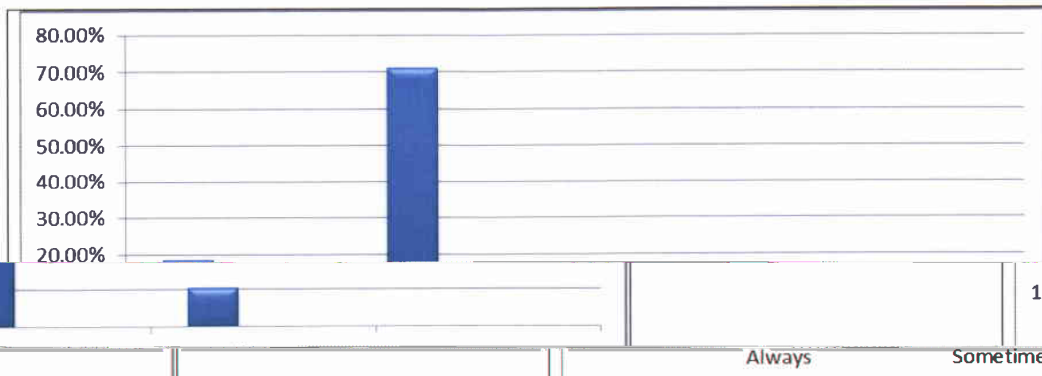
Figure 7: show that shortages can occur at particular times of year. These include religious festivals and the return of children back to school. Over 70% of respondents reported that they sometimes had difficulty in finding the product wanted. Only 9% had not experienced such problems.





**FIGURE 8: RESPONDENT ATTITUDE TOWARDS VISITING OTHER SUPERMARKETS**

Figure 8: investigate whether respondents regularly use supermarkets belonging to a rival chain from their regular supermarket. When consumers were asked about shopping elsewhere if they could not find what they wanted at their regular supermarket, nearly 30% said they would always go to competitors; whilst 65% would do it sometimes. Only 5% of customers would refuse to use competitors.



**FIGURE 9: RESPONDENTS LIKELIHOOD OF SWITCHING SUPERMARKETS OVER PRODUCT UNAVAILABILITY**

Highly satisfied with their supermarket  
 47% were able to find the product automatically. 68% would sometimes

In respect of the product availability, most respondents 53% were highly satisfied as they could always find what they wanted (at all times). A further 22% requires sometimes. Figure 9: show that only 22% would do this a change whilst only 10% would never do this.

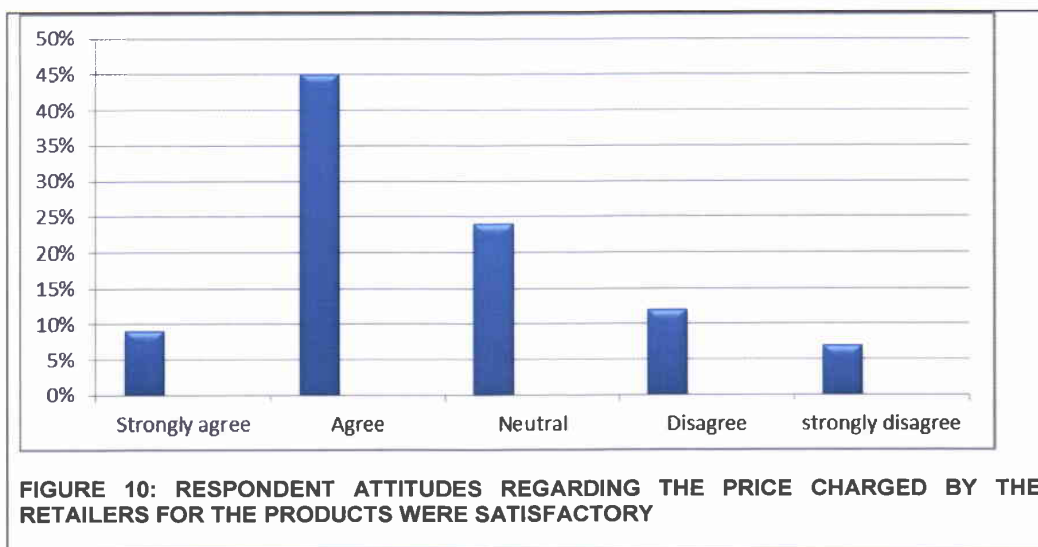


Figure 10: Investigate respondent perception in terms of price satisfaction. This is of course affected by respondent observations of what is reported in the media and from announcements on inflation levels by governmental authorities. The results show that 54% either strongly agree or agree that supermarkets attempt to satisfy the price demands of customers. On the other hand, 19% either strongly disagree/ disagree on the supermarket attempted to provide products at the prices demanded by customers.

##### 5. DISCUSSION AND CONCLUSION:

Organized retail traders in Saudi Arabia are increasing with incredibly swift. Developments in the foodstuff industry have led to expansion of shopping malls, mostly in the big cities of Saudi Arabia. A shopper contributes vital responsibility in any business. Consequently, understanding purchaser buying behaviors towards the sector are significant to achievement of organized retail business.

The result indicates that customers check product quality first and foremost important concern when they consider to buying the products from supermarket/ hypermarket. In addition, respondents always check the expiry date, majority of respondents never experienced in getting the faulty product from the super market and if someone faced this type of problem they usually return the faulty product to the supermarket straight way. It is observed that respondents are fully aware regarding the faulty, damaged and expiry date of products.

Therefore, it can be suggested that marketers should continuous check product damaged, faulty product and expiry date of products to keep the customer satisfy and loyal. Furthermore, most of the time the super market shelves were full of products a very small number- less than 5%- have experienced cases where there were too many shelves been empty. In response to the shortage of products majority of respondents reported that they sometimes had difficulty in finding the product wanted specially it occurs at particular times of year these include religious festivals and the return of children back to school etc.

When consumers were asked about shopping elsewhere if they could not find what they wanted at their regular supermarket, majority explained that they used to visit it sometimes. In addition, respondent perception towards price satisfaction it reveals that majority were strongly agreed or agree that supermarkets attempt to satisfy the price demands of customers on the other hand only very small percentage were insignificantly differenced in their opinion that supermarket attempted to provide

products at the suitable prices. The above result shows that they have very good impression about the availability of products and in relation with price charged by the marketers for needed product they have very positive response.

These results enable to make customer repeat purchase and loyal. From the above results it can be concluded that marketers can have a good chance to get their strong image in consumer mind moreover it is suggested that marketers must keep these perceptions for longer time to deal with better customer relationship and to be a leader in this sector.

#### LIMITATION OF THE RESEARCH:

While very well attempt have been made to put up for the investigation though the subsequent factors have been unavoidable absent as a result of their critical limiting factors for this study:

- Lack of time and cost
- In this study, it was not possible to cover all dimensions of shopping.
- The sample size was limited because of time and cost.

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#### AUTHOR PROFILES:

**DR. Salah Mahmoud Abunar** earned his Ph. D degree in Supply Chain Management from the University of Liverpool in 2012. Currently he is a Dean College of Business Administration, University of Business and Technology (UBT), Saudi Arabia. Dr. Abunar has been a member of evaluation committee for establishing M.Sc. program for engineering college and Vice president of financial committee for Alquran & Alhadeeth competition for Islamic Families in UK, Organized by Saudi Embassy. He has been served as president of the University delegation to the Annual conference for international universities supervised by Ministry of Education 2015. He has served as a member of many reputed committees and councils during his career. Email: [salah@ubt.edu.sa](mailto:salah@ubt.edu.sa)

**Dr. Mohammad Zulfeequar Alam** completed his Ph.D. Degree from Aligarh Muslim University, Aligarh (AMU), India, 2005. He is currently serving as Assistant Professor, Dept. of Marketing, University of Business & Technology (UBT), Kingdom of Saudi Arabia. He has been served as Head of Department of Management Studies and deputy controller of examination in Sacred Heart Degree College on behalf of Kanpur University in 2007. Dr. Alam was the Founder Head of the Dept. of Management Studies in Jahangirabad Institute of Technology, India. Dr. Alam has authored a book, he has to his credit a number of research papers published in various reputed journals and attended a number of workshops/ conferences of national and international level. Dr. Alam has been editorial board member/ reviewer of several committees/ journals at the national and International level. Email: [zulfeqarm@ubt.edu.sa](mailto:zulfeqarm@ubt.edu.sa)

# **A Comparative Study of Organizational Role Stress and Organizational Commitment Among The University Faculty Members of India and Saudi Arabia**

***Dr. Sayeeduzzafar Qazi***

Professor College of Business Administration  
University of Business & Technology Jeddah, KSA

***Dr. Afroze Nazneen***

Asst. Professor- IHGI IKG Punjab Technical University. Jalandhar, India

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## **Abstract**

Stress is define as a dynamic condition in which an individual is confronted with an opportunity , constraint , demand related to what he or she desires and for which the outcome is perceived to be both uncertain and important. Organizational role stress comes from three sectors i.e. job and organization, social factor and intra-psychic factor. Organizational commitment is defined as “an individual psychological bond to the organization, including a sense of job involvement, loyalty and belief in the values of the organization”. The cross cultural study was conducted on 245 Faculty members working in various Indian and Saudi Arabian universities using questionnaire method and standardized psychometric tests were used to collect the data on the variable under investigation. The study reveals that faculty members of Saudi Arabia were shown moderate level of organizational role stress and low level of organizational commitment while their Indian counterparts were shown high level of organizational role stress and moderate level of organizational commitment. The organizational role stress dimensions were found to be negatively correlated with organizational commitment means if the organizational role stress will go up the commitment level of the faculty members will go down and affect the performance of the faculty members negatively. The data were also analyzed using other demographic variables and the obtained results were discussed.

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**Keywords:** Organizational Role Stress, Organizational Commitment, Cross Culture, Stress Audit

## **Introduction**

“Stress now a days considered as a big threat to the quality of life and to physical and psychological well-being.. The very idea of stress was introduced in 1936 by Hans Selye, who actually kind of borrowed it via natural sciences. “During the eighteenth and nineteenth centuries, stress was equated with force, pressure or strain exerted upon a material object or person which resists these forces and attempts to maintain its original state”. Hans’s ‘General Adaptation Syndrome’ provoked quite a lot of research on this topic, primarily focusing stress and disease, i.e., noxiousness to tissues systems and adaptation response to tissues systems.

Lazarus (1971) proposed what is essentially an interactional definition of stress. He suggested that “Stress occurs when there are demands on the person which taxes or exceeds his adjustive resources”. He further elaborated that it depends not only on external conditions but also on the constitutional vulnerability of the person and the adequacy of his cognitive defensive mechanisms.

Similarly Cox and McKay (1981) suggested that stress arises when there is an imbalance between the perceived demand and person’s perception of his capability to meet that demand. The system treats stress as an intervening variable, the reflection of transaction between the person and his environment.

## **Organizational Role Stress**

In any social system, such as family, club, religious community, work organization etc., individuals has certain obligations towards the system, which in turn gives each one of them a defined place in the society. This system of mutual obligations can be called a role and the individual’s place, a position or an office. It can be said that role is a very useful concept in understanding the dynamics of the integration of the individual with an organization. It also helps in understanding the problems which arises in this individual-organization interaction and integration. This would enable the individual to function effectively in an organization. Also role is, a central concept in work motivation ( Pareek, 1974). In other words, we can say that organizations have its own structures and goals. Similarly the individual has his personality and needs (motivation).

## **Concept of Role Stress**

Kahn and others (1964) were the ones who drew attention towards organizational stress (in general) and particularly role stress. In their eyes, role stress was one of the variants of stress. Furthermore, variants like role overload, role ambiguity, and role conflict were a part of role stress. In short,

any role expectation that exceeded the incumbent's resources could be named as role stress, according to them.

On the other hand, Pareek (1976) had something else to say. He defined stress to be inevitable, for there are always inherent problems in performance of any role. Furthermore, the concept of role space, role set, including the role itself as a whole, has an in-built potential for stress (and even conflict one can say). In fact, as the role is more or less and most of the times defined by the expectations of the role senders, the expectations on the other hand can remain ambiguous conflictive to each other, unless integrated, shared or articulated in right manner.

Pareek (1983) has identified the following role stresses:

### **Role space conflicts**

Role space (the dynamic relationship amongst the various roles an individual occupies and his self) has three main variables: self, the role under question, and the other roles he occupies. Any conflicts may take the forms mentioned below:

1. **Self-Role Distance:** This pressure arises out of the disagreement between the self-concept and the outlook form the role, as supposed by the role, as apparent by the role tenant. If a person occupies a role which he may subsequently find as conflicting with his self concept, he feels stressed. For example, an introvert may experiences self-role distances if he accepts the job of a salesman which includes meeting people and being social.

2. **Role Stagnation:** An individual grows in the role that he occupies in an organization. With the advancement of the individual the role changes, and with this change in role, the need for taking up original role becomes vital. This trouble of role enlargement becomes sharp especially when a human being who has busy a position for a long time enters an additional role in which he may feel less secure. However, the new position demands that an individual outgrow the previous ones and take charge of the new role effectively. This is bound to produce some stress.

3. **Inter-Role Distance:** When an individual occupies more than one role, there are bound to be conflicts between the different roles that he occupies. For example, an air traffic controller often faces the conflict between his organizational role as an air traffic controller and his familial role as a a husband and a father.

### **Role set conflicts**

The other field which is important vis-à-vis an individual's role is the set which consists of important persons who have varying expectations from the role that he occupies. The conflicts which arise as a result of incompatibility amongst these expectations by the 'significant' others (and



by the individual himself) are called role set conflicts (Pareek, 1983). These conflicts take the following forms:

1. **Role Ambiguity:** When the individual is not apparent about the various outlook that people have as of his position the conflict that he faces is called role uncertainty. Marshall and Cooper (1979) point out that role ambiguity exists when and person has insufficient information about his work role, that is, where there is ‘lack of clarity’ about the work colleagues’ expectation of work role and about the scope and responsibilities of the job.

2. **Role Expectation Conflict:** When there are contradictory prospect or demands by different position senders, the role occupant may experience this stress. There may be conflicting expectations from the superior, subordinates, friends.

3. **Role Overload:** When the role inhabitant feels that there are too many expectations from the ‘significant’ other in his role set, he experiences role over load. Role overload is more likely to occur where role occupants lack power, where there are large variations in the expected output and when delegations or assistance cannot procure more time. French and Caplan (1973) have differentiated overload in term of ‘qualitative’ and ‘quantitative’ overload. Quantitative overload refers to having “too much to do.” Qualitative overload means works that is “too difficult”.

4. **Role Erosion:** A role inhabitant may feel that some functions which he would like to carry out are being performed by various other roles. The stress felt may be called role erosion. In other words, role erosion is the subjective feeling of the individual that some important role expectations he has from the role are shared by other roles within the role set. Pareek (1983) is of the view that role erosion is likely to be experienced in an organization which is redefining its role and creating new roles.

5. **Resource Inadequacy:** Resource insufficiency pressure is knowledgeable when the capital required by the role occupant for performing the role effectively is not available. These may be information, people, material, finance or facilities.

6. **Personal Inadequacy:** When a role occupant feels that he is not prepared to undertake the role effectively, he may experience this stress. The role occupant may feel that he does not have enough knowledge, skills, or training, or he/she has not had time to prepare for the assigned role.

7. **Role Isolating:** In this category, Pareek (1983) includes stressors which Marshall and Cooper (1979) identify as arising from nature of relationships at work. Pareek (1983) suggests that in a role set, the role occupant may feel that certain roles are psychologically closer to him, while others are at a much greater distance. The main criterion of distance is frequency and ease of interaction. He future suggests that when linkages are strong, the role isolation will be low and in the absence of strong linkages,

the role isolation will be high. The gap between the desired and the existing linkages will indicate the amount of role isolation.

To sum up, Pareek (1983) identified the following ten stresses in relation to organizational roles:

1. Self-Role Distance (SRD) 2. Inter-Role Distance (IRD) 3. Role Stagnation (RS)
4. Role Isolation (RI) 5. Role Ambiguity (RA) 6. Role Expectation Conflict (REC)
7. Role overloads (RO) 8. Role Erosion (RE) 9. Resource Inadequacy (RIN)
10. Personal Inadequacy (PI)

### **Organizational commitment**

O'Reilly (1989) defines organizational commitment as “an individual psychological bond to the organization, including a sense of job involvement, loyalty and belief in the values of the organization”. This perspective of organizational commitment is more characterized by the employee's acceptance of the organizational goals and his/her willingness to make effort on behalf of the organization to achieve those goals (Miller and Lee, 2001).

According to Cohen (2003), “commitment is a force that binds an individual to a course of action of relevance to one or more targets”. This, however, is quite a general description and somewhat relates to the one given by Arnold (2005). Arnold described it as “the relative strength of an individual's identification with and involvement in an organization”.

Miller (2003) defines organizational commitment as “a state in which an employee identifies with a particular organization and its goals, and wishes to maintain membership in the organization”. Therefore, it can be reiterated as the degree to which the employee wants to be associated with the organization willingly, keeping in view the relationship with the organization's values and goals.

### **Affective Commitment Dimension:**

The first that is taken is the affective commitment dimension. It can also be termed as emotional commitment. This represents the employee's emotional attachment with the organization he/she works for. Meyer and Allen (1997) explain the term affective commitment as “the employee's emotional add-on to, recognition with, and participation in the organization”. According to this, the members who are really devoted to a certain organization emotionally continue to work for that organization, for they want to (Allen and Meyer, 1991). Emotionally devoted members continue to work for the organization for they feel that their personal goals and values

are congruent to the organization's goals and values (Beck and Wilson, 2000).

Beck & Wilson (2000) say that the development of affective commitment involves internalization and identification. An employee's emotional attachment with his/her organization is based on his identification with his wish to establish a honoring relationship with the organization. Furthermore, internalization refers to the congruency between the goals and values of individual and organization. Therefore, overall, per (Allen & Meyer, 1990), emotional (or affective) organizational commitment is more so related to the individual's identification with the organization.

### **Continuance Commitment Dimension**

Out of the three aforementioned dimensions, the second one is continuance commitment. It is explained by Meyer & Allen (1997) as "awareness of the costs associated with leaving the organization". As the word 'cost' comes in, it obviously has a calculative nature, as the individual herein perceives the risks and costs attached if he decides to leave the current organization. The researchers (Meyer & Allen, 1991) further say that "employees whose primary link to the organization is based on continuance commitment remain because they need to do so". Now, this very statement clearly differentiates the affective from continuance commitment.

According to Beck and Wilson (2000), continuance promise can be considered as an active attachment as here the association of the individual with the organization is based on the degree of appraisal or the degree of financial benefits. The commitment is developed towards an organization because of the optimistic external plunder received from side to side the effort-bargain lacking identification with the values and goals of the organization.

Their need to stay with the organization can be termed as 'profit' that they would continue to reap if they continue to be associated with the organization. On the other hand, this would directly change to 'cost' if they plan to leave the organization

### **Normative Commitment Dimension**

Normative commitment stands as the last of the three dimensions as explained by the 3-dimensional model of organizational commitment. It is explained by Meyer & Allen (1997) as "a feeling of obligation to continue employment". Per Allen and Meyer (1990), interiorized normative beliefs of duty and responsibility make an individual grateful to affirm his membership in the organization. Meyer and Allen (1991) also believe that "employees with normative commitment feel that they ought to remain with the



organization”. As far as normative dimension is concerned, employees generally do not leave the organization because they think it is good to do so.

Normative commitment as defined by Weiner and Vardi (1980) is “the work behavior of individuals, guided by sense of duty, obligation and loyalty towards the organization”. According to Iverson and Buttegieg (1999), ethical reasons motivate the organizational members to stay with the organization. An employee who adheres to norms and is committed towards the organization feels morally attached to the organization, irrespective of the job satisfaction or status enhancement is provided over the years by the organization.

### **Literature review**

Hashemi, et al (2015) conducted a study to analyze the direct effect of the relationship between role stress and organizational commitment in the hospitality industry. Studies reviewed indicate that stress has important effects on personnel and organizational outcomes. Stress at the work place may result in unfavorable outcomes such as low level of performance and resignation from the job. Therefore, identifying the job stress’s factors in an organization will significantly improve job satisfaction, which in turn strengthens staff’s loyalty to the organization. Moreover, organizations need to acknowledge the contribution made by each employee in order to instill loyalty and a strong sense of belonging as well as reduce the tendency to resign from the organization.

Alipour and Kamaee (2015) explored that job stress may lead to organizational commitment, which is a vital factor for achieving organizational efficiency. Materials and The study was conducted on 120 nurses working in the hospitals of Behbahan. The results showed that there is a significant inverse relationship between job stress and organizational commitment. Moreover, there is a significant inverse relationship between job stress and affective, normative and continuance commitment.

Nazneen et al (2014) conducted a study on 350 top executives of public and private enterprises to check the level of organizational role stress and stress tolerance level. They found that top executives of private sectors are showing high level of organizational role stress and the dominant stressors are role erosion, role isolation and inter role distance while in the case of public sector enterprises top executives the level of organizational role stress is moderate and dominant stressors are the same as the case of private enterprises.

Nazneen & Bhalla (2013 ) conducted a study on 220 faculty members of Public and Private Universities and found that faculty members of private universities are suffering with High level of Organizational Role Stress as compare to their Public Universities counterparts. The dominant role



stressors found were role erosion, inter-role distance, role expectation conflict and personal inadequacy. While in the case of faculty members of public universities the dominant stressors are role erosion, resource inadequacy, role expectation conflict and role isolation. They further found that there are significant negative correlation among role stagnation and organizational commitment, role overload, role and ambiguity were also found to be significantly negative correlated with organizational commitment. They also found significant negative correlation between total organizational role stress and organizational commitment, means, if in any organization level of stress will go up the organizational commitment will go down and vice-versa.

Nazneen & Bhalla (2013) conducted a study on 218 male and 132 female employees of organized retail sectors and found that the employees of organized retail sectors are suffering with high level of organizational role stress and dominant stressors are personal inadequacy, role erosion, role stagnation and inter role distance. They further found that male employees of organized retail sectors are showing high level of organizational role stress as compared to female employees.

Muncherjee and Pestonjee (2013) conducted a study to find out organizational role stress and emotional intelligence level of members of private bank. They conducted the study on 56 Top Executives and found high level of organizational role stress among them and the dominant stressors were role over load, inter role distance, personal inadequacy and role erosion respectively.

Bhalla and Sayeed (2013) conducted a study on 150 executives of organized retail sector and found that the employees are suffering with high level of organizational role stress and the dominant stressors are role erosion, inter role distance, role expectation conflict and personal inadequacy and low level of organizational commitment. Further they found negative significant relationship between organizational role stress and organizational commitment.

Nazneen and Singh (2012) conducted a study on 126 faculty members of UPTU and PTU affiliated institutions and found that PTU faculty members are showing high level of organizational role stress than their PTU counterparts and dominant stressors are role erosion, role expectation conflict, inter role distance and role isolation.

### **Objective of the study**

We have not formulated any Hypothesis and make our research Exploratory in nature and hence formulated following objectives:

- To study the level of Organizational Role Stress and Job Commitment and its components among Faculty Members Working in Indian and Saudi Arabian University
- To examine the effect of Organizational Role Stress on organizational commitment.
- To suggest the Strategy to Stakeholders to overcome Stress and increase Organizational commitment and Job Satisfaction.

## Methodology

The present research is directed to explore organizational role stress and organizational commitment among faculty members working in Indian and Saudi Arabian Universities. It was a descriptive research to determine the level of organizational role stress and organizational commitment and their relationship with reference stress and organizational commitment and to certain demographic variables.

## Samples

The researcher used a non-probability or informal guide that “there should be ten respondents for each variable plus fifty respondents”. And as per the guideline or the rule we should have  $13 \times 10 + 50 = 180$  respondents. Keeping this in view and availability of the data this study was conducted on 245 randomly selected faculty members out of which 155 Faculty members were from Indian Universities and 90 Faculty members from Saudi Arabia were taken as sample of the study. The respondents were also divided on the basis of demographic variables.

## Procedure

Faculty members from Management, Engineering and Information Technology departments of Indian and Saudi Arabian Universities were selected as a sample keeping in mind the availability of the data, cost and distance for the data collection. Only faculty members 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 using survey method. Each of the responses is collected through questionnaire. The data were collected by the investigator and the data were 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.

## Tools Used

The study was performed through questionnaire and following two standardized psychometric measures were used in this study and the details of them are as follows:

**Organizational Role Stress Scale** developed by Pareek, (1983) was used, consists of 50 items and measure 10 type of role stressors. Each dimension of ORS is measured by five questions. The reliability and validity is well within acceptable norms:

**Organizational Commitment Scale developed by Meyer and Allen** (1997) were used to measure organizational commitment. There are 18 items in the scale, 6 each for Affective, Normative commitment and Continuance commitment. Reliability and validity found to be within acceptable norms.

The data obtained were statistically analyzed for all the ten dimensions of organizational role stress and three dimensions of organizational commitment separately for the comparison group and also on the dimensions of demographic variables which were also dichotomized. The data has been analyzed by using Systat- VII statistical package in terms of mean, median, standard deviation, critical ration and correlation between organizational role stress and organizational commitment Necessary adjustment were made, keeping in view their diametrically opposite scoring patterns and also to facilitate easy assimilation.

## Results and discussions

**TABLE 1:** Showing Mean and SD Value on ORS and OC Dimensions among Faculty Members Working in Indian University. (N-155)

VARIABLES	MEAN	SD
INTER ROLE DISTANCE	8.95	3.56
ROLE STAGNATION	7.50	4.05
ROLE EXPECTATION CONFLICT	8.29	3.992
ROLE EROSION	8.07	3.576
ROLE OVERLOAD	7.43	4.145
ROLE ISOLATION	7.08	3.889
PERSONAL INADEQUACY	7.21	4.143
SELF ROLE DISTANCE	7.15	3.706
ROLE AMBIGUITY	7.04	4.239
RESOURCES INADEQUACY	8.02	3.269
TOTAL ORGANIZATIONAL ROLE STRESS	76.74	28.10
AFFECTIVE	16.17	3.028
CONTINUANCE	15.18	2.773
NORMATIVE	17.34	3.028
TOTAL COMMITMENT	48.69	6.208

Source: Compiled from primary data collected by questionnaire.

It is clear from the above Table that Faculty members of Indian universities are showing moderately high level of organizational role stress and dominant stressors are inter role distance means there is a conflict between organizational role and other roles and the faculty members are not

able to divide the time between the organizational role and family role hence feeling stress. The second dominant stressors is role expectation conflict means faculty members are getting different demands from different people in the university and are not really aware about their actual role which leads to stress among them. The third dominant factor is role erosion means faculty members felt whatever important activity they are doing in the university the credit for the same are being taken by some one else in the university. The fourth dominant factor is resources inadequacy means they are feeling resource constraint or lack of basic resources to perform the given task effectively and hence felt stressed. The rest of the organizational role factors are within the acceptable range of tolerance.

As shown in the table that faculty members are showing a moderate level of organizational commitment and dominant type is normative commitment, followed by affective and continuance commitment supported the findings of Sharma (2015) who also reported moderate level of organizational commitment among university faculty members. The faculty are feeling sense of moral organization to remain in the organization and hence showing moderate level of commitment.

**TABLE 2:** Showing Mean and SD Value on ORS and OC Dimensions Among the Faculty Members Working in Saudi Arabian Universities. (N-90)

VARIABLES	MEAN	SD
INTER ROLE DISTANCE	7.88	3.46
ROLE STAGNATION	7.34	3.99
ROLE EXPECTATION CONFLICT	6.75	3.96
ROLE EROSION	8.03	3.54
ROLE OVERLOAD	7.52	4.14
ROLE ISOLATION	7.18	3.84
PERSONAL INADEQUACY	6.01	4.16
SELF ROLE DISTANCE	6.34	3.75
ROLE AMBIGUITY	5.68	4.39
RESOURCE INADEQUACY	6.69	3.22
TOTAL ORGANIZATIONAL ROLE STRESS	69.05	30.12
AFFECTIVE COMMITMENT	15.80	3.05
CONTINUANCE COMMITMENT	17.64	2.96
NORMATIVE COMMITMENT	14.78	3.16
ORGANIZATIONAL COMMITMENT	51.22	6.75

As shown in the Table that faculty members working in Saudi Universities are showing moderate level of organizational role stress and dominant stressor are role erosion means faculty members felt whatever important activity they are doing in the university the credit for the same are being taken by some one else in the university. The second dominant stressor



is inter role distance means there is a conflict between organizational role and other roles and the faculty members are not able to divide the time between the organizational role and family role hence feeling stress. The third role stress is role overload means faculty members felt that lot much are being expected from them by the leadership than they cope with in the university which leads to work load and ultimately leading to stress. The fourth stressor is role stagnation means the faculty members are not seeing any opportunities for learning and growth in the organization.

It is also observed from the table that faculty members working in Saudi Arabian Universities are showing a moderately high level of organizational commitment and dominant type is continuance commitment, followed by affective and normative commitment supported the findings of Sharma (2015) who also reported moderate level of organizational commitment among university faculty members. The faculty members are showing high level of commitment because they felt that that leaving the could be a — organization is related with cost and since leaving the university c

significant differences of means were also found on the dimensions of Inter Role Distance, Role Expectation Conflict, Personal Inadequacy, Role Ambiguity and Resources Inadequacy of Organizational Role Stress. And in all cases Faculty members of Indian universities were shown high level of role stress than Saudi Arabian counterparts. It is also clear from the Table that Faculty members of Saudi Arabian universities were shown moderately high level of organizational commitment than the faculty members working in Indian universities and the difference were found to be significant at .01 level of significance. Continuance commitment were found to be high in Saudi Arabia university faculty member because they realize that leaving this university will be a costly affair and they may not get the kind of salary and other related financial benefits they are getting. While normative commitment were found high among Indian universities faculty members as it is related with moral obligation to remain in the university as compare to their Saudi Arabian university faculty members who are not committed morally but committed because of financial aspects and in both the cases the differences of means were found to be significant at .01 level of significance.

**TABLE-4** : Showing Z Value between the **Male Faculty** Members Working in Indian and Saudi Arabian Universities.

VARIABLES	India (N-80)		Saudi Arabia (N-55)		CR
	MEAN	SD	MEAN	SD	
INTER ROLE DISTANCE	9.35	3.56	8.15	3.46	1.98**
ROLE STAGNATION	7.82	4.04	7.71	3.98	0.15
ROLE EXPECTATION CONFLICT	9.21	3.99	7.32	3.97	2.75*
ROLE EROSION	8.27	3.57	8.38	3.45	0.18
ROLE OVERLOAD	7.59	4.14	7.61	4.41	0.02
ROLE ISOLATION	7.12	3.88	7.71	3.84	0.88
PERSONAL INADEQUACY	8.87	4.11	6.92	4.11	2.73*
SELF ROLE DISTANCE	7.12	3.67	6.98	3.75	0.21
ROLE AMBIGUITY	8.71	4.19	6.69	3.87	2.93*
RESOURCE INADEQUACY	7.76	3.26	6.45	3.91	2.06**
TOTAL ORS	81.82	27.87	73.92	28.03	1.63
AFFECTIVE	17.62	3.08	15.59	3.00	3.88*
CONTINUANCE	15.34	2.75	17.53	2.97	04.43*
NORMATIVE	16.95	3.03	14.01	3.17	5.46
TOTAL COMMITMENT	52.91	6.24	47.13	6.74	5.11

As it is clear from the Table that no significant differences between Means were found among the Male faculty members working in Indian and Saudi Arabian Universities on the total Organizational Role Stress but the differences were observed on the dimension of Inter Role Distance, Role Expectation Conflict, Role Ambiguity and Resources Inadequacy dimension

of Organizational role Stress. And in all the mentioned cases Male faculty members were shown high level of stress than Saudi Arabian universities Male faculty members and the differences were found to be significant at .01 and .05 level of significance. Surprisingly Male Faculty members of Indian universities were shown High level of Organizational Commitment than Saudi Arabian universities Male faculty members and the dominant dimension were Affective and Normative while on the dimension of Continuance Commitment Male Faculty members of Saudi Arabian universities were shown high level of commitment that is associated with the Cost involved in leaving the university is very high hence showing commitment and be a part of the university.

**TABLE-5:** Showing Z Value between the **Female Faculty** Members Working in Indian and Saudi Arabian Universities.

VARIABLES	India (N-75)		Saudi Arabia (N-35)		CR
	MEAN	SD	MEAN	SD	
INTER ROLE DISTANCE	8.55	3.56	7.61	3.23	1.32
ROLE STAGNATION	7.18	4.18	6.98	3.94	0.23
ROLE EXPECTATION CONFLICT	7.37	3.79	6.18	3.84	1.48
ROLE EROSION	7.87	4.26	7.69	3.76	0.21
ROLE OVERLOAD	7.27	3.87	6.67	4.09	0.71
ROLE ISOLATION	7.05	3.77	6.65	3.71	0.51
PERSONAL INADEQUACY	5.56	4.31	5.11	4.01	0.52
SELF ROLE DISTANCE	7.18	3.84	5.70	3.97	1.79
ROLE AMBIGUITY	5.38	4.33	4.67	3.95	0.83
RESOURCE INADEQUACY	8.26	3.32	6.93	2.88	2.09**
TOTAL ORS	71.67	31.23	64.19	27.54	1.23
AFFECTIVE	14.72	2.86	16.01	2.98	1.09
CONTINUANCE	15.02	2.37	17.76	2.76	05.02*
NORMATIVE	17.74	2.80	15.56	3.76	2.99*
TOTAL OC	47.48	5.10	49.33	5.76	1.59

As it is clear from the Table that Female faculty members of Indian and Saudi Arabian university were not showing any significant dimension of all Organizational Role Stress dimensions except on Resources Inadequacy and Female faculty members of Indian Universities were having high level of stress because of lack of proper resources in executing their duties and responsibilities and the differences between the means were found to be significant at .05 level of significance. It was also found that there were no significant differences on organizational commitment and both country university faculty members were showing moderate level of organizational commitment. Female faculty members of Saudi Arabian Universities were showing high level of organizational commitment on the dimension of

continuance commitment as compare to Indian female faculty members and the difference between means were found to be significant at .01 level of significance and this is because of the High Cost involved in leaving the university. While on the dimension of Normative commitment Female faculty members of Indian universities were shown high level of commitment as compare to Saudi Arabian universities Female faculty members and the differences between Mean were found to be significant at .01 level of significance and this high level of commitment among Female Indian universities faculty members were because they morally feel to be remain and committed in the university.

TABLE 6: Showing Correlation among ORS and OC Dimensions of Faculty Members working in Indian Universities.

VARIABLES	AFFECTIVE	CONT	NORM	T.COMM
IRD	0	0.018	-0.31*	-0.14
RS	0.018	-0.09	-0.36*	-0.21
REC	-0.16	-0.07	-0.29**	-0.25**
RE	-0.11	-0.011	-0.29**	-0.2
RO	-0.06	0	-0.15	-0.04
RI	-0.03	-0.1	-0.27**	-0.19
PI	-0.13	-0.04	-0.36*	-0.26**
SRD	-0.05	0.06	-0.21*	-0.1
RA	-0.05	-0.05	-0.18	-0.14
RIN	-0.08	-0.07	-0.12	-0.13
T.ORS	-0.07	-0.05	-0.33*	-0.21**

\*: Significant at .01 level of significance.

\*\* : Significant at .05 level of significance

It is evident from the Table that Organizational role stress and its components are negatively correlated with organizational commitment and its dimensions. It means if the level of organizational role stress among the faculty members working in Indian Universities will go up the level of organizational commitment will go down. Similar results were found by Nazneen and Bhalla (2013) and they also reported similar phenomenon among the faculty members of Indian Universities. It is the responsibility of the university leadership to manage the organizational role stress at manageable level so that organizational commitment among faculty members should be induced to the upper limits, which will lead to high productivity and effectiveness among faculty members and they will be able to give the desired results in the form of effective teaching, researches, innovations and consultancies in to their respective fields.



TABLE 7: Showing Correlation between ORS and OC Dimensions among Faculty Members Working in Saudi Arabian Universities.

VARIABLES	AFF	CONT	NORM	OC
IRD	-0.009	0.047	-.205**	-0.079
RS	0.017	-0.068	-.317**	-.172**
REC	-.187**	-0.058	-.244**	-.224**
RE	-0.086	0.041	-.263**	-.143**
RO	0.071	0.058	-0.047	.035*
RI	-0.051	-0.079	-.198**	-.151**
PI	-.113*	0.034	-.311**	-.181**
SRD	-0.047	.116*	-.162**	-0.045
RA	-0.065	0.038	-0.097	-0.057
RIN	-.141**	-0.011	-0.062	-0.097
ORS T	-0.076	0.015	-.245**	-.142**

\*: Significant at .01 level of significance.

\*\* : Significant at .05 level of significance.

Source: Compiled from primary data collected by questionnaire.

As shown in the table that the faculty members working in Saudi Arabian universities were shown a negative correlation with organizational role stress and its components and organizational commitment and its components. It clearly means that, if the level of organizational role stress and its components will increase the level of organizational commitment of the faculty members will decrease, supported the finding of Nazneen and Bhalla (2013). IRD were found negatively correlated with normative commitment means if there were high gap between conflict demands of various roles, the obligation to remain in the organization will go down hence reducing the level of commitment. Hence it is the responsibility of the affiliated institutions to manage the organizational role stress at manageable level so that maximum organizational commitment among faculty members should be induced which will lead to high productivity and performance among faculty members.

**Conclusion and Suggestions**

Indian Universities Faculty members were showing high level of organizational role stress and dominant stressors are Inter role distance, role expectation conflict, role erosion and resources inadequacy while organizational commitment was found to be moderate with normative commitment as dominant commitment. While in the case of faculty members working in Saudi Arabian universities organizational role stress were found to be moderate with dominant stressors include role erosion, inter role distance, role overload and role isolation with moderately high level of organizational commitment and continuance and affective commitment were

found to be dominant commitment. Faculty members of both countries universities differ significantly on organizational role stress and organizational commitment. Male faculty members of Indian universities are showing high level of organizational role stress but surprisingly also showing high level of organizational commitment while in the case of Saudi Arabian faculty members moderately low level of organizational role stress and organizational commitment were reported. While in the case of female faculty members of Indian and Saudi Arabian universities no significant differences were found on organizational role stress and organizational commitment. Negative correlation were found among the various dimensions of organizational role stress and organizational commitment means if organizational role stress will go high the organizational commitment of both country university faculty members will go low.

It is recommended that all the universities should have stress audit on routine basis so that the dominant stressors can be identified and suitable individual and organizational interventions can be made accordingly. The universities should have proper rules regulations and policies to create a congenial environment and must ensure that their rules regulations and procedures laid down must be strictly implemented so that the faculty members should feel comfortable. The universities must ensure that their faculty members are attending faculty development programme at least once in a year related to their field of specialization. Universities must ensure that the faculty members are engaged in teaching, research and academic administration related work only. All universities should ensure proper pay package to the faculty members to avoid their exploitation and must induce element of job security. Proper career programs should be implemented in all the universities. These recommendations if implemented, may be helpful to reduce stress level among the faculty members and may ensure high level of organizational commitment among the faculty members.

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كلية إدارة الأعمال  
College of Business Administration

# CONFERENCE PROCEEDINGS

# **“The Effect of Oil Price Shocks on the Saudi Manufacturing Sector”**

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By

**Abdelhamid A. Mahboub,**

Professor of Economics,

College of Business Administration,

University of Business and Technology, Jeddah, KSA.

And Faculty of Commerce,

Zagazig University, Egypt

[a.mahboub@ubt.edu.sa](mailto:a.mahboub@ubt.edu.sa)

and

**Heba E. Ahmad**

Lecturer of Economics,

College of Business and Economics,

Qassim University, Qassim, KSA.

[Ha.ahmad@qu.edu.sa](mailto:Ha.ahmad@qu.edu.sa)

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## **1. Introduction:**

The recent fall of oil prices since June 2014 is just one round of a series of fluctuations, in the form of shocks, in oil prices. Nevertheless, a debate has arisen about the effect of this price fall on the world economy in general and on oil exporting countries in particular. The economy of Saudi Arabia, the major oil exporting country, is not an exception in this matter of course.

The main objective of this paper is to estimate quantitatively, in the economy of Saudi Arabia, whether there exists an impact of oil price shocks on the output of the manufacturing sector, and whether it is a positive (direct) or a negative (inverse) relationship.

The focus on the manufacturing sector here is for two reasons. First, the Saudi economic planning and policy have long targeted to diversify the sources of Gross Domestic Product GDP. Growth of the manufacturing sector is expected to be very important in this diversification process. Second, the growth of manufacturing sector is one of the important measures and/or indicators of economic development. For both reasons we have chosen to study ‘the effect of oil price shocks on the Saudi manufacturing sector’ in our paper.

### ***Theoretical Background and Related Literature:***

Theoretically, the change in oil prices is expected to have two contradictory effects on the manufacturing sector. For example the fall in oil prices, given that energy is an essential input to manufacturing industries (especially petrochemicals, which commonly represent a major industrial subsector in most oil rich countries), will reduce the cost of production. This may very well induce manufacturing output. Many researches have emphasized this effect. Alper and Torul (2009) have studied this relationship in the Turkish economy, using the Vector Auto Regressive (VAR)



Model for Turkish 1988-2006 data, and found that while oil price increases did not significantly affect the manufacturing sector in aggregate terms, some sub-sectors are adversely affected. Guidi (2015) has done a similar exercise on the UK economy, applying the VAR model for the 1970-2006 data. He found that the positive oil price changes resulted in a consistent contraction in manufacturing output, while the services sector did not seem to be affected by these increases in oil prices. As for Fukunaga, Hirakata and Sudo (2010), who studied the issue in the US and Japan economies at industry level, they have found that the way oil price changes affect each industry depends on what kind of underlying shock drives oil price changes, as well as on industry characteristics, i.e. whether the industry is oil-intensive industry or not. Again the inverse effect of oil price changes on industrial output appeared in most of the cases with different degrees. These preceding examples emphasize the role of oil as affecting the cost of production and hence the industrial total product.

But on the other hand, and especially in Saudi Arabia where the government plays an important role in supporting domestic industrial firms, the lower oil price will reduce oil export revenues (given the inelastic demand for oil). The government may not be able to provide the same level of support to domestic industry as it used to do. There is a great deal of researches sharing the same results that a fall in oil prices reduces government expenditure in oil exporting countries. See for example El Anshasy and Bradley (2011), Dizaji (2014), Garkaz et al. (2012), Hamdi and Sbia (2013). However, in the context of Saudi Arabia, some writers referred to the fact that the country has accumulated enough reserves as a buffer stock against unexpected drop in oil prices and revenues. This should reduce the effects on domestic industrial firms.

What we expect is that the manufacturing sector in Saudi economy will not be significantly affected by the oil price changes in the cost of production. The government is subsidizing the price. Whitley and Makhijani (2014) have reported this observation. Therefore the effect through the effect on the government expenditures only.

The above discussion shows that the net effect of oil price fall on the manufacturing sector is not known for sure. The same two contradictory effects apply to the case of an increase in oil prices but in the opposite directions, and the net effect is again uncertain. Therefore, there is a need for an empirical research to estimate and test this relationship. This paper tends to do the job in the context of the Saudi Economy.

### ***Research Hypothesis:***

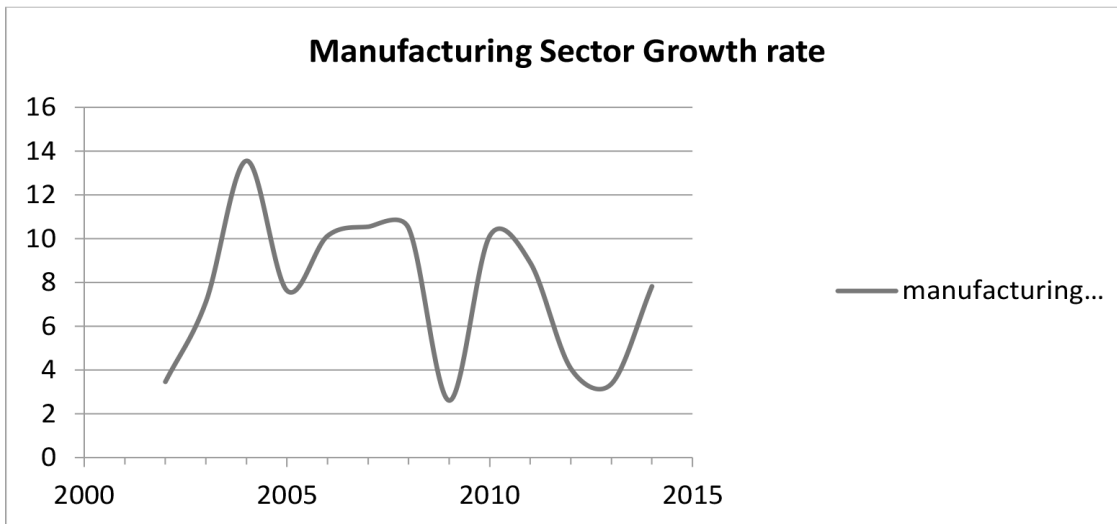
This paper plans to test the following hypothesis:

“The oil price shocks have a significantly inverse effect on the output of the manufacturing sector in Saudi Arabia.

## **2. Manufacturing Sector in Saudi Economy:**

Manufacturing sector in the Saudi economy is growing continuously since there has been a realization of the importance of diversifying the economy. Growth of the manufacturing sector is expected to be in the heart of this diversification process. Besides, the growth of manufacturing sector is one of the important measures and/or indicators of economic development. Specifically, the relative share of manufacturing sector in generating GDP is expected to increase in the course of economic development. During the period considered in this paper, the annual growth rate of the manufacturing output has increased from 3.4% in 2002 and jumped to 13.5% in 2004 and stayed around 7% and 10% in the remaining period.

Figure (1) Manufacturing sector Growth rate



Source: World Development Indicators, several issues.

The two giant existing industrial complexes, SABIC and Saudi ARAMCO are already producing plastics and petrochemical products and they are heading towards the production of aluminum. Saudi Arabia is endowed by two ingredients needed to produce aluminum; bauxite ore and cheap electricity, and hence the country aims at developing the aluminum industry into the production of car parts and even fully assembled cars (The Economist, 2015). Besides, there is already an investment spending plan of more than \$70 billion in building up six new “economic cities” with modern infrastructure and business-friendly regulations.

Transforming the economy into industrialization is not an easy journey, especially with the existence of oil export revenues that tend to delay the incentive for such transformation. During the years covered by this study, the manufacturing output as a percentage of GDP was around 10% to 13% (SAMA, several issues). Similarly, the exports of manufacture as percentage of merchandise exports were running between 7% and 11%, as appears in the following table, which supports our previous remark that industrialization was slower than it should have been for several years because of the high oil export revenues.

Table (1) the manufacturing sector growth rate

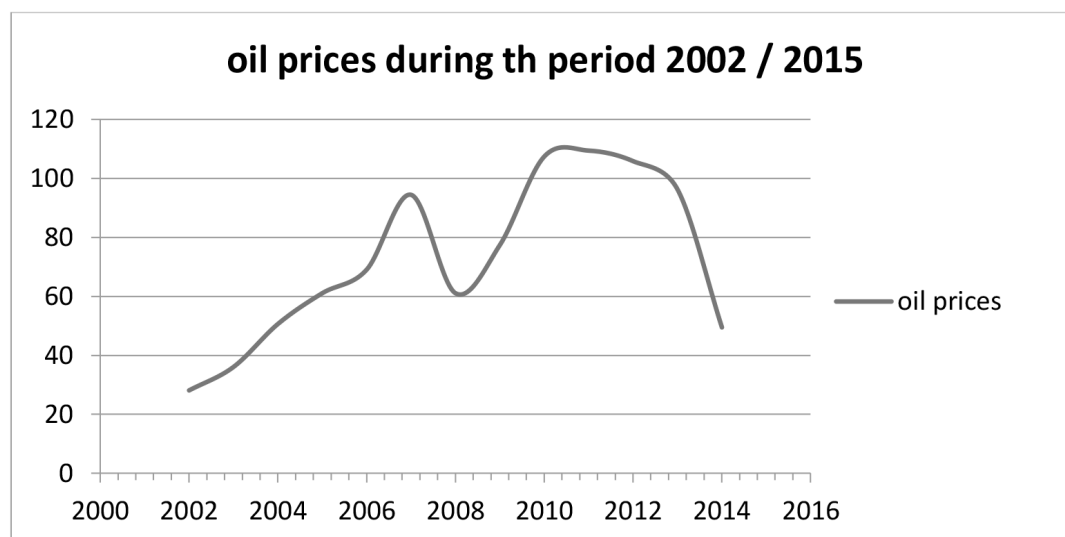
Year	2000	2001	2002	2003	2004	2005	2006
%	7.1	9.8	9.6	10.4	9.3	8.1	8.0
Year	2007	2008	2009	2010	2011	2012	2013
%	8.7	6.0	8.1	11.1	10.3	10.5	11.2

Source: World Development Indicators, several issues.

### 3. Changes in Oil Prices:

World oil prices were always subject to changes. The world market forces, no doubt, are responsible for these changes. However, since there exist a few big sellers and a few big buyers, the final outcome of interaction among them does not necessarily agree with the traditional supply and demand model. During the years considered in this paper, oil price increased from \$28.1 per barrel in 2003 to the highest level \$109.45 per barrel in 2012 and then back to \$ 26.94 per barrel in 2016. The following graph summarizes these movements in oil prices.

Figure (2) Oil Prices



Source: World Development Indicators WDI, several issues demand for oil results in similar movements (in direction) in export revenues, and in the Saudi economy this is very true.

### 4. The model and its Estimation



As expected, the manufacturing output can be affected by many other variables besides the oil prices. We need to include these variables when we assess the relationship between oil prices and manufacturing output. We have already mentioned the government subsidies. Also the government expenditures in general represent a significant component of domestic demand for manufacturing products. In addition, when these products are exportable, the exchange rate must be considered in the analysis.

In order to test our hypothesis, we will use the Vector Auto–Regressive (VAR) model to estimate the relationship between oil price changes and the manufacturing sector output in Saudi Arabia. The data set, for each variable included in the model, consists of quarterly observations for the period Q1:2002 to Q4: 2014.

All the data will come from World Development Indicators, WDI reports. The EVIEWS package will be used for estimation and hypothesis testing purposes.

#### **1.4: Variables, Data and Methodology**

The focus of the study is to estimate the relationship between oil price shocks and manufacturing sector product. The model contains five variables, namely oil price, industrial exports, government expenditure, real exchange rate and manufacturing sector product. We define the variables as follows:

- **Ln oil\_price** is the log of oil price
  - **Ln manuft** is the log of the manufacturing sector product growth rate
  - **Ln Gov** is the log of Government expenditure (% of GDP)
  - **Ln Real\_exch** is log of the index of real effective exchange rate.
- Ln export** is the log of the industrial exports (% the total exports of goods and services.

#### **2.4: Unit Root Test**

The first step in constructing time series data is to determine the stationarity property of each variable. All variables were tested at the levels using the Augmented Dickey-Fuller (ADF) Test. Consider the equation below:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha \sum_{i=1}^p \Delta Y_{t-1} + u_t \quad (1)$$

where Y is the variable of interest,  $\Delta$  is the change, t is the time trend and the difference operator, P is the number of time lags, and u is the white noise residual of zero mean and constant mean and variance. The parameters  $\alpha_1, \alpha_2, \beta_1, \dots, \beta_m$  are to be estimated. If the stationarity test is significant, the variable data series is stationary and has no unit root. Thus, the null hypothesis will be rejected.

The results from the tests of the study are discussed. Unit root test based on Augmented dickey-fuller (ADF) was performed to measure the stationarity property of the time series data. The results are shown below.

Table (2) Unit Root Tests

Variables	Level		1 <sup>st</sup> Difference	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
Oil_price	1.63	2.22	6.83***	6.86***
Real_exch	2.9	1.9	7.06***	8.09***
Manufat	2.74	2.35	5.69**	5.44**
Export	1.58	1.95	6.90***	6.93***
Gov	1.9	2.27	6.93***	6.99***

Note: (\*, \*\*) and (\*\*\*) indicates the rejection of the null hypothesis of non-stationary at 10%, 5% and 1% significance level.

\*MacKinnon (1996) one-sided p-values.

**Table (2)** shows that all variables (oil prices, manufacturing value added, gov, real\_exchange and Export) are non-stationary at the level with the constant and with the time trend. However, in the first difference test, the results for all variables showed that they are significant. This means all variables are stationary.

### 3.4:Cointegration test

The second step is testing the long run relationship between our variables, so we used Johansen test (Johansen, 1991), the result was as follow:

Table (3) Johansson cointegration test results

Null Hypotheses	Alternative Hypotheses	Max Eigen Statistic	Critical value (Eigen at 5%)	Trace Statistic	Critical value (trace test at 5%)
$r = 0$	$r = 0$	17.8	33.87	58.2	69.81
$r \leq 1$	$r = 1$	1.25	27.58	40.48	47.85
$r \leq 2$	$r = 2$	14.12	21.13	23.22	29.79
$r \leq 3$	$r = 3$	5.32	14.26	9.10	15.49
$r \leq 4$	$r = 4$	3.77	3.84	3.77	3.84

Trace test indicates no cointegration at the 0.05 level

Max-eigenvalue test indicates no cointegration at the 0.05 level

**Table (3)** shows the results of the Johansen co-integration test by using trace test and max-Eigen value test. The results indicate that there is no co-integrating equation at 5% level. Therefore there are not long-run effects of oil prices on manufacturing sector. So we can't run error correction model, but we run vector auto regressive model (Gajuarati,2008).

### 5.4:Estimating VAR model

The VAR model has been used in similar researches as it appears in the above mentioned examples. Besides, it allows us to utilize the impulse response function and variance decomposition, which assess the current and future effects of oil price shocks on the economic variables included in the model. The variance decomposition analysis will allow us to assess the relative importance of oil price

shocks on the volatility of the other variables. An identified VAR model has the following form:

$$Y_t = \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \dots + \Pi_p Y_{t-p} + \Phi D_t + G X_t + \varepsilon_t \quad (2)$$

**Where:**  $D_t$  represents an  $(1 \times 1)$  matrix of deterministic components,  $X_t$  represents an  $(m \times 1)$  matrix of exogenous variables, and  $\Phi$  and  $G$  are parameter matrices.

#### 6.4: VAR Lag Length order Criteria

The optimal lag length of the VAR is (4) according to AIC, SC and HQ indexes (table 3).

Table (3) VAR Lag Length order Criteria

Lag	LogL	AIC	SC	HQ
0	-622.28	28.51	28.71	28.58
1	-434.58	21.11	22.33	21.56
2	-426.49	21.88	24.11	22.71
3	-408.54	22.20	25.45	23.40
4	-232.6*	15.35*	19.61*	16.93*

\*Indicates lag order selected by the criterion

AIC: Akaike information criterion; SC: Schwarz information criterion and HQ: Hannan – Quinn information

After determining the optimal lag-length of the VAR models by log-likelihood ratio criterion, and Akaike information criterion, We estimate the effect of oil prices shocks, on all variables specially the manufacturing sector product in Saudi Arabia during the period using the impulse response function as follow:

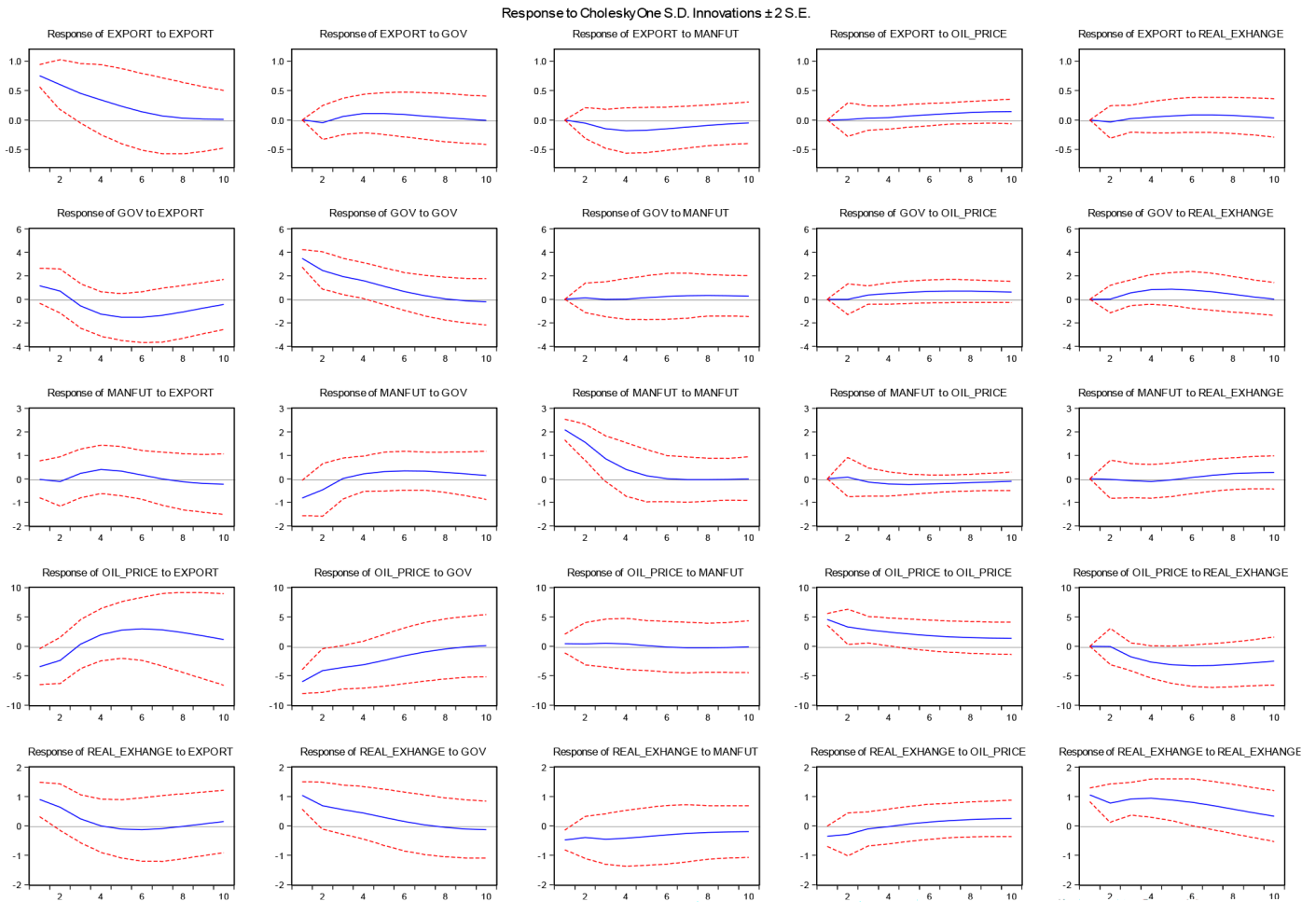
#### 7.4: The impulse response functions

As a conclusion, the VAR "manuf – oil\_price" model can be considered representative to describe autoregressive connections between oil prices shocks and



manufacturing sector growth rate of Saudi Arabia . Based on the model, we can identify four impulse responses (illustrated in Figure 3), which evaluates the effect of a shock on variations in current or future values of the oil prices and manufacturing sector growth and the other variables. Accumulated response to Cholesky one S.D. innovations  $\pm 2$  S.E.

**Figure (3): The impulse response functions**



result of the impulse response function and var results oil prices has positive effect on the government spending during the next 10 years.

### ***5 - Conclusion***

Investigating the relationship between oil price and manufacturing sector has been an issue of interest now . While numerous studies have been conducted and substantial progress have been achieved on developed economies, particularly on the U.S. economy, the dynamics for emerging small open economies have not been revealed, yet. In this study, we investigate the effects of oil prices and the growth of the manufacturing sector production o in Saudi Arabia. Using many control variables in the literature,, as well as real exchange industrial exports , government expenditure and the index of the real effective exchange rate , we perform multivariate VARs in order to estimate the net effect of oil price changes on the growth rate of the manufacturing sector.

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# Enhancing Accounting Information Systems to Facilitate Supply Chain Management between Supermarkets/Suppliers: The Case of Saudi Arabia

Abunar SM and Zerban AM\*

Supply Chain Management and Accounting Departments, College of Business Administration (CBA), University of Business and Technology (UBT), Jeddah, Saudi Arabia

## Abstract

Supply chain management is one of the most powerful determinants for creating competitive advantages for companies. In today competitive environment, companies strive to respond and offer its services faster to the market. The market of information technology is huge and expanding. Cloud computing is changing the way organization activities are performed including finance, accounting and supply chain management. The value of companies depends on events that occurred daily and the lag and gap in responding is increasingly making companies less effective. The application of information technology is prominent in the improvement of the supply chain. The main goal of supply chain activities is to satisfy customers' demand, so that products are distributed with the lowest possible cost, highest quality and within the time deemed suitable for customers which is the recent challenge. The ability to produce quality information and accessing it will become crucial aspect in the new world. Technology will help to control business and companies will manage better their relation with stakeholders. We aim to explore the relationship between retailers and suppliers in Saudi Arabia Market and their sharing of information regarding stock levels to improve supply chain management. The integration of information in processing orders from supermarkets to suppliers is going to be investigated in order to improve supply chain management.

**Keywords:** Supply chain management; Accounting information system; Saudi Arabia

## Supply Chain Management as a Crucial Organization's Function

Supply chain management is essential in today's world for companies' success. In addition, many organizations are becoming more involved in strategic alliances, networks and virtual relationships. It is an activity that requires managing raw materials until delivering to customers. According to Li et al. [1] as companies are focusing on satisfying customer demand, while reducing managerial control of daily logistics operations. Less control and more supply chain partners led to the creation of the concept of supply chain management. The purpose of supply chain management is to improve trust and collaboration among related parties, thus improving inventory management.

Companies often want to create a closer relationship with suppliers in order to reduce the cost of the products they buy, shorten lead-time, and improve quality and enhancing the service level. Simchi-Levi et al. [2] argued that supply chain management requires managing supply chain in order to allow goods to be produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize costs while satisfying customers. Supply Chain Management can be critical to customer satisfaction and enhancing companies' position. Supply chain management is critical to business operations and success. It has great impact on companies' profitability and firm's value because they decrease in the use of large fixed assets such as plants, ware houses and transportation vehicles in the supply chain can decrease expenses and ultimately enhancing profitability. The availability of products to customers and more responsive to their needs can boost sales revenues. Also, cash flow can increase because if delivery of the product can be accelerated, accounts receivable turnover will be faster. Information sharing among firms along supply chain plays a vital role in supply chain management [3].

This paper aims to explore the nature of collaboration between Saudi supermarkets and their suppliers, and the degree of operational and information integration internally and externally if there is any. An exploratory case study approach is carried out to provide a better

understanding the relation between retailers and suppliers in Saudi supermarkets.

## Computerized Accounting Information System Role in Supply Chain Management

Computerized accounting information system is a computer-based method for tracking financial transactions based on information technology resources. The system is responsible for processing financial data that can be used for internal and external decision making. The success of accounting in the last five centuries and its prominent position during and after industrial revolution is in the last decade and afterwards being tested and became a controversial issue among academics, accountants and users who are the customers of accounting information. Customers of accounting information are no longer satisfied and are looking for other sources of information which are comprehensive and solid [4]. The traditional accounting and financial system are suitable when companies are striving for cost efficiency in a stable market. By providing information related to elements of production with variance analysis reports, managers were able to take operational decisions in the age of industrial economy [5]. The value of companies depends on events that occurred daily and the lag and gap in reporting it is increasingly making accounting reports less useful. Supply chain management is crucial in today's world for companies

\*Corresponding author: Zerban AM, Supply Chain Management and Accounting Departments, College of Business Administration (CBA), University of Business and Technology (UBT), Jeddah, Saudi Arabia, Tel: +966 2 215 9000; E-mail: [ayman@ubt.edu.sa](mailto:ayman@ubt.edu.sa)

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success. In addition, regardless of the size or sector of organizations, many companies are becoming more involved in strategic alliances, networks and virtual relationships. Requirements of reliable and on-time information are a must not an option. Supply chain management can benefit from management accountants as they can help analyzing key performance indicators and costing information to recognize inter-organizational relationships and contribute to cutting costs and enhance value. The Management Accounting Committee (MAC) of the Institute of Management Accountants [6] in its statement of the need of integration between retailers and suppliers provide example about Wal-Mart and its way of integrating suppliers into a network responsive to a defined vision of customer values.

Management accounting expertise can help supply chain management through a number of ways including reporting and improving financial and non-financial performance management across the supply chain, and improving performance through the use of technology; using management accounting tools at different stages of developing supply chain relationships; supporting and promoting sustainable distribution; facilitating trust among collaborating organizations and supporting partnership throughout the supply chain [7]. Munteanu [8] argued that supply chain management includes coordination and collaboration with different partners, which can be suppliers, retailers, and customers. In general, integration is vital between different parties involved in supply chain. Supply chain management can be viewed as an integrating function, which should be connected to other business functions and processes within and outside companies. Creating value through supply chain requires proper flow of information. He states (p.514, original emphasis):

When we speak of the information needs of Supply chain management, we think, in a first stage, of the information on providers, customers, distribution networks, etc., and we must take into account that their essence consists, in most cases, of quantitative information that, to a great extent, comes from accounting. Using past events recorded at present, we can obtain certain data on costs, stocks, debts, and recorded results, and we can make predictions and design strategies for the future.

In order to improve company performance, integrated supply chain cost management is considered important. For accounting and supply chain to get such a view, management accounting systems should be able to measure costs at the level of individual activities and calculate total costs along activity chains, across the different responsibility centers and legal entities. Activity-based costing could do the job [9].

Sutton et al. [10] argued that today's business environment is not only about cost reduction or quality but about more response to customer's needs. It is a competition between supply chains with an organization's success depends on the viability and success of its supply chain partners as much as, or more than, enterprise policies and decisions. There is a need for systems to connect supply chains. Still, the current accounting model fails to recognize the complexity of this new reality. Failure to effectively integrate policies for trading partners and to secure information across the supply chain can cause a number of risks for companies. They provide example about Cisco Company which built its success on outsourced manufacturing and growth through acquisition and the failure of the company in 2011 by stating (p.6):

Two of the more publicized failures were Nike and Cisco Systems. Nike's crisis came in May 2001 when reported sales for the prior quarter had to be reduced by \$100 million because of confusion in its

supply chain. Cisco Systems experienced an even bigger hit when \$2.2 billion was written off for unusable inventory resulting from problems in the supply chain.

Sacer and Oluic [11] argued that accounting information system is important in preparing quality accounting information. The application of information technology impacts the operations of organizations. Organizations need to fully understand the role of technology on organizational process. Accounting information system backed by suitable information technology is cornerstone in new knowledge economy. Accounting in the new environment is not going to be the same. Financial accounting needs to be more responsive to stakeholder's needs of information while management accounting need to be more integrated in management process. Accountants are trying to amalgam financial and non-financial information to satisfy various needs. Management accounting moved from cost determination and financial control to create value by participating more on organization's decision making process and strategy formulation. It is in this environment where accountants act as advisors with multidisciplinary skills. He must be knowledgeable, ethically responsible and equipped with highly professional skills [5]. Stede and Malone [12] pointed to the changing role of accountants and financial professional. Accountants are more likely to add value and support management in their companies instead of the traditional accounting responsibilities and to be more involved in its future direction. They must be highly professional and equipped with information related to risk management, financial instruments and cash flow.

Next section is going to explore the status of information technology in Saudi Arabia and how advances in information technology infrastructure can facilitate the integration of information.

### **The Status of Information Technology in Saudi Arabia**

The role of information in the new economy is paramount. Technology, globalization, intangible assets, and communication are impacting and shaping our world. The ability to produce quality information and accessing it will become crucial aspect in the new world. Technology will help to control the business and companies will manage better their relation with stakeholders. Companies must think of ways to make their processes more flexible [13].

The first appearance of internet technology in Saudi Arabia was in 1994 where it made its first appearance in educational, medical and research institutions. It became available for public use in 1999. The number of Internet users in 2001 was one million and had increased to 11.03 million by the end of 2010 with an annual average growth of 31%. By the end of 2010 40% of the populations were using the Internet. It is nearly 70 % of the Saudi populations are aged less than 30 years in 2007. Generally, the spread in use of the Internet by Saudi companies increased from 59% in 2008 to 65% in 2009. In detail, 85% of large companies had an Internet connection, 75% of medium companies used the Internet technology, whilst the 58% of small companies had internet. Furthermore, 69% of the firms in 2009 used the Internet for business [14].

According to CITC [15] (Communication and Information Technology Commission) by the end of 2014, the number of subscriptions to fixed broadband services had increased 3 million, representing 54% of households, and total mobile broadband population penetration had reached 94.5%. Internet penetration increased rapidly over the past years; it rose from 13% in 2005 to about 65.5% at year-end 2014. The number of Internet users in the Kingdom is currently estimated at about 19.6 million. An increase in demand

for Internet services and broadband was observed recently with greater use of social networking channels, resulting in users seeking higher speeds and greater bandwidth. The amount of data used also increased dramatically in the past few years. The following figure shows the growth of internet users 2001-2010 (Figure 1).

This increasing in the number of Internet users for different factors. Firstly, after 2005 the Saudi government allowed more operators to work in the market and provide the Internet services and they are overseas firms. Secondly, because of oil prices increasing, the Saudi government increased the wages for the employees in the government as well as the increasing in the allowance and benefits. The following

graph highlights growth in total subscriptions to mobile services in Saudi Arabia from 2007-2014 (Figure 2).

Brinkley [16], pointed to the characteristics of knowledge economy and knowledge organization, it is an economy where knowledge is diffused in all sectors not just some industries. Work in organizations is organized to store and share information through knowledge management practices. An organization that manages for stakeholders allocates more resources to satisfy the needs and demands of its legitimate stakeholders than would be necessary to simply retain their participation in the organization's productive activities. Organizations that manage for stakeholders develop trusting relationships with

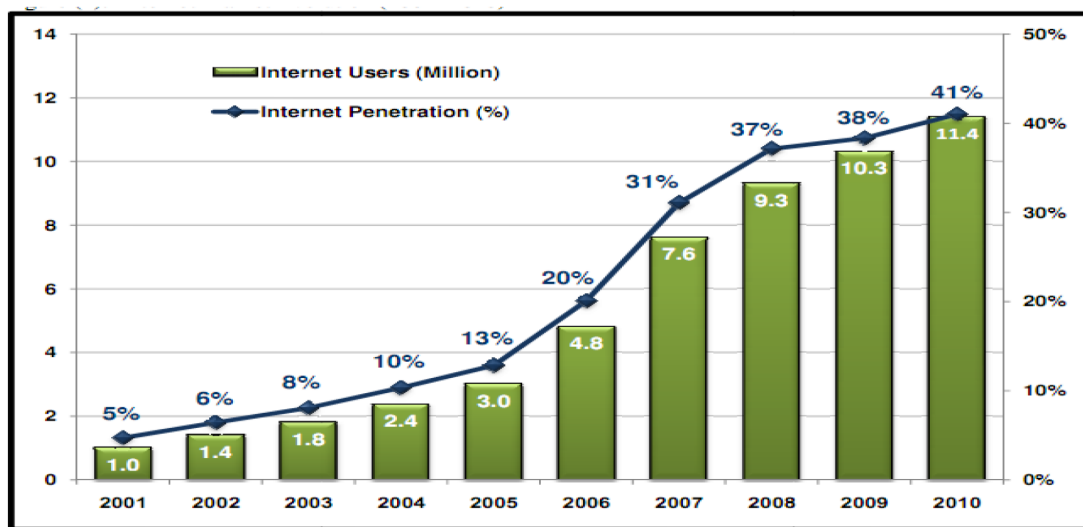


Figure 1: Number of Internet users in Saudi Arabia (2001-2010).

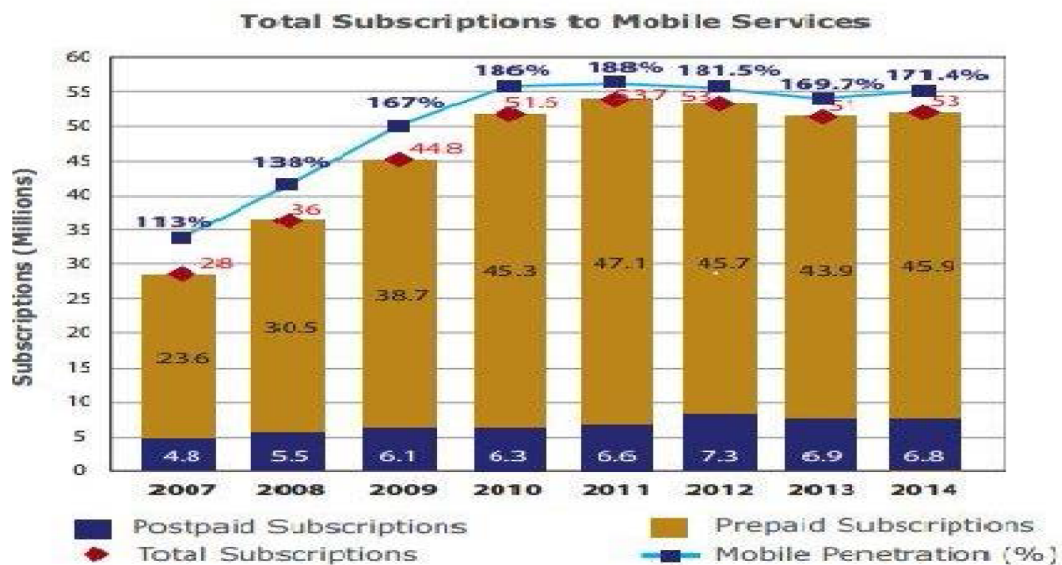


Figure 2: Total subscriptions to mobile services in Saudi Arabia (2007-2014).



them. Under these conditions, stakeholders are more likely to share information regarding their utility functions, thereby increasing the ability of the firm to allocate its resources to areas that will best satisfy them.

Cloud computing has become a trend that gained popularity in

from static, centralized and closed systems to a more comprehensive, timely and dynamic model. Accounting information system is a tool that helps companies in running its business model [17]. It is used daily to provide information for decision making in various organization activities such as production, human resources, finance and supply chain management. In order to integrate business, an emerging technology known as cloud computing might be the answer to these concerns, since it is related to share computing resources between companies, providing a common interface to all users at the same time [18]. Kinkela [19] argued that cloud computing technology allows software and data to be managed offsite. It causes a huge cost benefits and efficiencies. In this case, computing resources may reside in a technology center shared with other organizations and managed by a third-party vendor. Mattison and Raj [20] identify three factors as a determination of the fit of cloud computing with ERP. They are the size of company's revenue, the geographical area of its operations, and the industry sector in which business operates. Cloud-based ERP offers smaller and mid-sized enterprises significant greater benefits in terms of cost. Jia [21] promoted the integration of conventional ERP system with cloud services as a solution that takes advantage of cloud services with lower investment, especially for the enterprises that have been running ERP systems for years.

Next section is going to shed light about the development of supermarkets industry in Saudi Arabia.

### Saudi Arabia Supermarket Industry

The retailing sector in Saudi Arabia is one of the fresh and fastest growing sectors from a consumers demand perspective. Consumers now prefer to shop at modern supermarkets and hypermarkets for different reasons. Firstly, young people in general have developed a Western shopping where they prefer shopping from supermarkets. Secondly, old people prefer supermarkets because they are convenient. Thirdly, they are considered as a place for family entertainment due to the conservative nature of the Saudi community as supermarket have playground areas that lead to allow parents to shop whilst their children are entertained [22]. In contrast of old people preference of supermarkets, young Saudi population prefers to shop online. However, the development in the online retail is slow due to many obstacles such as:

The reasons why online sales could pick-up are the convenience that it provides in receiving goods at home and it allows women to carry out purchases from the comfort of their home. Other reasons for limited development of online or e-commerce transactions in the Kingdom are:

- Lack of proper infrastructure (no secure payment gateway mechanism, lack of multiple payment options, limited technical knowledge to design e-commerce platforms, etc.).
- Non-availability of an efficient delivery system (the current postal system uses P.O. Box systems rather than postal addresses and the new Wasel service, which uses geographic information systems (GIS) covers only 2% of the Saudi population).
- Legislations regulating e-commerce retailing are still under development.

There were 32,000 food retailing shops in Saudi Arabia; of these supermarkets accounts for only 1%. In addition, the largest food producer sells only 4 % of it produces to these supermarkets. Compared with supermarkets in the west, Saudi supermarkets are very limited in providing special promotions to their customers, which is a major

performance of Saudi supermarkets, we will refer to the annual report from one of the largest supermarket chain in Saudi Arabia, Al-Azi Panda. Total sales in 2012 were 9.5 billion SAR and the growth rate was 12% that is well above sector growth. Over 86 million customers visited their 161 branches. Their market share was 7.7% in 2012 and expected to be 8% in 2013 [23]. This in comparison to western based and managed supermarkets, such as Carrefour, which have grown rates of 11% and 7% respectively between 2007 and 2012.

Al-Rajhi [22] and Euro-monitor research suggests that in 2010, the annual growth for small grocery retailers was 3.2%, Supermarkets 4.4% and Hypermarkets 7.2%. whereas market share of Hypermarket is the least of them by only 16%, and supermarket share was 24% and finally the small grocery retailers is 60% because of their large number [24] (Figure 3).

In order to explore the nature of collaboration between Saudi supermarkets and their suppliers, and the degree of operational and electronic integration if there is any, structured interviews were conducted with eight retailers who belonging to supermarket and hypermarket chains who represent the major players in the market. The interviewees were purchasing department managers and CEC. In addition, four suppliers participated in the structured interview. This method enabled the extraction of the required information. The advantage of using this method is that the researcher can obtain data directly from their sources.

### Saudi Arabia Supermarkets/Suppliers Integration Case Study

This section is exploring the integration between Saudi supermarkets and their suppliers. It considers information gathered through structured interviews with the top management of both retailers and suppliers. The structured interview technique was used to cover the gap in the literature in order to identify the level of integration in information systems among retailers and their suppliers. In addition, this part of the study attempts to identify the barriers/enablers to the integration. The structured interview investigated three major areas:

- General information about retailers and suppliers such as their annual income, number of branches, and any other related information.
- The second part of the structured interview concern information systems used internally (between the branch and head office) and externally (supplier-retailer information exchange). It also considered information system budget renewal and updating plans and the level of involvement of the system users in determining the features required when buying a new information system.
- Thirdly, it investigated the behavior of Supply Chain Management from different perspectives. These concern the nature of communications between suppliers and retailers, product stock levels, product quality checking, and payment suppliers that affect SCM performance.

The sample consisted of eight retailers and four of their fo



suppliers. The retailers were the biggest retailers in the Kingdom of Saudi Arabia. They had supermarket chains and hypermarket chains distributed across the country in five regions; the central region, west region, east region, north region and south region. Seven of the interviewees were purchasing managers for supermarkets chains. One interviewee was chief executive officer and board member of one of the supermarket chains. Seven of the supermarkets had their main office and central department situated in Jeddah; the other was located in Riyadh the capital of the Saudi Arabia (Table 1).

Interviews were also carried out with four suppliers. They were all food suppliers to the supermarkets and to other kind of retailing outlets such as, corner shops, mini markets and the wholesalers. In addition, these suppliers had distribution channels that covered all regions in

Saudi Arabia. The reason for using food suppliers was to examine the behavior of products with fast movement and high consumptions rates where shelf life is a key issue. From the interviews, the researchers tried to identify the general operational culture of each organization and how they viewed their suppliers; the same approach was followed for the suppliers. Table 2 presents the annual turnover for each supplier interviewed with and the products are producing.

In case of internal communication, the answers received from the retailers showed that all of them were using e-business tools on a daily basis to manage stock level, schedule tasks, inventory, and financial transactions. This indicates that all retailers were using electronic applications to organize their work irrespective of what size their daily activities are as shown in Table 3.



The second form is external communication. Table 4 shows that the retailers do not have electronic communication systems in place that to allow suppliers to access retailer's system to check stock level or for completing financial transactions.

The communications with suppliers is vital in facilitating relations with supermarkets. Apart from retailers A and B where the main method of communication was email, retailers primarily communicated with their suppliers directly at retail branch level through supplier sales representatives. If a sales representatives could not be reached or is not available then there was an almost equal split between phone and fax as a second alternative and fax and phone as third alternative as shown in Table 5.

From the interviews, it was found that while all of the previous retailers were using the above mentioned methods with their suppliers; however, it could be different from supplier to another depending on the degree of relationship with the supermarket or even the division supervisor, if the ties are strong. In case of supplier dose not turn up to the supermarket to check its product or not supplying and fulfill the orders, retailer will use alternative suppliers for that product. How frequently do you update your hardware (PCs/servers) and ERP software?

Table 6 shows that the retailers A, E and F did not have any set plan to change their software or hardware, whilst retailers C, D, H and G

Method of Communication	Retailers								
	A	B	C	D	E	F	G	H	I
Externally									
EDI System (Electronic Data Interchange)	No	No	No	No	No	No	No	No	No
Internet portal	No	No	No	No	No	No	No	No	No

Table 4: External communications.

Retailer	Method of communication				
	1 <sup>st</sup> method	2 <sup>nd</sup> method	3 <sup>rd</sup> method	4 <sup>th</sup> method	5 <sup>th</sup> method
A	Email	Visiting the branch	Online check	Fax	Phone
B	Email	Fax	Phone	-	-
C	Visiting the branch	Fax	Phone	-	-
D	Visiting the branch	Fax	e-mail	phone	-
E	Visiting the branch	phone	fax	Email	-
F	Visiting the branch	phone	fax	Email	-
G	Visiting the branch	phone	fax	-	-
H	Visiting the branch	Fax	phone	-	-

Table 5: Communications with suppliers.

Plan in Years and Budget	Retailers							
	A	B	C	D	E	F	G	H
2	-	✓	-	-	-	-	-	-
4	✓	-	✓	✓	-	-	✓	✓
No set plan	-	-	-	-	✓	✓	-	-
The Budget in SAR	500000	500000	100000	300000	-	-	100000	10000

Table 6: Software and hardware updating time.

planned to update them every 4 year. Furthermore, only one retailer B updated the software and hardware every 2 years. In addition, the average budget varies from 10,000 for retailer H to 500,000 for retailers A and B. It is also noticeable that the two retailers that have no set plans for hardware or software renewal also have no budget allocated for it.

The supermarkets/suppliers relationship and how both sides can manage the stock levels, payments to suppliers, and quality of the products is of a great concern to an effective supply chain management.

The interviews with Supermarkets clarified none of them had an integrated system with suppliers. Although retailer A answered yes, but in effect the system was not integrated. Retailer A only gave large suppliers a user name and password to access the retail website to check and download issued orders and print them. Only two retailers were able to provide information about the number of orders issued each day. Retailer D had 600 orders and retailer E had 200 orders each day while the others did not have information about the number of daily orders as shown in Table 7.

The ability of retailers to identify accurately their current stock levels at each store is in doubt. The responses regarding the availability and shortages of products in the retail stores showed that retailers B, D, E, F, G and H report that product shortages occur occasionally. Retailer A, on the other hand, is a little more interesting as it reports that there are shortages and that some of their stores often run out of stock for perishable goods. In the contrary they report that they never suffer shortages of long life goods, electronic goods, clothing, tools and hardware (Table 8).

From the collected data reported in Table 9, we can see that suppliers depend on regular visit of their sales representatives to the supermarkets to find out stock levels and obtain further orders; phone and fax are also used. E-mails are rarely used. There is no electronic integration in terms of sharing information on stock level and products availability on a daily basis.

The payments arrangements from retailers to suppliers are considered problematic. All of the suppliers present a monthly statement of indebtedness. Suppliers confess that the process can lead to a delay in payment because some retailer's branches have problems in recording invoices and that the warehouse is unable to assemble information due to workload issues. This only becomes apparent to suppliers when payment is made. It is only then that they discover invoices documentation has either been lost or not acted upon. Suppliers agreed that they try to solve any problems in a friendly way. If that fails to settle they can always go to court. In addition, if retailers default with bank refusing to pay out due to lack of credit, for instance then the supplier can ask the ministry of trade to deal with the case. All suppliers agreed that the relationship is unbalanced between the parties and all power is on the retailer's side. The main reasons for the poor relationship between suppliers and retailers are due to two main

Retailer	Number of orders per day
A	Information not available
B	Information not available
C	Information not available
D	600 orders
E	200 orders
F	Information not available
G	Information not available
H	Information not available

Table 7: Number of daily orders.

Retailer	Perishable goods	Short life goods	Long life goods	Electronics	Cloths, tools and hardware
A	Yes	sometimes	No	No	No
B	sometimes	sometimes	sometimes	sometimes	sometimes
C	sometimes	sometimes	sometimes	sometimes	No
D	sometimes	sometimes	sometimes	sometimes	sometimes
E	sometimes	sometimes	sometimes	sometimes	sometimes
F	sometimes	sometimes	sometimes	sometimes	sometimes
G	sometimes	sometimes	sometimes	sometimes	sometimes
H	sometimes	sometimes	sometimes	sometimes	sometimes

Table 8: Product shortages and availability.

Supplier	1 <sup>st</sup> method	2 <sup>nd</sup> method	3 <sup>rd</sup> method	4 <sup>th</sup> method
W	By regular visit to retailer	Phone	Fax	e-mail
X	By regular visit to retailer	Fax	Phone	e-mail
Y	By regular visit to retailer	Phone	Fax	e-mail
Z	By regular visit to retailer	Phone	Fax	e-mail

Table 9: Supplier/retailer method of communication.

Supplier	Main Cause of Conflict
W	Retailers are paying suppliers late
X	Retailers are paying suppliers late
Y	Retailers are paying suppliers late; we are not supplying them on time either
Z	Retailers are paying suppliers late; we are not supplying them on time either

Table 10: Causes of conflict between suppliers and retailers (supplier's views).

reasons: late payment and failure to deliver on time (even though the penalty for late delivery is written into contracts (Table 10).

## Conclusion

In today's competitive environment it is no longer enough to integrate only operations, internal infrastructure with the company's competitive strategy but organizations that better integrate internal processes with suppliers in order to build effective supply chains is necessary. Supermarkets in Saudi Arabia need to move away from the current means of communication to a more effective model. The late payments to suppliers and failure of delivery of goods to customer's on-time can have a tremendous impact for customer's satisfaction in Saudi Arabia. Solutions are needed for a more integrated system. The transformation here could see the introduction of electronic systems that simplify and speed up the communication process. An information system for managing the supply chain being used through the cloud would enable this business model in a more simple way and especially with greater flexibility. Allowing sharing of information in an integrated system is a cornerstone to improve Supermarkets/Suppliers relation towards more efficient supply chain.

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# Quantifying the intangible costs related to non-ergonomic work conditions and work injuries based on the stress level among employees



Mohammad Mansour

University of Business and Technology (UBT), Industrial Engineering Department, Jeddah, Saudi Arabia

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## ABSTRACT

Undoubtedly, no specific method exists to measure the cost of displeasure among employees due to unpleasant or non-ergonomic work conditions. Despite the financial impact of these hidden costs on organizations' performance, these types of expenses are usually ignored. The intangible costs are insubstantial and represent expenses that have no common quantity or labeled value attached to them. Estimating intangible costs related to work conditions based on stress level among employees is a technique that attempts to formulize a multidimensional relationship between input qualitative variables related to the state of work conditions or work injuries and the monetary value of the hidden costs encountered with them. This technique approaches the problem from a unique standpoint, revealing the concealed effect of the state of disorder of the production system and the stress level among employees that impact the overall efficiency. In addition, the influence of the stress level on the invisible costs of the optimal amount of labor and capital due to reduced ergonomic work conditions will be investigated over both the short run and the long run. Finally, the effect of work conditions on profit-cost-volume and the breakeven quantity will be formulated.

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## 1. Introduction

In today's competitive global economy, attempts to reduce production costs are a serious priority for most industries. The fluctuations in raw material and fuel price and the tumbling in sales rates stimulate companies to develop policies to guide and control their expenses. The costs of work injuries and the effect of non-ergonomic work conditions are major contributors to the overall expenses. Worldwide, there are more than 270 million work accidents and 2 million deaths due to work injuries or work related diseases yearly (TC-OSH, 2013). The unquestionable economic impact of these work condition related injuries are massive at the individual, enterprise, and societal levels. In the USA, the detectible cost of work injuries and fatalities is \$198.2 billion a year (Michaels, 2014). Consequently, new strategies should be adapted to minimize the contribution of work conditions and injuries to the total expenses. Although the unobserved costs of inappropriate work conditions and work injuries are usually disregarded, they have a significant influence on the total costs and are consequently worth investigating (Dorman, 2000). Work injuries and flawed work conditions increase the stress level among employees, which results in extra costs related to

declining co-worker integrity, morality, and virtuous behavior. Likewise, hiring and training new or temporary employees increases the undesirable turn-over rate. Time lost from work, overtime, and the administrative time spent in accident investigations will intensify the overhead costs unnoticeably. The costs of equipment impairment or unsecured products caused by work accidents add further unscheduled obstacles to organizations' overwhelmed budgets. Meanwhile, litigation expenses, legal penalties, citations, interrupted production schedules or any failure to fulfill customer commitments will reduce the competitive edge of the company and have a severe impact on the total revenue (Miller et al., 2002; Aldana, 2001).

## 2. Literature review

To promote less stressful work conditions, understanding the real causes that provoke stress among employees is necessary. Work places with high stress levels reduce employee engagement. Employees become less productive and have higher absence rates than those operating under lower stress conditions. A global survey showed that 90% of staff were disengaged with high stress levels and 57% of those felt absolutely disconnected from their employer. Additionally, the survey conveyed the destructive link between high stress levels and reduced productivity (Dyble, 2014). The

E-mail address: [m.mansour@ubt.edu.sa](mailto:m.mansour@ubt.edu.sa)

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foundations of stresses at work are numerous and might originate from certain areas that are not immediately visible to management without a good communication structure. Robert (2014) found that 22% of employees in Great Britain accused their financial situation of having a negative impact on their productivity at their workplace. Furthermore, 82% of employer respondents said that helping employees to manage their finances would reduce employee stress levels. In addition, Knauth (1998) addressed the effect of certain characteristics of work schedule on fatigue. Night shifts, early morning shifts, extended working days, and short daily rest periods are among the characteristics that may cause work accidents and reduced productivity. The core concept of reducing risks of fatigue with a shift schedule is to keep it simple. Inconvenient work conditions cause fatigue that reduce the personal ability to think and function well (Wilkinson, 2013). On the other hand, research conducted by Cheese (2010) addressed the fatal combination of fear of losing a job and fatigue that results in rising workers' compensation claims. The study found that the poor economy encouraged organizations to cut their workforce to stay afloat. Accordingly, those who were left to operate the production lines were working prolonged hours and performing duties that were unfamiliar to them without proper training. Statistics show that human errors contribute to up to 80% of industrial accidents. A study on 24/7 industries revealed that a large share of human-error incidents can be attributed to fatigue caused by long work weeks, nighttime work, and repetitive activities, not by equipment or system malfunctions (Carter, 2007). Brecher (2014) addressed the role of management to understand the factors that cause poor job performance among employees. The study showed the impact of work environments on employees' performance, behavior, and motivation.

Previous research focused on the estimation of the cost of work injuries due to unsuitable work conditions using one of three primary methods: the human capital method, the friction method, and the willingness to pay method (Amador-Rodezno, 2005; Behm, 2004; Oxenburgh, 2005). The human capital method suggests that the costs lost in production due to mortality or permanent disability are a multiplication of the prospective discounted earnings by the probability of living to that age. This approach is the most common approach used to estimate the cost of work injuries. However, this approach has two major limitations. First, certain groups are assigned a higher value of impact than others according to their age, gender, etc. The second drawback is the use of full replacement costs independent of whether the worker was replaced or not. The friction cost method has been proposed as an alternative to the human-capital approach of estimating indirect costs. The friction cost method is argued to be based on implausible assumptions not supported by neoclassical economic theory. Furthermore, consistently applying the friction cost method would mean that the method should also be applied in the estimation of direct costs (Johannesson and Karlsson, 1997). Additionally, the friction cost method considers the productivity costs only during the restoration period needed to return to initial production level. This approach covers the cost of short term disability and hiring or training a new employee (Koopmanschap, 1995; Ale, 2008). Determination of the duration period to return to the initial level of productivity is a major shortcoming of this approach (Currie, 2000; Goeree, 1999). The willingness to pay method considers the maximum amount that person would be willing to pay or sacrifice to mitigate or eliminate the probability of injury risk. It measures the monetary difference between the good choice and the bad choice. Usually, this will be conducted by a survey or the additional pay for high risk jobs. The drawback of this method is that the cost will be intensified and overestimated (Rydlewska-Liszkowska, 2005; Hirth, 2000).

### 3. Tangible and intangible costs of a non-ergonomic work place

Obviously, no specific and unique method could monetarily describe the cost of displeasure due to unpleasant work conditions or the cost of pain due to work injuries. Despite the impact of these costs on organizations' performance, these types of costs are usually ignored and mistreated. Accordingly, the costs of work conditions and any subsequent injuries or diseases should be classified as tangible costs and intangible costs. The tangible costs are those that have a common quantity or a tag value attached to cost objects. The costs of equipment repair due to work accidents represent an example of tangible costs (Reville, 2001). Furthermore, the tangible costs can be classified as direct and indirect costs. Reimbursement, compensation, medical invoice, rehabilitation, remedy, wage, and continuation of benefit are examples of direct costs that have close and diametric connections with work injuries (EU-OSHA, 2009; Niven, 2000; Leigh, 1997). On the other hand, indirect costs are the implicit and inevitable expenses that are related to work injuries. Property damage, work interception, rescheduling, administrative costs, rehiring and training, costs of contingency plans, settlements and legal expenses are typical examples of indirect cost of work injuries. The cost object of a direct or indirect cost should be determined to a certain extent without any ambiguity. The sum of both the direct and indirect costs measures the overall cost of work injuries (Weil, 2001). The problem that arises is how to estimate the uncertain intangible costs of work injuries (Mrozek, 2002).

The monetary value of the intangible cost objects related to the level of stress among employees is not well defined. This cost could not be recognized directly during the accounting period. Thus, the intangible costs are insubstantial and can neither be collected within the normal accounting system nor rely on the past or future payments or commitment to pay. The ground of intangible costs is flimsy, and they measure the opportunity that is lost or sacrificed when the choice of action requires an alternative course of action to be given up. The real cost of forgone efficiency or declined performance, lost time due to work accidents, or loss of pleasure are a few examples of intangible costs. Estimating the intangible costs gives a significant judgment about the actual cost of any course of action when there is no explicit accounting system or determinant monetary price attached to the cost objects. Ignoring the intangible cost will result in illusions and false estimations of the true costs that are directly related to the state of work conditions. Based on the tangible and intangible expenses, the cost of inconvenient work conditions and work injuries could be formulated as:

$$C = \sum_{i=1}^k T_i + \sum_{j=1}^m I_j \quad (1)$$

where  $C$ , the total seen and unseen costs;  $T$ , the tangible costs;  $I$ , the intangible costs;  $k$ , the set of all cost objects of tangible costs;  $m$ , the set of all cost objects of intangible costs.

### 4. The effect of stress on efficiency

Details of the intangible costs of work injuries should be accumulated to describe the entire imperceptible cost objects. For example, suffering due to work injury is a case of input quality variable that relies on but is not limited to other qualitative variables such as the severity of injuries, age, and duration of pain. Based on these descriptions, the intangible cost analysis based on stress level evaluates the employee performance. These evolutions in most cases are qualitative. The intangible costs of work injuries are a function of multiple variables and the relationship between these variables and their values are interpreted and mapped to the input vector. The sum of the individual's deficiency due to work



conditions represents the total efficiency of the system. For example, the loss of efficiency shown in Fig. 1 is a function of the severity of injury and the level of experience of the injured person. Normally, this relationship is not linear and could not be generalized. It should reflect the degree of beliefs, the culture of the society, the common laws, and many other factors.

Work conditions and consequent work accidents affect the stress levels among employees. Let ( $x$ ) represent a scaled input qualitative variable such as anxiety, fatigue, work environment, working hours, training level, machine conditions, management–employee engagement, decline in coworker integrity, morality, virtuous behavior, turn-over rate, and time lost from work, which can be surveyed and evaluated based on the Likert Scale. The relationship between these qualitative input variables can be mapped to represent a single value that represents the stress level among employees. Accordingly, the stress can be expressed as the average normalized weight according to:

$$S = \sum_{i=1}^n w_i x_i \tag{2}$$

where  $S$ , stress level;  $x_i$ , the scaled elements of work conditions that cause stress;  $w_i$ , normalized weights.

The level of stress among employees due to work conditions directly affects the employee efficiency. Higher levels of stress among employees reduces the efficiency dramatically, as shown in Fig. 2. Usually, the relationship between the stress level and efficiency is not linear. Hence, the affiliation between the stress level and efficiency can be formulized as:

$$\rho = e^{-\frac{s}{m}} \tag{3}$$

where  $\rho$ , efficiency;  $m$ , stress scale factor.

### 5. The effect of stress on short term costs

Many stress factors affect the productivity of the production system. Usually, the temporary stress elements will negatively impact employee performance and efficiency in the short term. Hence, the actual amount of labor will drift from the standard level due to the decreased performance level. The stress level affects the total cost of short term tasks due to the decreased production output from the standard level. Therefore, to maintain the output quantity at a certain level, the amount of labor should be increased. This can be done either by hiring extra labor in terms of count or increasing the production schedule time. In both cases, the total cost will increase. Considering the interaction between the amount of labor and capital, the total cost function represents the sum of

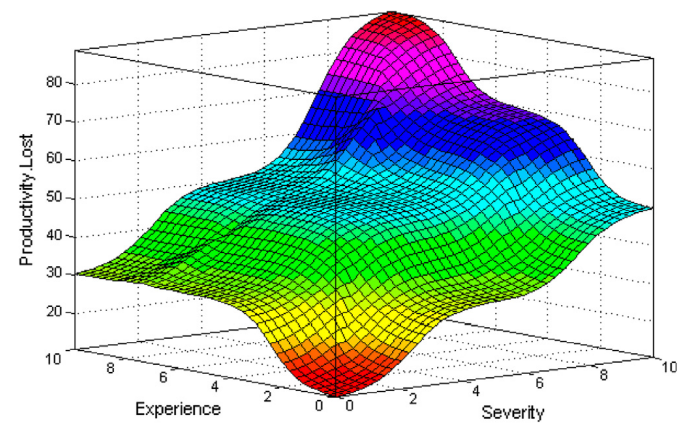


Fig. 1. The nonlinear relationship between efficiency, level of experience, and the severity of work injury.

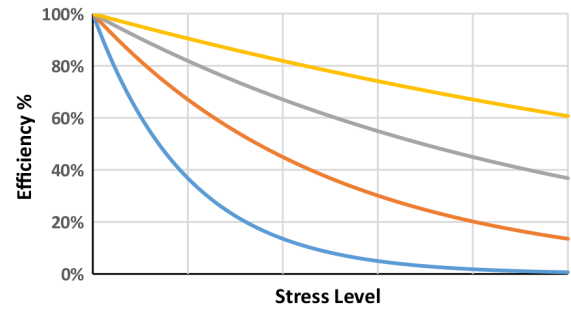


Fig. 2. The relationship between stress level and efficiency for different values of  $m$ .

variable costs that are represented as labor costs and the fixed costs that are represented as capital costs. The objective function will be to minimize the total costs as follows:

$$\text{minimize } TC = \bar{P}_k \bar{K} + \bar{P}_L L_A \tag{4}$$

Subject to

$$Q = A \bar{K}^\alpha (\rho L_A)^\beta \tag{5}$$

where  $TC$ , total cost;  $\bar{P}_k$ , price per capital unit;  $\bar{K}$ , capital units;  $\bar{P}_L$ , price per labor unit;  $L_A$ , actual labor unit;  $Q$ , output quantity;  $A$ , productivity factor.

From an economic point of view, the capital is not substitutable in the short run and is treated as a fixed cost. Meanwhile, the labor can be vary based on the production level. Accordingly, the amount of actual labor to meet a specific demand can be written as:

$$L_A = \left( \frac{Q}{A \bar{K}^\alpha} \right)^{\frac{1}{\beta}} e^{s/m} \tag{6}$$

The derivative of Eq. (6) will change the amount of labor with respect to the stress level as:

$$\frac{dL_A}{ds} = \frac{1}{m} \left( \frac{Q}{A \bar{K}^\alpha} \right)^{\frac{1}{\beta}} e^{s/m} \tag{7}$$

Substituting Eq. (6) in Eq. (4) yields:

$$TC = \bar{P}_k \bar{K} + \bar{P}_L \left( \frac{Q}{A \bar{K}^\alpha} \right)^{\frac{1}{\beta}} \cdot e^{\frac{s}{m}} \tag{8}$$

The change of the total cost with respect to the stress level can be formulated as:

$$\frac{dTC}{ds} = \bar{P}_L \left( \frac{Q}{A \bar{K}^\alpha} \right)^{\frac{1}{\beta}} \cdot \frac{1}{m} e^{\frac{s}{m}} = \frac{TC - \bar{P}_k \bar{K}}{m} \tag{9}$$

#### 5.1. Illustrative example

$$\text{minimize } TC = 40\bar{K} + 10L_A$$

Subject to

$$100 = 10 \times 4^{1/2} (\rho L_A)^{1/2}$$

In the short run, the capital is fixed at 4 units. The prices of capital and labor are \$40 and \$10, respectively. The efficiency of the production system is assumed to be  $\rho = e^{-s/m}$ . The demand is 100 units. Based on Eq. (6), the effect of the stress level on the amount of labor is:

$$L_A = 25e^{s/m}$$

The above equation retains its standard design capacity at a minimum amount of labor at zero stress level. As the stress level increases, the amount of labor will increase to keep production



at the same level to match the required demand. Accordingly, the increased labor due to the stress level will increase the total cost, as shown in Fig. 3 by:

$$TC = 160 + 250e^{S/m}$$

The change in the amount of labor with respect to the stress level can be calculated as:

$$\frac{dL_A}{dS} = 5e^{S/m}$$

Similarly, the change in the total cost due to increasing the stress level among employees is depicted in Fig. 4 and can be expressed as:

$$\frac{dTC}{dS} = 50e^{S/m}$$

### 6. Effect of stress level on the long term costs

Unlike the short term costs, non-ergonomic work conditions and frequent work injuries affect both variable and fixed costs over the long run. Harmful and unmaintained work conditions affect the state of production capital. The frequency of breakdowns, outdated machines, machine malfunctioning, maintenance and repairs, system shutdowns, and the timeworn production structure are influenced by employee performance due to the stress level.

In the long term, the efficiency of labor and capital will be affected by the stress level among employees. From an economic point of view, the unit of capital such as machines can vary over the long run. Let's assume that the labor efficiency is reduced by  $\rho$ . The actual amount of labor will be  $L/\rho$ . Accordingly, the stress level will decrease the capital utilization by  $K(1-\rho)$  and the actual amount of capital units will be  $K(2-\rho)$ .

$$\text{minimize } TC = \bar{P}_k K_A + \bar{P}_L L_A \tag{10}$$

Subject to

$$Q = A \left( \frac{K_A}{2-\rho} \right)^\alpha (\rho L_A)^\beta \tag{11}$$

Setting up the Lagrangian function will result in:

$$l = \bar{P}_k K + \bar{P}_L L_A + \gamma \left( \bar{Q} - A \left( \frac{K_A}{2-\rho} \right)^\alpha (\rho L_A)^\beta \right) \tag{12}$$

Determine the first order conditions:

$$\frac{\partial l}{\partial K} = \bar{P}_k - \gamma A \alpha \frac{1}{2-\rho} \left( \frac{K_A}{2-\rho} \right)^{\alpha-1} (\rho L_A)^\beta = 0 \tag{13}$$

$$\frac{\partial l}{\partial L} = \bar{P}_L - \gamma A \beta \rho \left( \frac{K_A}{2-\rho} \right)^\alpha (\rho L_A)^{\beta-1} = 0 \tag{14}$$

$$\frac{\partial l}{\partial \gamma} = \bar{Q} - A \left( \frac{K_A}{2-\rho} \right)^\alpha (\rho L_A)^\beta = 0 \tag{15}$$

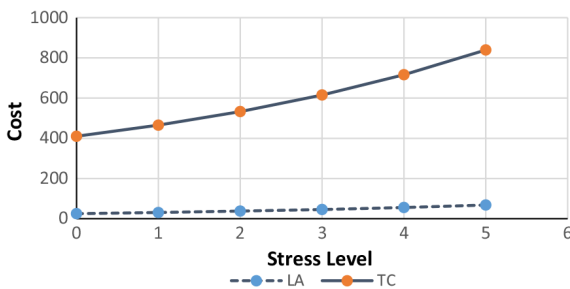


Fig. 3. Short term effect of stress on labor and total cost.

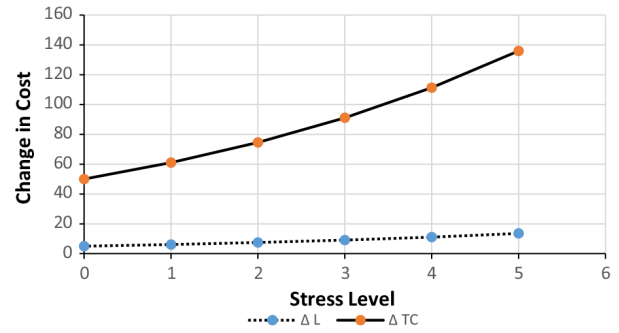


Fig. 4. Short term change in total cost and labor with respect to stress ( $m = 5$ ).

Solving the first two first order conditions yields:

$$L_A = \left( \frac{\bar{P}_k}{\bar{P}_L} \right) \left( \frac{\beta}{\alpha} \right) K_A \tag{16}$$

Substituting Eq. (16) into Eq. (15) will result in:

$$K_A = \left[ \left( \frac{\bar{Q}}{\bar{A}} \right) \left( \frac{\bar{P}_L}{\bar{P}_K} \right)^\beta \left( \frac{\alpha}{\beta} \right)^\beta \right]^{\frac{1}{\alpha+\beta}} (2 - e^{-S/m})^{\frac{\alpha}{\alpha+\beta}} (e^{-S/m})^{\frac{-\beta}{\alpha+\beta}} \tag{17}$$

$$L_A = \left( \frac{\bar{P}_k}{\bar{P}_L} \right) \left( \frac{\beta}{\alpha} \right) \left[ \left( \frac{\bar{Q}}{\bar{A}} \right) \left( \frac{\bar{P}_L}{\bar{P}_K} \right)^\beta \left( \frac{\alpha}{\beta} \right)^\beta \right]^{\frac{1}{\alpha+\beta}} (2 - e^{-S/m})^{\frac{\alpha}{\alpha+\beta}} (e^{-S/m})^{\frac{-\beta}{\alpha+\beta}} \tag{18}$$

$$TC = \left[ \bar{P}_k + \bar{P}_L \left( \frac{\bar{P}_k}{\bar{P}_L} \right) \left( \frac{\beta}{\alpha} \right) \right] \left[ \left( \frac{\bar{Q}}{\bar{A}} \right) \left( \frac{\bar{P}_L}{\bar{P}_K} \right)^\beta \left( \frac{\alpha}{\beta} \right)^\beta \right]^{\frac{1}{\alpha+\beta}} \times (2 - e^{-S/m})^{\frac{\alpha}{\alpha+\beta}} (e^{-S/m})^{\frac{-\beta}{\alpha+\beta}} \tag{19}$$

Consequently, the change in labor with respect to the stress level will be:

$$\frac{dL_A}{dS} = \frac{1}{m(\alpha + \beta)} \left( \frac{\bar{P}_k}{\bar{P}_L} \right) \left( \frac{\beta}{\alpha} \right) \left[ \left( \frac{\bar{Q}}{\bar{A}} \right) \left( \frac{\bar{P}_L}{\bar{P}_K} \right)^\beta \left( \frac{\alpha}{\beta} \right)^\beta \right]^{\frac{1}{\alpha+\beta}} \times \left[ \beta (2 - e^{-S/m})^{\frac{\alpha}{\alpha+\beta}} (e^{-S/m})^{\frac{-\beta}{\alpha+\beta}} + \alpha (2 - e^{-S/m})^{\frac{-\beta}{\alpha+\beta}} (e^{-S/m})^{\frac{\alpha}{\alpha+\beta}} \right] \tag{20}$$

The change in the capital with respect to the stress level will be:

$$\frac{dK_A}{dS} = \frac{1}{m(\alpha + \beta)} \left[ \left( \frac{\bar{Q}}{\bar{A}} \right) \left( \frac{\bar{P}_L}{\bar{P}_K} \right)^\beta \left( \frac{\alpha}{\beta} \right)^\beta \right]^{\frac{1}{\alpha+\beta}} \times \left[ \beta (2 - e^{-S/m})^{\frac{\alpha}{\alpha+\beta}} (e^{-S/m})^{\frac{-\beta}{\alpha+\beta}} + \alpha (2 - e^{-S/m})^{\frac{-\beta}{\alpha+\beta}} (e^{-S/m})^{\frac{\alpha}{\alpha+\beta}} \right] \tag{21}$$

The change in the cost with respect to the stress level will be:

$$\frac{dTC}{dS} = \frac{1}{m(\alpha + \beta)} \left[ \bar{P}_k + \bar{P}_L \left( \frac{\bar{P}_k}{\bar{P}_L} \right) \left( \frac{\beta}{\alpha} \right) \right] \left[ \left( \frac{\bar{Q}}{\bar{A}} \right) \left( \frac{\bar{P}_L}{\bar{P}_K} \right)^\beta \left( \frac{\alpha}{\beta} \right)^\beta \right]^{\frac{1}{\alpha+\beta}} \times \left[ \beta (2 - e^{-S/m})^{\frac{\alpha}{\alpha+\beta}} (e^{-S/m})^{\frac{-\beta}{\alpha+\beta}} + \alpha (2 - e^{-S/m})^{\frac{-\beta}{\alpha+\beta}} (e^{-S/m})^{\frac{\alpha}{\alpha+\beta}} \right] \tag{22}$$

#### 6.1. Illustrative example

$$\text{minimize } TC = 40K_A + 10L_A$$

Subject to

$$80 = 10 \left( \frac{K_A}{2-\rho} \right)^{0.5} (\rho L_A)^{0.5}$$

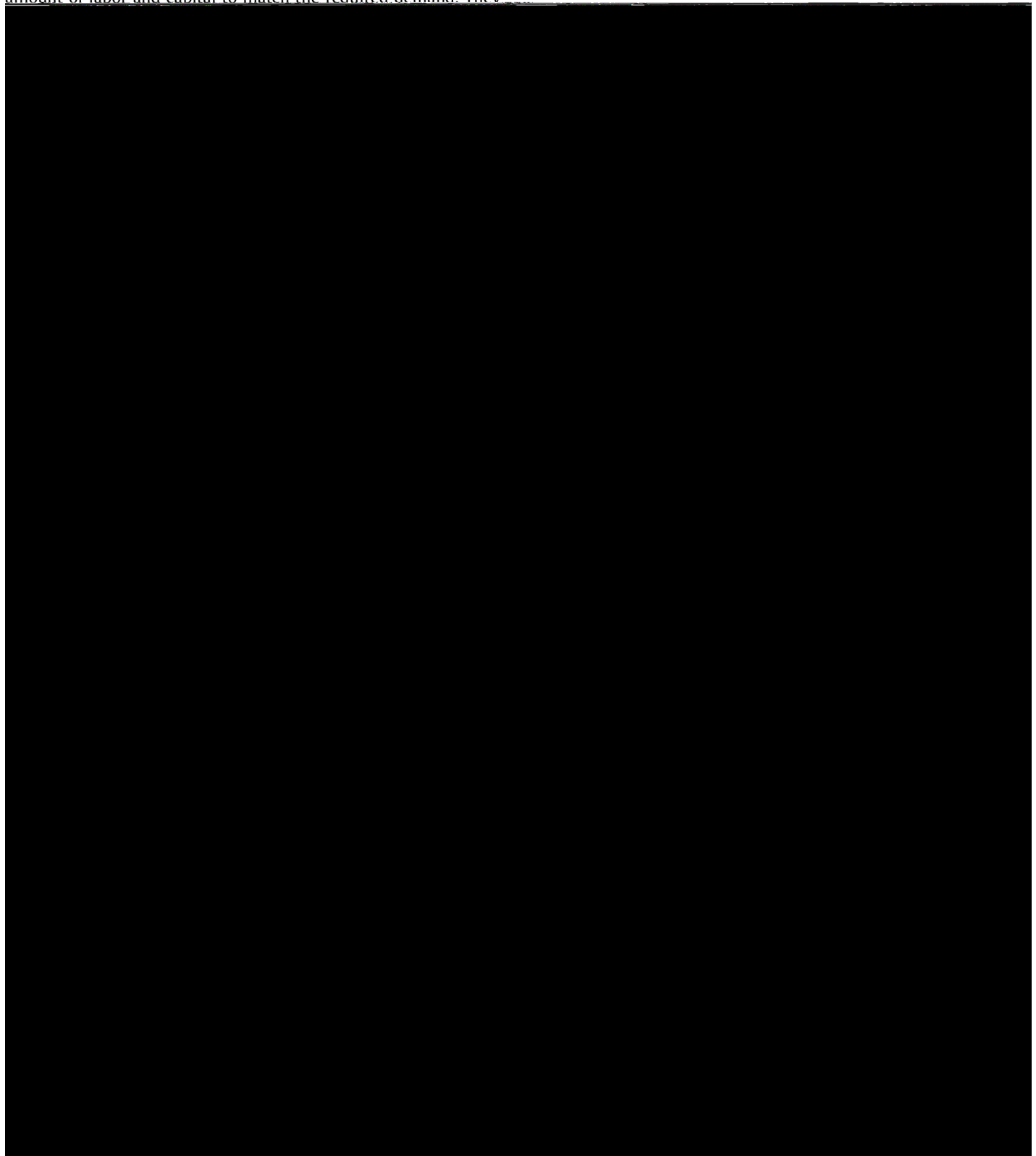
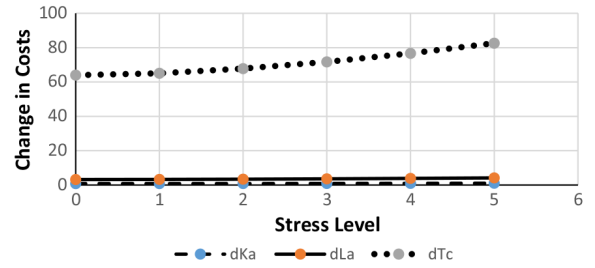
The relationship between the amount of labor, capital, total cost, and the stress level can be formalized based on the above equations as:

$$K_A = 4(2 - e^{-S/m})^{0.5} (e^{-S/m})^{-0.5}$$

$$L_A = 16(2 - e^{-S/m})^{0.5} (e^{-S/m})^{-0.5}$$

$$TC = 320(2 - e^{-S/m})^{0.5} (e^{-S/m})^{-0.5}$$

These equations explain the effect of the stress level on the amount of labor and capital to match the required demand. They



## 8. Conclusions

This study demonstrates the effect of work conditions and related work injuries on the level of stress among employees. Unappropriated work conditions will amplify the stress level among employees, which will significantly influence the production system productivity. On the other hand, a more ergonomic work place and safer practices will benefit corporations in numer-

stantial, and they measure the opportunity that is lost or sacrificed. Usually, these costs are not estimated and are ignored. This research addressed the link between the intangible costs and the stress levels among employees over the short term and the long term. The equations addressed the increased amount of invested capital and labor due to the increased stress level. This increase will affect the total cost over both the short run and the long run. An improvised work place will create chaos that represents the amount of production system disorder. The proven resilient relationship between the level of production system disorder and the encountered stress level assure the importance of enhancing the work conditions to make a profit. The breakeven quantity is highly sensitive to the employee's performance, and this research shows that under harsh work conditions, the breakeven quantity might be unattainable. Sources of disorder are numerous in any service or manufacturing facility, and these sources prevent any manufacturing system from reaching 100% efficiency. Therefore, the elements that aggravate stress among employees should be eliminated or reduced. Management's efforts should be oriented toward a more ergonomic, safer, and more pleasant work environment to sustain an optimum level of productivity. This research illustrates the unseen economic impact of stress levels among employees in terms of hidden costs that are impeded in the production process due to the state of work conditions over the short run and the long run.

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# Adoption of Information Systems (IS): The Factors that Influencing IS Usage and Its Effect on Employee in Jordan Telecom Sector (JTS): A Conceptual Integrated Model

Abdelrahim M. Zabadi<sup>1</sup>

<sup>1</sup> College of Engineering & Information Technology (CEIT), University of Business & Technology (UBT), Saudi Arabia

Correspondence: Abdelrahim M. Zabadi, College of Engineering & Information Technology (CEIT), University of Business & Technology (UBT), Saudi Arabia. E-mail: a.zabadi@ubt.edu.sa

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## Abstract

Based on IS adoption theories and models, this research suggested a conceptual model to the adoption and use of information systems (IS) in the Jordanian Telecommunications Sector (JTS). The framework specifies some of contextual variables such as technological, organizational, and individual characteristics as primary factors influencing on IS adoption in JTS. This study is a significant contribution to managerial practices and academic literature in the future. The study also makes a conclusion followed by recommendations for future research.

**Keywords:** information systems (IS), TAM, TOE, IS adoption

## 1. Introduction

In this turbulent era, organizations strive to improve their competitiveness by enhancing productivity, innovation, quality and flexibility of services at the individual and organizational levels (Naranjo, 2009). According to this situation, information processing capabilities are challenged by additional and diverse demands in organization, such as speed and reliability. In order to address this strategic challenge, organizations develop and apply more sophisticated and comprehensive IS (Ghorab, 1997). A computer-based information system (IS) is an important fast growing technological innovation in this century. IS providing opportunities for businesses to increase efficiency, effectiveness and ability to survive in competitive markets (Porter & Millar, 1985).

Jordan organizations have been motivated to advanced use of IS / IT that are made possible through technology adoption initiatives. Recently, many Jordanian establishments substantial changes have been noted which can be attributed to the achievement in ICT. In general, Jordanian agencies such as JTS have encountered organizational, technological, and individual problems during the adoption and usage of recent technology. Therefore, it became necessary to diagnose the key factors affecting the adoption of information systems in one of the largest services sector in Jordan.

Jordan, is small and limited natural resources country, but highly educated people, Successive governments also continued it's improving in several fields where there is a fast development in education, e-government, computerization, and Information technology (IT) in coordination with private sector. Information and Communication Technology (ICT), is the largest sector for competition and opportunities that enables Jordan to obtain the competitive advantage compering with other countries in the Middle East.

In accordance of existing literature, the purpose of this research is: *First, highlight the factors that affect the adoption of IS and effectively use by employee in JTS. Second, due to the scarcity of research at the individual characteristics, the current research intend to understand the impact of IS use on employee attitudes and behavior in JTS, and Third, To develop an integrated conceptual model that enables academic and practitioners to understand the requirements that affect success with IS adoption and usage in JTS. Accordingly, the research questions are: What are the factors enabling or inhabiting IS adoption and use of IS in JTS? How these factors do relates to each other and determines the effects on end user attitude and behavior?*

## 2. Telecom Sector in Jordan: An Overview

The Telecommunication Regulatory Commission (TRC) which was established in 1996 is responsible for



regulating the Telecommunication sector in accordance with the government policy, and thus for achieving many of the objectives set out in the government policy statement including the promotion competition in the ICT sector (Source: www.tec.gov.jo). Jordan's telecom infrastructure is growing at a very rapid pace and continually being updated and expanded, as depicted in Table 1.

Table 1. Telecommunications indicators

Fixed Phone		Q2/2014	Q3/2014	Q4/2014	Q1/2015	Q2/2015
	Residential	243,220	242,501	242,976	244,477	244,318
	Business	133,988	134,768	132,507	131,996	131,283
	Total Subscriptions	377,208	377,269	375,483	376,473	375,601
	Penetration Rate	5.1%	5.1%	5.0%	5.0%	4.6%
Active Mobile Phone		Q2/2014	Q3/2014	Q4/2014	Q1/2015	Q2/2015
	Post-Paid	791,366	832,664	864,299	893,150	888,500
	Pre-Paid	9,900,231	10,170,727	10,255,982	10,670,516	11,379,843
	Total Subscriptions	10,691,597	11,003,391	11,120,281	11,563,666	12,268,343
	Penetration Rate	146%	147%	147%	147%	152%
Internet Users		Q2/2014	Q3/2014	Q4/2014	Q1/2015	Q2/2015
	Total Internet Users (millions)	5.4	5.6	5.7	5.9	6.2
	Penetration Rate	73.0%	74.0%	75.0%	76.0%	76.0%
Internet Subscriptions		Q2/2014	Q3/2014	Q4/2014	Q1/2015	Q2/2015
	Dial-Up	364	362	361	359	359
	ADSL	207,713	211,732	213,398	218,459	223,435
	Wi-Max	125,909	125,481	128,626	121,754	114,133
	Leased Line	1,629	1,525	1,620	1,575	9,270
	FTTx	6,069	6,000	6,200	6,400	
	Mobile Broadband	1,209,603	1,300,908	1,430,184	1,587,549	1,682,064
	Total Subscribers	1,551,287	1,646,008	1,780,389	1,936,096	2,029,261
	Penetration Rate	21%	22%	24%	25%	25%

Source: www.tec.gov.jo

Jordan has one of the most competitive mobile markets in the Middle East countries. This competition had created further of excellence and great deal of innovation. Jordan's mobile market is the second most competitive in the region according to a recent index produced by Arab Advisors Group (see Table 2). The most competitive mobile telecoms market divided between the three main operators: Zain Jordan, maintaining the largest share (40%) of the market, followed by Orange Jordan (36%) and Umniah (29%), (See Table 2). The increased competition has led to pricing that is more favorable to consumers. 103% of the population (6,860,776) has a cell phone, 15% have more than one.

Table 2. Mobile subscriptions

Active Mobile Subscriptions (Q2-2015)			
	Post-Paid	Pre-Paid	Total
Zain	598,559	3,856,850	4,455,409
Orange	175,959	3,777,452	3,953,411
Umniah	131,982	3,678,562	3,810,544
Total	906,500	11,312,864	12,219,364

Source: www.trc.gov.jo

Telecommunications is a billion-dollar industry with estimates showing that core markets of fixed-line, mobile and data service generate annual revenue of around JD836.5m (\$1.18bn) per year, which is equivalent to 13.5% of GDP (Inta, 2014).

## 2.1 Theoretical Background

With growing needs for technology, since more than three decades as well as the increasing failures of systems adoption, prediction of system usage has become focus of attention for many researchers in this area. IS adoption literature used as the theoretical background for this research. Adoption is conceived as a social change process in which an innovation is communicated over time among members of a social system (Ashrafi, Xu, Kuilboer, & Koehler, 2006). Adoption as the process through which an individual or other decision-making unit passes from first knowledge of an innovation, to forming an attitude towards the innovation, to a decision to adopt or not adopt new idea, and to confirmation of this decision (Rogers, 1995).

User acceptance or rejection of the technologies is considered of the main challenges facing the adoption of information systems in organizations. For this, many investigators in this field have studied the user's attitude towards the system and behavioral intention to use. There are many adoption behavior theories and models being developed in the IS disciplines which consider technological, environmental, and organizational characteristics as important predictor of individual technology adoption (Yaser, Alina, & Nor, 2015).

IS literature about telecom sector addressed the issues of implementation and sustainability implementation, little research on the determinants of IS adoption. While the debate is still going on about the nature of these factors and level of its impact on the adoption of IS by individuals. One should emphasize in this regard that the adoption of IS depends mainly on interrelated factors namely, technological, organizational and individual characteristics. Indeed, those factors have not yet received further attention from researchers' and businesses.

Success adoption of IS is fuzzy and wide concept, complex structured, and exhibits high level of complexity and uncertainty, for that it is not always clear what is expressed by this system. Based on interviews conducted by the researchers with concerned employees and managers of JTCs, the main obstacle that impede the adoption and use of IS in this companies are not only technological but also organizational and individual factors.

Based on the foregoing, it is significant to investigate the effect of some innovation factors that influencing IS in Jordan. This research intends to identify such characteristics and their components addressed by previous studies that actually effect on IS adoption in JTS that significantly improved organizational efficiency, effectiveness, and even gain competitive advantage. In summary, this research emphasized only on three factors, namely *characteristics of Technology, characteristics of Organization, and Individual characteristics*. The research findings could be applied in the telecommunication companies to increase managerial performance and effective IS adoption and use.

## 3. An Integrated Research Model

### 3.1 An Overview

Successful adoption of IS issues by organizations and individuals alike are areas of research that gained importance recently. Many theories/models being adopted in the context of adoption of IS and technology innovation, which explains user acceptance and utilization of IS. The most common theories in this regard: The Technology Acceptance Model (TAM) (Davis, 1989). Diffusion of Innovations Theory (DIT) (Rogers, 1995), the Technology, Organization, and Environment (TOE) framework (Tomatzky & Fleischer, 1990), and Computer Usage Model (CUM) (Igbaria & Iivari, 1995).

#### 3.1.1 The Technology Acceptance Model (TAM)

In 1985, Fred Davis proposed the Technology Acceptance Model (TAM), in this propose Davis suggested that users' motivation can be explained by three factors: Perceived usefulness (PU), perceived ease of use (PEU), and attitude toward using the system (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Chuttur, 2009; Davis & Olson, 1985). Although PU and PEU were significantly correlated with system use, PU mediates the effect of PEU on usage (8). TAM is the most widely applied model of users' acceptance and usage of IS and IT (Venkatesh, 2000; Awa, Eze, Urieto, & Inyang, 2011). On the whole, TAM on the use of computer by individual's, with the motivation factors but did not address the essential social practicability of IS implementation and development and the implications of its usage. In this research, we extend TAM to include beliefs that are posited to influence use behavior via their impact on attitude.

#### 3.1.2 Diffusion of Innovation Theory (DOI)

Diffusion of Innovation is defined as: "*the process by which an innovation is communicated through certain channels over time among the members of a social system*" (Rogers, 1995). DOI describes innovations as having certain characteristics, such as relative advantage, complexity, compatibility, trialability, and observability (Rogers, 1995).

COMPUTER USAGE MODEL (CUM): Social cognitive theory (SCT), Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB); and TAM is the theoretical backgrounds of this theory. This theory introduces an extended technology acceptance model (TAM) that explicitly incorporates self-efficacy and its determinants (user experience and organizational support) as factors affecting, perceived ease of use, perceived usefulness and the use of computer technology (Igbaria & Iivari, 1995).

### 3.1.3 Technology-Organization- Environment Model (TOE)

The (TOE) framework was developed by Tornatzky and Fleisher (1990) (Tomatzky & Fleischer, 1990). It identifies three aspects of an organization's context that influence the technology adoption process and its likelihood: *technological context, the organizational context, and the environmental context*. The TOE perspective has been used successfully by information system (IS) researchers to understand key contextual elements that determine new IS adoption at the firms (Tomatzky & Fleischer, 1990). For this study we adopt two factors: technology and organization context.

### 3.2 Proposed Research Model

After carefully reviewing the literature on IS adoption, the research found that both TAM and TOE models is a suitable framework for the study of factors influence the IS adoption and intension to use the IS form Jordan context (Figure 1). TAM is the most influential model in the adoption of IS in the literature in terms of initiatives factors and constructs that determines the acceptance and usage by individuals. While, the TOE framework has a solid theoretical foundation, empirical supported, and the potential of application to IS innovations though specific factors identified in the contexts may vary across different researches. Each of the variables is discussed below.

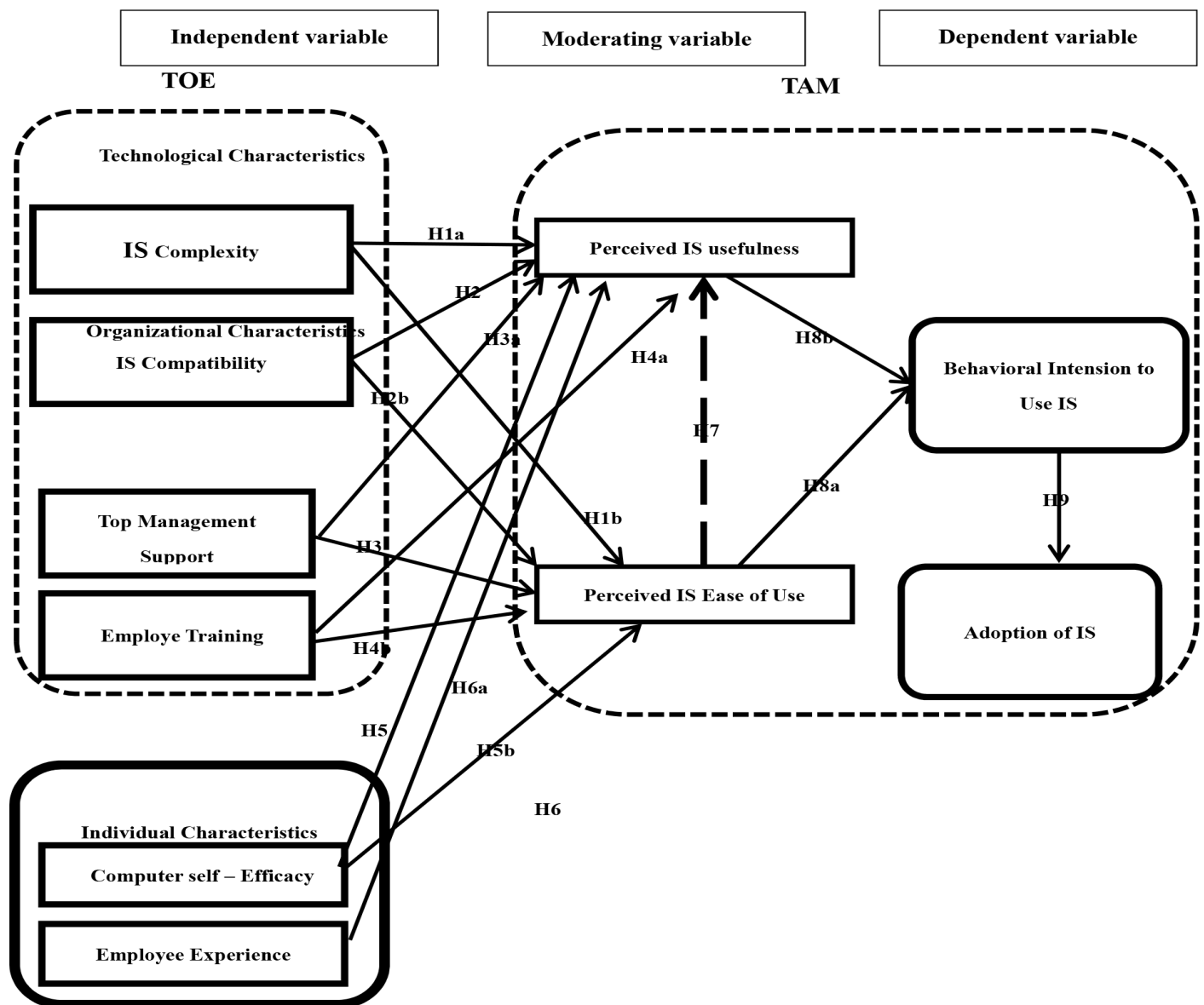


Figure 1. Proposed integrated research model

### 3.3 Technological Characteristics

Two components of technological characteristics that are related to adoption and usage of IS are: *Technology Complexity*, and *Technology Compatibility*.

**IS Complexity:** According to (Lee, 2007) and (Shih, 2007), complexity had a significantly negative impact on the intention to use (Yee, 2007; Shih & Huang, 2009). In addition, a negative relationship between complexity and PU was also supported by Hardgrave et al. (2003) Previous researches also shown higher complexity results in higher mental workload, stress, and lower the use's intention to use the system (Sokol, 1994). The complexity of a system could negatively affect user's attitudes towards using the system (Chang, Cheung, & Cheng, 2008). The following hypotheses can be stated based upon the presenting researches.

*H1a: A higher Complexity of IS negatively influence employee Perceived IS usefulness.*

*H1b: A higher Complexity of IS negative influence employee perceived IS ease of use.*

**IS Compatibility:** Karahanna et al. (2006) brought forward four dimensions reflecting the definition of compatibility. Compatibility with: existing work practices; preferred work style; prior experience; and existing values (Karahanna, Agarwal, & Angst, 2006). Chau and Hu (2001) compatibility was found to be significant



only in relation to PU (Chan & Hu, 2001). Wu and Wang (2005) and Chang and Tung (2008) reported that the compatibility had a significant positive and direct impact perceived usefulness (PU) and the behavioral intention to use the system (Chang & Tung, 2008). In addition, previous literatures have examined compatibility from different sides, resulting in support for compatibility effect on both PU and PEU (Hardgrave, Davis, & Riemenschneider, 2003). The following hypotheses address the impact of technology complexity on PU & PEU.

*H2a: IS Compatibility positively influence employee perceived IS usage.*

*H2b: IS Compatibility positively influence employee perceived ease of IS usage.*

### 3.4 Organizational Characteristics

Two variables are used in the present study to consider the organizational factor: *Top management support, and employee training.*

**Organizational Support:** Organizational support was categorized by Lee et al. (2006) into technology support and top management support (Lee, Kim, Rhee, & Trimi, 2006). Top management support is the readiness of that management to provide a necessary resources and the authority for the success adoption of IS and actually used within an organization. Ralph (1991) defined technology support as people assisting the users of computer software and hardware products, and other facilities (Ralph, 1991).

Organizational support is considered one of the critical factors when adopting and using the new systems. However, there is a lack in the literature on the impact of this component, in particular; the technical support at the adoption of IS and its impact on employee behavioral intention to use the system. Organizations such as telecom companies which intensively use a technical systems, the organizational support will impact on employee perceived usefulness and ease of IS usage.

It is reasonable that, when top management consecrate a high level of necessary resources to support IT; they resort to embrace a better utilize of IS within an organization; meanwhile, if senior managers support using an IS, they may establish a reward systems to prompt the employee to use the IS (Yaser, Alina, & Nor, 2015). Our proposed integrated theoretical assumed a positive link between organizational support and employee PU and PEU. Chen and Hsiao confirming the view of others do that top management support positively influences employee PU of IS and usage (Chen & Hsiao, 2012). In addition to this, Shih & Huang strongly supported that top management support positively affects perceived usefulness and ease of system use (Shih, 2007). Organizations such as telecom companies which intensively use a technical systems, the organizational support will impact on employee perceived usefulness and ease of IS usage. Accordingly, we hypothesized:

*H3a: Top management support positively influence employee perceived usefulness of IS.*

*H3b: Top management support positively influence employee perceived ease of IS usage.*

#### 3.4.1 Employee Training

Individual considered as a basis of production process, for that, he needs to renovation and development; this comes by providing him with modern and sophisticated methods that enhance his performance and skills refinement. Training has an effective and significant role in the development of individual's regular work to increase productivity by providing him with information that will help to achieve goals and develop skills and abilities. Employee training within an organization has a great significance in the development of work and organization alike.

Employee training constitutes a cornerstone for adopting IS successfully in organization. Companies increasingly use end-user training to help create a more productive and competitive workforce. End-user training programs are often designed to specifically address issues of usefulness and ease of use. Training influence user's belief towards the system, while training programs increases the user's certainty to use.

The proposed model for this research proposed that end user training effect on employee PU and PEU of IS. Rouibah et al. (2009) and Igarria et al. (1995), confirmed that employee training had a direct influence on PU. Accordingly, the following hypotheses were formulated:

*H4a: Employee training positively influences his perceived of IS usefulness.*

*H4b: Employee training positively influences his perceived ease of IS usage.*

#### 3.4.2 Individual Characteristics

These relates to the interpersonal skills of the individuals involved with the project. Burke et al. (2001) suggests that human issues have the biggest impact on the process as they argue that when implementation and adoption of information systems is successful, it is because a focused attention was paid to the human issues (Burke,

2001). In this dimension, two variables are used in the present study to consider: *Computer self – efficacy, and User Experience in Technology.*

### 3.4.3 Computer Self-Efficacy

Computer self-efficacy has a great effect on an individual's expectations towards using computers, according to Compeau and Higgins (2000) Computer self-efficacy plays a vital role in demonstrating the usage intention out of PU (Agarwal & Karahanna, 2000). Previous literatures in technology adoption (Holden, & Rada, 2011; Venkatesh, 2000), denoted that the higher level an employee's computer self-efficacy; the more he/she perceives using IS to be beneficial

The proposed model for this study assumed that computer self – efficacy influence PU as well ease of IS use. This assumption also supported by Ramaya and Aafaqi (2004) that self-efficacy positively influence employee PU of IS (Ramayah, & Aafaqi, 2004), this was supported by Lopez and Manson(1997) that computer self-efficacy positively related to PU (Lopez, & Manson, 1997), last, Venkatesh (2000), Wu and Wang (2005) based on these previous researches the below hypotheses were stated as follows:

*H5a: Computer Self- efficacy positively influence employee perceived usefulness of IS.*

*H5b: Computer Self- efficacy positively influence employee perceived ease of use of IS.*

### 3.4.4 Employee Experience

Employee experience in this research defined as: the awareness and abilities needed to fulfill computer-related duties, and technical skills as well as other specific tasks. User experiences have been classified into three main categories: user's state and previous experience, system properties, and the usage context (Hassenzahl, & Tractinsky, 2006). Meditating employee typical, interactions, characteristics, and resulting senses, all of which helps to use the system.

Employee experience in technology is measured by using terms such as but not limited to: I have experience in using the systems, I have experience in using spreadsheet, I have experience in using word processing, I have experience in using programming languages, and I participation in design of computerized information systems (Igbaria & Iivari, 1995). Experience as conceptualized in previous research conducted by Kim and Malhotra 2005; reflects an opportunity to use a target technology and is typically operationalized as the passage of time from the initial use of a technology by an individual (Venkatesh, Moris, & Davis, 2003). Our research integrated theoretical model proposed that user experience influence on the PU & PEU. This is supported by Kim (2008) user experiences had a positive impact on PU (Kim, 2008). Also, Igbaria & Iivari supported that employee technical experience will have a positive direct impact on PU (Igbaria & Iivari, 1995). The following hypotheses address the impact of user experience on PU and PEU.

*H6a: Employee experience positively influences his perceived usefulness of IS.*

*H6b: Employee experience positively influences his perceived ease of use of IS.*

### 3.5 Perceived Ease of Use

It is argued that perceived ease of use is the extent to which a person accepts as true that usage an exacting method would be free to that individual (Gahtani, 2001; Gefen & Straub, 2000). Zeithaml et al. (2002) declared that the degree to which an innovation is easy to understood or used could be considered as perceived ease of use.

Over the past decade, expanded research provides evidence of the significant impact of perceived ease of use on usage intention, either directly or indirectly (Guriting & Ndubisi, 2006; Wang, Lin, & Tang, 2003). IS literature indicated that PEU has a positive effect on employee behavioral intention to use the system (Chin & Todd, 1995). Recently, Chen and Barnes (2007) have empirically found that two technological aspects of the mediator, viz PU and PEU significantly affect end – user adaptation intentions to use the system (Chen & Barnes, 2007).

Information systems that users perceive easier to use and less complex will increase the likelihood of its adoption and usage (Teo, 2008). According to several researches on TAM (Davis, 1989; Teo, 2008). PEU has been shown to influence behavior through two causal ways: a direct effect on behavior and an indirect effect on behavior via PU. Therefore, the following hypothesis was formulated:

*H7: Perceived IS ease of use positively influence perceived IS Usefulness.*

*H8a: Perceived IS ease of use positively influence employee behavioural intension to use IS.*

### 3.6 Perceived Usefulness

Perceived usefulness is positively associated with system usage (Thompson, Higgins, & Howell, 1999). IS literature have investigated technology acceptance model (TAM), and proven that PU was proper in predicting the person's approbation of various information systems (Venkatesh, Moris, & Davis, 2003). Several researches indicated that PU positively influences users' behavioral intention to use the system.

There are extensive evidences demonstrates the significance influence of perceived usefulness on employee behavioral intention to use IS. (Venkatesh, Moris, & Davis, 2003; Guriting P, Ndubisi, 2006; Chen & Barnes, 2007; Tan & Teo, 2000). According to, Tan and Teo (2000) perceived usefulness is an important factor in determining adaptation of innovations. Similarly, Zeithaml et al. (2002) stated that the degree to which an innovation is easy to understand or use could be considered as perceived ease of use. Recently, Chen and Barnes (2007) have empirically found that the technological aspects of the interface, namely perceived usefulness significantly affect end user adaptation intentions. Therefore, the following hypothesis was formulated:

*H8b: Perceived IS usefulness positively influence employee behavioural intension to use IS.*

### 3.7 Behavioral Intension to Use IS

According to Davis, an individual's intention to use the system and its applications is explained and predicted by his perception and attitude towards the technology's usefulness and its simplicity / complexity to actually use, TAM posit that perceived usefulness is influenced by perceived ease of use and both predict attitudes (Davis, 1989). TAM proposed that individual adopt and accept IS based on his perceptions and attitudes. More precisely, TAM characterizes the causal relationship between user's attitudes and perceptions toward IS and the actual adoption and use (Davis, 1989). Moreover, if the information system is easy to use and require less effort from employee, this will increase the adoption processes and usage (Teo, 2008). PEU has been shown to influence behavior through two causal ways: a direct effect on behavior and an indirect effect on behavior via PU. Thus, users' intention to use IS can be depending on their perception towards the ease of use of the system. The following hypothesis can be stated for this research:

*H9: Employee Behavioral Intension to Use IS will have a positive impact on IS adoption.*

### 3.8 Procedural Definitions

Table 3 shows the procedural definitions for key words and the variables that have been used throughout this suggested integrated model.

Table 3. Procedural definitions

Term/Variable	Definition
Information Systems(IS)	<i>A set of interconnected components including : machinery, peoples, and procedures which manages the necessary data in organization.</i>
TAM	<i>An IS theory that paradigms how employed accept and actually use a new technology.</i>
TOE	<i>A construal framework which identify the lineaments of technology, the organizational capabilities, and the environmental situations as critical factors for technology adoption.</i>
Technological Characteristics	<i>The internal and external technologies (infrastructure, equipment's, processes) that is relevant to the organization.</i>
Technology Complexity	<i>The extent to which a new technologies is more troublesome for the employee than the prior that applied for the same or comparable activities.</i>
Technology Compatibility	<i>The extent to which a technology fits with employee's current job processes.</i>
Organizational Characteristics	<i>"The characteristics and resources of the firm, including the firm's size, degree of centralization, degree of formalization, managerial structure, human resources, technology infrastructure, amount of slack resources, and linkages among employees.</i>
Top management Support	<i>The degree to which top managers perceived the significance of the information systems role, and the extent to which it is interested in IS implementation and development activities.</i>
Employee Training	<i>The amount of training provided by computer specialists inside or outside the organization.</i>
Individual Characteristics	<i>Interpersonal skills of individual through his interaction in work environment with other people, machines such as computer self - efficacy and experience in technology.</i>
Computer self-	<i>Employee's perception of efficacy in accomplishing a particular computer - related tasks within the field of</i>



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<i>efficacy</i>	<i>common computing.</i>
<i>Employee Experience</i>	<i>The awareness and abilities needed to fulfill computer-related duties, and technical skills as well as other specific tasks.</i>
<i>Perceived usefulness</i>	<i>An employee expectation that computer usage will be helpful in improving his functional duties.</i>
<i>Perceived ease of use</i>	<i>The extent to which a person believes that using a particular system with little effort.</i>
<i>Behavioral intention</i>	<i>The degree to which an employee has formulated awareness outlines to do or not to do somewhat specified future behavior.</i>
<i>IS adoption</i>	<i>Using computer software and hardware applications to support management, operations, and any work – related activities.</i>

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#### 4. Conclusion

This research urges organizations to better understand the factors in terms of technological, organizational, and individual characteristics that promote or inhibit the adoption of IS. A conceptual integrated model is suggested by combining different theories/ models to develop the hypotheses depending on these six components. The adoption of this model by Jordan telecom companies will impact on end user attitudes and behavior intention to use IS. A definition of key terms and model components is structured according to the nature of the factors. Empirical examining for this integrated research model will be the subsequent phase of this study.

#### 5. Recommendations for Future Research

Future research is recommended to explore the interrelationships between technological, organizational, and individual characteristics. It is suggested also to expand the model to including other applicable variables including, organization size, management structure, computer anxiety, and IS quality from theories/models that have a high influence on understanding of IS success adoption in recent years.

Finally, it would be useful to study in depth the individual factors which an organization constitutes both managerial and functional departments' personal attributes, skills and attitudes affects greatly IS adoption. Individual issues have the critical impact on the processes when implementing and adopting IS successfully. The adoption of IS in organizations need further studies and investigation, these studies could open up prospects for researchers in information systems to examine and develop the current model to encompass other variables that influence IS adoption and actually usage by individuals and organizations.

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## RESEARCH ARTICLE

### IMPACT OF GREEN BRAND TRUST, GREEN BRAND AWARENESS, GREEN BRAND IMAGE, AND GREEN PERCEIVED VALUE ON CONSUMER'S INTENSION TO USE GREEN PRODUCTS: AN EMPIRICAL STUDY OF JORDANIAN CONSUMERS.

Mohammad saleem alshura<sup>1</sup>, Abdelrahim. M. Zabadi<sup>2</sup>.

1. The world Islamic sciences & Education University: College of Business.
2. University of Business&Technology: College of Engineering & InformationTechnology

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##### \*Corresponding Author

Mohammad saleem  
alshura.

#### Abstract

This paper aims to study the effect of trust in green bran, image of green brand, awareness in green brand, and green perceived value on consumer's intention to use green products in Jordan context. A survey was managed by using questionnaires to gather data from (450) people in Amman city the capital of Jordan. By using descriptive and inferential statistics, the collected data were analyzed. Multiple regression analysis was used to examine the hypothesis. The findings revealed that there are statistically significant relationships between trust in green bran, awareness of green brand, green perceived value, and Jordan's consumer intention to use these products, while image of green brand was not having.

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#### Introduction:-

Indeed, the world encounters an environmental sustainability issues and environmental problems affecting and changing the consumptions patterns of human life and activities. Green marketing is a wide concept and includes the promotion and ads activities of products, services, and corporations with ecological concerns. Green marketing includes a wide range of activities like changes in the production process, packaging changes remodeling, modification in products, and stylizing as well as modifying advertising activities and campaigns (1). The environmental concern speedily emerges as key issue for consumers and businesses alike because of global warming. For this, many companies are seeking to seize this opportunity.

In the current years, due to the tremendous amount of ecological pollution which immediately concerns with industrial manufacturing in the world, associations pay more attention to this issue is growing steadily. This interest has led to several companies to express their willingness and readiness to accept such responsibilities and issues relating to the environment. It must be emphasized in this respect that not all companies have a capability to commercialize their green products to their consumers. If companies are willing to adopt green marketing successfully and efficiently, thereafter their environmental notions should be incorporated into all parts of marketing. If companies were able to provide products / services that meet the environmental needs for customer, then the customer will prefer such product or service.

In the advent of ecological era, firms have to discover an opportunities to reinforce their products' environmental performance to strengthen their trade mark equities. Business organizations need to participate in the green marketing which the business owners must have an environmental conscience from the processes of product



designing, manufacturing, packaging and advertising until the products being the hands of consumers in response to continuously increasing and expanding green consumerism (2). In addition, the consumers are willing to pay higher prices to purchase the environmentally friendly products and services.

Because of more popular environmentalism in the world, the sales of green products have dramatically increased nowadays, and, therefore, more consumers are willing to pay higher price for green products (3). According to (Yu – Shan Chen, 2009), five reasons for companies to develop green marketing: compliance with environmental pressures; gaining competitive advantage; improving corporate images; seeking new markets or opportunities; and enhancing product value (4). Therefore, this study assumed that understanding green marketing by companies could raise their intangible brand and attracts more customers.

Although previous studies have paid great attention to explore the relevant issues for green brand awareness, green brand trust, green brand image, and green perceived value [ (5); (3); (6) ], none of these explored them about green or ecological issues and its impact on consumers' intention to use. Thus, this study intends to fill this gap. Also, this study proposed four constructs – Green brand awareness; green brand trust; green brand image; and green perceived value – and discussed their implications in the field of green marketing. In addition, this study developed a research model and examined it, which can enhance green marketing.

In the Arab region particularly, we note that there is a growing environmental awareness at the official level as response to global developments in the field of social responsibility and environmental awareness, especially in the past decades. This was demonstrated through the enactment of several environmental laws and issuance of various legislation aimed at preserving the environment and its natural resources, especially non – renewable materials. In addition to that, this environmental awareness has led to emergence of movements and non-official groups that supports the global trend to preserve the environment, and denounces all environmentally harmful behavior practices.

Finally, the structure of the current research is as follows: a literature review is discussed in literature review and hypothesis development section, and four research hypotheses are also assumed. In research methodology section, this study described the methodology, sample, data collection, and the measurement of the variables. Next, descriptive statistics, reliability of measurements. In the end, this study mentioned the discussions about the findings and implications, and pointed out possible directions for future research in conclusion and implications section.

### **Study objective:-**

The objective of study is to: investigate the influence of green brand trust, Green brand awareness, green brand image, and green perceived value on the Jordanian customers' intention to use green products.

### **Problem statement:-**

Although many studies investigate the different aspects of green brand, there is a shortage of an empirical study about how to increase customers' intentions to use these green products among Jordanian customers and other Arab Countries. So, the first problem in this research is the lack of empirical studies on these dimensions and its effect on customers' intention to use green products in Jordan. After carefully reviewed of the previous studies on the same subject, it was noted that it have looked at green brand awareness, green brand trust and green brand image of green products, others looked at green perceived value.

However, little of these studies looked at all these factors together. In addition to that, these studies have linked green brand awareness to green perceived risk, and buying decisions, but not with intention to use green products as this research intend to do. According to this literature gap and review, the research problem is "investigating whether green brand awareness, green brand trust, green brand image, and green perceived value has a relationship to intention to use green products among Jordanian consumers.

**Research importance:** According to the background and significance of the problem statement mentioned above, the researcher was interested to investigate the influence of green brand dimensions and green perceived value on Jordanian customer intention to use green products. In the study, the researcher selected four constructs: green brand image, green brand trust, green brand awareness, and green perceived value. This study could help in a decision - making on the brand to create and gain a competitive advantage. Also, it provides a body of knowledge in the field

of green marketing to marketers, manufacturers, or those who are interested in applying or a guideline for planning the strategies of the brand and creating a strong brand.

### **Literature review and hypotheses development:-**

This research was established on a literature review as follows:

**Intention to use:-**The Theory of Reasoned Action (TRA) first developed by Martin Fishbein and revised and expanded by Fishbein and Icek Azjen in the decades that followed, is a theory that focuses on a person's intention to behave a certain way. An intention is a plan or a likelihood that someone will behave in a particular way in specific situations — whether or not they actually do so [ (7); (8)]. This Theory has been broadly developed in comprehending consumers' decision-making processes in different contexts [ (9); (8)].

According to TRA, behavioral intention is a function of two factors; namely, attitude toward subjective norm and performing the behavior [ (7); (8); (9)]. To understand behavioral intent, which is seen as the main determinant of behavior, the TRA looks at a person's (or population's) attitudes towards that behavior as well as the subjective norms of influential people and groups that could influence those attitudes (9).

TRA proved its applicability in explaining social behavior purposed at buying green products. The most excellent predictors of the intention to buy green products are attitudes towards the behavior perceived value (10). Vazifehdoust (2013) indicated that the intention of customers to buy green products is defined by having a positive attitude and green perceived value toward green products (11).

**Trust in a green brand:-** According to (Chen, 2010), green brand trust is defined as “the readiness to be depended on only one thing based on the trust or belief resulting from its reliability, kindness, and capability about eco-friendliness” (3). According to Mayer et al. (1995) trust has three characteristics (ability, benevolence, and integrity) (12), is an expectancy held by one that the word or promise of another one be able to be relied on (13).

Consumer trust is a fundamental determinant of long-term consumer attitude (14). For that consumer intent to purchase influenced his trust for that product or service. Our research model proposed that green brand trust influence customer intention to use green product, alike [ (14); (15)], confirmed that customers purchase intentions significantly affected by customers' trust and it is a determinant of consumer purchase intentions to buy.

Also supported a study conducted by Kang (2012) affirms that green satisfaction has positive impacts on green trust and green affect (16). These findings support our hypothesis in positive significant relationship with customers' intention to buy eco – friendly products. Purchasers trust with the sellers will lead to a higher level of buy intentions. All this confirm that prior consumer trust in the product is very necessary for his intention to use. **This leads to the hypothesis saying that:**

**Hypothesis One (H1): Trust in a green brand has a statistically significant relationship with Jordanian's customer intention to use green products.**

**Awareness in a green brand:-** The study proposes the green brand awareness and it can be defined as: “the ability for a buyer to recognize and to recall that a brand is environmental friendly” [ (17); (18)]. Customers whom have some environmental concerns their purchasing decision is positively affected by green product, price awareness and brand image awareness. Hence the role of marketers is providing information relating to the green products.

Governmental and Non-Governmental organizations should take initiatives to originate environmental awareness among customers then absolutely this will led to increase the sales of green products. If there is higher level of brand equity then customer will buy a brand to which higher brand awareness is attached and with the strong association of brand awareness there is a positive influence on consumer's buying behavior towards green product (19).

Ng (2013) stated that increasing awareness amongst customers on environmental threats caused by electronic products has pushed companies to incorporate eco-friendly attributes in their products to fulfill consumers green expectations (6). Thus, the corporations that offering environmentally sustainable products and services will promote their green perceived value of brands.

However, mixing green features in products or services not directly impact perceived value of a trading name. Chen (2012) indicates that awareness about products, especially green products, create positive perception about the products and decrease the perceived risk of green products (20). Ottman (2008) found that there is a strong positive effect and correlation of green awareness, green brand image and green trust and green brand preference (21).

According to the definition of green brand awareness, this study proposes that that green brand awareness is positively related to buying decision of customers. Furthermore, according to social cognitive theory, environmental issues modify the human behavior (22), and human behavior influences the aspects of the environmental to which they are exposed, for example, awareness and education about green products significantly effect on purchasing behavior of customers [ (23); (24); (25)]. **Accordingly, the following hypothesis was formulated:**

**Hypothesis Two (H2): Awareness in green brand has a statistically significant relationship with Jordanian's customer intention to use green products.**

**Image of a green brand:**-Chen (2010) defines green brand image as "a whole range of impressions, conceptions and apprehensions towards a brand in the customers' memory which is correlated to the sustainability and eco-friendly concerns" (3). Cretu (2007) defines brand image as "the consumer's mental visuals that illustrate a specific brand which is related to the products produced by a company"(26).

Brand image is the spirit of the product or service, which is usually passed on to consumers, thus causing them to believe in a certain level of production and helping them to make a purchase decision(19). The main advantage of creating grand brand image is the definite increase in environmental awareness, which companies can exploit for competitive advantage through the deployment of their products in different markets (27). Ko (2013) the outcomes of green marketing significantly connected to the creating a positive brand image for green products, and results shows that the customers intention to use these products (28).

Mourad (2012) stated the green brand image is understood to have a positive effect on the green brand choice (29). Both, company's reputation and positive grand image enhance consumer's intention to use green products. Company's success in attracting additional customers and creating loyalty for its products is important step in appropriate marketing strategies. An individualis inherently tends to choose products which are more well – known according to social cognitive theory. This means that the reputability and brand image is a valid reason of individual purchasing activities, decisions, and behaviors [ (30); (31); (32)]. **Based on the foregoing; the following hypothesis has been developed:**

**Hypothesis Three (H3): Image if a green has a statistically significant relationship with Jordanian's customer intention to use green products.**

**Green brand perceived value:**-The concept of perceived value in recent years has been the focus of many studies [ (33); (34); (35)]. Perceived value is described as "a customer's general assessment of the net benefit of a service or product based on a customer's judgment" (33). Perceived value because it has a positive effect on marketing performance (Sweeney et al., 1999). Because perceived value is more significant today's, corporations can increase customer purchase intention through product value (36). Perceived value can not only be a central determinant in maintaining long-term consumer relationships, and also play a key role in affecting intentions to buy(37); perceived value is also significant in influencing consumer trust (38).

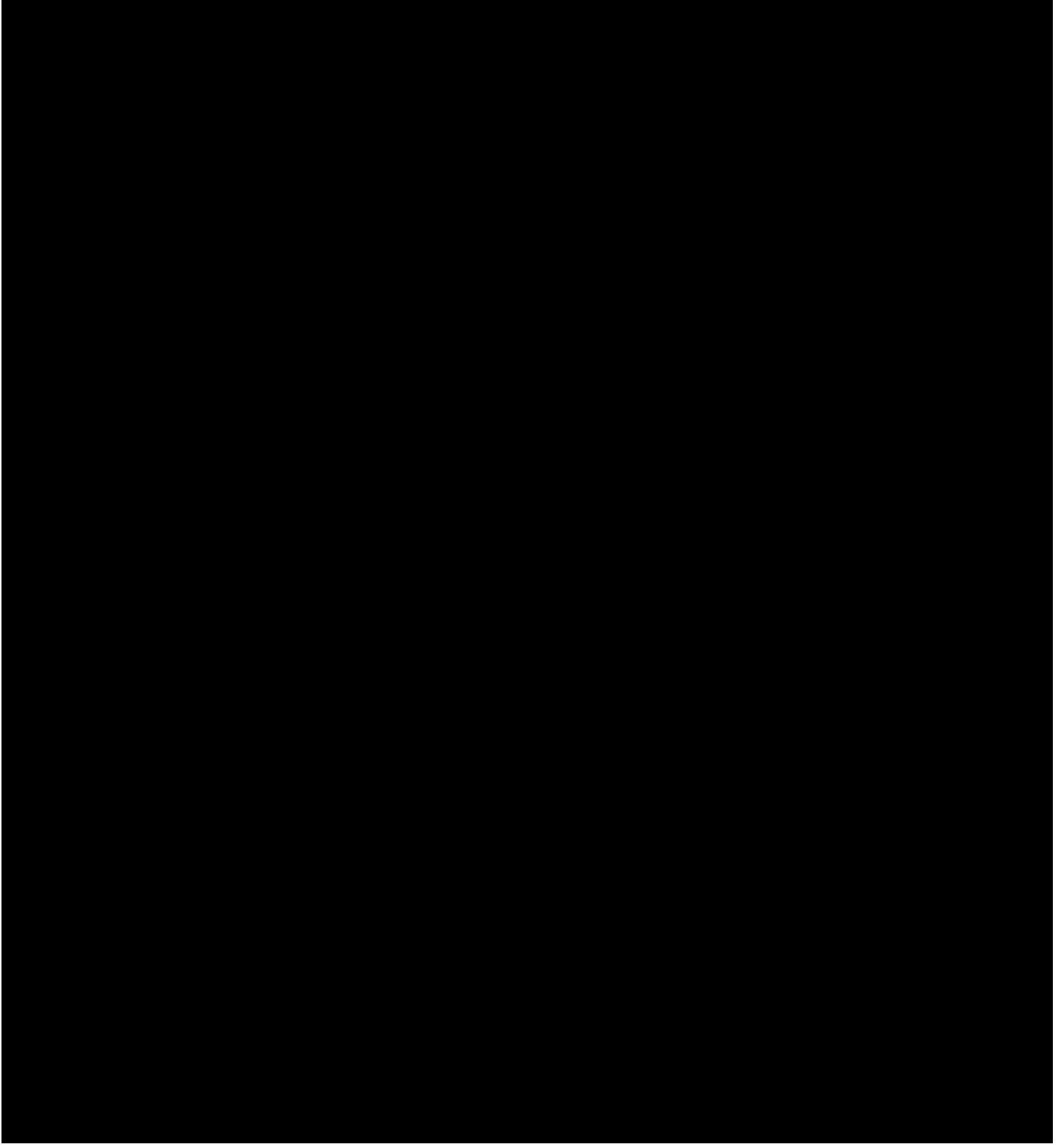
According to [ (39); (40)], green brand is an overall assessment of the perceived value of a product or service by the customer, and the net profit between what is perceived and what customers are offered based on environmental concerns, expectations, and needs of a sustainable green product. Nowadays, consumers believe that the use of environmentally friendly products offers many advantages compared to the conventional products (41); therefore, the needs of the customers for green products or services could be developed while the perceived value of the desired brand/green product increases (20).

Green perceived value is one of the most significant for green users. More and more consumers actually care about their purchases, it is important for them that green products which they buy were accepted in their social surrounds (19). If a product execute poorly in terms of social approval, negative incident like disagreement or dissatisfaction are probably could happen [ (19); (6); (42); (43)]. **Based on the discussion above it can be hypothesized that:**

**Hypothesis Four (H4): Green perceived value has a statistically significant relationship with Jordanian's customer intention to use green products.**

**Research model:-**

Based on the frame of reference discussed in the literature, the authors have developed a research model. Authors of this model will describe what factors are influences on consumer in his decisionmaking behavior towards the ecology problems. These factors are influence on consumer which lead his behavior towards action, which in turn consumer decide to buy the ecology energy and finally outcome is acceptance and continue to adopt the process for





**Primary data and research sample:**-Primary data was undertaken by gathering information directly from respondents out of questionnaire designed to collect primary data from customers to explain the relationship between variables shown in research framework. Because there is no method to quantify the number of entrants from customers to these malls, this study used convenience sampling techniques to collect the representative sample from customers.

Total of (450) questionnaires were distributed using drop and collect method among customers of those three centers under study. From (450) questionnaires, (400) questionnaires were filled up and returned, fifteen of them have been neglected and considered as incomplete data. Overall, (385) questionnaires were usable for further analyses. Multiple regression analysis was used to analyze the relationship between selected variables.

**Secondary data:**-An overall review of literature was carried out to identify the literature gaps. Also, databases, books, conference papers, journal articles, thesis and working papers from both national and international researches were utilized to ensure the quality of the study.

**Research instrument:**-Questionnaire items were adapted from several studies of previous literature with pre tested, reliable and valid scales. These scales were modified to suit this study. The questionnaire consists of two parts. The first part includes the demographic profile of the respondents such as gender, age, education, income, and position. This was followed the second part by (24) items. Trust in green brand was measured using (5) items developed by (20), (5) items to measure awareness in green brand were adopted from (23), image of green brand was measured using (5) items which were adopted from (10), green perceived value was measured using (5) items adopted from (10), and consumer intention to use green products trust was measured using (4) items developed by authors. Each rated on five – point Likert scale running from (1 = Strongly disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly Agree). In this study, face validity and content validity of the scale was ensured through consultation by experts in the field.

**Statistical methods:**-The result processing is conducted by using "SPSS" program to calculate the different statistics used in this study: **Descriptive statistics used to analyze and compare the responses in terms of respondent profile:** frequency, percentage, mean and standard deviation, and **inferential statistics** analysis by using a multiple regression analysis for examining the hypotheses testing.

### Results:-

This part of the study offers the data analyses and the empirical findings acquired from statistically testing the data. Respondents' profile questions of the questionnaire for this study were asking the respondents': Age, Gender, Education, Occupation, and Monthly salary. The frequency and percentage of demographic distribution of (385) respondents are given in **Table (3)**. Descriptive analysis and reliability test are shown in **Tables (1 and 2)**, respectively. Cronbach's Alpha value is greater than (0.70) for designed questions, this indicates that the statements measurements are valid to measure the constructs (46).

**Table (1): Descriptive Analysis.**

Variables	Mean	Standard Deviation (SD)
Green Brand Trust	3.479	1.99
Green Brand Awareness	3.669	0.960
Green Brand Image	3.480	1.101
Perceived Value	3.119	1.320
Intention to Use Green Products by customers	3.459	1.129

**Table (2): Reliability**

Variables	No. of Statements	Cronbach's Alpha
Green Brand Trust	5	0.901
Green Brand Awareness	5	0.923
Green Brand Image	5	0.932
Perceived Value	5	0.945
Intention to Use Green Products by customers	4	0.930

**Table (3): Respondents' profile.**

Item	Frequency	Percentage (%)
<b>GENDER</b>		
Male	256	66.5%
Female	129	33.5%
<b>AGE</b>		
Below 30 yrs.	128	33.25%
Between 31 and 40 yrs.	84	21.82%
Between 41 and 50 yrs.	74	19.22%
Greater than 50	99	25.71%
<b>EDUCATION LEVEL</b>		
College Degree	55	14.30%
University degree	225	58.4%
Post Graduate	25	6.5%
Other	80	20.8%
<b>OCCUPATION</b>		
Self –Employed	33	8.57%
Employed	76	19.74%
Student	85	22.08%
Retired	75	19.48%
House keeper	37	9.61%
Other	79	20.52%
<b>SALARY</b>		
Less than 400 JD	109	28.31%
Between 400 and 600 JD	129	33.50%
Between 600 and 800 JD	59	15.33%
Between 800 and 1000 JD	45	11.69%
More than 1000	43	11.17%
*Jordan Dinar TOTAL:385 100%		

The Pearson Correlation coefficient value shows the correlation between independent and dependent constructs. Based on information based on **Table (4)**, there is high correlation between the independent variables and customer's intention to use green products as all Pearson values are greater than (0.90).

**Table (4): Correlation among the constructs**

	Intention to Use	Brand Trust	Brand Awareness	Brand Image	Perceived Value
Intention to Use	1.00				
Brand Trust	0.94	1.00			
Brand Awareness	0.96	0.91	1.00		
Brand Image	0.93	0.92	0.93	1.00	
Perceived Value	0.91	0.86	0.88	0.87	1.00

The findings of **F - test** demonstrates whether the suggested model for the current study is appropriate to describe the variations in customer's intention to use green products. **Table (5)** shows the P-value for ANOVA is (0.000) < .05, which indicates that the suggested model is suitable.

**Table (5): ANOVA**

	Sum of Squares(SoS)	Degrees of Freedom(DF)	Mean Squares(MS)	F-test	Sig.level
Reg.	471.90	04	117.00	3.79E3	000
Res.	14.49	378	0.39		
Total	486.39	382			

**Table (6): Results Summary**

R	R <sup>2</sup>	R <sup>2</sup> Adjusted	Standard Error	R <sup>2</sup> change	F-test	Df1	Df2	Sig.
<b>0.98</b>	<b>0.971</b>	<b>0.971</b>	<b>0.189</b>	<b>0.971</b>	<b>3086.67</b>	<b>4</b>	<b>378</b>	<b>0.000</b>

**Testing of hypotheses:-**

**hypothesisOne (H1): Trust in a green brand has a statistically significant relationship with Jordanian's customer intention to use green products.** The p – value for the relationship between trust in green brand, and Jordanian's customers' intention to use green products is also (**0.000**). Therefore, we can conclude that trust in a green brand has a statistically significant relationship with Jordanian's customers' intention to use green products.

Besides, the **beta value** for the relationship between trust in brand image and Jordanian's customers' to use green product is (**0.298**). This value is an indication that the relationship between the independent variable (trust in green brand), and the dependent variable (Jordanian's customer intention to use green products) is positive. Accordingly, the **first hypothesis (H1) also acceptable.**

**Hypothesis Two (H2): Awareness in green brand has a statistically significant relationship with Jordanian's customer intention to use green products.** In the same manner, for the relationship between awareness in green brand, and Jordanian's customers' intention to use green products – **the P – value is (0.000)** as shown in **table (7)**. So, we can conclude that awareness in green brand has a statistically significant relationship with Jordanian's customers' intention to use green products.

Besides, the beta value for the relationship between these two variables is (**0.599**). This value is an indication that the relationship between the independent variable (awareness in green brand), and the dependent variable (Jordanian's customer intention to use green products) is a **positive relationship**. As a result, the decision **requires accepting the second hypothesis (H2).**

**Hypothesis Three (H3): Image of a green brand has a statistically significant relationship with Jordanian's customer intention to use green products.** According to the findings, **the third hypothesis (H3) is rejected**; this is due to the **P-value is (0.121)** for the relationship between image of green brand and Jordanian's customers' intention to use green products, also the value of beta is (**0.51**).

Ultimately, **hypothesis Four (H4): Green perceived value has a statistically significant relationship with Jordanian's customer intention to use green products.** The p – value is (**0.000**), there is a statistically significant and positive relationship between green perceived value and Jordanian customer's intention to use green products. Also, the Beta value is (**0.139**) as a consequence, **the fourth hypothesis (H4) is accepted.**

**Table (7): Results of Multiple Regression Analysis**

	B	Standard Error	Beta	t-test	Sig.
<b>Constants</b>	<b>-0.309</b>	<b>0.499</b>	<b>-----</b>	<b>-6.840</b>	<b>0.000</b>
<b>Brand Trust</b>	<b>0.309</b>	<b>0.031</b>	<b>0.298</b>	<b>11.120</b>	<b>0.000</b>
<b>Brand Awareness</b>	<b>0.599</b>	<b>0.030</b>	<b>0.509</b>	<b>18.320</b>	<b>0.000</b>
<b>Brand Image</b>	<b>0.051</b>	<b>0.030</b>	<b>0.051</b>	<b>1.549</b>	<b>0.121</b>
<b>Perceived value</b>	<b>0.139</b>	<b>0.020</b>	<b>0.159</b>	<b>7.579</b>	<b>0.000</b>

**Discussion:**

This research examines the influence of four variables on consumer's intention to use green products. From the results, it is investigated to note that only three factors, namely trust in green brand (**H1**), awareness in green brand (**H2**), and perceived value (**H4**) influenced the Jordanian consumer's intention to use green products. This supports the findings of previous studies proposed by [ (3); (20); (9); (29)]. Awareness of green brand image is the strongest factor that has positively influenced their intention to use green products. This study confirmed that an individual who has some concern for the environment and its green brand image would have a stronger preference in using a green product.

In this respect, it is important for marketers to develop and implement emotional green branding strategies effectively and strategically to encourage positive sales of green products, as there is an increased demand for green products (47). Researches indicate that awareness about products, especially green products, create positive perception about the products and decrease the perceived risk of green products. Moreover, according to social cognitive theory, environmental issues modify the humans' behavior. And human's behavior influences the aspects of the ecological to which they are exposed.

Awareness about green products generates positive understanding about the products and minimizes the expected risk of green products. Over and above, according to social cognitive theory, ecological issues modulate the individuals' behavior towards green products. And that consequently affects human behavior towards the environmental problem they encounter.

The result also, shows that there is a significant positive relationship between trust in green brand and customers' intention to use green products. This result supports the findings of many researchers [ (14); (15); (48)] that customers buy intentions significantly affected by customers' trust and it is a crucial constraint of consumer purchase intentions. These findings indicate that customer trust is a primary determinant of consumer behavior and attitude, besides, high level of trust between the consumer and the seller leads to increased intention to purchase the product or service. So manufacturers should organize appropriate strategies to create trust in its products which will encourage consumer to purchase.

In the end, it must be noted herein that the study utilized **TRA** to examine the relationship between the independent and dependent variables included in the research model. Implication of **TRA** and Social Cognitive Theory in green marketing which provide a precious opportunity for further studies to support from these two theories. A result of this study presents a significant evidence for investigators to identify the link between these constructs.

The findings of this study provide a good evidence for scholars to explore the effects of brand awareness, brand trust, and perceived value of green products on customers buying behavior. And, this study explored the implication of Theory of Reasoned Action and Social Cognitive Theory in green marketing which provide opportunities to further studies to support for these theories.

### **Limitations and future researches:-**

In order to obtain comprehensive results for this study, all possible steps to achieve that have been made. This study has some limitations, as all other research studies. These limitations and suggested future researches can be summarized as follows:

**First:** Sampling, the study was carried out on a limited size of population. So it is not easy to generalize the results; **second,** this study was conducted for all green products for better results future research can be studied on a particular product and brand; **third,** Lack of available studies, especially in the Arab world for the user's intention to use green products on behavior intention that leads to customers to use green products, for future researches it should be studied on different circumstances.

### **Implication for: governments, manufacturing companies, and marketers:-**

**Governments** should develop plans to enact laws and legislations, and campaigns regarding environmental protection and sustainability in order to maintain the safety of homeland and the citizen from global warming.

**Manufacturing Companies** should originate an ecological awareness concerning ecological protection and sustainability amongst present and potential customers, and manufacture the green products at reasonable prices and high quality to satisfy green needs of customers.

**Marketers** and advertisers should use proper and fair ecological issues in their ads in order to increase sales and profits, as well as maintaining the present customers and acquiring others. Marketers also, should design strong brand evolution, and put forward brand awareness strategies to create and maintain the image of "I like Green" in customer's targeting.



### Conclusion:-

This study contributes to theory and in practices alike. In the theoretical framework, this study has contributed in the areas of green marketing and consumer behavior. It added a value to the existing literatures an indicator and incentive on green purchasing behavior amongst all customers in the Jordanian society. In practice, the study supplies shoppers and salesmen simultaneously understand more clearly understandable about how to influence consumer behavior towards purchase green products. Organizations in addition to that, can push sales and increase their market share by adopting an appropriate marketing strategy.

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## A transition map method to find Overlay text

Mohamed Shajahan H  
College of Engineering and Information Technology  
University of Business and Technology  
Jeddah, Saudi Arabia  
shajahan@ubt.edu.sa

Dr.Munir M. Alhaddad  
College of Engineering and Information Technology  
University of Business and Technology  
Jeddah, Saudi Arabia  
mmhaddad@ubt.edu.sa

### ABSTRACT

*A transition method find overlay text brings important semantic clues in video content analysis such as video information retrieval and summarization, since the content of the scene or the editor's intention can be well represented by using inserted text.. The main aim of the research is to propose a novel framework to detect the Overlay text information in video frames. This method produces better than the previous methods. Resultant accuracy is highly improved.*

### General Terms

Image processing covers a vast area of scientific and engineering knowledge. It is built on a foundation of one- and two-dimensional signal processing theory and overlaps with such disciplines as artificial intelligence (scene understanding), information theory (image coding), statistical image classification (pattern recognition), communication theory (image coding and transmission), and microelectronics (image sensors, image processing hardware). Broadly, image processing may be subdivided into the following categories: enhancement, restoration, coding, and understanding. The goal in the first three categories is to improve the pictorial information either in quality (for purposes of human interpretation) or in transmission efficiency. In the last category, the objective is to obtain a symbolic description of the scene, leading to autonomous machine reasoning and perception.

### Keywords

Overlay text, Transition map, Inpaint, Video restoration, candidate region refinement, Sub patch method

## 1. INTRODUCTION

With the development of video editing technology, there are growing uses of overlay text inserted into video contents to provide viewers with better visual understanding. Most broadcasting videos tend to increase the use of overlay text to convey more direct summary of semantics and deliver better viewing experience. For example, headlines summarize the reports in news videos and subtitles in the documentary drama help viewers understand the content. Sports videos also contain text describing the scores and team or player names. In general, text displayed in the videos can be classified into scene text and overlay text. Scene text occurs naturally in the background as a part of the scene, such as the advertising boards, banners, and so on. In contrast to that, overlay text is superimposed on the video scene and used to help viewers understanding. As a preliminary preparation, data will be collected as part of this research. The

main aim of the research is to propose a novel framework to find the Overlay text information in video frames.

## **2. IMPLEMENTATION**

Lot of methods are already implemented for overlay text detection. Color based methods are not working properly because of un-uniform color distribution. Most of existing video text detection methods has been proposed on the basis of color, edge, and texture-based feature. The method proposed by Agnihotri [13], concentrates on the red color component, instead of all the 3 color components. Some methods used the high contrast video frames to extract the texts. Kim et al. [14] uses RGB color space and clustering concept. But no methods are fully efficient for clustering. So text detection is not so better in this case. The edge based methods are not made success because of complex background. Modified edge map is introduced by Lyu et al. [15]. This is providing some improvement in overlay text detection.

## **3. METHODOLOGY**

### **3.1 TRANSITION MAP GENERATION**

As a rule of thumb, if the background of overlay text is dark, then the overlay text tends to be bright. On the contrary, the overlay text tends to be dark if the background of overlay text is bright. Therefore, there exists transient colors between overlay text and its adjacent background due to color bleeding, the intensities at the boundary of overlay text are observed to have the logarithmical change. The intensities of three consecutive pixels are decreasing logarithmically at the boundary of bright overlay text due to color bleeding by the lossy video compression. It is also observed that the intensities of three consecutive pixels increases exponentially at the boundary of dark overlay text. To find the intensity change in the transition region three steps are adopted. They are as follows:

1. Saturation calculation
2. Modified Saturation calculation
3. Transition map generation

If a pixel satisfies the logarithmical change constraint, three consecutive pixels centered by the current pixel are detected as the transition pixels and the transition map is generated.



#### 4. VIDEO FRAMES

The difference of the previous frame's Transition map and current frame's transition map, decides whether to process the current frame or neglect the current frame. A threshold is used here for decision making.

#### 5. CANDIDATE MAP REGION DETECTION

The transition map can be utilized as a useful indicator for the overlay text region. To generate the connected components, first generate a linked map [5]. If a gap of consecutive pixels between two nonzero points in the same row is shorter than 7% of the image width, they are filled with 1s. Next the Hole filling algorithm is used to fill the small gaps and to maintain the connectivity. Then each connected component is reshaped to have smooth boundaries. Since it is reasonable to assume that the overlay text regions are generally in rectangular shapes, a rectangular bounding box is generated by linking four points, which correspond to (min\_x, min\_y), (max\_x, min\_y), (min\_x, max\_y), (max\_x, max\_y) taken from the link map and candidate regions.

#### 6. OVERLAY TEXT REGION DETERMINATION

In this subsection, we introduce a texture-based approach for overlay text region determination. Based on the observation that intensity variation around the transition pixel is big due to complex structure of the overlay text, we employ the local binary pattern (LBP) introduced in [6] to describe the texture around the transition pixel. LBP is a very efficient and simple tool to represent the consistency of texture using only the intensity pattern. LBP forms the binary pattern using current pixel and its all square neighbor pixels and can be converted into a decimal numbers as follows:

$$LBP_P = \sum_{i=0}^{P-1} s(g_i - g_c) 2^i$$

Where

$$s(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases}$$

P denote the user's chosen number of square neighbor pixels of a specific pixel.

$g_i$  -> neighbor pixels intensity.

$g_c$  -> intensity of current pixel.

#### 7. OVERLAY TEXT MARKING

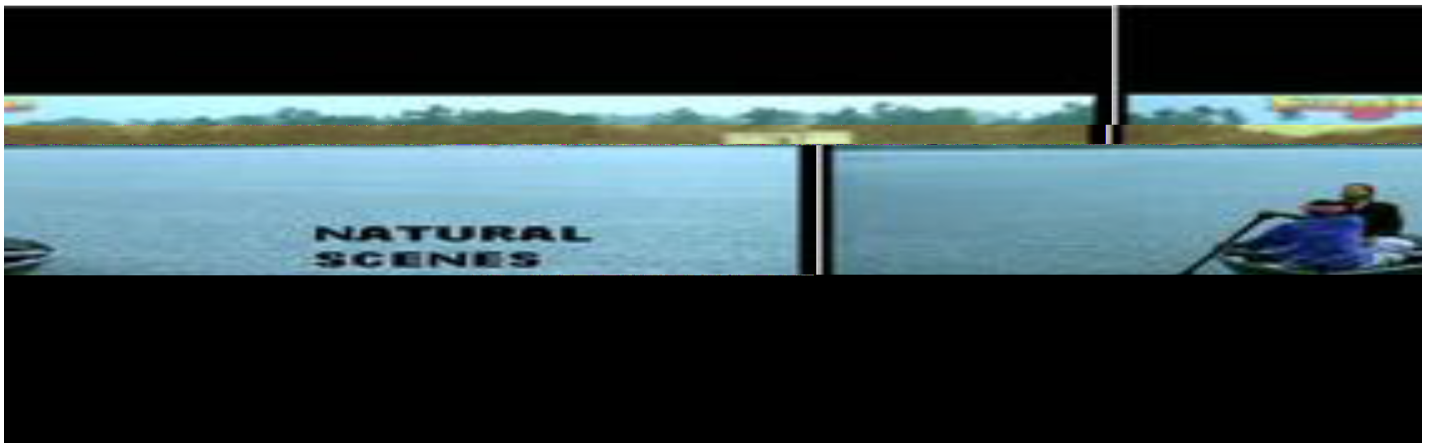
The rectangle bounding box is projected around the extracted overlay text region. Using the four corner points of candidate region we can mark the Text data.

## 8. RESULTS AND DISCUSSIONS

Most of existing video text detection methods has been proposed on the basis of color, edge, and texture-based feature. Color-based approaches assume that the video text is composed of a uniform color. However, it is rarely true that the overlay text consists of a uniform color due to degradation resulting from compression coding and low contrast between text and background. Edge-based approaches are also considered useful for overlay text detection since text regions contain rich edge information. The commonly adopted method is to apply an edge detector to the identify regions with high edge density and strength. This method performs video frame and then mplex background and it becomes less reliable as the scene contains more well if there is no co und. Texture-based approaches, such as the salient point detection and the edges in the backgro ave also been used to detect the text regions. However, since it is almost wavelet transform, h text in a real video by using only one characteristic of text, some methods impossible to detect nbined features to detect video text. take advantage of cor

PUT

8. SAMPLE OUT



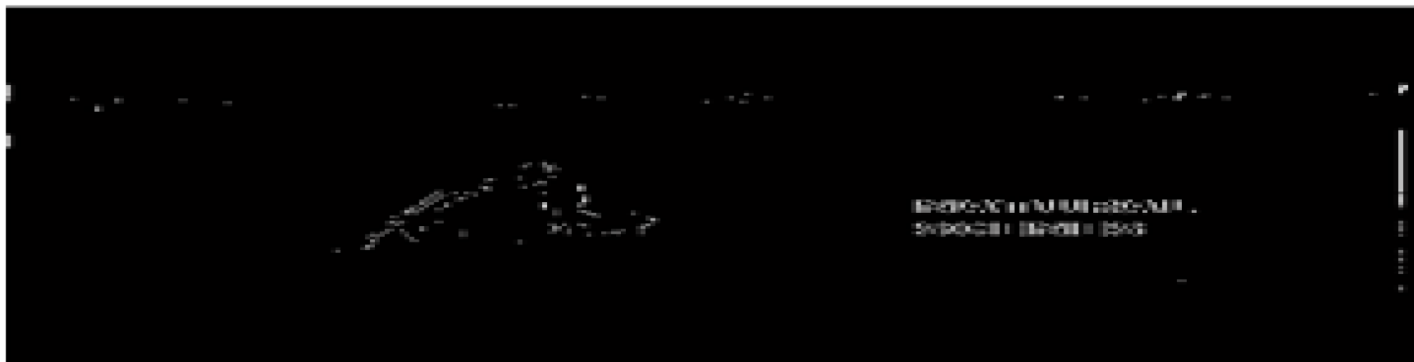


Fig 2: Transition map generation

## 9. CONCLUSION

The various processes on overlay text detection from complex videos are proposed in this paper. The main concept of the work is based on the observation that there exist transient colors between inserted text and its adjacent background. We compute the density of transition pixels and the consistency of texture around the transition pixels to distinguish the overlay text regions from other candidate regions. The local binary pattern is used for the intensity variation around the transition pixel in the proposed method. The boundaries of the detected overlay text regions are localized accurately using the projection of overlay text pixels in the transition map. This research is well adopted in video data processing.

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## **NANOLEAD-FREE SOLDER ALLOYS FOR ELECTRONIC PACKAGING AND INTEGRATION**

**A. E. Hammad<sup>1,2,\*</sup> and Sara El-Molla<sup>1,3</sup>**

<sup>1</sup>Physics Department

Faculty of Science

Zagazig University

Zagazig, Egypt

e-mail: [a\\_hammad\\_82@yahoo.com](mailto:a_hammad_82@yahoo.com)

[a\\_hammad@zu.edu.eg](mailto:a_hammad@zu.edu.eg)

<sup>2</sup>Basic Sciences

College of Engineering and Information Technology

University of Business and Technology

Jeddah, Saudi Arabia

e-mail: [a.hammad@ubt.edu.sa](mailto:a.hammad@ubt.edu.sa)

<sup>3</sup>Institute for Nanoelectronics

Technische Universität München

München, Germany

e-mail: [sara.el-molla@tum.de](mailto:sara.el-molla@tum.de)

[sara.el-molla@nano.ei.tum.de](mailto:sara.el-molla@nano.ei.tum.de)

### **Abstract**

Synthesis of metal nanoparticles with specific properties is a newly established research area attracting a great deal of attention. Several methods have been put forward for synthesis of these materials,

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\*Corresponding author

namely chemical vapor condensation, arc discharge, hydrogen plasma-metal reaction, and laser pyrolysis in the vapor phase, microemulsion, hydrothermal, sol-gel, sonochemical. Nanoscale lead-free solders (i.e., Sn- $x$ Ag [ $x = 0, 20, 40, 60, 80, 100$ (wt%)], Sn-3.0Ag-0.5Cu, Sn-3.5Ag-0.5Cu, Sn-3.5Ag- $x$ Zn ( $x = 0.5$  to 3.5wt%) and Sn-0.7Cu) have been investigated. For Sn-3.5Ag and Sn-3.5Ag-0.5Cu nanoparticles, the melting temperature with average size of 30 nm was 210°C and 201°C, much lower than that of bulk alloy. Also, Sn-Ag-Cu nanopowders showed good wettability with contact angles less than 30°. The peak melting temperatures of the 21 nm, 18 nm and 14 nm Sn-0.7Cu nanoparticles were 212.9°C, 207.9°C and 205.2°C, respectively. In this paper, the fundamentals of synthesis of nanolead-free solder materials including their characterization and their use in microelectronic packaging are reviewed.

## 1. Introduction

Nanoscience and nanotechnology involve the design, fabrication, and engineering of materials and systems at the nanometer scale (1-100 nm). Materials and systems at this scale may exhibit novel mechanical, electronic, electrical, magnetic, and optical properties. There have been significant developments in new nanomaterials fabrication and novel nanotechnology development, e.g., the emerging and evolving of carbon nanotubes, nanoparticles, and nanowires [1-3].

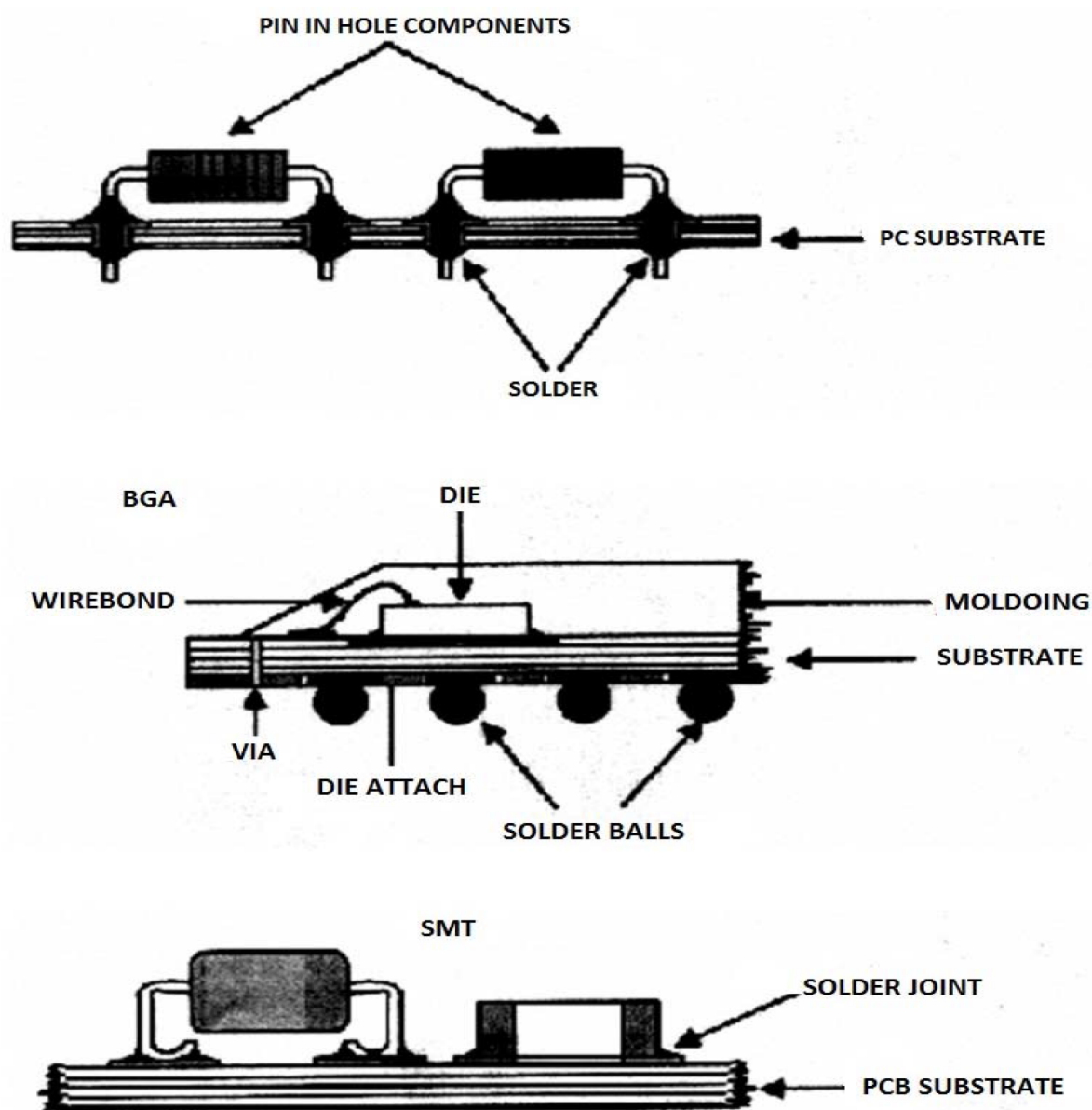
Today, solders are used in numerous applications and in electronics industry for connecting electrical components. Soldering is a well-known metallurgical joining method using a filler metal (the solder) [4]. Material selections for solder alloys are thus critical and play key roles in joint reliability of assemblies in electronic packaging. Over the past several decades, Pb-Sn systems have been the mainstay of the conventional solder process owing to their unique combination of material properties such as good wettability, low cost, high ductility, and low eutectic temperature [5].

## 2. Lead-bearing Solders

The Sn-Pb solder is the most widely utilized soldering alloy, the

popularity of this alloy is due to its relatively low melting temperature, aggressive bonding characteristics, good electrical continuity, and low cost [6, 7].

Lead-bearing solders, particularly the eutectic 63Sn-37Pb or near-eutectic 60Sn-40Pb alloys, have been used extensively in interconnection technologies such as pin through hole (PTH), ball grid array (BGA), surface mount techniques (SMT), chip scale packaging (CSP), flip-chip, etc. [8], where strict electrical, mechanical and thermal properties of solder alloys are essential (Figure 1).



**Figure 1.** Schematic structures of PTH, SMT and BGA packages using solder interconnects.

### 3. Health and Environmental Concerns

Medical studies have shown that Pb is a heavy metal toxin that can damage the kidney, liver, blood and the central nervous system. In Europe, the elimination of Pb in solder alloys has gained a common consensus. From January, 2004, European nations will adopt Pb-free solder alloys in all electronic assemblies, according to Directive on Waste from Electrical and Electronic Equipment (WEEE) [7].

Recycling lead in electronics can increase the cost and efforts than that in batteries or cathode ray tubes (CRT) due to the difficulty in removing it from the components of electronic products. Therefore, rapid switching and great effort for seeking Pb-free solder alloys as a replacement for Sn-Pb eutectic alloy [5].

### 4. Lead-free Solder Alloys

Basic criteria were proposed for “perfect” lead-free alternatives. The most important characteristics that must be considered in selecting suitable lead-free solders are nontoxic, availability, low melting temperature, low cost, good wettability, better electrical properties, and adequate mechanical properties [7]. Table 1 summarizes some of important properties of solder alloys [7].

**Table 1.** Important properties of solder alloys

<b>Properties relevant to reliability and performance</b>	<b>Properties and Aspects relevant to manufacturing</b>
Electrical conductivity	Melting/liquidus temperature
Thermal conductivity	Wettability to copper
Coefficient of thermal expansion	Cost
Shear properties	Environmental friendliness
Tensile properties	Availability and number of suppliers
Creep resistance	Manufacturability using current processes
Fatigue properties	Ability to be made into balls
Corrosion and oxidation resistance	Copper pick-up rate
Intermetallic compound formation	Recyclability
	Ability to be made into paste



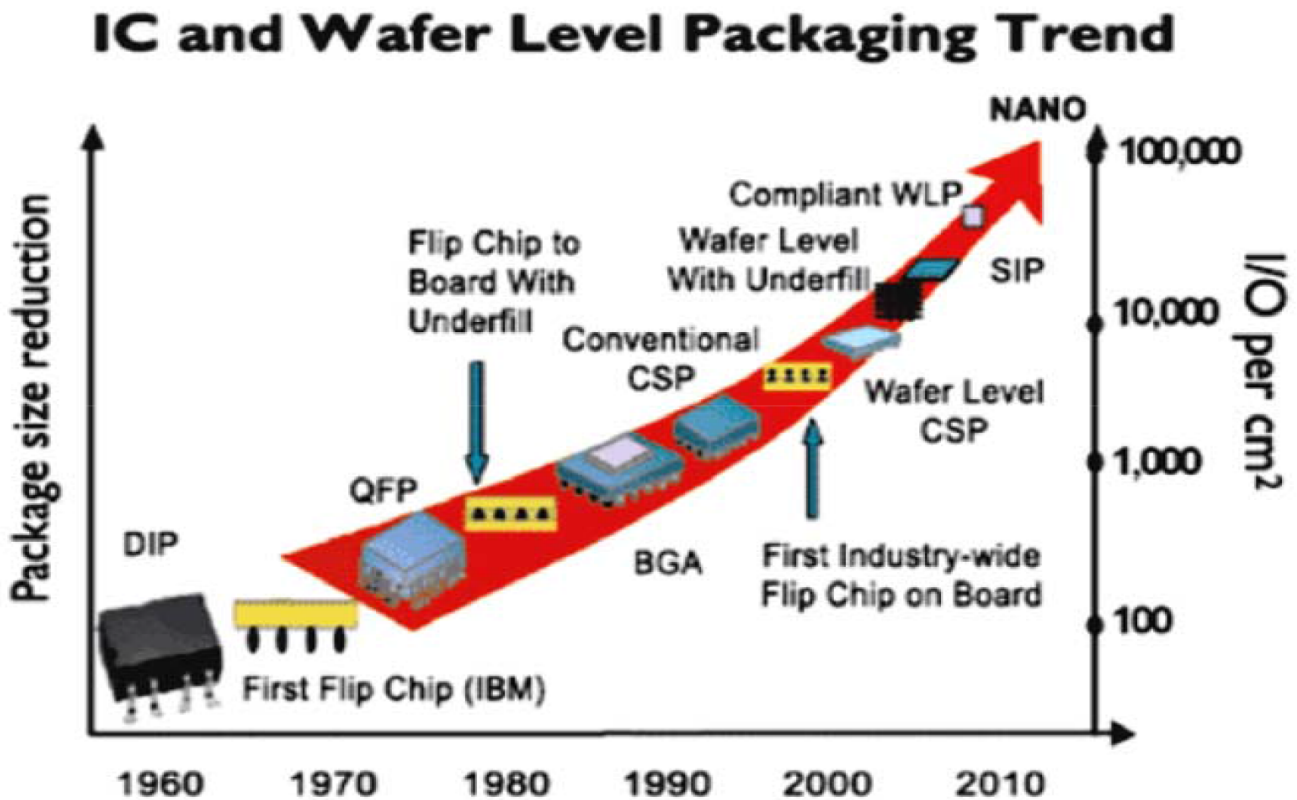
Up to now, several types of binary and ternary Sn-based lead-free solders such as Sn-Zn, Sn-Ag, Sn-Cu, Sn-Ag-Zn and Sn-Ag-Cu have been studied [9, 10]. Table 2 shows major lead-free solder system candidates to replace eutectic Sn-Pb.

**Table 2.** Listing of major lead-free solder system candidates to replace eutectic Sn-Pb

Solder	Weight Percent								Temperature (°C)		
	Sn	In	Ag	Sb	Bi	Cu	Au	Zn	Liquidus	Solidus	Range
60Sn-40Bi	60				40				170	138	32
50Sn-50In	50	50							125	118	7
91Sn-9Zn	91							9	199	Eutectic	0
96.5Sn-3.5Ag	96.5		3.5						221	Eutectic	0
97Sn-3Cu	97					3			300	227	73
80Au-20Sn	20						80		280	Eutectic	0
95Sn-5Sb	95			5					240	235	5
83.6Sn-8.8In-7.6Zn	83.6	8.8						7.6	187	181	6
98Sn-1.5Ag-0.5Cu	98		1.5			0.5			210	215	5
54.0Bi-29.7In-16.3Sn	16.3	29.7			54				81	Eutectic	0
65Sn-25Ag-10Sb	65		25	10					233	Eutectic	0
95.5Sn-4Cu-0.5Ag	95.5		0.5			4			260	204	65

## 5. Nanosolder for Electronics Interconnect Applications

Recently, as micro-/nano-systems technologies are advancing, the size of electrical components is shrinking leading to an increase in the number of input/output terminals (Figure 2) [7].



**Figure 2.** IC and wafer level packaging trend.

Among the many novel lead-free solders, nanocomposite solders are considered the most probable candidates to replace current lead-free solder. For example, researchers examined the influence of reinforcing  $\text{TiO}_2$  and  $\text{Al}_2\text{O}_3$  nanoparticles on the microstructural development and hardness of eutectic Sn-Ag-Cu solders, and measurements of the microhardness, ultimate tensile strength (UTS) and 0.2% offset yield strength (0.2YS) revealed that the addition of  $\text{TiO}_2$  and  $\text{Al}_2\text{O}_3$  nanoparticles enhanced the overall strength of the eutectic solder. Carbon nanotubes (CNTs) were introduced into the solder matrix. The resulting solder exhibited a lower diffusion coefficient, which signified that the presence of CNTs was effective in retarding the growth of the IMC layer [11].

High melting point, in turn, pushes the solder reflow (i.e., spreading of molten alloy on the contact surface) temperature to over  $260^\circ\text{C}$  and severely limits the applicability of this metal alloy to temperature sensitive components and/or low cost organic printed circuit boards. It was found that decreasing the size of the material could reduce its melting point [12]. The

size-dependent nature of melting nanoscaled metal particles has received attention from a number of experimental studies. A well accepted model for the melting temperature  $T_{melt}^*$  is given by the Gibbs-Thomson formula

$$T_{melt}^* = T_{bulk}^* \left( 1 - \frac{w}{R^*} \right), \quad (1)$$

$$w = \frac{2\sigma^*}{\rho_s L}, \quad (2)$$

where  $R^*$  is the radius of the spherical particle and  $T_{bulk}^*$  is the bulk melting temperature, which is the temperature at which the material would melt if the interface was flat. The physical constants  $\rho_s$ ,  $L$  and  $\sigma^*$  are, respectively, the density of the material in the solid phase, the latent heat of fusion, and a parameter proportional to surface energy effects acting on the solid-melt interface.

The effect of equation (1) is that for small  $R^*$ , the melting temperature of the spherical particle is significantly reduced. This size dependence on melting temperature is a consequence of nanoparticles having a much larger surface-to-volume ratio than bulk materials, and occurs for both for round and faceted particles. Since both the solid and liquid molecules on a curved surface are more weakly bonded than their counterparts in the solid and liquid bulk, the difference between the binding of liquid and solid molecules on the surface is a driving factor for this reduced melting temperature. Thus, ultimately the size dependence on melting temperature of a nanoscaled spherical particle is due to the very high surface-to-volume ratio and lower interfacial energy of the liquid phase. We note that there is no observable reduction in melting temperature for macrosized particles; this is a small-scale phenomenon only, as the length scale  $\omega$  in equation (1) is typically of the order of nanometres. The constant  $\sigma^*$  in equation (2) is a measure of the surface energy effects, also referred to as surface tension.

Nanoparticles have gained increasing attention in recent years owing to the large surface to volume ratio and quantum size effect. Therefore, there is

an increasing interest in the application of nanoscale metal alloys as low temperature lead-free solders. Due to the environmental concern against the lead component of the eutectic Sn-Pb solders, electrically conductive adhesives (ECAs) have been explored for surface mount technology and flip chip application as lead-free alternatives. ECAs are composites of the polymer and metal fillers. Among the metal fillers, silver may be used because silver has the highest electrical conductivity and its oxides are also conductors [13]. Tin has been proposed as alternative conductive filler. The synthesis of a nanosize binary Sn-Ag alloy of specific composition is much more difficult than that of monocrystalline nanotin and nanosilver particles [14].

## 6. Methods for Synthesis of Nanostructured Metals

There are many methods to produce nanoparticles, such as chemical vapor deposition CVD [15, 16], laser ablation [17, 18], microemulsion [19, 20], sol-gel [21, 22], and chemical reduction [23, 24]. In addition, there are two general approaches top-down and bottom-up to the synthesis of nanomaterials and the fabrication of nanostructures. The principle behind the top-down approach is to take a bulk piece of the material and then modify it into the wanted nanostructure and subsequent stabilization of the resulting nanosized metal nanoparticles by the addition of colloidal protecting agents. Cutting, grinding and etching are typical fabrication techniques, which have been developed to work on the nanoscale. The sizes of the nanostructures which can be produced with top-down techniques are between 10 to 100 nm. Bottom-up self-assembly refers to construction of a structure atom-by-atom, molecule-by-molecule or cluster-by-cluster. Colloidal dispersion used in the synthesis of nanoparticles is a good example of a bottom-up approach. An advantage of the bottom-up approach is the better possibilities to obtain nanostructures... with... less... defects... and... more... homogeneous... chemical



**Table 3.** Top-down and bottom-up approaches to synthesis nanomaterials and the fabrication nanostructures

Approach	Top-down	Bottom-up
Principle	These approaches use larger (macroscopic) initial structures, which can be externally-controlled in the processing of nanostructures.	<ul style="list-style-type: none"> <li>- These approaches include the miniaturization of materials components (up to atomic level) with further self-assembly process leading to the formation of nanostructures.</li> <li>- During self-assembly the physical forces operating at nanoscale are used to</li> </ul>

## 7. Synthesis and Characterization of Lead-free Nanosolder Alloys

Pande et al. [12] prepared Sn-Ag nanoalloy via two fundamentally differing routes.

Route 1. The Sn-Ag nanoalloy was prepared following a two-step procedure. In the first step, 40 mL of silicone oil, 1 g of hydrazine hydrate, and 0.5 mg of 0.00% tin chloride were mixed in a 100 mL mixing equipment. The mixture necked flask equipped with stirring and reflux for 3 h for molecularization of was heated to  $\sim 240^{\circ}\text{C}$  with vigorous stirring black resorcinol capped silver metallic tin. In the second step, 3.5 mg of but at room temperature nanoparticles was added into the flask articles were used, which yield Alternatively, oleic acid capped silver nanoparticles molecularized tin and silver similar result. The reaction mixture containing 3 h reflux. The reaction mixture nanoparticles was then heated to  $\sim 240^{\circ}\text{C}$  for 3 h and centrifuged to obtain the black was cooled, and the suspended particles were

One of the interesting observations in case of Route 2 is that, when tin acetate and silver acetate (96.5:3.5) are heated in ethylene glycol (pH ~11-12) under refluxing conditions, no alloy resulted and instead Sn(II) glycolate and silver nanoparticles in dispersion are obtained. However, when tin acetate and silver acetate are dispersed in silicone oil and treated with ethylene glycol (pH ~11-12) at room temperature and refluxed at ~240°C (~4h) followed by sonication (~2h), a black colored alloy is obtained. Hence, silicone oil plays an important role in the alloy formation in the presence of ethylene glycol. In this procedure, the particles become quite smaller (~30nm) than the particles obtained from Route 1. This size reduction is due to the sonication effect before refluxing. The effect of sonication on the mean particle size has been investigated. Sonication produced a drastic particle-size reduction, and the particle size relates to the melting point. The particle size drastically decreased to  $30 \pm 5$  nm. The thermal analysis of the Sn-Ag nanoalloy of the smaller size particles (~30 nm) exhibits a drastic change in the endothermic peak position (~128°C) with the decrease in particle size indicating a sharp lowering of the melting point (~128°C).

Zhang et al. [26] synthesized nanoparticles of lead-free solder alloys (Sn-3.5Ag (wt%) and Sn-3.0Ag-0.5Cu (wt%)) through a chemical reduction method by using anhydrous ethanol ( $\text{CH}_3\text{CH}_2\text{OH}$ ), 1,10-phenanthroline ( $\text{C}_{12}\text{H}_8\text{N}_2 \cdot \text{H}_2\text{O}$ ) and sodium borohydride ( $\text{NaBH}_4$ ) as the solvent, surfactant and reducing agent, respectively. Tin (II) 2-ethylhexanoate ( $\text{C}_{16}\text{H}_{30}\text{O}_4\text{Sn}$ ) and silver nitrate ( $\text{AgNO}_3$ ) were used. In terms of the synthesis of Sn-3.0Ag-0.5Cu nanoparticles, copper (II) ethoxide monohydrate ( $\text{Cu}(\text{OC}_2\text{H}_5)_2 \cdot \text{H}_2\text{O}$ ) was added to the reactant.

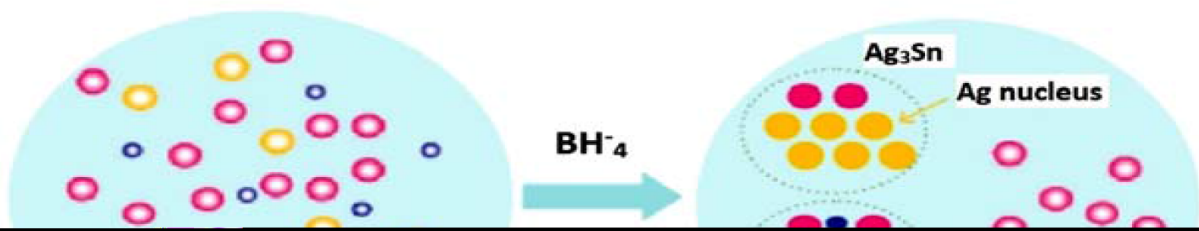
In a typical synthesis of Sn-3.5Ag nanoparticles, 0.2998g of tin (II) 2-ethylhexanoate, 0.0051g of silver nitrate, and 0.2775g of 1,10-phenanthroline were mixed with 60mL of anhydrous ethanol to prepare the precursor solution. The mixture was stirred for about 2 hours before 0.1892 g of sodium borohydride was added into the stirring solution. The reaction time was the variable to be tested in the experimental procedure, so set reaction times of 15, 30, 45, and 60 min were used. The as-synthesized nanoparticles were

precipitated by a centrifuge at a rate of 4000 rpm for 45 min. Due to the low solubility of  $\text{NaBH}_4$  in ethanol, the reaction rate during the separation process was extremely low. The reduction reaction could be stopped at any predetermined time through this method. The nanoparticles obtained were rinsed 3 times with anhydrous ethanol and then dried in the vacuum chamber at  $40^\circ\text{C}$  for 8 hours. The synthesis procedure of Sn-3.0Ag-0.5Cu nanoparticles was similar to that of Sn-3.5Ag nanoparticles.

Most of the Ag and Cu cations were reduced to their metallic form and formed nuclei, respectively. At the same time, a few Sn atoms were generated in the solution. With mechanical agitation, the nuclei of Ag and Cu acted as the heterogeneous seed, absorbed Sn atoms and formed the intermetallic phases,  $\text{Ag}_3\text{Sn}$  and  $\text{Cu}_6\text{Sn}_5$ .

The rest of the Sn atoms, that were not used in the formation process of the intermetallic phases could nucleate and grew into the Sn phase. The capping effect of the surfactant and the size of the synthesized nanoparticles can be well controlled. The formation process of SAC nanoparticles was illustrated in Figure 3 [26]. A typical SEM image of the SAC nanoparticles synthesized at room temperature with a reaction time of 60 min was shown in Figure 4 [26]. The particles were basically spherical with a narrow diameter distribution of  $37.6 \pm 14.9$  nm. Despite the low content of Cu in the core-shell structure, the relatively small particle size could make it detectable.





Zou et al. synthesized tin nanoparticles with different size distribution using chemical reduction method by applying  $\text{NaBH}_4$  as reduction agent [27]. In different cases, different amounts of surfactant, 0, 0.1, 0.2, and 0.4 g, were chosen to control the morphology and size distribution of the products.

The Sn nanoparticles synthesized using 0.33 g of tin(II) 2-ethylhexanoate as precursor in the presence of 0, 0.1, 0.2 and 0.4 g surfactants were marked as Sn1, Sn2, Sn3 and Sn4, respectively. The melting temperatures of the Sn1, Sn2, Sn3 and Sn4 nanoparticles in diameter of 81, 40, 36 and 34 nm were 226.1, 221.8, 221.1 and 219.5°C, and the corresponding latent heats of fusion were 35.9, 23.5, 20.1 and 15.6 J/g, respectively.

Using the same route, Jiang et al. synthesized tin nanoparticles with various sizes by using  $2.1 \times 10^{-4}$  mol tin(II) acetate as a precursor in the presence of 0.045 mol surfactants and 0.1 g sodium borohydride as reducing agents [28]. The average particle size calculated was around 61 nm. The interplanar spacing was about 0.29 nm which corresponds to the orientation of (200) atomic planes of the tetragonal structure of Sn.

The average particle size of Sn nanoparticles which were synthesized by using  $4.2 \times 10^{-4}$  mol tin(II) acetate as a precursor in the presence of 0.045 mol surfactants was around 52 nm. The melting point of the Sn nanoparticles was around 228.0°C, which was 4°C lower than that of micron sized Sn particles. The average particle size of Sn nanoparticles which were synthesized by using  $1.1 \times 10^{-3}$  mol tin(II) acetate as a precursor in the presence of 0.045 mol surfactants was around 85 nm. The melting point of the as-synthesized Sn nanoparticles was 231.8°C, which was still lower than the melting point of micron sized Sn particles.

The average particle size of Sn nanoparticles which were synthesized by using  $1.75 \times 10^{-4}$  mol tin(II) acetate as a precursor in the presence of 0.045 mol surfactants was around 26 nm. The melting point of these particles was around 214.9°C, which was 17.7°C lower than that of micron sized Sn particles. The heat of fusion of the as-synthesized Sn nanoparticles was smaller than that of micron sized Sn powders.

Zhang et al. prepared successfully Sn-3.0Ag-0.5Cu (mass fraction, %) alloy nanoparticles [29]. In different conditions, different amounts of tin(II) 2-ethylhexanoate were mixed into 60 mL anhydrous ethanol and the concentrations for SAC1, SAC2, SAC3, SAC4 were 0.0068, 0.0101, 0.0202 and 0.0271 mol/L, respectively. In a typical synthesis process, for example SAC1, 0.222 g surfactant was added into the solution and intensively stirred for about 2h in atmospheric environment. Afterwards 0.0946g reducing agent was added into the homogeneous precursor solution and stirred for another 1h till the end of the reaction.

The particle sizes of SAC1 and SAC2, whose solution concentrations were at relatively low level, were smaller than 50nm and mainly concentrated in the range of 15-40 nm. In the case of higher reactant concentration, namely SAC3 and SAC4, the proportion of particles less than 50 nm was rapidly reduced to about 65%. Despite the average diameters for SAC3 and SAC4 were almost the same, the size distribution of the latter was much larger due to the thicker reactant. It should be noticed that there were even particles of about 200 nm in the SAC4 sample. In addition, the particle sizes of SAC1 and SAC2 were well controlled considering the lower level of surfactant concentration. That is to say, the particle size was mainly influenced by the reactant concentration [29].

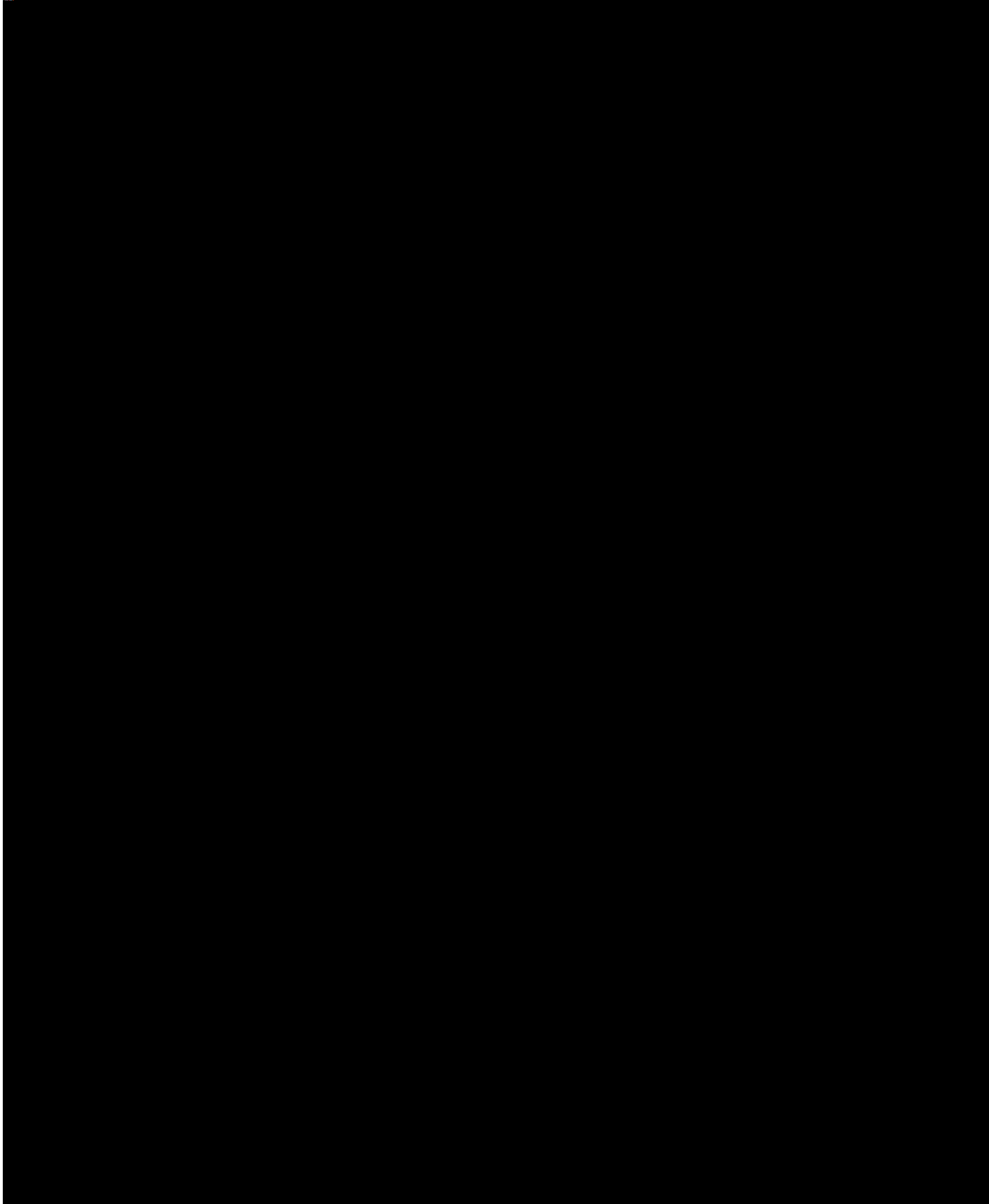
Nanoparticles of Sn-3.0Ag-0.5Cu were also synthesized using the same method by Zou et al. [30]. Authors mixed 0.3293 g tin(II) 2-ethylhexanoate, 0.0047 g silver nitrate, 0.0017 g copper(II) acetate monohydrate and 0.1110 g 1,10-phenanthroline into a 60 mL anhydrous ethanol solution. The solution was then stirred intensively for 2h. Then 0.1892 g sodium borohydride was added into the solution and the reaction continued for 1h at ambient temperature. Different amounts of surfactant, i.e. 0.1110 g, 0.4440 g, and 0.8880 g, were chosen to control the morphology and size distribution of the products.

The results showed that the calorimetric onset melting temperature of the Sn-3.0Ag-0.5Cu alloy nanoparticles could be as low as 200°C, which was about 17°C lower than that of the bulk alloy (217°C). The images of the as-

prepared nanoparticles indicated that the major particle size of Sn-3.0Ag-0.5Cu nanoparticles is smaller than 50 nm [30].

As well, Zou et al. synthesized Sn-3.5Ag nanoparticles [31]. They selected different amounts of surfactant, i.e. 0, 0.15, 0.3, and 0.6. It was found that the larger ratio of the weight of the surfactant to the precursor was used, the smaller the particle size was obtained. This is due to the capping effect caused by the surfactant molecules coordinate with the nanoclusters, and resultantly a larger amount of surfactant restrict the growth of the nanoparticles. Figure 5 shows the typical SEM images of the as-synthesized Sn<sub>3.5</sub>Ag nanoparticles: (a) surfactant 0; (b) surfactant 0.15; (c) surfactant 0.3; (d) surfactant 0.6. The particle size distribution of Sn-Ag with sample surfactant 0 was very large, from 30 to 1,500 nm. The particle size distribution of sample of surfactant 0.15 was much smaller than sample with surfactant 0, from 20 to 300 nm. The particles size distribution of Sn-Ag sample with surfactant 0.3 had the similar size distribution as Sn-Ag sample with surfactant 0.15, from 20 to 300 nm. The particle size distribution of Sn-Ag sample with surfactant 0.6 was even smaller than Sn-Ag sample with surfactant 0.3, from 10 to 150 nm, and most of the particles were smaller than 100 nm.





20Ag-80Sn nanoparticles. The TEM analysis, on the other hand, reveals no surface oxidation layer for the 80Ag-20Sn and 60Ag-40Sn nanoparticles.

The results of XRD analysis show that the 100Sn, 100Ag, 40Ag-60Sn, and 20Ag-80Sn compositions have  $\beta$ -Sn, fcc,  $\beta$ -Sn+Ag<sub>3</sub>Sn, and  $\beta$ -Sn+Ag<sub>3</sub>Sn phases, respectively. For the 20Ag-80Sn nanoparticles, a portion of the  $\beta$ -Sn phase was much higher than that of the 40Ag-60Sn nanoparticles. Hence, a large amount of surface oxidation layer was observed in the 20Ag-80Sn nanoparticles. In contrast to the TEM images, the XRD analysis of the 20Ag-80Sn nanoparticles shows no SnO<sub>x</sub> peak, because the XRD analysis failed to detect the thin surface oxidation layer.

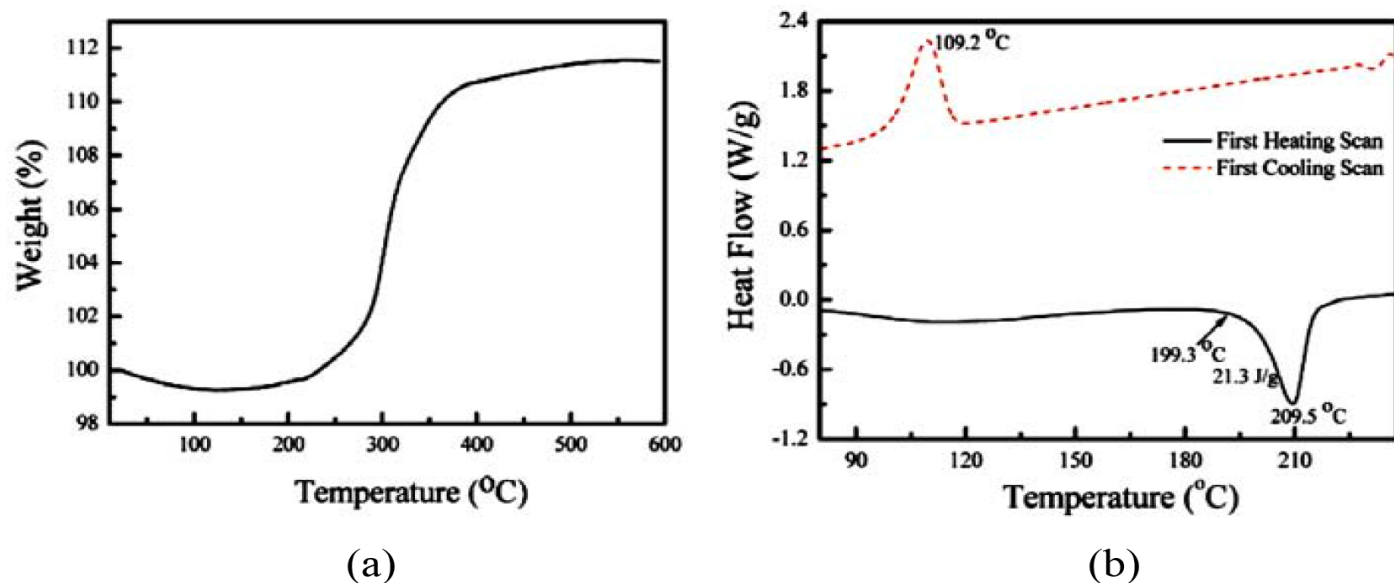
The results of analyses confirm that the formation of a bimetallic phase, such as Ag<sub>4</sub>Sn or Ag<sub>3</sub>Sn, hinders the  $\beta$ -Sn phase and, consequently, leads to the removal of the surface oxidation layer. The sheet resistance is decreased by the conductive Sn-Ag phases, such as the fcc, Ag<sub>4</sub>Sn, and Ag<sub>3</sub>Sn phases, but sharply increased by the low-conductive Sn nanoparticles and the surface oxidation layer on the Sn nanoparticles. An increase in the solubility limit of Sn in Ag enables fcc and Ag<sub>4</sub>Sn + Ag<sub>6.7</sub>Sn phases to be observed in 80Ag-20Sn and 60Ag-40Sn compositions; however, these phases are inconsistent with the expected phases of the bulk phase diagram. In the 40Ag-60Sn and 20Ag-80Sn nanoparticles, the  $\beta$ -Sn and Ag<sub>3</sub>Sn phases were observed in accordance with the bulk phase diagram. The  $\beta$ -Sn phase renders the surface oxidation layer observable in both compositions but to a much greater extent in the 20Ag-80Sn nanoparticles than in the 40Ag-60Sn nanoparticles. The sheet resistance results confirm that 80Ag-20Sn and 60Ag-40Sn bimetallic nanoparticles are suitable candidates for inkjet printing materials [32].

Pan et al. [33] synthesized Sn-3.5Ag alloy nanosolders by using different amounts of reducing agent (NaBH<sub>4</sub>). The experimental results revealed that increased addition of NaBH<sub>4</sub> to the bath (0.01-1 g) transformed the color of the precipitate from grey to black. It might be attributed to the fact that the reduction reaction was incomplete because of the insufficient amount of reducing agent. For the reduction reaction to be completed, it is essential to keep the reducing agent amount of at least 0.1 g in this system.

As nanoparticles tend to agglomerate together in the SEM images, thus PVP plays an important role in the successful synthesis of the Sn-3.5Ag alloy nanoparticles. SEM image for Sn-3.5Ag solder alloy obtained without PVP demonstrated that most of the Sn-Ag nanoparticles aggregated into a cluster. Increased addition of PVP (0.2 g) resulted in stronger aggregation of primary particles. Nevertheless, further increase in the PVP content to 2 g significantly decreased the agglomeration of nanoparticles and greater dispersion of nanoparticles was noticed. The dispersion of the nanoparticles in the presence of PVP could be attributed to the fact that the protective polymer PVP adsorbed on the nanoparticles and exhibited protective function by steric stabilization. The other part of the protective polymer dissolved in the free-state in the suspension of the alloy nanoparticles as a free polymer.

X-ray diffraction (XRD) patterns revealed that  $\text{Ag}_3\text{Sn}$  was formed due to the successful alloying process. The morphology of Sn-3.5Ag alloy nanosolder changed with increase in the PVP content in the bath. The size of the nanoparticles ranged from 300 to 700 nm.

Sn-Ag alloy nanoparticles were synthesized and their thermal properties were studied [34]. The melting point can be achieved as low as  $194^\circ\text{C}$  when the diameter of the nanoparticles is around 10 nm. The 64 nm (average diameter) Sn-Ag alloy nanoparticle pastes showed good wetting properties on the cleaned copper foil surface and the IMCs formed. Figure 6(a) shows the TGA curve of the dried Sn-Ag alloy nanoparticles in nitrogen atmosphere. The weight loss below  $180^\circ\text{C}$  might be due to the evaporation of a small amount of absorbed moisture and surfactants. Above  $180^\circ\text{C}$ , the weight gain was observed, which was attributed to thermal oxidation of the Sn-Ag alloy nanoparticles. Figure 6(b) displays the thermal profile of the dried Sn-Ag alloy nanoparticles. The melting point of the Sn-Ag nanoparticles was found at  $209.5^\circ\text{C}$ , about  $13^\circ\text{C}$  lower than that of the micrometersized 96.5Sn-3.5Ag particles ( $222.6^\circ\text{C}$ ).



**Figure 6.** TGA (a) and DSC (b) curves of the Sn-Ag alloy nanoparticles which were synthesized by using  $7.4 \times 10^{-4}$  mol of tin(II) 2-ethylhexanoate and  $3.0 \times 10^{-5}$  mol of silver nitrate as precursors in the presence of  $5.6 \times 10^{-4}$  mol of surfactants [34].

Zou focused on the research aimed to lower the melting temperature of the lead-free solder alloy through decreasing the particle size down to nanometer level by chemical reduction method [35]. The Sn-3.5Ag and Sn-3.5Ag-0.5Cu nanoparticles (average size about 30nm) are obtained by adjusting the drops rate of reductant, the concentration of surfactant and reactant. It was found that when the addition rate of reductant is decreased, the particle sizes and size distribution showed the same result. Also, the melting temperature of lead-free solder showed strong size-dependent tendency and the melting temperature of Sn-3.5Ag and Sn-3.5Ag-0.5Cu nanoparticles with average size of 30 nm was 210°C and 201°C, much lower than that of bulk alloy.

An attempt was made to synthesize Sn-3.5Ag- $x$ Zn ( $x = 0.5$  to 3.5wt%) alloy nanoparticles by Lin et al. [36]. The chemical precipitation was carried out by using  $\text{NaBH}_4$  as a reducing agent and PVP as a stabilizer. X-ray diffraction patterns revealed that  $\text{Ag}_3\text{Sn}$  was formed due to the successful alloying process. Other IMCs such as  $\text{Ag}_4\text{Sn}$  and  $\text{Ag}_5\text{Zn}_8$  were also obtained in the XRD patterns. Results on TEM revealed that the isolated particles



were spherical in shape and the particle size varied from 2 to 10 nm. The microstructure for Sn-3.5Ag-0.5Zn alloys showed selected area diffraction patterns for  $\text{Ag}_3\text{Sn}$  nanoparticles. However, diffraction patterns for compounds like  $\text{Ag}_4\text{Sn}$  and  $\text{Ag}_5\text{Zn}_8$  could not be obtained due to the strong aggregation of nanoparticles. The morphology of Sn-Ag-Zn nanoparticles revealed that the major particle size of Sn-Ag-Zn nanoparticles were in the range of 60-80 nm.

Sn-3.0Ag-0.5Cu nanoparticles with different size distribution could be successfully synthesized using different amounts of surfactant i.e. 0.075 g, 0.15 g, 0.3 g and 0.6 g, which were also used to prevent the synthesized nanoparticles from aggregating and being oxidized [37]. The experimental results indicated that the major particle size of Sn-3.0Ag-0.5Cu nanoparticles was smaller than 100 nm. It was evidenced by the differential scanning calorimetry curves that the melting temperature of Sn-3.0Ag-0.5Cu nanoparticles was 214.7°C, 213.8°C, 213.5°C and 213.6°C lower than that 217.8°C of the bulk alloy. In addition, the undercooling of the Sn-3.0Ag-0.5Cu nanoparticles was in the range of 82.0-88.5°C at different cooling rates, which was much larger than that of the Sn-3.0Ag-0.5Cu micro-sized particles, showing stronger cooling rate dependence.

Sn-3.0Ag-0.5Cu nanosolders were produced via a chemical reduction method by Yung et al. [38]. Tin sulfate ( $\text{SnSO}_4$ ), silver nitrate ( $\text{AgNO}_3$ ), copper nitrate ( $\text{Cu}(\text{NO}_3)_2 \cdot 2.5\text{H}_2\text{O}$ ), PVP ( $M_w = 40,000 \text{ g/mol}$ ), and  $\text{NaBH}_4$  were used as precursors, surfactant, and reducing agent, respectively.

Through different reaction conditions including variation of the amounts of PVP and  $\text{NaBH}_4$ , temperature, and pH value, the nanosolder particle diameter was well controlled to the range of 10 nm to 22 nm, and the size-dependent melting point was depressed to 204.4°C. Although Sn oxides formed on the nanosolders during the reduction process, these oxides could be cleaned by citric acid.

Different amounts of the reducing agent  $\text{NaBH}_4$  were added into the precursor solution to investigate the effect on nanosolder particle size. The reaction took place with 1.5 times PVP addition and at 25°C. For

$\text{NaBH}_4/\text{SnSO}_4 = 1$ , it is difficult to determine the particle size due to its large distribution range. Some nanosolders have high aspect ratio rather than being spherical. Based on results, increasing the amount of  $\text{NaBH}_4$  addition resulted in the generation of nanosolders with narrow size distribution. Spherical nanosolders with diameters of 10 nm to 22 nm can be obtained with 4 times  $\text{NaBH}_4$  addition. At low ratio of  $\text{NaBH}_4/\text{SnSO}_4$ , the reduction rate of the metallic ions is low and only a small amount of nuclei are generated at the nucleation step, leading to larger particles formed after the subsequent diffusional growth. On the contrary, as the concentration of  $\text{NaBH}_4$  increases, more  $\text{BH}_4^-$  ions are available for transferring electrons to the metallic ions. As a result, a large number of nuclei are formed in the solution and act as self nucleation centers. The formation of this large number of nuclei consumes a large portion of the metallic ions in solution, which inhibits the growth of nanosolders, leading to the formation of spherical nanosolders with narrow size distribution [38].

Hsiao and Duh synthesized  $\text{Sn-3.5Ag-xCu}$  ( $x = 0.2, 0.5, 1.0$ ) nanoparticles by chemical precipitation with  $\text{NaBH}_4$  [4]. The XRD patterns revealed that the  $\text{Ag}_3\text{Sn}$  was formed due to the alloying process. Besides, only  $\text{Cu}_6\text{Sn}_5$  was formed when Cu concentration was as high as 1.0 wt% in the derived nanopowders. The formation of  $\text{Ag}_3\text{Sn}$  and  $\text{Cu}_6\text{Sn}_5$  gave strong evidence that the nanoparticles were mixed homogeneously. From TEM observation, the isolated particles were close to spherical shape and the particle sizes of powders were about 5 nm. The field emission scanning electron microscopy morphology of Sn-Ag-Cu nanoparticles indicates that the major particle size of Sn-Ag-Cu nanoparticles is in the range of 40 nm.

Jiang et al. synthesized Sn-Ag-Cu alloy nanoparticles with various sizes [39]. It was found that the 10-13 nm (average diameter) Sn-Ag-Cu alloy nanoparticles have a low melting point at  $\sim 199^\circ\text{C}$ , which will be compatible with the reflow temperature of the conventional eutectic micron sized Sn-Pb alloy particles. The as-synthesized Sn-Ag-Cu alloy nanoparticles were dispersed into an acidic type flux to form the nanosolder pastes. Their wetting properties on the cleaned copper surface were studied. It was found

that the nanoparticle pastes completely melted and wetted on the copper surface and the tin and copper IMCs formed. These low melting point Sn-Ag-Cu alloy nanoparticles could be used for low temperature lead-free interconnect applications.

At room temperature Sn-3.5Ag-0.5Cu nanoparticles were synthesized by chemical precipitation with  $\text{NaBH}_4$  in aqueous solutions [40]. The results indicated that the primary particles after precipitation were  $(\text{Ag}, \text{Cu})_4\text{Sn}$ , with a size of 4.9 nm.  $(\text{Ag}, \text{Cu})_4\text{Sn}$  was transformed into  $(\text{Ag}, \text{Cu})_3\text{Sn}$ , when the total amount of Sn contributed from both  $(\text{Ag}, \text{Cu})_4\text{Sn}$  and Sn covering the  $(\text{Ag}, \text{Cu})_4\text{Sn}$  overtook that of  $(\text{Ag}, \text{Cu})_3\text{Sn}$ . The final particle size of polycrystalline particles was 42.1 nm owing to the depletion of Sn atoms in the solution.

The polyol process is one of the chemical reduction methods. It has been proposed as a method for the preparation of finely divided powders of easily reducible metals, in which the metal salts are dissolved or suspended into the liquid polyols such as ethylene glycol, diethylene glycol or a mixture of both. The polyol acts as both the solvent for starting inorganic compounds and a reducing agent. PVP can be used as the protective agents for preventing nanoparticles from sintering, which covered the surface of silver nanoparticles and prevent the possibility of silver-silver particle bond formation [41].

A various size of Sn-Cu nanoparticles were synthesized by using a modified polyol process for low temperature electronic devices [42]. Monodispersive Sn-Cu nanoparticles with diameters of 21 nm, 18 nm and 14 nm were synthesized. The peak melting temperature of the Sn-0.7Cu bulk alloy was  $230.6^\circ\text{C}$ . The peak melting temperatures of the 21 nm, 18 nm and 14 nm Sn-0.7Cu nanoparticles were  $212.9^\circ\text{C}$ ,  $207.9^\circ\text{C}$  and  $205.2^\circ\text{C}$ , respectively. These temperatures are  $17.7^\circ\text{C}$ ,  $22.7^\circ\text{C}$  and  $25.4^\circ\text{C}$  lower than the corresponding temperatures of the Sn-0.7Cu bulk alloys. Another observable feature beside the melting temperature depression was the broadening of the melting temperature peak. This feature is more evident for smaller nanoparticles than for bulk alloys.

Nanocrystalline samples of pure Sn and of Sn-rich ternary Ni-Sb-Sn alloys, with compositions ranging from 80 to 97.5 at% Sn and a Ni to Sb molar ratio of 1 : 1, were synthesized by reduction of stoichiometric metal chloride solutions with  $\text{NaBH}_4$  at  $0^\circ\text{C}$  in alkaline medium [43]. In the first step aqueous stock solutions of  $\text{SnCl}_2$  (0.08 M),  $\text{SbCl}_3$  (0.03 M), and  $\text{NiCl}_2$  (0.06 M) were prepared by dissolving  $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$  and  $\text{SbCl}_3$  (99.99% purity) in diluted hydrochloric acid (5 M), and  $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$  (99.9985% purity) in distilled water. Appropriate volumes of the above metal chloride solutions were mixed together to make compositions with Sn contents varying from 80 to 97.5 at% and with a Ni to Sb molar ratio of 1:1. To the resulting solutions required amounts of a 1 M solution of tri-sodium citrate was added as chelating reagent. A 0.5 M  $\text{NaBH}_4$  stock solution was prepared at a pH value of 14 from a 4.4 M  $\text{NaBH}_4$  stable solution. The two separate aqueous solutions were cooled to  $0^\circ\text{C}$  in ice water before reaction. 40 mL of metal chloride solution was added drop wise within 10 min to 40 mL of the  $\text{NaBH}_4$  solution under strong magnetic stirring. With continued addition, the color of the solution turned brown with formation of some bubbles which was followed by the appearance of some black suspensions. The mixed solutions were stirred for another 30 min, and for the entire period the reaction vessel was cooled in ice water. The resultant suspensions were separated by centrifuge and rinsed several times with distilled water and acetone. The precipitate was dried under vacuum at room.

The particle sizes of the obtained alloys were found to be in the range of 40-350 nm. A relative decrease in melting temperature of up to  $15^\circ\text{C}$  was observed for these alloys compared to a bulk sample.

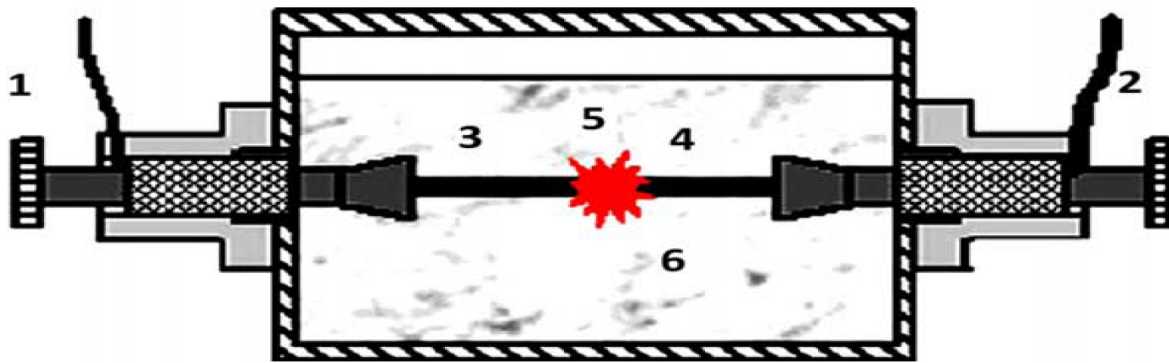
The nanoscaled Sn-3.5Ag solder was prepared successfully by a supernatant process [44]. 9.65 g of Sn powder was weighed to mix 0.35 g of Ag powder in a sealed vacuum tube. Then the tube was placed in an oven and was heated at temperature  $260^\circ\text{C}$  for 2h with intermittent shaking. The as-received alloy was immersed in the solvent, paraffin oil, and heated again at temperature  $320^\circ\text{C}$  for 10h with a magnetic stirrer for blending the solution. To prevent the alloyed particles from agglomerating, the solution was quenched and the viscosity was raised by mixing with dry ice. Then the



supernatant, composed of Sn-3.5Ag particle and paraffin, was scooped up and blended with chloroform to dilute the paraffin.

It was found that the average diameter of the particle was 137 nm with a standard deviation of  $\pm 5$  nm. The eutectic element, Ag with a weight percentage of 3.5%, was found to be homogenous over all of the particles. It was found that the trace element, Ag was dissolved in the matrix, a tetragonal system, without an intermetallic phase.

Gao et al. [45] prepared nanoparticles with a consumable-electrode direct current arc (CDCA) technique. Nanoparticles were prepared from the master alloy with a recently developed consumable-electrode direct current arc (CDCA) technique as shown schematically in Figure 7 [45].



**Figure 7.** Schematic of the CDCA setup for nanoparticles preparation (1) cathode, (2) anode (connected to a high current and low voltage power source), (3) and (4) bulk alloy electrodes, (5) arc discharge taking place between the electrodes, and (6) dielectric coolant.

Liquid paraffin was chosen as a dielectric protection media. The anode and cathode, with a diameter of 6 mm, were made from the master alloy by means of a suction casting technique. The anode and the cathode electrodes were fixed inside the CDCA container and connected to a power supply. When the two electrodes get close enough, an arc discharge could be produced between them, causing a local melting and breakdown of the solder material into nanoparticles. The obtained particles were rinsed with chloroform for several times to remove the liquid paraffin. Furthermore, the rinsed particles were centrifugally separated at 4000 rpm for 45 min to

remove the possibly existed large particles. It was found that the size of most particles at 20 A arc current was in the range 15-60 nm with an average of about 30 nm. The melting peak of the aforementioned nanoparticles was shifted to lower temperatures and broadened. The peak onset temperature was decreased to about 197°C, 20°C lower than that of the bulk master alloy. Increasing the arc current to 50 A led to a significantly narrower size distribution of the nanoparticles. The particle size was concentrated in the range 25-42 nm, again with an average of about 30 nm. The melting onset temperature is lowered below 190°C and remained nearly unchanged even after repeated heating-cooling cycles. Due to the large specific surface area of the nanoparticles, it was hard to avoid oxidation during preparation, storage and the measurement.

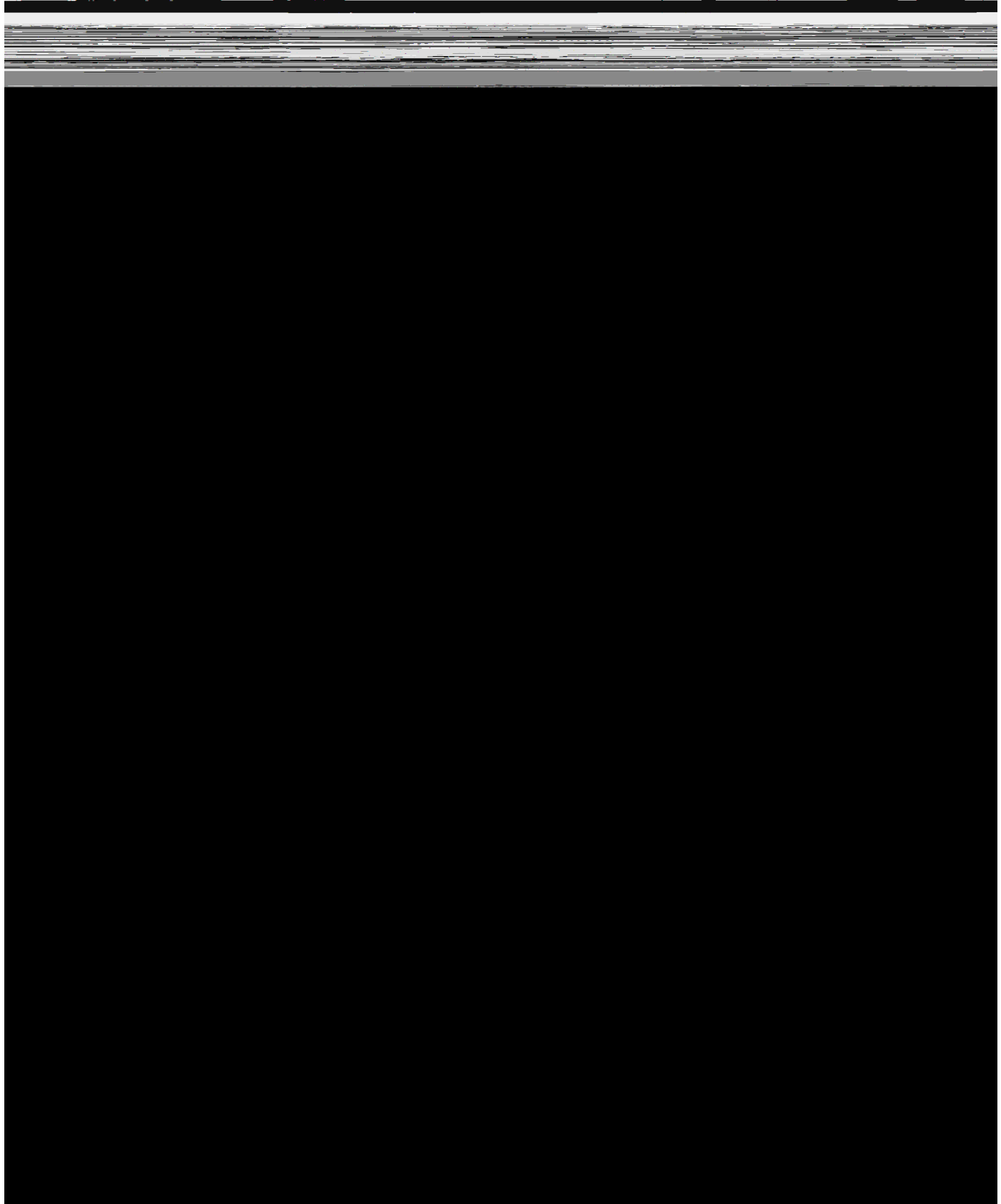
The Sn-3.5Ag droplets in various sizes have been prepared by the consumable-electrode direct current arc technique [46]. The cooling rates of the droplets have been evaluated based on Newton's cooling law and it shows that the cooling rates of the droplets increase dramatically from  $6.84 \times 10^2$  to  $2.52 \times 10^5$  K/s as the droplet size decreases from 830 to 43  $\mu\text{m}$ . The range of cooling rate is close to that of laser soldering (up to  $10^4$  K/s). It has been found that the  $\beta$ -Sn dendrites are refined as the cooling rate increase, and when the cooling rate is  $1.30 \times 10^5$  K/s, which corresponding to the size scale smaller than 60  $\mu\text{m}$ , the dendrites nearly disappear in the droplets. In addition, it has been observed that the high cooling rate could successfully avoid the precipitation of plate-like  $\text{Ag}_3\text{Sn}$  and promote the formation of nanoparticles which are desirable in practical application. These nanoparticles uniformly distribute in the Sn matrix and the average size of nanoparticles in different droplets is 46.4 nm (in 380-830  $\mu\text{m}$  droplets), 57.2 nm (in 150-250  $\mu\text{m}$  droplets), 60.6 nm (in 96-150  $\mu\text{m}$  droplets), 63.2 nm (in 43-60  $\mu\text{m}$  droplets) and 65.3 nm (in droplets of  $< 43 \mu\text{m}$ ), respectively. According to the dispersion-strengthening effect, the existence of nanoparticles would be beneficial to improve the mechanical property of the Sn-3.5Ag solder alloy.

The nanoparticles of Sn-3.0Ag-0.5Cu were manufactured using the self-

developed consumable-electrode direct current arc (CDCA) technique [47]. Two different protection dielectric media were used, namely liquid paraffin and triethanolamine. The electrodes manufactured from the master alloy by means of a suction casting technique had a circular cross section with a diameter of 6 mm. The anode and the cathode electrodes were fixed inside the CDCA container and externally connected to a power supply. When coming close enough, an arc discharge is produced between the electrodes, resulting in local melting and breakdown of the solder material into small nanoparticles. The discharge and solder alloy breakdown takes place inside the dielectric media. The manufactured nanoparticles were almost spherical in shape and the size distribution was between  $\approx 10$  nm and 100 nm.

The DSC results showed that the melting temperature of the nanoparticles was  $213^{\circ}\text{C}$ , which is approximately  $10^{\circ}\text{C}$  lower compared with that of the bulk alloy. No difference in morphology and melting temperature was found between the nanoparticles manufactured in liquid paraffin and with triethanolamine, meaning that both dielectric media are suitable to protect the nanoparticles from oxidation. The depression in melting temperature of the investigated SAC nanoparticles can be attributed to the large particle free energy caused by the size effect.

A low temperature chemical reduction method is employed to synthesize the Ag-Cu alloy nanoparticles for lead-free interconnects applications [48]. Figure 8 shows the XRD patterns of Ag-Cu alloy nanoparticles synthesized by chemical reduction reaction using  $\text{CuSO}_4 + \text{AgNO}_3$  and  $\text{Cu}(\text{OAC})_2 + \text{AgNO}_3$ , respectively. The crystallite size of Ag-Cu alloy size is found to be in the range of 13-16 nm for the sample prepared with  $\text{CuSO}_4 + \text{AgNO}_3$  and 13-15 nm for the sample prepared with  $\text{Cu}(\text{OAC})_2 + \text{AgNO}_3$ . Figure 9(a) shows the typical SEM image of the Ag-Cu alloy nanoparticles prepared from  $\text{CuSO}_4 + \text{AgNO}_3$ . The spherical alloy particles remain well separated, and the size distribution calculated from several SEM images indicates that the average particle diameter is in the range of  $(65 \pm 5)$  nm. Figure 9(b) shows the typical SEM image of the Ag-Cu nanoalloys nanoparticles prepared from  $\text{Cu}(\text{OAC})_2 + \text{AgNO}_3$ . The spherical alloy particles linked with each other and





For readers' convenience, the fundamentals, advantages/disadvantages of each method, and compositions of different nanomaterials produced in various studies are given in Table 4.

**Table 4.** Synthesis of different nanosolders produced in various studies

Materials	Method	Conditions	Results
Sn-Ag	Two fundamentally differing routes	<b>Route 1. In the first step,</b> 40 mL of silicone oil, 1 g of hydrazine hydrate, and 96.5 mg of 99.9% tin powder were mixed together in a 100 mL two necked flask equipped with stirring and refluxing equipment. The mixture was heated to $\sim 240^{\circ}\text{C}$ with vigorous stirring for 3 h for molecularization of metallic tin. <b>In the second step,</b> 3.5 mg of black resorcinol capped silver nanoparticles was added into the flask but at room temperature. Alternatively, oleic acid capped silver nanoparticles were used, which yield similar result. The reaction mixture containing molecularized tin and silver nanoparticles was then heated to $\sim 240^{\circ}\text{C}$ for 8 h reflux. The reaction mixture was cooled, and the suspended particles were centrifuged to obtain the black product. Finally, the black mass was washed thrice with petroleum ether (60-80) and three times with tetrahydrofuran (THF)	The particle size become quite smaller ( $\sim 30\text{ nm}$ ) than the particles obtained from Route 1. A sharp lowering of the melting point ( $\sim 128^{\circ}\text{C}$ ) [12].

		<p>and then dried under vacuum. The percent yield was 87%.</p> <p><b>Route 2.</b> In this step, 20mL of silicone oil, 20mL of ethylene glycol, 96.5 mg of 99.9% Sn(II) acetate, 3.5 mg of 99.9% Ag(I) acetate, and 200 mg of NaOH were mixed in a 100mL two necked flask. The mixture was then sonicated (~2 h) for homogeneous mixing. The mixture turned black. After that, the mixture was heated to ~240°C with vigorous stirring for 8 h for the preparation of Sn-Ag nanoalloy. Next, the reaction mixture was cooled, and the suspended particles were centrifuged to obtain the black product. Finally, the black mass was washed with petroleum ether (60-80) and THF. The product yield was 93%.</p>	
Sn-3.5Ag (wt%)	Chemical reduction	<p>- Using different amounts of reducing agent (NaBH<sub>4</sub>) (0.01 - 1 g) [33] - 0.33 g of tin(II) 2-ethylhexanoate as precursor in the presence of 0, 0.1, 0.2 and 0.4 g surfactants were marked as Sn1, Sn2, Sn3 and Sn4, respectively. The melting temperatures of the Sn1, Sn2, Sn3 and Sn4 nanoparticles in diameter of 81, 40, 36 and 34 nm were 226.1, 221.8, 221.1 and</p>	<p>- The larger depression of the melting temperature of the nanoparticle with 50 nm was about 7°C [31]. The size of the nanoparticles ranged from 300 to 700 nm [33].</p> <p>- The melting temperature of Sn-3.5Ag nanoparticles with average size of 30 nm was 210°C much</p>

		219.5°C, and the corresponding latent heats of fusion were 35.9, 23.5, 20.1 and 15.6 J/g, respectively [35].	lower than that of bulk alloy [35].
	Supernatant process	9.65 g of Sn powder was weighed to mix 0.35 g of Ag powder in a sealed vacuum tube. Then the tube was placed in an oven and was heated at temperature 260°C for 2 h with intermittent shaking. The as-received alloy was immersed in the solvent, paraffin oil, and heated again at temperature 320°C for 10 h with a magnetic stirrer for blending the solution. To prevent the alloyed particles from agglomerating, the solution was quenched and the viscosity was raised by mixing with dry ice. Then the supernatant, composed of Sn-3.5Ag particle and paraffin, was scooped up and blended with chloroform to dilute the paraffin [44].	The average diameter of the particle was 137 nm [44].
Tin (Sn)	Chemical reduction	- 0.33 g of tin(II) 2-ethylhexanoate as precursor in the presence of 0, 0.1, 0.2 and 0.4 g surfactants were marked as Sn1, Sn2, Sn3 and Sn4, respectively. The melting temperatures of the Sn1, Sn2, Sn3 and Sn4 nanoparticles in diameter of 81, 40, 36 and	In the presence of 0, 0.1, 0.2 and 0.4 g surfactants were marked as Sn1, Sn2, Sn3 and Sn4, respectively. The melting temperatures of the Sn1, Sn2, Sn3 and Sn4 nanoparticles in diameter of 81, 40, 36 and 34 nm were 226.1,

		<p>34 nm were 226.1, 221.8, 221.1 and 219.5°C, and the corresponding latent heats of fusion were 35.9, 23.5, 20.1 and 15.6 J/g, respectively [27].</p> <p>- Using <math>2.1 \times 10^{-4}</math> mol tin(II) acetate as a precursor in the presence of 0.045 mol surfactants and 0.1 g sodium borohydride as reducing agents.</p> <p>Using <math>4.2 \times 10^{-4}</math> mol tin(II) acetate as a precursor in the presence of 0.045 mol surfactants.</p> <p>Using <math>1.1 \times 10^{-3}</math> mol tin(II) acetate as a precursor in the presence of 0.045 mol surfactants.</p> <p>Using <math>1.75 \times 10^{-4}</math> mol tin(II) acetate as a precursor in the presence of 0.045 mol surfactants [28].</p>	<p>221.8, 221.1 and 219.5°C, and the corresponding latent heats of fusion were 35.9, 23.5, 20.1 and 15.6 J/g, respectively [27].</p> <p>- The average particle size calculated from the TEM picture was around 61 nm. The interplanar spacing was about 0.29 nm which corresponds to the orientation of (200) atomic planes of the tetragonal structure of Sn [28].</p>
Sn-3.0Ag-0.5Cu		<p>- Different amounts of tin(II) 2-ethylhexanoate were mixed into 60 mL anhydrous ethanol and the concentrations for SAC1, SAC2, SAC3, SAC4 were 0.0068, 0.0101, 0.0202 and 0.0271 mol/L, respectively. In a typical synthesis process, for example SAC1, 0.222 g surfactant was added into the solution and intensively stirred for about 2 h in atmospheric environment. Afterwards 0.0946 g reducing agent</p>	<p>The particle sizes of SAC1 and SAC2, whose solution concentrations were at relatively low level, were smaller than 50 nm and mainly concentrated in the range of 15-40 nm. In the case of higher reactant concentration, namely SAC3 and SAC4, the proportion of particles less than 50 nm was rapidly reduced to about 65% [29].</p>



		<p>was added into the homogeneous precursor solution and stirred for another 1 h till the end of the reaction [29].</p> <p>- Authors mixed 0.3293 g tin(II) 2-ethylhexanoate, 0.0047 g silver nitrate, 0.0017 g copper(II) acetate monohydrate and 0.1110 g 1,10-phenanthroline into a 60 mL anhydrous ethanol solution. The solution was then stirred intensively for 2 h. Then 0.1892 g sodium borohydride was added into the solution and the reaction continued for 1 h at ambient temperature. Different amounts of surfactant, i.e., 0.1110 g, 0.4440 g, and 0.8880 g, were chosen to control the morphology and size distribution of the products [30].</p>	<p>The calorimetric onset melting temperature could be as low as 200°C, which was about 17°C lower than that of the bulk alloy (217°C). The particle size is smaller than 50 nm [30].</p> <p>The melting temperature with average size of 30 nm was 201°C, much lower than that of bulk alloy [35].</p> <p>- The particle size was smaller than 100 nm. The melting temperature was 214.7°C, 213.8°C, 213.5°C and 213.6°C lower than that 217.8°C of the bulk alloy. Undercooling was in the range of 82.0-88.5°C at different cooling rates [46].</p> <p>- The nanosolder particle diameter was well controlled to the range of 10 nm to 22 nm, and the size-dependent melting point was depressed to 204.4°C [37].</p> <p>- The 10-13 nm (average diameter) nanoparticles have a low melting point at ~199°C [39].</p> <p>- The final particle size of polycrystalline particles was 42.1 nm</p>
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			owing to the depletion of Sn atoms in the solution [40].
Sn-3.5Ag- $x$ Zn ( $x = 0.5$ to 3.5 wt%)	Chemical precipitation method was carried out by using $\text{NaBH}_4$ as a reducing agent and PVP as a stabilizer.	Tin sulphate ( $\text{SnSO}_4$ ), silver nitrate ( $\text{AgNO}_3$ ), zinc nitrate, $\text{Zn}(\text{NO}_3)_2$ ; sodium borohydride ( $\text{NaBH}_4$ ) and PVP of molecular weight $\sim 40,000$ were used. Both $\text{NaBH}_4$ and PVP were dissolved in a beaker containing 200 ml of distilled water using a Teflon coated magnetic stirrer. The stoichiometric amounts of the salts, i.e. $\text{SnSO}_4$ , $\text{AgNO}_3$ and $\text{Zn}(\text{NO}_3)_2$ were dissolved in aqueous solution as the metal precursors. The total weight of the Sn-Ag-Zn alloy was 2 g. Solutions of these metal precursors were rapidly added to $\text{NaBH}_4$ , PVP, NaOH solution under constant stirring for 3-4h. The stirring time was varied from 12 h to 48h to ensure complete reduction. A black coloured precipitate was obtained after stirring for 12 h. The upper aqueous layer of the solution was removed and to the rest of the precipitated solid, 2 g of PVP dissolved in 200 mL of distilled water was added. Then the solution was stirred for 2 consecutive days. The	The isolated particles were spherical in shape and the particle size varied from 2 to 10 nm [36].

		black precipitate was washed several times with distilled water and filtered. The precipitate thus obtained was then dried in the oven maintained at 40°C for 12 h [36].	
Sn-3.5Ag- $x$ Cu ( $x = 0.2,$ 0.5, 1.0)	Chemical precipitation with NaBH <sub>4</sub>		The particle size is in the range of 40 nm. One endothermic peak at 215°C. Also, Sn-Ag-Cu nanopowders showed good wettability with contact angles less than 30° [38].
Sn-0.7Cu	Polyol process	Tin (II) acetate (Sn(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> ) and copper(II) acetylacetonate (Cu(C <sub>5</sub> H <sub>7</sub> O <sub>2</sub> ) <sub>2</sub> ) were used as precursors of the Sn-Cu nanoparticles. The reducing agent, surface stabilizer, and solvent were NaBH <sub>4</sub> (99%, Sigma-Aldrich), poly(vinyl pyrrolidone) (PVP) (MW = 55000), and 1,5 pentanediol (96%), respectively. All chemicals were used as received without further processing or purification. All solutions were vacuumed and purged argon continuously during experiments to prevent from oxidations. This step was followed by various heating temperatures under argon in the presence of PVP [42].	The peak melting temperatures of the 21 nm, 18 nm and 14 nm Sn-0.7Cu nanoparticles were 212.9°C, 207.9°C and 205.2°C, respectively [42].

Ni-Sb-Sn	Prepared with compositions ranging from 80 to 97.5 at% Sn and a Ni to Sb molar ratio of 1 : 1, were synthesized by reduction of stoichiometric metal chloride solutions with $\text{NaBH}_4$ at $0^\circ\text{C}$ in alkaline medium.	In the first step aqueous stock solutions of $\text{SnCl}_2$ (0.08 M), $\text{SbCl}_3$ (0.03 M), and $\text{NiCl}_2$ (0.06 M) were prepared by dissolving $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$ and $\text{SbCl}_3$ (99.99% purity) in diluted hydrochloric acid (5 M), and $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ (99.9985% purity) in distilled water. Appropriate volumes of the above metal chloride solutions were mixed together to make compositions with Sn contents varying from 80 to 97.5 at% and with a Ni to Sb molar ratio of 1 : 1. To the resulting solutions required amounts of a 1 M solution of tri-sodium citrate was added as chelating reagent. A 0.5 M $\text{NaBH}_4$ stock solution was prepared at a pH value of 14 from a 4.4 M $\text{NaBH}_4$ stable solution. The two separate aqueous solutions were cooled to $0^\circ\text{C}$ in ice water before reaction. 40 mL of metal chloride solution was added drop wise within 10 min to 40 mL of the $\text{NaBH}_4$ solution under strong magnetic stirring. With continued addition, the color of the solution turned brown with formation of some bubbles which was followed by the appearance	The particle sizes were found to be in the range of 40-350 nm [43].
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		of some black suspensions. The mixed solutions were stirred for another 30 min, and for the entire period the reaction vessel was cooled in ice water. The resultant suspensions were separated by centrifuge and rinsed several times with distilled water and acetone. The precipitate was dried under vacuum at room [43].	
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## 8. Conclusions

Nanoparticles show different properties from bulk materials because of their large surface area to volume ratio and quantum size effect. Bimetallic alloy nanoparticles are such a kind of materials with special properties that are different from either constituent in relation to their optical, catalytic and electronic properties.

Two kinds of methods have been developed to synthesize bimetallic alloy nanoparticles. One is called “bottom-up” method, the most studied chemical reduction technique; the other one is the physical method called “top-down” approach. The chemical reduction method for the preparation of bimetallic nanoparticles can be divided into two groups: one is the co-reduction of two different kinds of metal precursor salts. The other one is successive reduction of two metal salts, which is usually carried out to prepare a core-shell structure of bimetallic nanoparticles. Many researches on size or shape dependent properties for nanocrystals and their synthesis methodology have been reported, where interesting and exotic phenomenon were observed. Therefore, a discovery for a certain structure or form that has not been seen before, can open a new area of science, research or applications.

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## Time Comparison Algorithm for University Examination Scheduling

**Mohamed Shajahan H**

**College of Engineering and Information Technology  
University of Business and Technology  
Jeddah, Saudi Arabia**

**H Mohamed Zakir**

**Preparatory year Deanship  
King Faisal University  
Saudi Arabia**

### ABSTRACT

*Every educational institution needs to create either lecture or examination time tables for their students. Almost all institution prefers to perform this task with the help of software. The difficult and complex part involved during the development of such type of software's are comparing times. Programmer should come across a situation to find logic for time comparison and if it is not performed properly, it may leads to an improper output. For example, one student may get schedule for two different courses in the same time or in other scenario, same examination hall will be allocated for two different courses in the same time. Both the situation leads to a mess.*

*This paper discusses about the time comparison techniques for such software's. There are various methods available in modern day programming languages for comparing two timings. But in some cases, we have to perform the comparison up to four or more timings. The reason for this paper is, the same situation was faced by me and browsed through different articles and blogs for a possible solutions. But most blogs remains unanswered or answered with some complex solutions. So, it was an inevitable situation for me to find a new solution for the problem. This paper proposes an algorithm for comparing up to four timings.*

*In this paper, we discussed about the multiple instances where the time comparison is required while developing such software's and the various methods available in programming environment for addressing the same. The implementation difficulties for the specific requirement and the outputs acquired through the above methods are also discussed. Also, the comparison of outputs from the Dotnet methods and our algorithm is also addressed.*

**Keywords: Course or Examination Scheduling, Timetabling, Time Comparison, Timeslots, University**

### 1- INTRODUCTION

In every educational institution, always there is a need to prepare course or exam schedules for their learners. In a small to medium size institutions with less number of learners, it is easy to prepare the schedule manually. But, it is a difficult and tedious task when comes to a large scale educational institutions. Moreover, there are more possibilities of error in manual scheduling, which results into the disaster. So, there comes a need for software which should capable of preparing schedules in a single click.

When developing scheduling software's, the programmers may require comparing times in their logics. There may be a situation for performing a comparison between two timings or more. For example, if we consider two times **TIME-A** (Start Time) and **TIME-B** (End Time), it requires the following comparisons.

- a. **TIME-A** is greater than **TIME-B**
- b. **TIME-B** is lesser than **TIME-A**
- c. **TIME-X**(User Time) is greater than **TIME-A** and **TIME-B**
- d. **TIME-X**(User Time) is lesser than **TIME-A** and **TIME-B**
- e. **TIME-X**(User Time) falls between **TIME-A** and **TIME-B**

There are several functions and methods available in modern day languages to compare two timings, like **DateTime.Compare** method in visual studio.NET, which can be used to compare two **DateTime** instances. But, when there are cases, where more than two time comparisons are required, then it is inevitable to find a new logic or algorithms.

Even though there are multiple methods and functions available to compare timings, we would like to explain our own time comparison algorithm in order to perform the task efficiently and quickly. This algorithm has been already tested in Dotnet environment. Also, this can be customized based on other IDE's or database applications.

## 2- SCENARIOS IN TIMETABLING

For instance, if we develop a project which schedules examinations for an educational institution, the programmer may come across many situations to compare times in his program. For better understanding, we will proceed with an example of examination scheduling.

Now, consider the case, there are five labs in an institution (as shown in *table 1*) **2037, 2039, 2013, 2001, 2002** which can be used for scheduling the exams. These labs will be used for all departments' examination within the institution. Under this condition, the programmer needs to check the below scenarios in his program.

### Scenario 1

- a. All labs should be utilized for **COURSE-A** if all the labs are free on **DATE-A**
- b. No labs should be allocated for **COURSE-B** on **DATE-A**, since the labs are already occupied by **COURSE-A** on **DATE-A**

### Scenario 2

- a. If only three labs (**2037, 2039, 2013**) are utilized for **COURSE-A** on **DATE-A**, then, the remaining two labs (**2001, 2002**) should be available for **COURSE-B** on **DATE-A**.

### Scenario 3

- a. If all labs are utilized for **COURSE-A** in the time range **TIME-A to TIME-B** on **DATE-A**, then no labs should be allocated for **COURSE-B** in the time range **TIME-A to TIME-B** on **DATE-A**
- b. But all labs should be available for **COURSE-B OR COURSE-C** from **TIME-C** onwards on **DATE-A**

Scenario4

- a. If only three labs(2037,2039,2013) are utilized for **COURSE-A** in the time range **TIME-A to TIME-B** on **DATE A**, then the remaining two labs (2001, 2002) should be available for **COURSE B**

### 3- EXISTING METHODS

In this section, we will focus the methods with outputs available for time comparison in Dotnet environment.

#### 3.1- Method1: DateTime.Compare(DateTime, DateTime)

This method compares two instances of DateTime and returns an integer value which indicates whether the first instance is *earlier than, the same as, or later* than the second instance.

Syntax (in c#)

Public static int Compare

```
(
    DateTime t1, t2
)
```

*t1*- the first object to compare & *t2*- the second object to compare.

**Table 2 Output of DateTime.Compare method**

Value Type	Condition
Less than zero	t1 is earlier than t2
Zero	t1 is the same as t2
Greater than zero	t1 is later than t2

The above method allows comparing two DateTime instances and the requirement for comparing more than two DateTime instances cannot be satisfied by the method.

#### 3.2- Method2: TimeSpan.Compare(TimeSpan, TimeSpan)

This method compares two TimeSpan values and returns an integer value which indicates whether the first value is *shorter than, equal to, or longer* than the second value.

Syntax (in c#)

Public static int Compare

```
(
    TimeSpan t1, t2
)
```

*t1*- the first time interval to compare & *t2*- the second time interval to compare.



**Table 3 Output of Timespan. Compare method**

Value	Description
-1	t1 is shorter than t2
0	t1 is equal to t2
1	t1 is longer than t2

The above method also allows comparing two TimeSpan instances and the requirement for comparing more than two TimeSpan instances cannot be satisfied by the method.

### 3.3- Using Operators for time comparisons

Generally, while comparison, it is a normal practice to use operators like *LessThan*, *LessThanOrEqual*, *GreaterThan*, *GreaterThanOrEqual* etc. in SQL queries which may not produce the desired outputs all the times. In technical web blogs, we can be find more queries related to using operators for time comparisons which remains unanswered or answered with complex logics. It may be a difficult task for a basic programmer to understand the logics behind the posted solutions or implementing the solutions in his programs. For example, the *table4* is one of the solutions given in the blogs for selecting all dates between two dates.

**Table 4 Selecting dates between two dates using SQL**

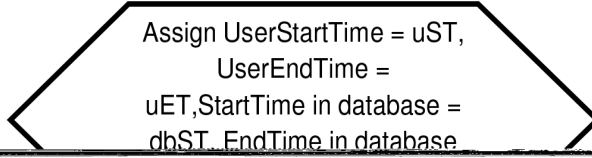
```
Select * from table_name where col_Date between '2011/02/25' AND DATEADD (s,-1,DATEADD(d,1,'2011/02/27'))
```

~~In table4, the logic is to add a day to the current col\_Date, it will be 2011-02-28 00:00:00 then subtract~~

**Table 5 Time Value Descriptions**

Serial No	Value Type	Descriptions
1	tsUserStartTime	This is the START-TIME from the user in which he needs to start the exam
2	tsUserEndTime	This is the END-TIME from the user in which he needs to end the exam
3	tsDBStartTime	This is the existing START-TIME available in database(in table Labs Allocation) which has been already allocated for another course
4	tsDBEndTime	This is the existing END-TIME available in database(in table Labs Allocation) which has been already allocated for another course

~~This algorithm can handle any number of labs and time slots if it is executed through a for loop statement. The~~



```
if (tsUserStartTime < tsDBStartTime)
{
    if (tsUserEndTime <= tsDBStartTime)
    {
        //Lab is free
        //Change Lab status to AVAILABLE
    }
    else if (tsUserEndTime > tsDBStartTime)
    {
        //Lab is busy
        //Change Lab status to NOT AVAILABLE
    }
}
else if (tsUserStartTime >= tsDBStartTime)
{
    if (tsDBEndTime <= tsUserStartTime)
    {
        //Lab is free
        //Change Lab status to AVAILABLE
    }
    else if (tsDBEndTime > tsUserStartTime)
    {
        //Lab is busy
        //Change Lab status to NOT AVAILABLE
    }
}
else if (tsUserStartTime >= tsDBEndTime)
{
    if (tsUserEndTime <= tsDBStartTime)
    {
        //Lab is free
        //Change Lab status to AVAILABLE
    }
    else if (tsUserEndTime >= tsDBStartTime)
    {
        //Lab is busy
        //Change Lab status to NOT AVAILABLE
    }
}
}
```



## 5- RESULTS AND DISCUSSION

In this section, we will consider some scenarios discussed in section 3 and compare the outputs by applying the methods available in Dotnet environment and our time algorithm.

From the *table1*, we can understand that all labs are already allocated for the **COURSE-BLUE** on **DATE-01/28/2016** in the time range **08.00:00 to 09:20:00AM**.

Now, the user wants to create schedule for another **COURSE-GREEN** on same **DATE-01/28/2016** in the time range **08.15:00 to 09:15:00AM**

Now assign the variables as below

**Table 6 Start Time and End Time from user**

Variable Name	Value
tsDBStartTime	08.00:00
tsDBEndTime	09:20:00
tsUserStartTime	08.15:00
tsUserEndTime	09:15:00

Since, the labs are already occupied, the software should not allow the schedule generation and stop the process by displaying the message **“Labs are busy. Choose another time”** to the user.

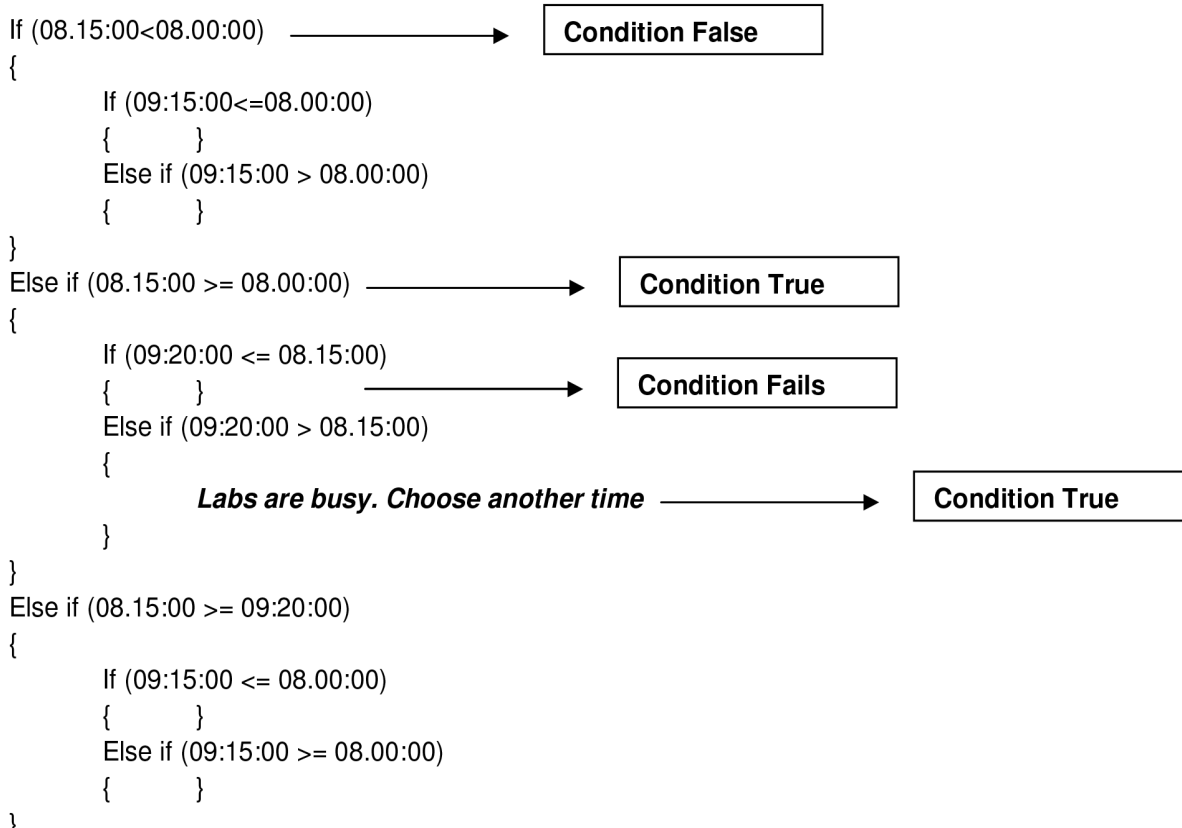
If we apply the *Timespan.Compare(TimeSpan, TimeSpan)* method for this scenario, we have to write the code as below

*Timespan.Compare*(tsUserStartTime, tsDBStartTime) = *Timespan.Compare*(08.15:00, 08.00:00)

*Timespan.Compare*(tsUserEndTime, tsDBEndTime) = *Timespan.Compare*(09.15:00, 09.20:00)

The first comparison will return an integer value 1, because the tsUserStartTime is longer than tsDBStartTime and the second comparison will return an integer value -1, because the tsUserEndTime is shorter than tsDBEndTime. Since, we can pass only two parameters to this *Timespan.Compare* method, we have to perform the comparison twice and with the returned values (1 & -1) around the neck logics should be written to achieve the required output.

Now, apply the time comparison algorithm for this scenario. As it is mentioned earlier, pass the required time slots (as in *table6*) as a parameter for the labs (2037, 2039, 2013, 2001, 2002) through a *for* loop to this algorithm.



The above algorithm will check the availability of each lab for the time slots given by the user.

## 6- CONCLUSIONS

Thus, in this paper we have discussed about the time comparison part, the core of any type of scheduling and proposed a method for comparison. All the scenarios discussed above in section 3 and other scenarios if any can be satisfied with the help of this algorithm. There are methods available in programming languages to compare two DateTime or time span values. But, through this algorithm we can perform comparison up to four timings for any number of labs and time slots.

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## A novel analysis to detect Overlay Text using OCR Process

Mohamed Shajahan H  
College of Engineering and Information Technology  
University of Business and Technology  
Jeddah, Saudi Arabia  
shajahan@ubt.edu.sa

Dr.Munir M. Alhaddad  
College of Engineering and Information Technology  
University of Business and Technology  
Jeddah, Saudi Arabia  
mmhaddad@ubt.edu.sa

### ABSTRACT

*A novel analysis to detect overlay text using OCR and linked map. Overlay text extraction for video optical character recognition (OCR) becomes more challenging, compared to the text extraction for OCR tasks of document images, due to the numerous difficulties resulting from complex background, unknown text color, size and so on. This proposed system solves the overlay text detection, OCR Process. For overlay text detection transition map is used. For OCR process font matching is used. The main aim of the research is to propose a novel framework to detect the Overlay text information in video frames. This method produces better than the previous methods. Resultant accuracy is highly improved.*

### General Terms

Image processing covers a vast area of scientific and engineering knowledge. It is built on a foundation of one- and two-dimensional signal processing theory and overlaps with such disciplines as artificial intelligence (scene understanding), information theory (image coding), statistical image classification (pattern recognition), communication theory (image coding and transmission), and microelectronics (image sensors, image processing hardware). Broadly, image processing may be subdivided into the following categories: enhancement, restoration, coding, and understanding. The goal in the first three categories is to improve the pictorial information either in quality (for purposes of human interpretation) or in transmission efficiency. In the last category, the objective is to obtain a symbolic description of the scene, leading to autonomous machine reasoning and perception.

### Keywords

Overlay text, Linked map, Transition map, Hybrid Inpaint, Video restoration, Optical Character Recognition, Sub patch method

## 1. INTRODUCTION

Most broadcasting videos tend to increase the use of overlay text to convey more direct summary of semantics and deliver better viewing experience. With the development of video editing technology, there are growing uses of overlay text inserted into video contents to provide viewers with better visual understanding. For example, headlines summarize the reports in news videos and subtitles in the documentary drama help viewers understand the content. Sports videos also contain text describing the scores and team or player names. In general, text displayed in the videos can be classified into scene text and overlay text. Scene text occurs naturally in the background as a part of the scene, such as the advertising boards, banners, and so

on. In contrast to that, overlay text is superimposed on the video scene and used to help viewers understanding. As a preliminary preparation, data will be collected as part of this research. The main aim of the research is to propose a novel framework to detect the Overlay text information in video frames.

## **2. IMPLEMENTATION**

Most of existing video text detection methods has been proposed on the basis of color, edge, and texture-based feature. The method proposed by Agnihotri [13], concentrates on the red color component, instead of all the 3 color components. Some methods used the high contrast video frames to extract the texts. Kim et al. [14] uses RGB color space and clustering concept. But no methods are fully efficient for clustering. The next coming methods used interpolation filter, wavelet coefficients, etc... In the method proposed by Wonjun Kim [5] the transition map model is proposed. But it didn't support OCR process. Also his method takes more time because frame updation is done after text detection. Thus existing methods experience difficulties in handling texts with various contrasts or inserted in a complex background. This research work proposes a novel framework to detect, extract the overlay text from the video scene, ASCII text conversion and Video restoration. Based on this observation that there exist transient colors between inserted text and its adjacent background, a transition map is first generated. Then the overlay text regions are determined based on the occurrence of overlay text in each candidate. The detected overlay text regions are localized accurately using the projection of overlay text pixels in the transition map and the text extraction is finally conducted. A video OCR method is adopted to convert the ASCII text form. The steps of the working methodology of the proposed system are described

## **3. METHODOLOGY**

### **3.1 TRANSITION MAP GENERATION**

As a rule of thumb, if the background of overlay text is dark, then the overlay text tends to be bright. On the contrary, the overlay text tends to be dark if the background of overlay text is bright. Therefore, there exists transient colors between overlay text and its adjacent background due to color bleeding, the intensities at the boundary of overlay text are observed to have the logarithmical change. The intensities of three consecutive pixels are decreasing logarithmically at the boundary of bright overlay text due to color bleeding by the lossy video compression. It is also observed that the intensities of three consecutive pixels increases exponentially at the boundary of dark overlay text. To find the intensity change in the transition region three steps are adopted. They are as follows:



1. Saturation calculation
2. Modified Saturation calculation
3. Transition map generation

If a pixel satisfies the logarithmical change constraint, three consecutive pixels centered by the current pixel are detected as the transition pixels and the transition map is generated.

#### **4. VIDEO FRAMES**

The difference of the previous frame's Transition map and current frame's transition map, decides whether to process the current frame or neglect the current frame. A threshold is used here for decision making.

#### **5. CANDIDATE MAP REGION DETECTION**

To generate the connected components, first generate a linked map [5]. If a gap of consecutive pixels between two nonzero points in the same row is shorter than 7% of the image width, they are filled with 1s. Next the Hole filling algorithm is used to fill the small gaps and to maintain the connectivity. Then each connected component is reshaped to have smooth boundaries. Since it is reasonable to assume that the overlay text regions are generally in rectangular shapes, a rectangular bounding box is generated by linking four points, which correspond to  $(\min_x, \min_y)$ ,  $(\max_x, \min_y)$ ,  $(\min_x, \max_y)$ ,  $(\max_x, \max_y)$  taken from the link map and candidate regions.

#### **6. OVERLAY TEXT REGION DETERMINATION**

In this subsection, we introduce a texture-based approach for overlay text region determination. Based on the observation that intensity variation around the transition pixel is big due to complex structure of the overlay text, we employ the local binary pattern (LBP) introduced in [6] to describe the texture around the transition pixel. LBP is a very efficient and simple tool to represent the consistency of texture using only the intensity pattern. LBP forms the binary pattern using current pixel and its all square neighbor pixels and can be converted into a decimal numbers as follows:

$$LBP_P = \sum_{i=0}^{P-1} s(g_i - g_c) 2^i$$

Where

$$s(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases}$$

P denote the user's chosen number of square neighbor pixels of a specific pixel.

$g_i$  -> neighbor pixels intensity.

$g_c$  -> intensity of current pixel.

## 7. OVERLAY TEXT MARKING

The rectangle bounding box is projected around the extracted overlay text region. Using the four corner points of candidate region we can mark the Text data.

## 8. ASCII TEXT CONVERSION

Optical character recognition, usually abbreviated to OCR, is the mechanical or electronic translation of scanned images of handwritten, typewritten or printed text into machine-encoded text into machine-encoded text. OCR is a field of research in pattern recognition, artificial intelligence and computer vision. The font database is created and database characters are extracted and stored in memory. The pure overlay content is defined by Otsu method [8]. Using vertical histogram projection the overlay text characters (in image format) is extracted. Using SSD method the matched alphabet is found and the text characters (in ASCII format) are collected into string format. In this collection of overlay texts the uniqueness strings are found and maintained as a list of overlay text.

## 8. RESULTS AND DISCUSSIONS

The previous methods are not robust to different character size. But the proposed method is robust to different character size because this is working based on transition map concept. Another advantage is the position of the text can be placed anywhere, the transition map can indicate it successfully. The proposed system is also robust to color and contrast variance. In the previous method [5] they use the frame-update after the Overlay text detection. It will take more time. To avoid this over time taken problem, this system uses the frame-update at the time calculation of transition map. This will reduce the execution time and speed up the process. The previous methods are not combined with OCR process. This system also processed a better OCR process which is adopted in Video scenes. No methods are coming with Overlay text removal facility. Here we adopted a better inpainting methodology in the extracted overlay image output. Hybrid inpaint method is used to restore the video by removing the overlay text. This hybrid method is the combination of sub-patch filling and weighted interpolation. Because of weighted interpolation the inpaint speedup. The restoration is also very accurate one.

## 8. SAMPLE OUTPUT



Fig 1: Original Frame (Sample Frame)



Fig 2: Transition map generation

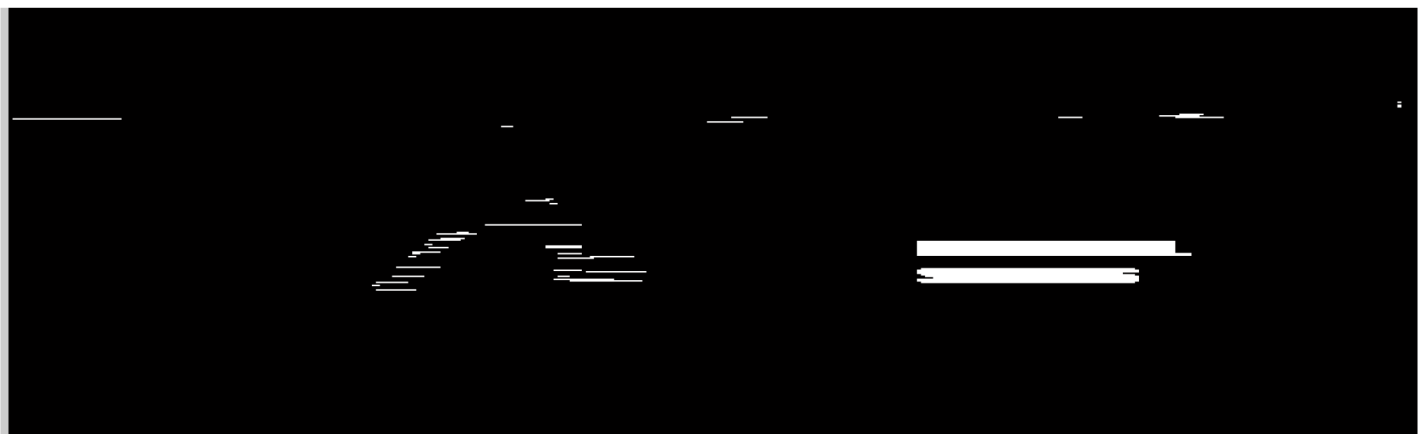


Fig 3: Linked Map

## 9. CONCLUSION

The various processes on overlay text detection from complex videos are proposed in this paper. The main concept of the work is based on the observation that there exist transient colors between inserted text and its adjacent background. We compute the density of transition pixels and the consistency of texture around the transition pixels to distinguish the overlay text regions from other candidate regions. The local binary pattern is used for the intensity variation around the transition pixel in the proposed method. The boundaries of the detected overlay text regions are localized accurately using the projection of overlay text pixels in the transition map. This research is well adopted in video data processing. The boundaries of the detected overlay text regions are localized accurately using the projection of overlay text pixels in the transition map. Next Overlay text data are converted into ASCII text form. This research is well adopted in video data processing.

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# University Students' Attitudes towards E-Learning: University of Business & Technology (UBT)-Saudi Arabia-Jeddah: A Case Study

Abdelrahim M. Zabadi<sup>1</sup> & Amr Hussein Al-Alawi<sup>1</sup>

<sup>1</sup> Dahban Campus, University of Business and Technology, Saudi Arabia

Correspondence: Abdelrahim M. Zabadi, Dahban Campus, University of Business and Technology, Saudi Arabia.  
E-mail: azabadi\_2011@hotmail.com

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## Abstract

Through the World Wide Web, education has become a ubiquitous service delivered anytime anywhere. Campus-based and without distance learners, higher education institutions attempt to fulfill the requirements of e-learning in conventional course transmission, to prepare students, staff, and educational institutions for the future involvements in educational processes. The study was conducted to examine attitudes of UBT students' in Dahban and Sari campuses towards e-learning by taking (371) students from four colleges and English language center.

In sampling techniques, we used the stratified random sampling in choosing the study sample. To gather the primary data from respondents, a well-structured questionnaire, developed by the researchers. The findings indicated that UBT participants' owns a high standard on attitude towards e-learning and their attitude results are significantly vary with their gender, technology usage and skills.

**Keywords:** E-learning, attitude, gender, student, UBT

## 1. Introduction

The rapid development and wide-spread usage of e-mail; chat rooms; social networks; interactive multimedia applications; web conferences; and internet technologies, as a result the internet effectively used in educational environment (Yamamoto, DEmiray, & Kesim, 2011; Yapici & Akbayin, 2012). This evolution led to creating a modern educational environment like: electronic and distance learning, and online learning-Learning includes several approaches and employments through web-based and computer-based learning, digital cooperation, and practical classes. Thus, e-learning recently is acceptable as a comprehensive modern concept that indicates to training based on different electronic equipment's and multimedia (Hazendar, 2012).

The experiences obtained from e learning in the long term provide a valuable opportunity to educational institutions for getting new and modern areas for this type of education. Likewise, those systems of education have enabled students to access several diverse contents anytime, anywhere. This allows the learners further dominance on their learning experiences, and qualifying the learners to collect the educational courses the students need , and study where as they have enough time (Bhatia, 2011).

In the current era, the internet has become more competent in helping individuals in everyday life activates, for this reason; it is globally utilizes in different fields of education, which becomes potential and appropriate. Very briefly, the extensive usage of computer technologies and internet had led to the acknowledgement of this technology in many different educational fields. Employing the technology as teaching and learning appliances has become to an increasing extent more wide-spread; the teaching materials are enriched and have been requested as a part of educational processes and even a priority objective (Yalman, GÖnen, & BaŞaran, 2013).

Various educational institutions around the world combine e- learning platforms to come upon the essential necessity of the rapid increasing of students' numbers who is searching for the appropriateness of online courses and to keep compete in quickly changeable educational environment and available opportunities. E- Learning offers opportunities to encourage education towards generate an environment where group of students and teachers can share their experiences and awareness.

Therefore, it is extremely significant to layout an effective e-learning scheme for instructions, education, human resources, and well – trained administration staff for higher education (Nelasco, Arputharaj, & Paul, 2007).

However, the major important question is here: Does that educational institution and students are willing to adopt e-learning facilities through their advancement? To answer this question, investigators attempted to verify the attitude of UBT students toward e-learning.

Several researches conducted to measure the influence of demographic on students' attitude towards e learning. Likewise, previous researches reports that the primary factors participating in internet usage are socio-demographic characteristics such as gender, rather than socio-economic characteristics like monthly salary, level of education, or another psychological factors (Nassoura, 2012).

In Developing countries, university student's attitudes vary towards e learning, but in general, we can say that their attitudes are positive. This was emphasized by (Nassoura, 2012) who expressed that the majority of students have a favorable behavior toward the e-learning, since, the e-learning had a positive influence on students' motivations (Nassoura, 2012).

The demographic characteristics and technological skills are considered as global problem to the learners; therefore, understanding users' personal characteristics and e-learning systems usage is necessary to introduce an effective e-learning.

As for student's factors, the researchers focused on investigating students' characteristics regarding to their gender, and technology experience and skills also. Previous studies show that there is a rareness of researches about student's individual differences such as Gender, Technology Usage and Skills. This research wishes to fallout this void in similar literature. The research is structured as following; the following section introduces the background, followed by research objectives, questions, and methodology. Finally, discussion and conclusions, suggestions for future researches are also included.

## **2. Theoretical Background**

In this part of the study, we will present some related previous studies on the variables under consideration. Many researches investigate the influence of demographic profiles such as computer ownership, age, gender, education, personal skills and computer and internet on university students' attitude towards e-learning (Paris, 2004).

### *2.1 E-Learning*

Developments in the field of science and technology influenced the education as many other scientific areas. For this, it becomes very important to expand the technological infrastructure for educational institutions, particularly as the methods and technologies of education changing quickly.

Internet usage and developed social media interactions by means of the internet technologies has influenced the technology facilitated the pedagogical services. Accordingly, our everyday lives have turn into technology centered more and more (NCTM, 2000). Pedagogic organizations, which are responsible for preparing learners to the future, making further technology utilization through enhancing curriculum. Computer usages assisted instructional systems (Chang, 2002), animations (Lin & Atkinson, 2011), emulation, and 3-D virtual environments have become familiar (Rafi, Samsudin, & Ismail, 2006).

Other adequate contribution of current technology growth for education is the widening of e-learning environments. With use of advancements in technology and communications, including visible and audial responses has become probable in the learning environment; e-learning environments offer lifelong learning opportunities by removing socio-economic discrepancies (Duran, Önal, & Kurtuluş, 2006).

Advantages of e-learning are: the learner determined the time of learning; materials can be accessed anytime, anywhere via internet connectivity; speed, time, and the amount of courses can decide by e-learners themselves; materials and information is already able to be obtained and can be regenerated; efficiency of the education can be assessed immediately; courses criteria can be dependently obtained by students; teachers are obtainable permanently through e-mail; forums, web, etc.; costs instructional costs were reduced (Gülbahar, 2012).

The expression electronic learning includes widely vision of educational instruments and methodologies that continue to meet the students and educators needs a like. Global communications and internet rapidity, the growth of web content became more and more interactive for end users. Systems of e-learning supplies additional adaptable methods of communicating that qualifies student has to inter act easily together (Spender, 2001). Newton (2003) suggested that systems of e-learning includes three major fields: enhancing accessibility to the beast learning and training; improving quality of education and study; and the necessity for higher education institutions (HIEs) to obtain competitive quality in changeable environment within the field of education (Newton, 2003).

Additionally, e-learning platform based on the network motivates accumulation of individual acquaintance, sharing of knowledge amongst learners, and therefore, strengthen the competitiveness of individuals and the group. In total, the e-learning platform looks like an advanced step towards education of with high-efficiency and better quality.

E Learning, particularly the utilize of learning management systems (LMSs), introduced a modernistic side. Investigators proposed that some learners and trainers might have insufficient skills and experience to use web-based learning platforms effectively (Brüchner, 2003). This concern is often researched in the context of gender variation. Primary issue is that female students are at a disadvantage due to different patterns of computer use (Richter, Naumann, & Horz, 2001).

## 2.2 Gender

Literature suggests that gender represents critical part in realizing the variation in perceptions towards technology skills and attitudes on e-learning; numerous researches were conducted to explore impact of gender, year of study on student attitudes towards e-learning. Many studies confirmed that student's male owns more positively attitudes towards e learning than female students (Liaw & Huang, 2011).

Egbo et al. (2011), they concluded that female would accept information and communication technologies (ICTs) use more than males (Egbo, Okoyeuzu, Ifeancha, & Onwumere, 2011). Liaw and Huang (2011) their findings confirmed that male owns a positive attitude toward e-Learning than female. Furthermore, the researchers proposed that experiences and skills in computer is an important indicator on learners' motivation toward e-learning.

Cheng (2006) believes that individual characteristics like gender, computer skills are not enough. Computer experience and skills played a primary factor in influencing on students' attitudes about e-learning (Cheng, 2006) also, identified characteristics like age, gender, computer experience, technology acceptance, and individual learning styles as principal factors when investigating the students attitudes concerning e-learning processes. Katz et al. (1995) stated that "no important variation between attitude scores for male and female".

Suri and Sharma (2013) clearly expressed that "no gender variations about the attitudes towards e-learning". These result fit with several new studies which exposed that the gap between male and female in this issue is narrowing (Bhattacharjee, 2008).

Yacob et al. (2012) examined the familiarity of university students' in e learning, discussion of analysis were carried out on the students' perceptions regarding to gender, technology usage and the knowledge about e-learning implementation. Results shows that gender have a significant effect on attitudes towards e-learning (Dørup, 2004), 46% of males from first-year students prefer replacing "traditional learning" by using computer in learning, while only 22% of women support this result.

Liaw and Huang (2011) explored the individual's attitudes and behaviors in utilizing e-learning regarding to gender differences, computer skills. A result shows that male learners have additional positive attitudes towards e-learning than female students, and experience in computer usage is a significant index on learners' attitude toward e learning.

According to Sebnmen (2015), the mean score of female attitude toward e-learning is higher than those of the male are; difference between the mean scores not found to be statistically significant. Gender did not significantly affect student's attitudes towards e-learning did not significantly affected by gender.

Dhiman et al. (2014), mentioned that male and female students own a high attitude towards e-learning although female students have slightly higher attitude towards e-learning than their male counterpart (30).

This finding is consistent with work of Mehra and Omnidan and Adewole-Odeshi who found that postgraduate students have high positive attitude towards e-learning. These results supported by the work of (Paris, 2004; Colley, 2003; Liaw et al., 2011) but not support the work of (Bhubaneswari & Padmanaban, 2012) who found that male and female students possess different attitude towards e-learning.

## 2.3 Technology Usage and Skills

The past few decades have witnessed an increasing interest in using computers in educational establishments in developing countries. The use of the Web networks, computer and mobiles acquired an interest between learners who utilize these tools for pedagogical objectives. This suggests that students have a high degree of computer skills and use its various applications. The students' ability to use Internet and communication Technologies (ICTs) was significantly hindered by the low level of technology access (Husain, 2007).

Bhuasiri et al. (2012) found that the greatest important factors concerning the growing technology knowledge



and improving behavior to e-learning, promoting principal technology familiarity and expertise, improving study content, demanding computer training, motivating users to utilize e-learning systems, and requiring a high degree of support from the institute (Bhuasiri, Xaymoungkhoun, Zo, Rho, & Ciganek, 2012).

In addition, attributes used to assess the attitudes towards ICT of students, teachers and principals have been categorized in two groups: demographics such as age and gender and computer skills and experience Papaioannou and Charalambous (2011) Many studies identified a positive correlation between computer experience and attitudes toward e-learning (Papaioannou, & Charalambous, 2011).

#### 2.4 Attitudes

The attitude toward e-learning can be viewed as a an umbrella for the methods of education supported by ICT, and specified with the consent or lack of consent of the students or lack of consent on the importance of technology and their special skills. Besides that, students' attitude towards e- learning affected through what they see as the advantages and disadvantages for this type of education.

Bertea (2009) talking about e learning, a favorable attitude shows a greater probability that learners will accept the new learning system. Factors such as patience, self-discipline, easiness in using software, good technical skills, and abilities regarding time management impact on student's attitude towards e-learning, thus, the attitude can be positive, if the new form of education fits the students' needs and characteristics, or negative if the student cannot adapt to the new system because he does not have the set of characteristics required (Bhatia, 2011).

### 3. University of business & Technology (UBT)

**UBT** is the leading private institution in the area of business and technology in Jeddah City / Saudi Arabia. **UBT** has grown progressively from a beginner College to a full four-year college, college of Business Administration (**CBA**). The launch of Faculty of Engineering and Information Technology (CEIT) in 2008, College of advertising (JCA) joined after approved by Saudi MOHE in 2011 as the third faculty. In 2012, the Higher Council of the Saudi Higher Education formally stated UBT as the University of Business & Technology.

As the technology is advancing, the need of the university faculties', staff, and the growing number of students, the demand of e-learning is also increasing, for this, UBT has to cope with these technological and human developments by improving and developing its own technology tools particularly in education and training programs.

UBT e-learning vision is *"to become the first university of e-learning education in the area"* according to the university president professor Hussein Al-Alawi. This is achieved by creating an environment where the use of ICTs is regarded as an integral part of the university practices and management of educational process.

UBT e-learning mission is *"to promote an e-learning phenomenon where students, teachers and investigators utilizes technology to develop the total pedagogical experiences in campus and off campus alike"*, as the president mentioned. This is achieved by provide quality of education that is accessible anytime , anywhere ,as well as to encourage and support the effective use of technology in the curricula through continuous improvements in existing programs and the creation of new technology opportunities for students , instructors , administration and faculty as a whole.

### 4. Study Objectives

This study seeks to achieve the following goals:

- 1) To reveal whether attitudes of UBT students towards e-learning varies according to gender.
- 2) To locate whether attitudes of UBT students towards e-learning varies according to student's use of technology and skills.
- 3) To investigate the overall attitudes of UBT students' towards e-learning.

### 5. Study Questions

In line with those objectives, questions below were formulated:

- 1) Are there significant differences in attitudes towards e-learning according to the gender?
- 2) Are there significant differences in attitudes towards e-learning according to student's use of technology and skills?
- 3) What are the overall attitudes of students towards e-learning?



## 6. Study Hypotheses

To study university students' attitudes towards e-Learning, the following research question is proposed: "What are the overall attitudes towards e-learning in UBT?" In relation to above research question, the following three hypotheses have been formulated:

The first Hypothesis (H1): There are no statistically significant differences in attitude towards the e-learning according to gender.

The Second Hypothesis (H2): There are no statistically significant differences in attitude towards e-learning based technology usage and skills.

The Third Hypothesis (H3): UBT students' attitude towards e-learning is low.

## 7. Research Methodology

### 7.1 Population

This study employed a questionnaire to examine the attitudes of students towards e-learning. The target population was the students of UBT, Dahban and Sari campuses, Jeddah, Saudi Arabia. A total of (402) questionnaires were distributed in College of Engineering and Information Technology (CEIT), College of Business Administration (CBA), and college of Graduate Studies (MBA), College of Advertising (JCA), in addition to English Language Center (ELC). (402) questionnaire were collected, (31) of those were neglected because they were incomplete. (371) found statistically usable for this study representing a response rate of (92.3 %). A reliability coefficient is more than (0.70) indicates that the items used in the study are reliable.

### 7.2 Instrument

Questionnaire composed from three parts. The first part includes the respondents' demographic profile such: as gender, age, and college. This was followed by (15) items on computer practices and skills related to e-learning tools and activities, while the third part is the statements of overall attitudes towards e-learning, consists of (11) items, each rated on five-point Likert scale running from (1 = Strongly disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly Agree). For this study, experts in the field ensured face and content validity of the items through consultation.

### 7.3 Procedures

Questionnaire was distributed during the classes under supervision of the lecturers and co-authors on a voluntary basis. An objective of the questionnaire is clear for all participants and aims. Participants were asked to fill in questionnaire during the lecture. It was ascertained that participants should not write their names or putting any distinctive mark on the questionnaire.

## 8. Data Analysis

### 8.1 Sample Characteristics

This section will discuss the demographic characteristics of the participants (gender, age, and college) Data indicates that (76%) are male, and (24%) are female, Figure 1. Majority of respondents aged between (20-26) years old (58%), (19%) were less than 20 years old, (19 %) were between (26-30) years old, and (4%) were greater than 30 years old, Figure 2. The distribution of student according to colleges, results indicated that: (33%) from CBA, (29%) from CEIT, (20%) from ELC, (10%) from MBA, and (8%) from JCA, Figure 3.

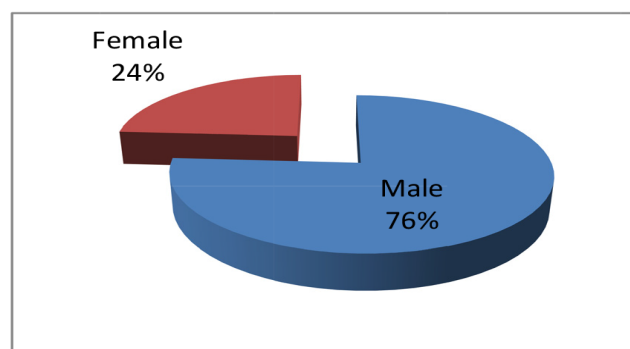


Figure 1. Respondents' distribution according to gender

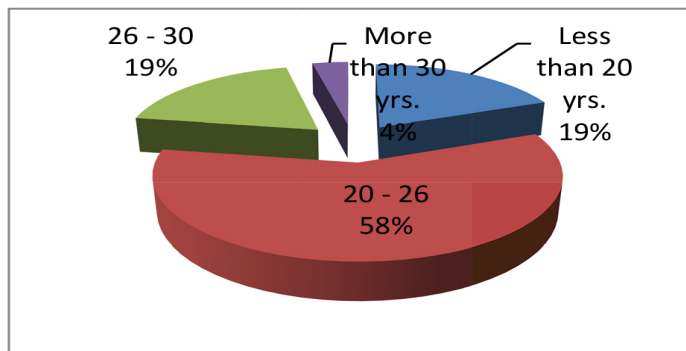


Figure 2. Respondents' distribution according to age

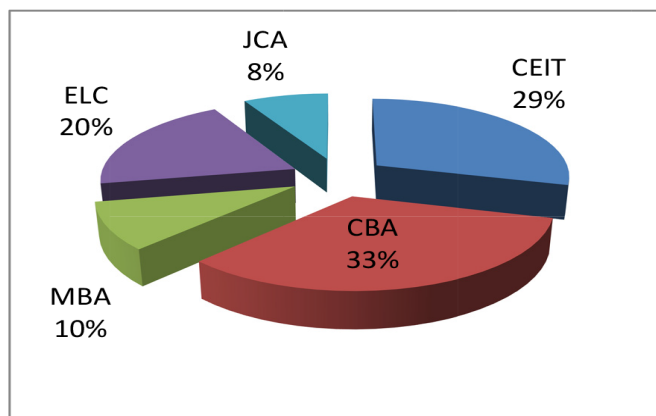


Figure 3. Respondents' distribution according to college

8.2 Statistical Results

Descriptive statistics (Means and Standard Deviations) of sample's responses regarding perception of variables.

Table 1. Technology usage and skills

Questions	Mean	Std. Deviation
I feel comfortable in my ability to do with computer technologies.	3.8	1.05465
I like working with computers.	3.8	1.00126
I do not feel threatened by the effect of computer technologies.	3.6	1.18683
I prefer to employ computer to wright my assignments.	3.6	1.17251
I would like to choose to use computers in my learning.	3.6	1.04331
I usually use Internet during my self- study.	3.9	1.00658
Normally, I download learning content from Internet.	3.7	1.05096
Reading e-book is favored for me.	3.1	1.22422
I download pictures, graphs, reports, assignments, course materials, presentations from Internet.	3.8	1.05846
I face several problems while using the internet.	3.2	1.20731
I use electronic library in my self-study.	3.2	1.15218
I prefer to transfer the educational materials electronically (by e- mail) to my colleagues, friends, and teachers.	3.6	1.11618
I feel satisfied and joy full when educational material collected from Internet.	3.5	1.03182
I use different educational blogs for interaction.	3.3	1.14722
Over all, I feel at ease learning by computer technology.	3.7	1.00361
Total	3.6	1.0971

Table 2. Overall attitudes

Questions	Mean	Std. Deviation
I am interested in studying some courses that utilize e-learning.	3.6	1.14673
I think that e-learning promotes my learning experiences.	3.8	1.78975
Presenting courses on the internet, makes learning more efficient.	3.6	1.04327
I intend to use e-learning tools during the semester, if available	3.6	1.00526
I am positive about e-learning.	3.7	1.04590
E-learning environment needs advanced technical knowledge.	3.7	.98498
I would prefer to have some courses on the internet, rather than in classroom (face-to-face).	3.3	1.23669
Online Learning is more comfortable and enjoyable to me.	3.2	1.15242
E-learning is a favorable alternative to the pen-paper based system.	3.3	1.13616
E-learning is not efficient as a learning method.	3.3	1.10268
Over All, I prefer e-learning and I believe that it is better than traditional method of learning.	3.4	1.21788
Total	3.5	1.1693

### 8.3 Hypothesis Testing

The Statistical Package for Social Sciences (SPSS) software tests the hypotheses.

**First hypothesis:** There is no significant difference in attitude towards e-learning according to gender.

Table 3. Test of hypothesis 1

variable	Gender	N	Mean	Std.	df	(t) value	(Sig) level
difference in attitude towards e-learning	Male	282	39.9	6.7	369	5.62	0.001*
	Female	89	34.4	10.6			

\* Significant at (0.05) level.

The mean of attitude scores for male and female university students is found to be (Mean=39.9) & (SD = 6.7) and (Mean = 34.4) & (SD = 10.6) respectively. It indicates that UBT male and female students have a high attitude towards e-learning although male students possess higher attitude towards e-learning than their female counterpart does.

T-Value (Table 3) is found to be ( $t = 5.62$ ) at significance level of (0.001) which is statistically significant. Therefore, there is a significant difference in attitude towards e-learning, between male and female student. In view of the above, the Null hypothesis is rejected. Thus, there is a significant difference in attitude towards e-learning, between UBT male and female student. This result supported by the work of (Bhubneswari et al., 2012), who found that male and female university students possess different attitude towards e-learning.

Second hypothesis: There is no significant difference in attitude towards e-learning based technology usage and skills.

Table 4. Test of hypothesis 2

variable	Gender	N	Mean	Std.	df	(t) value	(Sig) level
difference in attitude towards e-learning based technology usage and skills	male	282	55.3	8.2	369	4.83	0.001*
	female	89	50.4	12.5			

\* Significant at (0.05) level.

The mean of attitude scores for male and female university students is found to be (Mean=55.3) & (SD = 8.2) and (Mean = 50.4) & (SD = 12.5) respectively. It indicates that UBT male and female students have a high attitude towards e-learning although male students possess higher attitude towards e-learning than female.

T-Value (Table 4) is found to be ( $t = 4.83$ ) at significance level of (0.001) which is statistically significant. Therefore, there is a significant difference in attitude towards e-learning according to gender. In view of the

above, the Null hypothesis is rejected. Thus, there is a significant variation in attitude towards e-learning based technology usage and skills. This result supported by (Egbo et al., 2011) who found that both female and male students possess a different attitude towards e-learning.

Third hypothesis: UBT students' attitude towards e-learning is low.

Table 5. Test of hypothesis 3

variable	Mean	Std.	df	(t) value	(Sig) level	x <sup>2</sup> value	p-value
attitude towards e- learning level	3.5	1.0421	370	107.69	0.00	248.3	0.00

\* Significant at (0.05) level.

The mean of attitude scores is found to be (Mean=3.5) & (SD = 1.0421) and (Mean = 34.4) & (SD = 10.6) respectively, ( $3.40 < 3.5 < 4.19$ ). The t- Value (Table 5) is found to be (t=107.69) at significance level of (0.000), ( $x^2 = 248.3$ ), which is statistically significant. In view of the above, the third Null hypothesis is also rejected.

Thus, UBT students have a high attitudes towards e-learning. This indicates that an UBT student attitude towards e-learning is high. This finding is compatible with the study of (Ahmad Bendania, 2011) which supported that Saudi students have a high positive attitude towards e-learning.

## 9. Discussion and Conclusion

The aim of this study is to examine the UBT students' attitude towards e-learning. The study has examined the impacts of gender, technology usage and skills on students' attitude towards the e-learning. The outcomes from analyses provide strong support the three null hypotheses. In addition, this study has found that the influence of gender, technology usage and skills are statistically significant, this conclusion need to further consideration and testing. UBT students have generally positive attitude towards e-learning, consequently, the researchers can conclude with high confidence that university students are willing to accept many courses via online mode.

The study demonstrate that e-learning is offering a precious opportunities for higher education the institutions (HEIs) to a considerable amount of students who wish in pursuing their education regardless of their, spatial, economical, and social barriers. Teachers have to adopt strategies to change the negative attitudes towards e-learning by introducing further e-learning courses in lower study years and promote students to use the internet in their education and communication with their teachers and their colleagues.

## 10. Suggestions for Future Research

Based on the results of the current study, the researchers would like to suggest the following recommendations.

- The extensive and appropriate use of the internet and modern technologies can make up the lack of campus activities and the rarity of student-instructor interaction.
- Conduct similar studies for further investigation of instructors' attitudes to the e-learning.
- As no other researches consider the variable of academic level for the first university degree, it could be fruitful to outline it for further researches.
- Further research is recommended to identify other variables such as (class level, learning method, and motivation type) that may affect the students' attitudes toward e-learning.
- In addition, it would be advantageous to see that the findings presented in this study could expand to include instructors and institutions to assure the successfulness of the e - learning. This will be beneficial to the persistent evolution of this significant research area.

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# Encapsulation of L-Histidine Amino Acid Inside Single-Walled Carbon Nanotubes

Hakim Al Garalleh<sup>1,\*</sup>, Ngamta Thamwattana<sup>2</sup>, Barry J. Cox<sup>3</sup>, and James M. Hill<sup>3</sup>

<sup>1</sup>Nanomechanics Group, School of Engineering and Basic Sciences, University of Business and Technology, Jeddah 21433, Saudi Arabia

<sup>2</sup>Nanomechanics Group, School of Mathematics and Applied Statistics, University of Wollongong, NSW 2522, Australia

<sup>3</sup>Nanomechanics Group, School of Mathematical Sciences, University of Adelaide, SA 5005, Australia

Carbon nanotubes have attracted considerable interest for their use as carriers of drugs across biological barriers. In this work, we investigate the encapsulation of L-Histidine amino acid inside a single-walled carbon nanotube, and determine the resultant interaction energy for various sizes of the nanotubes. In our model, the L-Histidine amino acid is accounted for in four parts; the inner ring group, the half outer group, the linear part and the cylinder group, all interacting with a single-walled carbon nanotube. We calculate the acceptance and suction energies which depend on the radius  $r$  of the carbon nanotube and the orientation angle  $\varnothing$  that the amino acid makes with the central axis of the nanotube. Our results indicate the acceptance of the L-Histidine amino acid into carbon nanotubes of  $r > 3.7 \text{ \AA}$ , which is in good agreement with other recent studies.

**Keywords:** Carbon Nanotubes, L-Histidine Amino Acid, Encapsulation, Lennard-Jones Potential, van der Waals Interaction.

## 1. INTRODUCTION

The possibility of using carbon nanotubes as carrier for drugs has generated much interest due to their exceptional electrical and chemical properties.<sup>1</sup> These considerations have led to a number of studies involving geometries and the interaction between nanotubes and drugs, as well as the mechanisms of encapsulation and reactivity.<sup>2</sup> Other studies have also discussed the changes in the chemical and electrical properties at the surfaces of carbon nanotubes.<sup>3–7</sup> For example, the change of their conductivity is considered in Refs. [8–10]. Dresselhaus et al.<sup>11</sup> predict that the carbon nanotube with chiral vector (5, 5) would be the most significant physical nanotube.

Carbon nanotubes possess a huge potential for the development of new techniques for drug delivery systems. In particular, they can be covalently and non-covalently bonded to bio-molecules, such as amino acids, for targeted delivery applications.<sup>12</sup> Amino acids can interact with either the inner surface or the outer wall of carbon nanotubes.<sup>13</sup> In this paper, we study the interaction between L-Histidine amino acid which has chemical composition  $C_6H_9N_3O_2$  and a single-walled carbon nanotube. Histidine amino acid plays a major role in regulating

hormone secretion in humans and other mammals, and it is essential for both infants and adults.<sup>14</sup>

Histidine is a proteinogenic amino acid and has an imidazole functional group. It was first identified by Abrecht Kossel (German Physician) in 1986.<sup>15</sup> An acid dissociation constant (pKa) of the imidazole side chain in Histidine is approximately 6.0. At physiological conditions, any small shift in pH values changes its average charge. The imidazole ring is mostly protonated (pH less than 6), described by Henderson-Hasselbalch equation, and has a positive charge which is equally distributed between both basic nitrogen and bears two NH bonds.<sup>16,17</sup> The imidazole ring of Histidine is aromatic (has six pi electrons) at all values of pH, four from double bonds and two from a lone pair of nitrogen.<sup>17,18</sup> It was formerly thought that it was only an essential substance for infants during growth and for those recovering from an illness, but recent studies have established that it is as an essential substance for adults, especially for those recovering from deficiency and illness by involving in tissues repairing, synthesis of hemoglobin strengthening of the immune system.<sup>14,19</sup> In addition, L-Histidine helps to regulate feeding and energy behavior of leptin action in the brain.<sup>20–22</sup> The basic nitrogen in Histidine can absorb proton from Cysteine or Serine. Histidine proton is used to rapidly regenerate the active form of the enzyme by shuttling

\*Author to whom correspondence should be addressed.



protons from zinc-bound water molecules and also utilized as an essential substance during growth, childhood and teenage periods.<sup>19</sup>

Many studies have addressed the ability of proteins and amino acids to conjugate with carbon nanotubes as carriers or inhibitors for drug delivery and disease therapy.<sup>23–25</sup> There are also theoretical works on the interactions between different amino acids and multi-walled and single-walled carbon nanotubes. Molecular dynamics simulations show that the therapeutic effects of conjugated amino acid-nanotube are highly promising for use as selective protection against pathogens and viruses.<sup>26</sup> Roman et al.<sup>26</sup> investigate the encapsulation of amino acids and proteins in carbon nanotubes of small diameters ( $\approx 4$  Å) using density functional theory. Several studies have recently discussed the suitability of poly amino acids phosphazene biomaterials in regard to the major role in tissue engineering and delivery of therapeutics, and their distinct mechanical and responsive properties.<sup>27–29</sup> Sun et al.<sup>30</sup> use different types of  $\alpha$ -amino acids that have been effectively developed as building units for degradable polymers, this may offer several advantages such as imparting chemical functionality (hydroxyl-, carboxyl-, thiol- and amine-groups) which not only facilitates further modification with bioactive molecules, but also improves hydrophilicity and the possibility of interactions with proteins and genes. Ganji<sup>2</sup> investigates the encapsulation of different amino acids (namely Nonionic-gly, Histidine, Cysteine and Phenylalanine) inside single-walled carbon nanotubes and calculates the interaction energies for the outer and inner surfaces of the single-walled carbon nanotube (13, 0). His results show that the interaction energies between amino acids and single-walled carbon nanotubes are very small (in the range of approximately  $-0.1$  to  $-0.8$  eV) compared to those of gas molecules (20.8 eV) and nucleic acid bases (20.1 eV).<sup>31–36</sup> Ganji<sup>2</sup> obtains the potential energies between L-Histidine amino acid and carbon nanotubes using two different methods; density functional-based tight binding plus (DFTB+ and DFT) and the Spanish initiative for electronic simulations with thousands of atoms (SIESTA). In this paper, we propose a new model to describe the interaction between L-Histidine amino acid and a single-walled carbon nanotube by using classical mathematical techniques.

Particularly, this paper examines the encapsulation of L-Histidine amino acid inside various sizes of single-walled carbon nanotubes (Fig. 1). Various atomic interactions are modelled assuming both discrete and continuum atomic distribution. We assume that a single-walled carbon nanotube is well-defined and characterized and thus it is modelled as a perfect cylinder with uniform atomic distribution. The L-Histidine amino acid is assumed to be composed of four components as shown in Figure 2. The resultant total potential energy depends on the nanotube radius and the orientation of the L-Histidine amino

acid. Using the Lennard-Jones potential, we derive the interaction force and the potential energy which are used to determine the encapsulation of the amino acid in the nanotube. Through our assumptions, we obtain analytical expressions for the total potential energy, involving series of binomial and hypergeometric functions which are used to calculate numerical solutions.

This paper is structured as follows. In the next section, we outline the Lennard-Jones potential and the assumption used to derive expressions for the potential energy for various interactions. A certain part of the derivation for the total potential energy is presented in Appendix A. In Section 3, we evaluate the total potential energy and the interaction force, and present the numerical results of our model. Finally, concluding remarks are given in Section 4.

## 2. INTERACTION POTENTIAL

Here, we outline the approaches to describe the non-coulombic interaction between two distinct entities. Girifalco<sup>37</sup> states that “From a physical point of view the discrete atom-atom model is not necessarily preferable to the continuum model.” Discretely, this can be obtained by summing all interaction pairs which is given by

$$V^{\text{tot}} = \sum_i \sum_j \Phi(\rho_{ij}) \quad (1)$$

where  $\Phi(\rho_{ij})$  is the potential function for atoms  $i$  and  $j$  at a distance  $\rho_{ij}$  apart on two different molecular structures. In the continuum approximation, atoms are assumed to be uniformly distributed over the surfaces of the two molecules. Thus, we can replace the double summation by a double integral over the surface of each molecule, so that the total energy is given by

$$V^{\text{tot}} = \eta_i \eta_c \int_{\delta_c} \int_{\delta_i} \Phi(\rho) d\delta_i d\delta_c \quad (2)$$

where  $\eta_i$  and  $\eta_c$  are the atomic surface densities of atoms on the two interacting molecules,  $\rho$  is the distance between two typical surface elements  $d\delta_1$  and  $d\delta_2$  located on the two interacting molecules. We may also use the hybrid discrete-continuum approach which is given by

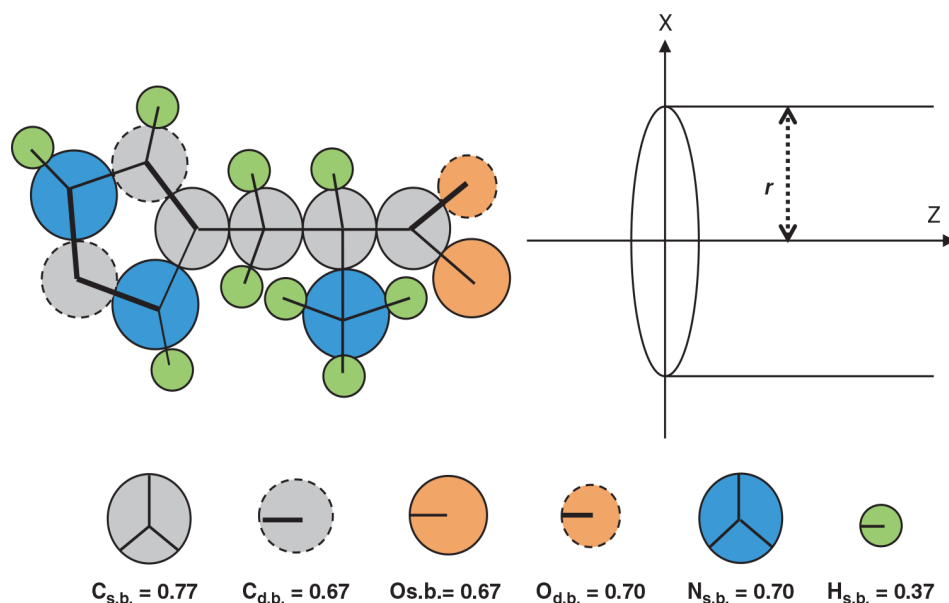
$$V^{\text{tot}} = \sum_i \eta_i \int \Phi(\rho) d\delta_i \quad (3)$$

to determine the interaction energy between a well-defined structure and an irregularly shaped molecule. Here, we adopt the classical Lennard-Jones potential which is given by either of the two equivalent forms

$$\Phi(\rho) = -A\rho^{-6} + B\rho^{-12} = 4\epsilon \left[ -\left(\frac{\sigma}{\rho}\right)^6 + \left(\frac{\sigma}{\rho}\right)^{12} \right] \quad (4)$$

where  $A = 4\epsilon\sigma^6$  and  $B = 4\epsilon\sigma^{12}$  are the attractive and repulsive constants, respectively,  $\epsilon$  is the well depth and  $\sigma$  is the van der Waals diameter. We also use the empirical combining laws<sup>38,39</sup> given by  $\epsilon_{ij} = (\epsilon_i \epsilon_j)^{1/2}$  and  $\sigma_{ij} = (\sigma_i + \sigma_j)^{1/2}$  to determine the values of  $A$  and  $B$  for different types of atoms.





**Fig. 1.** Interaction between L-Histidine amino acid ( $C_6H_9N_3O_2$ ) and a single-walled carbon nanotube (each atom specified by distinct color; Carbon: Grey, Nitrogen: Blue, Oxygen: Orange and Hydrogen: Green) (s.b.: Single bond and d.b.: double bond).

**2.1. Interaction Between L-Histidine Amino Acid and a Single-Walled Carbon Nanotube**

**2.1.1. Total Interaction Energy**

Here, we determine the interaction between L-Histidine amino acid and a nanotube in four parts as shown in Figure 2. Firstly, we consider the two nitrogen and three carbon atoms which are assumed as a ring of imidazole group interacting with a single-walled carbon nanotube of radius  $r$ . The nanotube is assumed to be cylindrical which can be parameterized by  $(r \cos \theta, r \sin \theta, z)$  where  $z \in (-\infty, \infty)$ . The ring of imidazole group is assumed to be located at  $(a_1 \cos \theta_1, 0, a_1 \sin \theta_1 + z_0)$ , as shown in Figure 2(i), where  $a_1$  is the radius of the inner ring,  $\theta_1 \in [0, 2\pi]$  and the distance  $\rho$  between the inner ring and the nanotube tube is  $\rho^2 = (r \cos \theta - a_1 \cos \theta_1)^2 + (r \sin \theta)^2 + (z - a_1 \sin \theta_1 - z_0)^2$ . From the work of Tran-duc et al.<sup>40</sup>

(special case:  $\epsilon = 0, R = a_1, \varnothing$  is variant), the interaction energy between the ring and the single-walled carbon nanotube is given by

$$E_1 = \eta_1 \eta_2 \int_{\delta_c} \int_{\delta_l} \Phi(\rho) d\delta_l d\delta_c = \eta_1 \eta_2 (-AJ_3 + BJ_6) \quad (5)$$

where  $\eta_1$  and  $\eta_2$  are the atomic surface density for a carbon nanotube and the atomic line density of the ring, respectively. We note that  $d\delta_c = r dz d\theta$  and  $d\delta_l = a_1 d\theta_1$ . Here, the integral  $J_n$  is defined by

$$J_n = r a_1 \int_0^{2\pi} \int_0^{2\pi} \int_{-\infty}^{\infty} \frac{1}{\rho^{2n}} dz d\theta d\theta_1 \quad (6)$$

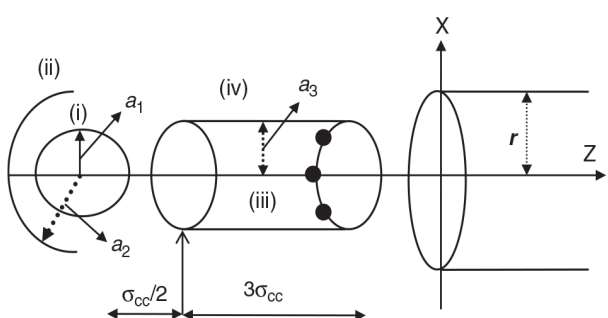
Secondly, the outer half ring of the three hydrogen atoms is assumed to be located at  $(a_2 \cos \theta_2, 0, a_2 \sin \theta_2 + z_0)$  as shown in Figure 2(ii), where  $a_2$  is the radius of the outer ring and  $\theta_2 = \theta_1 + \sigma_{CH}$ ,  $\sigma_{CH}$  is the C-H bond length and  $\theta_2 \in [\pi/2, 3\pi/2]$ . The distance  $\rho$  between the outer ring and the nanotube is given by  $\rho^2 = (r \cos \theta - a_2 \cos \theta_2)^2 + (r \sin \theta)^2 + (z - a_2 \sin \theta_2 - z_0)^2$ . From Tran-duc et al.<sup>40</sup> (special case:  $\epsilon = 0, R = a_2, \varnothing$  is variant), if we define  $I_n$  as

$$I_n = r a_2 \int_{\pi/2}^{3\pi/2} \int_0^{2\pi} \int_{-\infty}^{\infty} \frac{1}{\rho^{2n}} dz d\theta d\theta_2 \quad (7)$$

where  $\eta_3$  is the atomic line density of the outer ring, then the interaction energy can be given by

$$E_2 = \eta_1 \eta_3 (-AI_3 + BI_6) \quad (8)$$

Thirdly, we consider the three carbon atoms as a linear molecule which is assumed to be located at  $(0, 0, a_1 + \sigma_{CC} + t_1 \cos \varnothing + z_0)$  as shown in Figure 2(iii), where



**Fig. 2.** Schematic for L-Histidine amino acid on the  $z$ -axis interacting with a semi-infinite cylindrical single-walled carbon nanotube of radius  $r$ , (i) two nitrogen and three carbon atoms are considered as a ring of radius  $a_1$ , (ii) three hydrogen atoms are assumed to be on a half of a ring of radius  $a_2$ , (iii) three carbon atoms are assumed to be as a linear molecule and (iv) the remaining six hydrogen and two oxygen and one nitrogen atoms are assumed to be on a cylinder of radius  $a_3$ .

**Table I.** The Lennard-Jones constants ( $\epsilon$  and  $\sigma$ ).<sup>44</sup>

Interaction	(eV $\times 10^{-2}$ )	$\sigma$ (Å)
H-H	0.190	2.886
O-H	0.222	3.193
O-O	0.260	3.500
C-C	0.455	3.851
C-O	0.344	3.675
O-O	0.260	3.500
N-H	1.032	3.273
N-N	1.296	3.660

$t \in [0, 3\sigma_{CC}]$ . The distance  $\rho$  between the linear chain of carbon atoms and the nanotube is given by  $\rho^2 = r^2 + (z - (a_1 + \sigma_{CC} + t_1 \cos \varnothing + z_0))^2$ . Thus, by defining  $D_n$  as

$$D_n = r a_1 \sigma_{CC} \int_{-3\sigma_{CC}/2}^{3\sigma_{CC}/2} \int_0^{2\pi} \int_{-\infty}^{\infty} \frac{1}{\rho^{2n}} dz d\theta dt_1 \quad (9)$$

where  $\eta_4$  is the atomic line density of the linear chain of carbon atoms, the interaction energy can be given by

$$E_3 = \eta_1 \eta_4 (-AD_3 + BD_6) \quad (10)$$

we note that detailed analytical derivation of (9) is given in Appendix A.

Finally, we consider the six hydrogen, two oxygen and one nitrogen atoms as a cylindrical group of radius  $a_3$ . This cylinder is assumed to be located at  $(a_3 \cos \theta_3, a_3 \sin \theta_3, a_1 + (\sigma_{CC}/2) + t_2 + z_0)$  as shown in Figure 2(iv) and  $t \in [0, 3\sigma_{CC}]$ , where the distance  $\rho$  between the cylindrical group of radius  $a_3$  and the nanotube of radius  $r$  is given by  $\rho^2 = (r \cos \theta - a_3 \cos \theta_3)^2 + (r \sin \theta - a_3 \sin \theta_3)^2 + (z - (a_1 + (\sigma_{CC}/2) + t_2 + z_0))^2$ . From the work of Cox et al.,<sup>41</sup> if  $T_n$  is given by

$$T_n = r \sigma_{CC} \int_{-3\sigma_{CC}/2}^{3\sigma_{CC}/2} \int_0^{2\pi} \int_0^{2\pi} \int_{-\infty}^{\infty} \frac{1}{\rho^{2n}} dz d\theta d\theta_3 dt_1 \quad (11)$$

where  $\eta_5$  is the atomic surface density of the cylinder, then the interaction energy for this case is given by

$$E_4 = \eta_1 \eta_5 (-AT_3 + BT_6) \quad (12)$$

Thus, the total energy for the interaction between L-Histidine and a single-walled carbon nanotube can be given as

$$E = E_1 + E_2 + E_3 + E_4 \quad (13)$$

**Table II.** Values of various bond lengths.<sup>45</sup>

Atom-atom	Bond length $\sigma_x$ (Å)
H-H	0.354 $\pm$ 0.001
O-H	0.962 $\pm$ 0.002
O-O (Single bond)	0.639 $\pm$ 0.001
O-O (Double bonds)	0.634 $\pm$ 0.001
N-N	0.656 $\pm$ 0.001
N-O	1.294 $\pm$ 0.002
N-H	1.296 $\pm$ 0.002
C-O (Double bonds)	0.681 $\pm$ 0.002
C-O (Single bond)	0.672 $\pm$ 0.002
C-C (Single bond)	1.421 $\pm$ 0.001

**Table III.** Parameters for carbon nanotubes and L-Histidine amino acid.

Radius of CNT (5,5)	3.390 Å <sup>45</sup>
Radius of CNT (6,5)	3.735 Å <sup>45</sup>
Radius of CNT (7,4)	3.775 Å <sup>45</sup>
Radius of CNT (8,3)	3.860 Å <sup>45</sup>
Radius of CNT (10,0)	3.915 Å <sup>45</sup>
Radius of CNT (6,6)	4.070 Å <sup>45</sup>
Radius of CNT (10,3)	4.615 Å <sup>45</sup>
Radius of CNT (13,0)	5.195 Å <sup>45</sup>
Radius of the inner ring	$a_1 = 2.17$ Å
Radius of the outer half ring	$a_2 = 2.52$ Å
Radius of the cylindrical group	$a_3 = 1.74$ Å
Radius of the hydrogen sphere	$b = 1.296$ Å
Surface density for CNT	$\eta_1 = 0.3812$ atom/Å <sup>2</sup> <sup>46</sup>
Atomic line density of the inner ring	$\eta_2 = 0.438$ atom/Å
Atomic line density of the outer ring	$\eta_3 = 0.832$ atom/Å
Atomic line density of the linear carbon atoms	$\eta_4 = 0.3812$ atom/Å
Surface density of the cylindrical group	$\eta_5 = 0.907$ atom/Å <sup>2</sup>

For full detail regarding the derivation of the analytical solutions for (6), (7) and (11) we refer the reader to Refs. [40 and 41].

### 2.1.2. Acceptance and Suction Energies

Here, we determine the two physical quantities to demonstrate the encapsulation of the L-Histidine amino acid inside a single-walled carbon nanotube. We first evaluate the acceptance energy to determine whether the L-Histidine amino acid will be accepted into a carbon nanotube. Then we calculate the suction energy which is the total energy for a molecule moving from  $-\infty$  to  $\infty$ . Based on Cox et al.,<sup>42</sup> a molecule is accepted inside a nanotube if the acceptance energy  $W_r$ , which is defined by

$$W_r = \int_{-\infty}^{z_0} \frac{dE}{dz} dz = E(z_0) - E(-\infty) \quad (14)$$

is greater than zero. 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 is calculated as the total integral of the axial force from  $-\infty$  to  $\infty$  and is given by

$$W = \int_{-\infty}^{\infty} \frac{dE}{dz} dz = E(\infty) - E(-\infty) \quad (15)$$

**Table IV.** Numerical values of the attractive and repulsive constants taken from Ref. [44].

Interaction	Attractive constant	Value (eV Å <sup>6</sup> )	Repulsive constant	Value (eV Å <sup>12</sup> $\times 10^3$ )
CNT	$A_{CNT}$	17.40	$B_{O-CNT}$	29.000
O-CNT	$A_{O-CNT}$	20.01	$B_{O-CNT}$	35.299
N-CNT	$A_{N-CNT}$	23.07	$B_{N-CNT}$	49.041
H-CNT	$A_{H-CNT}$	10.90	$B_{H-CNT}$	15.774
CH-CNT	$A_{CH-CNT}$	14.15	$B_{CH-CNT}$	22.337
CN-CNT	$A_{CN-CNT}$	23.70	$B_{CN-CNT}$	49.041
Cylinder-CNT	$A_{Cyl-CNT}$	11.79	$B_{Cyl-CNT}$	19.657

**Table V.** Total energy  $E$  (eV) for L-Histidine amino acid interacting with a single-walled carbon nanotube of radius  $r$  for different values of  $\varnothing$ .

Radius (Å)	$E$ ( $\varnothing = 0^\circ$ )	$E$ ( $\varnothing = 30^\circ$ )	$E$ ( $\varnothing = 60^\circ$ )	$E$ ( $\varnothing = 90^\circ$ )
3.390	-0.1522	-0.1491	-0.1514	-0.1484
3.735	-0.1737	-0.1684	-0.1730	-0.1680
3.775	-0.1968	-0.1903	-0.1961	-0.1904
3.860	-0.2802	-0.2217	-0.2793	-0.2295
3.915	-0.3918	-0.3405	-0.3902	-0.3522
4.070	-0.5410	-0.5194	-0.5447	-0.5294
4.615	-0.4859	-0.4912	-0.4866	-0.4907
5.195	-0.3701	-0.3765	-0.3711	-0.3755

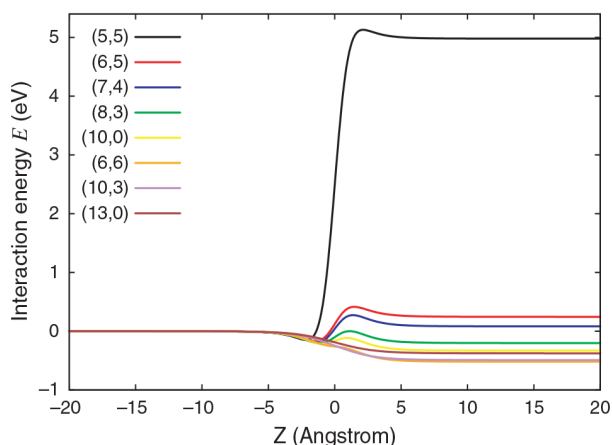
We note that in the case where there is no energy dissipation, the suction energy  $W$  can be converted directly to the kinetic energy of the moving molecule.

### 3. RESULTS AND DISCUSSION

In this section we evaluate the interaction energy of L-Histidine amino acid interacting with a single-walled carbon nanotube. The well-depth  $\epsilon$  and van der Waals diameter  $\sigma$  are shown in Table I. The values of bond lengths, radii  $r$  of carbon nanotubes and other physical parameters are given in Tables II and III. The attractive and repulsive constants,  $A$  and  $B$ , are calculated by using the well-depth  $\epsilon$  and the van der Waals diameter  $\sigma$  and are given in Table IV. Using the computer packages MAPLE, MATLAB and GNUPLOT, we plot the potential energy for L-Histidine and single-walled carbon nanotubes of various radii and chiralities  $(n, m)$  for different orientations. The negative and positive  $z$ -axes relate to the L-Histidine being outside and inside the single-walled carbon nanotube, respectively. The diameter of the carbon nanotube  $d$  can be determined by using the relationship,<sup>43</sup>

$$d = 0.783(n^2 + m^2 + nm)^{1/2} \quad (16)$$

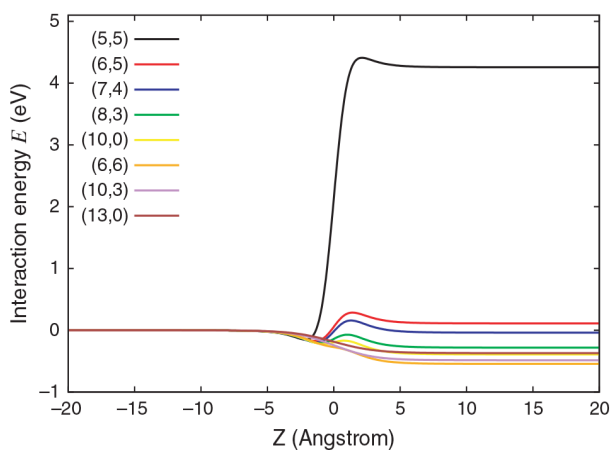
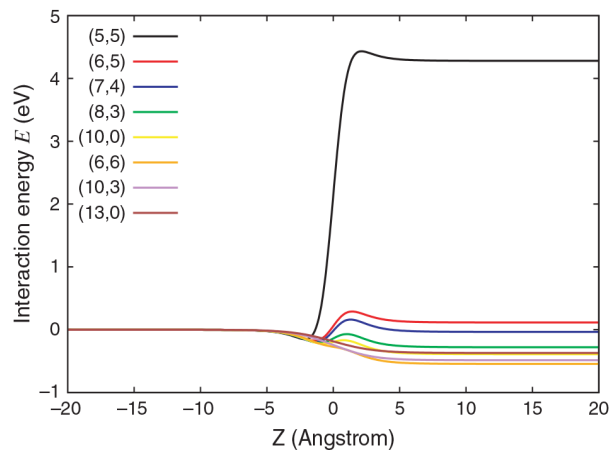
The total potential energy for the interaction between L-Histidine amino acid and a single-walled carbon

**Fig. 4.** Interaction energy for L-Histidine amino acid and single-walled carbon nanotubes of various radii  $r$  with  $\varnothing = 30^\circ$ .

nanotube depends on the radius  $r$  of the nanotube and the angle  $\varnothing$  for the amino acid. By assuming that  $\varnothing = 0^\circ, 30^\circ, 60^\circ$  and  $90^\circ$ , numerical solutions are evaluated as given in Table V.

In this paper, we consider the nanotubes  $(5, 5)$ ,  $(6, 5)$ ,  $(7, 4)$ ,  $(8, 3)$ ,  $(10, 0)$ ,  $(6, 6)$ ,  $(10, 3)$  and  $(13, 0)$  which have radii  $r = 3.390, 3.735, 3.775, 3.860, 3.915, 4.070, 4.615$  and  $5.195$  Å, respectively. We observe that the encapsulation of L-Histidine amino acid inside the single-walled carbon nanotube, as shown in Figures 3–6, occurs when  $r$  is greater than  $3.7$  Å and the lowest interaction energy is obtained when  $r = 3.915$  Å ( $(10, 0)$  nanotube) and is more favorable when  $\varnothing = 60^\circ$  then followed by  $0^\circ, 90^\circ$  and  $30^\circ$ . The values of the minimum energy for each orientation are given in Table V. As shown for all orientations the L-Histidine is repulsive and unstable when  $r < 3.7$  Å, and that the  $(10, 0)$  nanotube is the most favorable nanotube for this interaction.

Next, to confirm the above results we use the concept of the acceptance and suction energies, proposed by Cox et al.<sup>42</sup> We evaluate and plot the acceptance energy  $W_r$ ,

**Fig. 3.** Interaction energy for L-Histidine amino acid and single-walled carbon nanotubes of various radii  $r$  with  $\varnothing = 0^\circ$ .**Fig. 5.** Interaction energy for L-Histidine amino acid and single-walled carbon nanotubes of various radii  $r$  with  $\varnothing = 60^\circ$ .

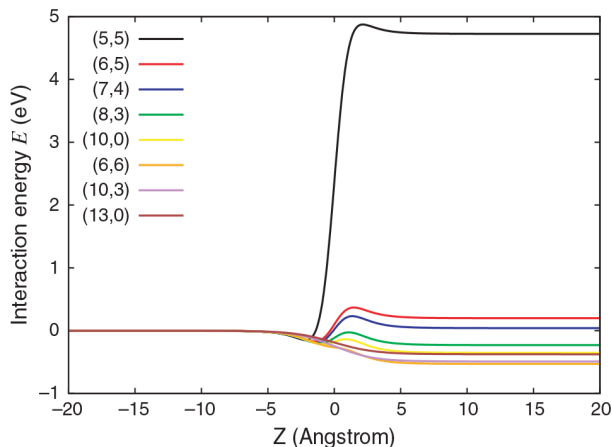


Fig. 6. Interaction energy for L-Histidine amino acid and single-walled carbon nanotubes of various radii  $r$  with  $\phi = 90^\circ$ .

for various radii of single-walled carbon nanotubes. We comment that the acceptance occurs when  $W_r$  is greater than zero. As shown in Figure 7, for the tubes with  $r < 3.4 \text{ \AA}$  and  $\phi = 0^\circ$  and  $60^\circ$ , and  $r < 3.7 \text{ \AA}$  with  $\phi = 30^\circ$  and  $90^\circ$ ,<sup>11</sup> the L-Histidine is not completely encapsulated into such nanotubes. The favorable single-walled carbon nanotubes are those with  $r$  in the range  $3.775 \text{ \AA} < r < 4.070 \text{ \AA}$ . Furthermore, our results show that the acceptance of L-Histidine is more favorable when  $\phi = 60^\circ$  then followed by  $\phi = 0^\circ, 30^\circ$  and  $90^\circ$ , respectively.

By using Eq. (15), we can determine the suction energy of the L-Histidine as a function of the nanotube radius. As shown in Figure 8, the carbon nanotube of radius greater than  $3.7 \text{ \AA}$  will accept the L-Histidine for all orientations. The L-Histidine amino acid prefers to be inside a single-walled carbon nanotube of radius  $r > 3.7 \text{ \AA}$  and when  $\phi = 0^\circ$ . For the single-walled carbon nanotube of radius  $r > 3.7 \text{ \AA}$ , there is no energetic barriers to prevent

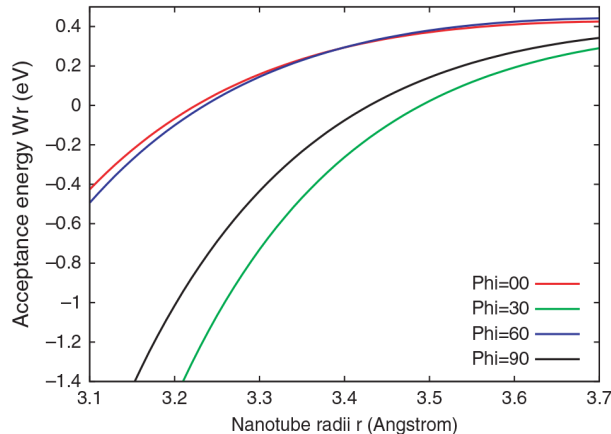


Fig. 8. Suction energy for L-Histidine amino acid and a single-walled carbon nanotube of radius  $r$  and  $\phi$  variant.

energy. Both calculations confirm that the L-Histidine amino acid is encapsulated inside single-walled carbon nanotubes for any values of  $\phi$  when  $r > 3.7 \text{ \AA}$ .

Our results are in good agreement with recent experimental findings. For example, our results show that the minimum energies for the L-Histidine amino acid encapsulated inside various single-walled carbon nanotubes are between  $-0.15$  to  $-0.55 \text{ eV}$  as shown in Figures 3–6 which are comparable with Ganji<sup>2</sup> who calculates the interaction energies for various amino acids, including nonionic-glycine, histidine, Phenylalanine and Cysteine. His results indicate that L-Histidine amino acid inside the single-walled carbon nanotube of radius  $r = 5.195 \text{ \AA}$  ((13, 0) nanotube) has the minimum binding energy of approximately  $-0.6 \text{ eV}$  which is in a good agreement with  $-0.55 \text{ eV}$  based on our results. From Table V, we can predict that the L-Histidine amino acid is more stable inside the carbon nanotube, and although the values of  $\phi$  vary, the magnitude of the interaction energies

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As a result, our model predicts no energetic barriers preventing the encapsulation of L-Histidine into a single-walled carbon nanotube. This means that the (5, 5) nanotube is the smallest physical tube that can be used to encapsulate the amino acid. Our results are in good agreement with the recent findings for Roman-Liu et al.<sup>48</sup> and

the encapsulation of the amino acid. The results based on the acceptance and suction energies are shown to agree with the results obtained from analyzing the total potential

shows minimal difference between the results. It is shown that there are energetic barriers to the encapsulation of L-Histidine into a single-walled carbon nanotube with  $r < 3.7 \text{ \AA}$ . This is the smallest effective radius for a single-walled carbon nanotube to encapsulate L-Histidine. Our results are in very good agreement with Roman-Liu et al.<sup>47</sup> who investigate the encapsulation of L-Histidine into a (10, 0) single-walled carbon

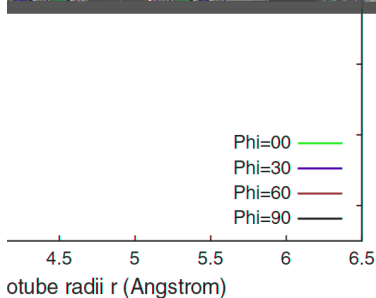
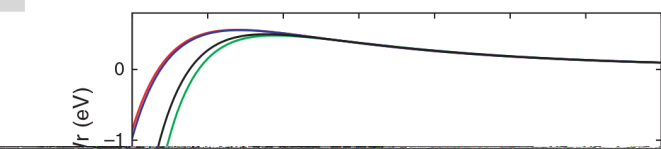


Fig. 7. Acceptance energy for L-Histidine amino acid and a single-walled carbon nanotube of radius  $r$  and  $\phi$  variant.



Ganji et al.<sup>49</sup> investigates the encapsulation of amino acids on a (3,3) nanotube. Their results confirm that the amino acids can only be encapsulated inside a carbon nanotube of radius greater than  $3.7 \text{ \AA}$ .

#### 4. CONCLUSION

We model the interaction between L-Histidine amino acid and a single-walled carbon nanotube using a continuum-discrete formulation and the Lennard-Jones potential. The present paper considers a special case which excludes the electrostatic effect (pKa) where we assume

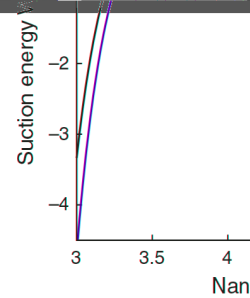


Fig. 7. Acceptance energy for L-Histidine amino acid and a single-walled carbon nanotube of radius  $r$  and  $\phi$  variant.



the single-walled carbon nanotubes to be well-defined and characterized. The interaction energy and force are obtained and expressed in terms of special functions. The overall interaction force is completely zero owing to the fact that the interaction against the distance  $z$  on the positive and negative sides are equal. The interaction energy is evaluated for various sizes of nanotubes and for various orientations of the amino acid. We find that a single-walled carbon nanotubes with radius  $r \geq 3.7 \text{ \AA}$  accept the L-Histidine amino acid of any orientations. Our results also show that the L-Histidine amino is not accepted into a nanotube of radius  $r < 3.44 \text{ \AA}$  when  $\varnothing = 0^\circ$  and  $\varnothing = 60^\circ$  and  $r < 3.7 \text{ \AA}$  when  $\varnothing = 30^\circ$  and  $\varnothing = 90^\circ$ . Overall, our results are in good agreement with Ganji<sup>2</sup> who calculates the interaction of different amino acids with single-walled carbon nanotubes. Our results show that the minimum interaction energy around  $-0.55 \text{ eV}$  which is in an excel-

lent agreement with work of Ganji<sup>2</sup> who predicts that the minimum binding energy of approximately  $-0.6 \text{ eV}$ .

Next, we perform the first part of the integral with respect to  $\theta$ . So,  $D_n$  becomes

$$\begin{aligned} &= \frac{\sigma_{CC}}{r^2} \int_{-3\sigma_{CC}/2}^{3\sigma_{CC}/2} \int_0^{2\pi} \int_{-\pi/2}^{\pi/2} \cos u^{(2n-2)} du d\theta dt_1 \\ &= 2\pi \int_{-3\sigma_{CC}/2}^{3\sigma_{CC}/2} \frac{\sigma_{CC}}{r^2} dt_1 \\ &= \frac{6\pi(\sigma_{CC})^2}{r^2} \end{aligned} \quad (22)$$

Finally, the total potential energy is given by

$$E_3 = \eta_1 \eta_4 \left( -\frac{3\pi}{8} AD_3 + \frac{63\pi}{256} BD_6 \right) \quad (23)$$

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## APPENDIX A: DERIVATION OF EQUATION (9) FOR INTEGRALS $D_n$

In this appendix, we present the details for the derivation of the integrals  $D_n$  defined by Eq. (9)

$$\begin{aligned} D_n &= \int \int \frac{1}{\rho^{2n}} d\delta_c d\delta_l \\ &= \int_{-3\sigma_{CC}/2}^{3\sigma_{CC}/2} \int_0^{2\pi} \int_{-\infty}^{\infty} \frac{r\sigma_{CC}}{(\rho^2)^n} dz d\theta dt_1 \\ &= \int_{-3\sigma_{CC}/2}^{3\sigma_{CC}/2} \int_0^{2\pi} \int_{-\infty}^{\infty} (r\sigma_{CC}) \times ([r^2 + (z - (a_1 + \sigma_{CC} \\ &\quad + t_1 \cos \varnothing + z_0))^2]^{-n})^{-1} dz d\theta dt_1 \end{aligned} \quad (17)$$

We perform the integral in Eq. (17) with respect to  $z$  by making the substitution  $\tan u = (z - (a_1 + \sigma_{CC} + t_1 \cos \varnothing + z_0))/r$  and  $\sec 2udu = dz/r$ . Noting that when  $z = -\infty$  we have  $u = -\pi/2$  and when  $z = \infty$  we obtain  $u = \pi/2$ . Thus,  $D_n$  is given by

$$\begin{aligned} &= \int_{-3\sigma_{CC}/2}^{3\sigma_{CC}/2} \int_0^{2\pi} \int_{-\pi/2}^{\pi/2} \frac{r\sigma_{CC}}{[r^2 \sec u^{(2n-2)}]} du d\theta dt_1 \\ &= \frac{\sigma_{CC}}{r^2} \int_{-3\sigma_{CC}/2}^{3\sigma_{CC}/2} \int_0^{2\pi} \int_{-\pi/2}^{\pi/2} \cos u^{(2n-2)} du d\theta dt_1 \end{aligned} \quad (18)$$

We now perform the integration with respect to  $u$  using the geometric series<sup>50</sup> which is given by

$$\begin{aligned} K_n &= \int \cos^{(2n-2)} u du \\ &= \frac{(2n-1)!!}{(2n)!!} \left[ \sin u \sum_{k=0}^{n-1} \frac{(2k)!!}{(2k+1)!!} \cos^{2n} u + u \right] \end{aligned} \quad (19)$$

Now, for  $n = 3$  and  $n = 6$  we have respectively

$$K_3 = \int_{-\pi/2}^{\pi/2} \cos^4 u du = \frac{3\pi}{8} \quad (20)$$

$$K_6 = \int_{-\pi/2}^{\pi/2} \cos^{10} u du = \frac{63\pi}{256} \quad (21)$$

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# Investigating the Performance of Ultra-Sensitive Optical Sensor Using Plasmonic Nanoparticles

Ali Elrashidi

*Department of Electrical Engineering, University of Business and Technology, Jeddah 21432, Saudi Arabia;  
Department of Engineering Physics, Alexandria University, Alexandria, 21544, Egypt*

An ultra-sensitive gas nanosensor using plasmonic nanoparticles of different metallic materials such as gold, silver, copper and vanadium dioxide is introduced in this paper. The surface plasmon resonance of plasmonic material is depending on the refractive index of surrounding medium such as generic organic polymer where the refractive index is changing according to gas concentration in contact with its surface. Refractive index sensitivity and half width full maximum of the optical incident wave for different metallic nanoparticles is simulated using finite difference time domain method. Half wavelength full maximum HWFM and refractive index sensitivity are compared for different refractive indexes of single and two different sizes of different metals plasmonic nanoparticles. The effect of changing radius of the nanoparticle is also introduced for both single and two different sizes nanoparticles. Maximum refractive index sensitivity, 580 nm/RIU, is obtained using two different size gold nanoparticles by using the proposed structure.

**Keywords:** FDTD, Plasmonics, SPR, Nanoparticles, Refractive Index, HWFM, Sensitivity.

## 1. INTRODUCTION

Detecting the concentration of particular gases in many industrial processes is a very important issue. Ultra high sensitive optical sensors have become a powerful tool in many applications such as, petroleum production,<sup>1</sup> agriculture,<sup>2</sup> environmental studies,<sup>3–5</sup> medical applications and safety.<sup>6–9</sup> In particular, gas sensors, for example, are used to detect methane in mines, molecules produced by food when it starts to rot, toxic gases from vehicles, greenhouse gases, oxygen concentration in biological cells, and dangerous gases produced by accidents.<sup>10–15</sup> As a result, the development of gas sensors has recently constant increasing attention in both academia and industry. Various technical approaches have been considered to improve the performance of gas sensors devices.<sup>16</sup>

Different techniques have been used to sense different gases by using metal oxide semiconductors,<sup>17</sup> carbon nanotubes,<sup>18</sup> moisture absorbing materials,<sup>19</sup> fluorescent materials,<sup>20</sup> polymers,<sup>21</sup> and flat plasmonic surfaces.<sup>22</sup> The electrical properties of carbon nanotubes are very sensitive to any change in the surrounding chemical environment, but this property at the same time is a drawback because it means a lack of selectivity.<sup>23</sup> Additionally, the fabrication process of carbon nanotubes is hard and expensive. The moisture absorbing materials can detect the water vapour concentration in the atmosphere because their dielectric constants are sensitive to humidity. These materials are

sensitive and selective; however, they can only detect water vapour.<sup>16</sup> The fluorescent intensity of some sensitive dyes is affected by the change of concentration of some specific gases. These dyes are cheap and selective but the main drawback of using them is that the fluorescent intensity can be changed by other factors such as, quenching by the excitation source which yields to low sensitivity.<sup>24,25</sup>

In recent years, numerous polymer-based gas sensors have been developed. The basic operation idea of these sensors is that the used polymeric material reacts with gases and consequently its chemical structure and properties are altered. The advantages of polymer-based sensors are numerous such as, short response time, low cost of fabrication, simplicity, selectivity, and low energy consumption. The main disadvantage of this kind of sensors is they lack high sensitivity.<sup>16</sup>

Finally, surface plasmon resonance (SPR) at a conductor-dielectric interface is another method for gas detection utilizing light. A dielectric gas sensitive material is deposited above a bulk flat conductive surface such that, any change in the properties of the dielectric layer through chemical reaction with the detected gas will affect the excitation of plasmons. Therefore, gas is detected by monitoring the change of incident light angle at which SPR occurs with varying gas concentration. Although this technique is ultra-sensitive, its experimental setup is complicated and very alignment sensitive which lead to it has not become commercially available.<sup>26</sup>



Grande and et al. introduced an optical organic sensor using a plasmonic grating immersed in asymmetric organic material.<sup>27</sup> Gold strips were placed on a silicon substrate and covered by organic material. Dielectric constant of the organic material changed with gas concentration which affects SPR position. The overall sensitivity of the introduced design is 350 nm/RIU.

Cho and et al. introduced an experimental demonstration of malaria pathogen detection in a whole blood lysate.<sup>28</sup> The authors used gold plasmonic nanohole array for sensing. The measured refractive index sensitivity of the nanosensor is 378 nm/RIU in the visible range.

In this paper I simulate gas sensor that combines all of the advantages of the gas sensors fabricated in the literature. Specifically, I will simulate gas sensor structure by using plasmonic nanoparticles conjugated with gas sensitive polymers. The proposed sensor is supposed to have the same advantages of polymer-based gas sensors but with ultra-sensitivity. The introduced design does not depend on measuring incidence angles at which SPR occurs. One more advantage of the proposed method is that the same structure can be used when using different polymeric materials to detect different gases. I used different nanoparticles as a plasmon materials and study the wavelength sensitivity of each metallic nanoparticles using the absorbance of the optical wave. The used materials are gold, silver, copper, and vanadium dioxide and the dielectric permittivity can be described by using a multi-oscillator Drude-Lorentz model. The wavelength sensitivity for different size and material structure consists of two nanoparticles are also given. I study the effect of changing refractive index and nanoparticles radius on the sensor sensitivity for single nanoparticle and two different sizes nanoparticles structure. Finally, full width half maximum FWHM is also calculated for different cases and different materials.

## 2. TRANSMISSION SPECTRUM OF NANOPARTICLES ARRAY

The basic idea of sensors used generic organic polymer (analyte) material is that, the refractive index of analyte materials is changing according to gas concentration in contact with analyte materials. Consequently, we can sense optical wave by direct/indirect monitoring the refractive index change of the used polymeric material with the change of gas concentration.

We can hypothesize that any slight change of the refractive index of the used analyte material due to the presence of small concentration of the sensed gas will be indirectly detected by observing the shift of the SPR wavelength of the used nanoparticles.

Plasmonic particle's shape, dielectric function of the gold nanoparticles, and dielectric constant of the surrounded medium are determine the spectrum position at maximum value of the transmitted data.<sup>24</sup> The maximum

value of reflectivity is located at wavelength  $\lambda_{max}$  according to the condition:<sup>25</sup>

$$\lambda_{max} = \frac{L}{q} \left( \frac{\varepsilon_d \varepsilon_m(\lambda_{max})}{\varepsilon_d + \varepsilon_m(\lambda_{max})} \right)^{1/2} \quad (1)$$

where  $L$  is structural periodicity,  $\varepsilon_d$  is the permittivity of the surrounding medium,  $\varepsilon_m$  is a gold nanoparticles dielectric permittivity at corresponding  $\lambda_{max}$  and  $q$  is an integer.

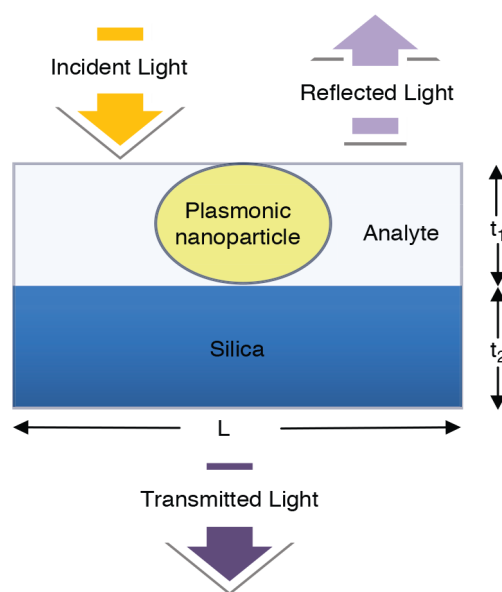
A metallic nanoparticles dielectric permittivity can be described by using a multi-oscillator Drude-Lorentz model:<sup>25</sup>

$$\varepsilon_m = \varepsilon_\infty - \frac{\omega_D^2}{\omega^2 + j\omega\gamma_D} - \sum_{k=1}^6 \frac{\delta_k \omega_k^2}{\omega^2 - \omega_k^2 + 2j\omega\gamma_k} \quad (2)$$

where  $\varepsilon_\infty$  is the dielectric constant at high frequency regime in the Drude model,  $\omega_D$  and  $\gamma_D$  are the plasma and collision frequencies of the free electron gas according to Drude model,  $\delta_k$  is define amplitude of Lorentz oscillator,  $\omega_k$  is the resonance angular frequencies, and  $\gamma_k$  is the damping constants for  $k$  value from 1 to 6 for gold, silver nanoparticles, from 1 to 5 for copper, and from 1 to 4 for vanadium dioxide.

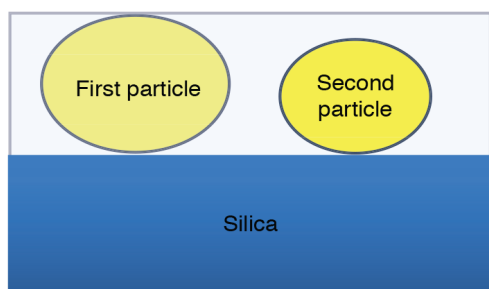
## 3. THE PROPOSED STRUCTURE

In this work, the proposed optical sensor using plasmonic metallic nanoparticles and analyte material is studied. I am using OptiFDTD simulation tool by Optiwave Inc. The FDTD method was performed using the OptiFDTD simulation tool. In our design, Cartesian coordinates  $x$ , and  $y$  are satisfy periodicity in boundary conditions, while, anisotropic perfect matching layer was used in the  $z$ -direction to serve as absorbing boundary condition.



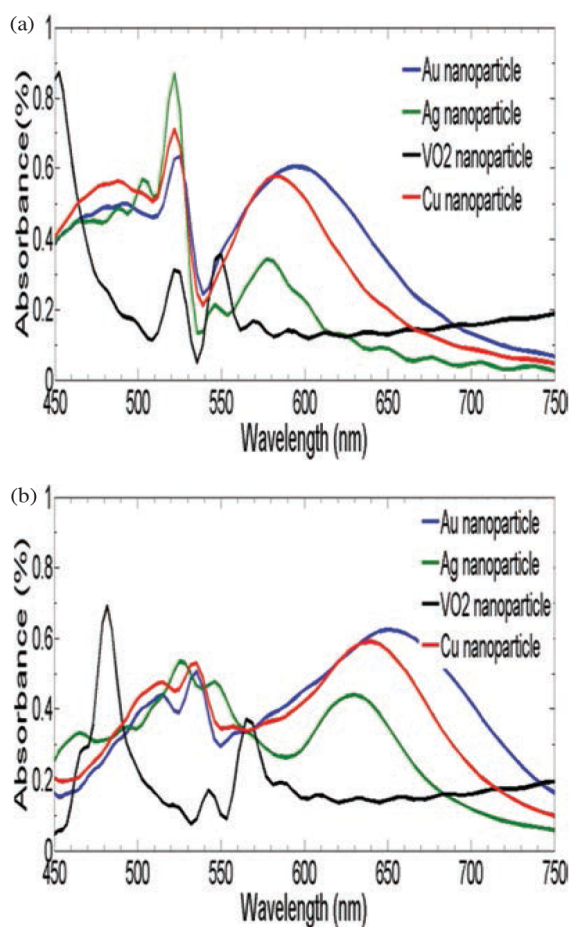
**Fig. 1.** Cell structure of the optical sensor using plasmonic nanoparticles.





**Fig. 2.** Cell structure of the two different sizes plasmonic nanoparticle.

In the first section, I compare the refractive index sensitivity  $S_n = \partial\lambda_{SP}/\partial n$  for single cell structure of metallic spherical nanoparticles. The used materials are gold, silver, copper and vanadium dioxide with dielectric permittivity can be described by using a multi-oscillator Drude-Lorentz model. Figure 1 illustrates the proposed structure of a single cell. The dimension of the cell is 400 nm length “L”, 400 nm width, and  $t_1 = t_2 = 200$  nm are the thickness of analyte and silica substrate respectively. Silicon dioxide is used as a substrate with refractive index 1.5, and the metallic nanoparticle has a spherical shape with different radius.



**Fig. 3.** (a) Illustrates the absorbance of different nanoparticles for  $n = 1.1$  versus the optical range (b) Absorbance of different nanoparticles for  $n = 1.3$  versus the optical range.

**Table I.** Wavelength sensitivity and HWM for four different nanoparticles.

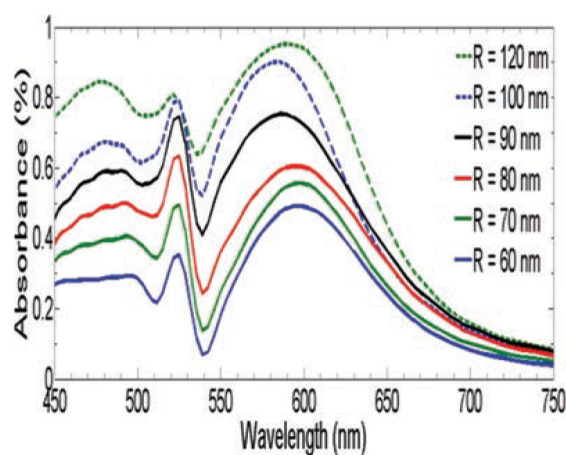
Material	SPR $n = 1.1$	SPR $n = 1.3$	$S_n$ (nm/RIU)	HWM
Au	593.66	650.28	359.30	77.86
Ag	576.92	630.25	341.84	36.90
VO <sub>2</sub>	549.78	564.97	150.13	11.01
Cu	585.17	640.11	350.97	54.13

In this section, the effect of changing plasmonic nanoparticle radius from 60 nm to 120 nm on the sensitivity of the given sensor is introduced. Absorbance, and FWHM are also illustrated in this section. Finally, the impact of changing index of the used analyte material on the refractive index sensitivity of gold nanoparticle is illustrated between 1.1 and 1.9 refractive index.

In the second section, the absorbance of the proposed structure for two different sizes nanoparticles of the spherical shape is studied, as shown in Figure 2. Refractive index sensitivity of two different nanoparticles, gold with 80 nm radius is used as first particle and the second nanoparticle is either gold, silver, copper or vanadium dioxide with radius 100 nm is illustrated in this section. For two different sizes gold nanoparticle with 80 and 100 nm radius, the absorbance, and refractive index sensitivity are also simulated. Finally, the impact of changing refractive index of the used analyte material on the refractive index sensitivity for two sizes gold nanoparticles is introduced between 1.1 and 1.9 refractive index and the space between centres is 200 nm.

#### 4. RESULTS AND DISCUSSION

In order to measure the spectral characteristic of nanoparticles in an analyte, I start the analysis by considering an analyte material with 400 nm length, 400 nm, and 200 nm height is placed over a silica with refractive index 1.5 and 400 nm length, 400 nm width, and 400 nm height. The



**Fig. 4.** Absorbance of gold nanoparticle of different radius for  $n = 1.1$  versus the optical range.

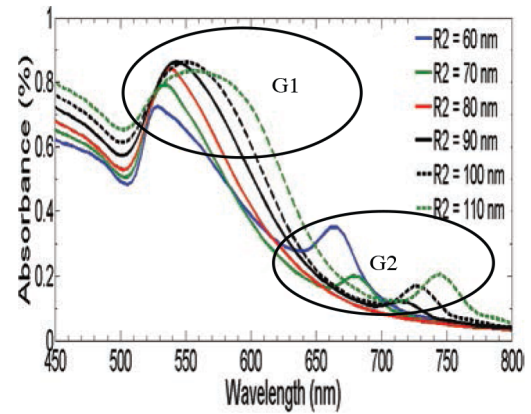
**Table II.** SPR and wavelength sensitivity of gold nanoparticle radius from 60 to 120 nm.

Radius of nanoparticle (nm)	SPR		$S_n$ (nm/RIU)
	$n = 1.1$	$n = 1.3$	
60	598.01	645.16	311.97
70	598.01	650.28	337.61
80	593.66	650.28	359.30
90	585.17	640.11	350.89
100	585.17	635.14	326.04
120	589.39	640.11	311.97

optical properties of different nanoparticles is described using Drude-Lorentz model with four, five or six resonance frequencies according to Eq. (2) using  $\epsilon_\infty = 1$ .

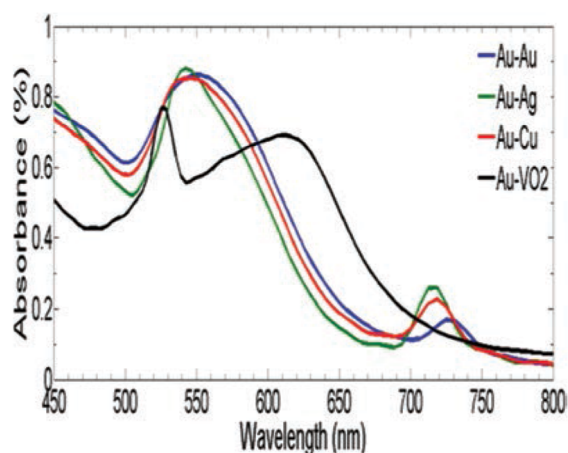
#### 4.1. Refractive Index Sensitivity and HWFM of Different Nanoparticles Materials

In this section, using the FDTD simulations, the refractive index sensitivity of different metals nanoparticle is studied. In the designed unit cell, I used gold, silver, copper, and vanadium dioxide nanoparticles with spherical shape. In this simulation I used FDTD method when lin-

**Fig. 6.** Absorbance of two gold nanoparticles 80 nm and from 60 nm to 110 nm radius for  $n = 1.1$  versus wavelength.

wide compared to  $\text{VO}_2$  of 11 nm HWFM which is a narrow bandwidth.

There are two plasmonic modes as illustrated in Figure 3 at intense band and at longer wavelength. Figures 3(a) and (b) can be used to get the refractive index sensitivity



**Fig. 7.** Absorbance of two different nanoparticles; gold with radius 80 nm and Au, Ag, Cu and VO<sub>2</sub> of radius 100 nm at  $n = 1.1$ .

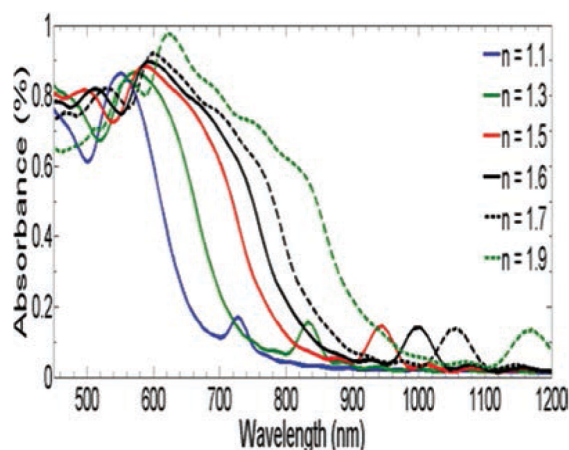
The maximum obtained refractive index sensitivity for gold nanoparticles is 359.3 nm/RIU at radius 80 nm which is higher than 350 nm/RIU obtained by Grande.<sup>27</sup> However, the measured sensitivity by Sang-Yeon Cho, 378 nm/RIU, is higher than what I get from the proposed structure.<sup>28</sup> So, in the following section I propose a composite structure of two different size nanoparticles and different nanometals.

#### 4.2. Two Different Spherical Nanoparticles

In this section, refractive index sensitivity of two different size of gold nanoparticles and the combination of gold and other nanoparticles with different sizes are simulated. Figure 6 shows the absorbance of the two gold nanoparticles of different sizes, 80 nm for the first nanoparticle and the radius of the second particle, R<sub>2</sub>, is changing from 60 to 110 nm with 10 nm step. By comparing Figures 4 and 6, one can notice that there is another group of resonance wavelength appears, G<sub>2</sub>, with higher wavelength than the first resonance. G<sub>2</sub> is disappeared in case of two gold nanoparticles with the same radius 80 nm for both nanoparticles, as illustrated by the red line. The second plasmonic resonance group G<sub>2</sub> at longer wavelength, between 650 to 800 nm, is appear because of using two different size nanoparticles with two different resonance wavelength. Hence, the absorbed wave is the overall absorption by the two different sizes nanoparticles and the second group will be appear.<sup>29</sup>

**Table IV.**  $S_n$  of two different nanoparticles with radius 80 nm of gold and 100 nm for the second one.

Nanoparticles material	$S_n$ for G <sub>1</sub> (nm/RIU)	$S_n$ for G <sub>2</sub> (nm/RIU)
Au–Au	115.48	556.04
Au–Ag	132.02	504.11
Au–Cu	113.91	504.11
Au–VO <sub>2</sub>	51.540	220.42



**Fig. 8.** Absorbance of two different six gold nanoparticles for analyte refractive index from 1.1 to 1.9.

Table III shows the refractive index sensitivity using the two different resonance positions first group, G<sub>1</sub>, and second group, G<sub>2</sub>, and we can clearly notice that, the calculated sensitivity using G<sub>2</sub> is higher than the calculated sensitivity using G<sub>1</sub>. The sensitivity is reaches to 556.04 nm/RIU for two gold nanoparticles with 80 nm and 100 nm radius.

Figure 7 shows the absorbance of two different nanoparticles, gold with 80 nm radius and another nanoparticle with 100 nm radius at  $n = 1.1$ . The second nanoparticle is gold, silver, copper or vanadium dioxide.

Four different combinations of nanoparticles are used, gold–gold, gold–silver, gold–copper, and gold–vanadium dioxide, for two different nanoparticles with 80 nm for the gold nanoparticle and 100 nm for the other nanoparticle. The gold is selected to be a common nanoparticle for its sensitivity as illustrated in Table I with radius 80 nm as given from Table II. The radius of the second nanoparticle is selected to be 100 nm to be consistent with the results given by Table III.

Table IV shows the calculated sensitivity at G<sub>1</sub> and G<sub>2</sub> of four different combinations. The highest calculated sensitivity is shown for Au–Au nanoparticles with average sensitivity 556.04 nm/RIU from the second resonance group G<sub>2</sub>. The average values are calculated for refractive index sensitivity between 1.1 and 1.9.

The absorbance of two different radius of gold nanoparticles is illustrated in Figure 8 for analyte refractive index from 1.1 to 1.9 at wavelength from 0.45 to 1.2  $\mu\text{m}$ .

The obtained refractive index sensitivity, 556.04 nm/RIU, by using two different size nanoparticles of gold is much higher than obtained by Sang-Yeon Cho 379 nm/RIU and can be widely used in medical applications.

## 5. CONCLUSION

Using FDTD method, the performance of refractive index sensitivity of several plasmonic metallic nanoparticles such



# A Conceptual Framework of the Implementation of E-Learning in University of Business and Technology (UBT)

Abdelrahim.M.Zabadi<sup>1</sup> & Amnah H. A. Dammas<sup>2</sup>

<sup>1</sup>University of Business & Technology (UBT)

<sup>2</sup>Department of Education Management and Developing- Females  
Ministry of Education, Jeddah, Saudia Arabia,

**Abstract-** This preliminary study discusses the implementation of an E-learning program at the University of Business and Technology (UBT) in Saudi Arabia – Jeddah. The program originally aimed to establish a virtual university which offers totally online courses but due to a number of reasons there had to be some changes in the implementation process as well as the changes and challenges faced by UBT in implementing its E-learning program from an Information System (IS) project management point of view. Findings suggest that implementing such projects needs careful consideration of a variety of issues to ensure that the objectives are achieved. The case provides rich insights to other educational institutions wishing to implement such projects. The outcomes will assist in its continuing implementation at other universities in the future.

**Index Terms-** E – learning, Information Systems / Information Technology (IS/IT) projects, project management phases , UBT.

## I. INTRODUCTION

Higher Education Institutions (HEIs) in the era of knowledge revolution faces different challenges as a result of the enormous achievements in the area of information and communication technology (ICT), that led to the erosion of boundaries among countries and makes the world a small village in the context of globalization and economic openness. Quality of education leads to increased investment, and create a well – qualified human resources. As a consequence, governments and private sector takes various approaches to delivering e - learning services and technologies. Some manage e - learning services through central information technology (IT); others provide e-learning services and technologies centrally; some have blended learning programs in which face – to – face instruction is combined with electronic usage applications to deliver courses (1).

E-learning is a controversial phenomenon, thus , the need for and significance of a strategic approach to implement and utilize of e – learning in HEIs has been of attention of considerable researchers. But actually what is meant by "e-learning"? . It is very difficult to find a common definition of this term, however, we will mention some of those definitions, (Dublin, 2003: 2), e-Learning is “the delivery of a learning, training or education program by electronic means, e-learning involves the use of a computer or electronic device (e.g. a mobile

phone) to provide training, educational or learning material” (2). The European Commission (2001) describes, e-Learning is “using new multimedia technologies and the Internet to improve the quality of learning by facilitating access to facilities and services as well as remote exchanges and collaboration” (3).

Successful implementation of e - learning and the selection and delivery of e - learning services and technologies depend on factors such as university size, vision, mission, and the priorities of university top management. The significance of e - learning for evolution has paved the way for launching several programs at a whole levels of educational body in a number of developing countries at schools and higher education institutions (HEIs) alike.

These transformations of the learning patterns present several challenges when implementing e - learning environment, namely three main challenges: technology, content, and staff. These aspects require be managing and implementing effectively to fulfill the overall enrichment of the staff and students learning experiences, which are improved through the appropriate usage of technological blends.

According to (Donoghue et al., 2003) experience indicates that implementing e-learning programs is still facing a numerous difficulties such as, performance, cost, and technology access especially in developing countries, questioning the benefits obtained by students, role of teachers , information ownership, availability of resources (modern technology and information), social inequalities and the actual benefits of accessing education online (4).

Finally, this study explores the implementation of e – learning at UBT in Saudi Arabia – Jeddah. This study will follow a case study approach. It is argued to be the suitable approach if the questions being answered are how and why questions (5), this case study can be categorized as an "interpretive case study", the aim of which is not to tell the "reality", but to tell a narrative which consists of the researcher's ideas and thoughts in connection with the phenomenon in question (6).

In this study, we aim to analyze an e- learning project according to its phases, the obstacles facing its implementation and the changes that have to be carried out. In sum, this study highlights on the processes by which it is being implemented from a project management point of view in order to assess the e-learning project. This study is structured as follows: it starts by providing the theoretical foundations that will be used as a nucleus to analyze this case. Then, presents the case study and analysis related issues. Thereafter, discuss the case based on the



above theoretical framework. finally, conclusions of this paper are discussed, recommendations for future research is drawn in the last section.

## II. PREVIOUS STUDIES

The e-Learning has become increasingly importance in HEIs. The development and presenting of a diversity of e-Learning tools has been bring out great modifications in HEIs, particularly with respect to their educational delivery and support processes.

The e – learning primary components include: The use of: online technologies (Internet and Web tools) in learning processes; learning technologies to promote the learning experience teachers and students alike; digital tools for assessment, curriculum delivery, ongoing professional development, collaboration and interaction.

For survival, higher education institutions'(HEIs) needs to consider cost – effective and efficient methods of operations. Certainly, the technology plays a key role in e – learning implementation in HEIs, but alone may not be answers to all of the universities problems. The benefits of utilising technology, particularly for developing online collaborative activities are well documented (7) . Relationships can also be fostered within the context of an online environment. Technology is a powerful medium particularly for part time work based students who find erratic attendance requirements and study difficulty (4).

Researchers believe that the goals of introducing e - learning process, either by facilitating many of the challenges that face instructors and learners daily; or by presenting opportunities that might have not existed before (8).Information and Communication Technologies(ICTs) are transforming the educational experience by affecting education in many ways (4).Therefore, the use of technology in the learning and teaching process is spreading widely at all levels of education both in developing and developed countries. The ease of access to education provided by ICTs makes it a viable option to provide better education to people who may have been otherwise deprived from such opportunities (9).

E – Learning is fully part of our learning environment and no longer an add-on to traditional pedagogies. It is integrated in the way we live, work, and teach and has been so since mid – 2000 as Web 2.0 – the Read Write Web[ (10); (11)], acknowledged that in implementation of E – learning, institutions will bear the risk of destroying those processes that offer important forms of support to students. Ultimately, it is possible that standardising a number of informal support systems will create competitive advantage – exactly the opposite to what the process sets out to achieve. Thus, HEIs need to consider the implementations for everyone involve before implementing any new e – learning strategies.

E – learning is described as the use of electronic technologies in learning, teaching, and research.it provides a set of different tools to enhance the learning experience, such as LMS (Learning Management System), CMS (Content Management System), interactive courses contents, digital libraries, virtual classrooms – learning can be applied in classroom based, instructor lead learning or computer / internet

based learning, or both classroom and computer (blended education).

Recent literature in this area has discussed a number of issues related to e-learning. For example, indications of a bias show in student evaluation of teaching against online instruction compared to face-to-face instruction (12).Other studies discussed issues that are important for student satisfaction within online instruction such as: interaction among students, quality and timely interaction between students and professors, consistent course design across courses, technical support availability, flexibility of online courses (13), in addition to providing support for lecturers in implementing computer-supported learning strategies within their classes (14).

E- Learning will ideally be employed by higher education institutions for reasons of enhancing the individualization of instructions, improving educational quality, increasing access, reducing costs, and sustaining innovations (15).E- Learning is designed to create environment rich of interactive applications based on computer technologies and the World Wide Web (WWW) for information, and enables the learner to access learning resources at any time and from any location. Many proponents of E – learning believe that everyone must be equipped with basic knowledge in technology, as well as use it as a medium to reach a particular goal.

Now the word E – learning has transcended the traditional definition of "education through internet only". The E- learning process is like an umbrella, under which lots of things are arranged to make the global education system more uniform, cost – effective and quality – rich. Broadly speaking E- learning is a process of training for all types of learners in their required fields through Information Technology (IT) Techniques.

The E - learning process includes courses from technology to art of living. There is a number of e - learning companies working around the world, the scope and objective of E – learning for all these companies vary and it largely depends upon the types of service offered by the E – learning process. We are going to discuss some features of this process (16). As a result, institutions of higher education have taken positive steps to focus on electronic learning (E – Learning) technology to improve educational efficiency and effectiveness.

Because of the flexible nature of e-learning and since it provides the right information in right time and in right place, students are now more familiar and feel more comfort in this new education system. Saudi universities compete to provide a rewarding learning experience for their students, and some of them have set the path to include distance students as well. A long with the new regulated approach of approving online courses by the ministry of higher education, UBT has to adopt and apply e – learning to enhance the educational experience inside its campuses and outside as well.

## III. THEORITICAL FRAMEWORK – PROJECT MANGEMENT PHASES

A project is a comlex,unique,one time effort,with specific limitations (budget , time, resources, and performance) designed to meet organizational goals or customer needs (17). Each project consist of a number of different phases that form what called the

project life cycle .Project management is concerned with providing project managers with new tools that improve their ability to plan, implement and manage activities to accomplish specific organizational objectives (18).

There are a number of different lifecycle models in project management literature, most have four or five phases, but some have nine phases or more (19) . A project is normally divided into a series of phases called the project life cycle model, which

could be conducted sequentially or in parallel.In this study, we utilized the simplest four – phase life cycle model of Gray and Larson (2008),namely **(Defining,Planning,Executing,and Delivering)** (20),which is shown in (Figure 1) and each phase is discussed briefly below.

Figure ( 1 ) : Project Life Cycle

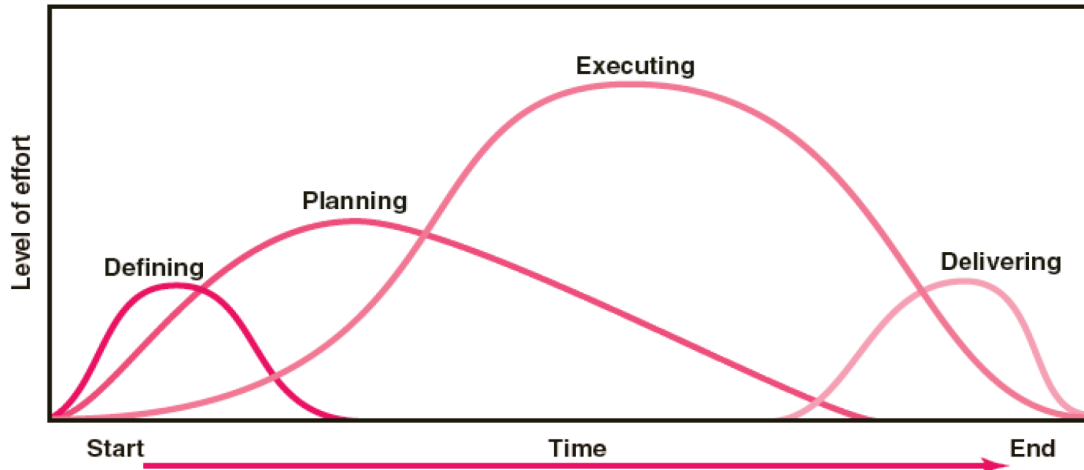


Figure 1: Project Life Cycle framework ( Gray and Larson 2008)

**DEFINING PHASE:**This is the first phase of the project Life Cycle where it's evaluated, selected, and defined well. This phase is about identifying project vision, mission and goals; specifications; tasks; and responsibilities. In addition to that it includes establishing project initiation committee; plan; management procedures; project management environment; and developing project chart.

**PLANNING PHASE:**In this phase, the project concept is verified and developed in to a workable plan in order to start implementation. This involves Schedules; budgets; estimating resources and creating resource plan ; identifying and assessing risks and alternatives, feasibility, estimating staffing and also certain management activates are carried out to assure that the project established with clear reference terms and substantial structure.

**EXECUTING PHASE:**Executing consists of the processes used to complete the work defined in the project management plan to accomplish the project's requirements. This is the phase in which the deliverables are physically built and presented to the customer for acceptance. While each deliverables is being constructed, a suite of management processes are undertaken to monitor and control. These processes include many sub - phases \ activities such as management time, cost, changes, forecasts quality, risks issues, suppliers, customers and communication project status.

**DELIVERING PHASE:** The focus of this phase is to bring the project to a successful end and the formal acceptance, where the project process is completed and documented and the responsibility moved from the developers to owners and users. Administrative activities include the archiving of the files and documenting lessons learned for future projects. This phase

involves finalize all activities across all of the processes, terminating suppliers contracts; obtain approval to close the project. In addition to customer training, documents transfer, release resources, release staff, and lessons learned.

#### IV. CHANGE MANAGEMENT IN IS PROJECTS

Change management is a process that helps organizations in the implementation of an appropriately planned change (21).Change management of IS projects is understood as activities, processes, and methodologies that support employee understanding and organizational aspects during the IS projects (22).Change management refers to all activities associated with the interaction of technology, processes, and people (23).Academic research has shown that it is not the technology that provides an organization with a success, but the integration of technology into an organizational change management process (24). A successful IS project requires, among other things, a human resource strategy to improve the necessary employee skills and their engagement in the process of change management (25).

The management of change is an important discipline in today's ever changing environment. Change is never easy, and managing it in a large corporate environment is even more challenging. Based on the relevant literature, change can only be effectively implemented through proper planning and communications. Technological change can affect the learning experience in profound ways, but the direction of change depends more on the historical event technological invention, and the diversity of business needs and opportunities.



In order to implement the powerful and widely used learning management systems(LMS),and software systems for managing projects,we must have an integrated information models of those projects. An Information System – Technology (IS / IT) project has unique attributes that give such projects a different nature from other projects. IS/IT project can differ in terms of project size, project complexity, ambiguity in project requirements, products produced, environment, resource requirements, skills of project team, the cost and benefits sides of the project which usually include many intangible and unexpected costs and benefits, in addition to rapid change in the technology used within these projects which brings more ambiguity and uncertainty in the project outcomes. Consequently, IS/IT project managers need to consider different factors due to the unique environment of these projects (26).

Due to the above factors, change in IS/IT projects is a normal and complex organizational concept. It is argued that no matter how carefully the project is defined through the initiation phase, the scope of most projects is subject to considerable uncertainty and change (27).Furthermore, even if the project is well – planned by the project manager and team for implementation; it is almost certain to be changed before its completion. These changes may result in changing business processes and procedures, creating new roles and responsibilities leading to organizational restructuring, and needing new equipment, human resources, or new skills (28).

There are many basic causes for change in projects such as; project team characteristics (e.g. awareness, qualifications and commitment), rules and regulations, and technological uncertainty. Some changes occur because mistakes were made in the initial assessment as how to achieve given goals, or in choosing a clear vision and goals for the project (29). Technological change is a fundamental factor for uncertainty, or project risks. Other changes result because the users or project team's lack of awareness, qualifications and commitment to the project, in addition to the high turnover. Many of these changes involve people, who are the key to the successful implementation of any IS/IT projects. Therefore, managing change is primarily dealing with people issues and involving them at every stage of the project (30).

In order to implement the powerful and widely used learning management systems(LMS),and software systems for managing projects,we must have an integrated information models of those projects. An Information System – Technology (IS / IT) project has unique attributes that give such projects a different nature from other projects. IS/IT project can differ in terms of project size, project complexity, ambiguity in project requirements, products produced, environment, resource requirements, skills of project team, the cost and benefits sides of the project which usually include many intangible and unexpected costs and benefits, in addition to rapid change in the technology used within these projects which brings more ambiguity and uncertainty in the project outcomes.

For us, the aim of this study has been to shed some light on issues related to e-learning, education, ICTs and project management that have been apparent in the implementation of the e-learning project at UBT. Such crucial issues still need further research especially in developing countries where

valuable resources are being invested in ICT related projects given that education in particular for these countries.

## V. UBT: E – LEARNING PROJECT

Before presenting the case study of this paper, it is useful to identify the context within which it is placed – Kingdom of Saudi Arabia – Jeddah City. Many countries realized the importance of ICT in developing life of an individual and society, and its role in boosting the economy and income for the individual and state.(31), the Kingdom of Saudi Arabia is witnessing noticeable growth and development in all aspects of life, which has led to its progress and prosperity .During the past few years, the Kingdom, has paid increased attention to rapidly growing and fast evolving sectors; one of which is ICT sector.

The wise leadership of the Kingdom has realized the vital role of ICT in building Information based society, characterized by the production, penetration, and processing information has led to the start of a number of e – learning initiatives both at school and university level. In view of this, came the kind directive to formulate a National Communications and Information Technology Plan (NCITP) for the Kingdom to implement it.

The e - learning project at UBT is placed within this context in which ICTs are becoming as an important means for change and development to eventually transform the kingdom into knowledge – based economy. UBT was the first private university to be established in 2012, with a pioneering role in providing private higher education in business and technology to students in the kingdom. In 2007, The College of Business Administration(CBA) started implementing its e - learning project.

The main objectives UBT e - learning project is:(a) to increase the learning and teaching efficiency and increasing flexibility to adopt the changes in the business environment; (b) improve students 'learning process by interactivity and boost their interest in learning where simulations, video projects, mobile learning, and such can be fruitful engagement;(c) enhance the assessment and evaluation process to evaluate students & faculties effectively in a timely manner;(d) provide lifelong learning resources for UBT graduates and alumni; (e) extend educational opportunities to those masses missing conventional education because of distance, disabilities ,or age; (f) balance educational opportunities for higher education by distance mode for a big amount of the population, including those in employment and others who wish to upgrade their educational level; and(g) serve the local community in general(Source: [www.ubt.edu.sa](http://www.ubt.edu.sa) ).

For UBT the project is still ongoing and vision is still to establish 'virtual university 'despite the challenges. Currently established and future plans in UBT will help it in establishing full e - learning tools and services, through two phase strategy to implement e - learning project that is responsible not only for implementing the project but also offers opportunities for training, consulting, and development of other projects in the future.

Before stating an e - learning program, any institution needs to have a clear vision of what its aims are and the risks and challenges involved. In addition, human resources, their culture

and the ability to sustain resources once they acquire the necessary know – how is major issue that needs careful consideration. Moreover, many constraints related to higher education laws and regulations within each country need to be considered carefully because the especial nature of the educational process (32).

A very important part of the project for UBT was the establishment of the e-learning Centre of Excellence at the University which hosts the most recent technology. It aims to facilitate offering ICT enabled education, developing online courses, and in general providing the community with services. Table (1) and Table (2) summarizes the current and future plans.

## VI. DATA COLLECTION

Data collection for case studies may come from a number of sources such as documents, archival records, interviews, and participant's observation (33). In this study primary data is collected through interviewing with some people involved in the project including: the president of UBT; and the former project coordinator and current project manager; and the general director of IT and communications department. Data collection took place between September and October 2014.

**INTERVIEWS:** Since the subject of this study deals mainly with human perception and knowledge, the interviews were needed to gain an understanding of chosen subject. In addition, the interviews had all the characteristics of the formal interview. Accordingly, they were arranged in advance; the respondents were contacted by researcher via e-mail prior to the interview. The interviews, therefore, were semi-structured, and the notes were taken which were immediately discussed and summarized afterwards with the permission of respondents. This kind of interview assisted in keeping track of and investigating specific issues about the e-learning.

Three face-to-face interviews were conducted for this study. The interviews with the president of UBT, and the general director of IT and communications were conducted at the main campus of UBT, Dahban – Jeddah, while interviews with the former e-learning project coordinator were held in Sari campus – Jeddah.

The interview with the president started by general questions about university such as, year of established, programs offered ...etc. This was followed by specific questions about e-learning project in the university.

Also, he added that the problems facing us in this matter is not only a technical, but also human and legislative, but the e-learning is coming inevitably and became an urgent need for some colleges and disciplines.

The vision and mission as expressed by the president of the university was: "Our vision is to become a leading institution in e-learning for UBT students as well as to those who did not have a chance to continue their college education. and "Our mission is to provide quality e-learning system for interactive teaching process in classes, off classes, and beyond university boarders".

According to an interview with UBT e-learning project manager, said that "along with the new regulated approach of approving online courses by the Saudi ministry of higher

education, UBT has to adopt and apply E-learning to enhance the educational experience inside their campuses and outside as well". "Our projet is promising due to the noevlty of the university, but we achieved a lot in few years. more recently we have established the virtual library to the teaching staff members, students and researchers".

Different forms of e-learning has been implemented at Saudi universities but at UBT the aim of this program was to develop courses that are "made at UBT, (See Table 1 and Table 2). " from scratch, and offer these courses to students online: "Our ambition at the UBT to become the Leader University of e-learning education in the region as well as develop an e-learning world where teachers, learners, trainees, and researchers use technology to enhance the overall educational experience both in campus and off campus", according to (E-learning project manager at UBT).

The interview with the general director of IT & communications department in the university, it took a longer time as the role of this department at UBT is very important; it is the basis for development and conducting the work at all sections and departments of the university, the most important department in the university when talking about e-learning.

According to general director, this department provides comprehensive applications development services to all UBT departments and managing all UBT applications, provides comprehensive infrastructure services to UBT and maintains a high expanding WAN network connecting all its campuses (Dahban, Jeddah, and MBA) providing services to all administrative and academic departments. With regard to e-learning, he stated: "at UBT, we have a good history of campus collaboration in developing technology plans. Prioritization and coordination of technology planning and implementation will ensure that UBT students, faculty, and staff have the combination of skills, knowledge, and technology to thrive in a technology".

## VII. DISCUSSION

In this piece of work we examines the nature of change in higher education with respect to the introduction and growth of E-learning. While the ostensible aim is to use E-learning to improve the quality of the learning experience for students, the advisors of change are numerous, and learning quality ranks poorly in relation to most of them. Those of us working to improve student learning, and seeking to exploit E-learning to do so, have to ride each new wave of technological innovations in an attempt to divert it from its more natural course of techno-hype, and drive it towards quality agenda. We have to build the means of e-learning to evolve and mature as part of the educational change processes, so that it achieves its promise of an improved system of higher education.

The original plan has been to offer online courses developed by UBT staff which lead to offering online degrees and ultimately achieve the vision of the 'virtual university'. Among Saudi universities, UBT is arguably the first university to follow such a methodology according to a market research.

This is what made the project more challenging. Therefore, for a number of reasons there have been many changes within the project as in the beginning in CBA., and such changes had to be



managed so that the project could be continued to Moodle the current e – learning system in **UBT**.

In this section we will discuss a number of these changes that have been faced and consequently discuss these issues with the people related to this system in relation to a theoretical framework. **First**, Higher Education in Saudi Arabia is subject to laws and regulations of the Ministry of Higher Education (MoHE.) and according to these laws, offering online degrees are still not allowed. Therefore, the implementation of the original vision of “E-learning University “is still not possible. The non-accredited status of on – line courses over the internet in the Kingdom is the known major reason for not taking on – line courses, the other reason is the non – interaction with other students and faculty (**34**).

**The second** issue that proved to be problematic is the development of a fully online course from scratch as this proved to be difficult, time consuming, and lacks some aspects such as the required interactivity between students and instructors (**17**). These problems have resulted in making changes to the development methodology for the courses themselves, which has led to UBT to adopt a new methodology for developing its tools and courses using Moodle. The aims of this new methodology are to shorten development time, provide better interactivity, enhance collaborative learning, and meet the requirements of the MoHE in terms of blending online with face to face teaching is argued to be most successful approach for e – learning (**35**).

Technological uncertainty is the **third** issue. The technology for the project had to be changed because the original specifications for that IT infrastructure were seen to be insufficient. The new technology infrastructure was with better specifications and the change in technology proved to be positive change in the project. **Fourthly**, the availability and sustainability of human resources involved in the project have been a major challenge and resulted in many changes within the project team, which has also been reflected on the implementation of the project.

The project also faced a number of challenges that have also affected its implementation. One of the major challenges is the culture related to e – learning among faculty members and students. For some faculty members, it was difficult to change the way of teaching for many years, as e – learning is a new trend

assistance to facilitate the use of such technology. .One of the other challenges for implementing e – learning systems in higher education is that some instructors may have felt threatened by change, so chose to resist e – learning systems (**17**).

To overcome these issues, extensive training is needed but the problem is that training is costly, time consuming and of course sustaining the qualified faculty members is another problematic issue. Furthermore, appointing a qualified project manager who is able to translate the vision of the e – learning project into a workable plan has proven to be difficult. Changing managers in a short period of time meant that each project manager comes with different: vision; plan of action; management style; and this create confusion and uncertainty (**17**).

## VIII. CONCLUSION, RECOMMENDATIONS AND FUTURE WORK

**8.1.CONCLUSION:** E-learning technologies become increasingly utilized in UBT issues related to standardizations for reusability and interoperability, assurance of quality, and prevention of adverse effects, become crucial. Therefore, national standards for E-learning should be developed. Moreover, many constraints related to Higher Education laws and regulations within each country need to be considered carefully because of the special nature of the educational process.

The issue of E-learning itself is still problematic in terms of its definition and consequently the methods of implementation. Before starting an E-learning program, any institution needs to have a clear vision of its aims and the risks and challenges involved. In addition, human resources, their culture and the ability to sustain these resources once they acquire the necessary know-how are major issues that need careful consideration. Empirical examining for this study will be the subsequence phase .

**8.2.RECOMMENDATIONS:** with reference to the findings and conclusions of the study, the following recommendations are offered:

In order to promote E – learning, the government should come up with regulation and accreditation plans so that

infrastructure. Finally, it could be argued that generalization in our case may be in drawing implications and contributions of insights that are useful for the e - learning project at UBT in the future.

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#### AUTHORS

**First Author** – Abdelrahim.M.Zabadi, University of Business& Technology (UBT), E- Mail: [a.zabadi@ubt.edu.sa](mailto:a.zabadi@ubt.edu.sa)  
**Second Author** – Amnah H. A. Dammas, Department of Education Management and Developing- Females Ministry of Education, Jeddah, Saudia Arabia, E-mail: [emc1430@hotmail.com](mailto:emc1430@hotmail.com)

**Table (1): E – learning current services at U.B.T.**

<b>Smart Classroom software</b>	UBT campuses install smart software in each classroom and in each instructor computer. The smart software includes smart notebook and smart board software and such. It allows the teacher to customize and designs his/her own lectures to be interactive and animated and present it inside the classroom using the smart touch boards. It transforms a rigid text lecture into a creative, innovative interactive experience inside the classroom. The students enjoy smart board lectures and they get to experience the board when presenting their projects themselves or solve exercises on the board.
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Source: [www.ubt.edu.sa/.../Applications-Development-Division/E-learning](http://www.ubt.edu.sa/.../Applications-Development-Division/E-learning)

**Table (2): E – learning Projects**

<b>Phase (1):</b> Interactive learning & communication and ease Of online process projects:
<b>Video Conferencing</b>
<b>E – Mail Services:</b> For staff e-mail Use your UBT e-mail account from any Web browser, Schedule meetings and appointments on your calendar, Save phone and address information for people you communicate with. Student Email services, Shared calendars, File sharing, One Drive cloud storage, Online conferencing, Screen sharing, Public website, Office Online: Create and edit Word, Excel, PowerPoint, and OneNote files via a web browser
<b>LMS:</b> learning management system (Moodle) enhancements; Moodle is a free and open source e-learning software platform, also known as a Course Management System, Learning Management System, or Virtual Learning Environment. E-learning system, Course materials , Presentations, Handouts, Projects , Quizzes, Assignments, Messages, Chat , Discussion Forums.
<b>Interactive course contents</b>
<b>E- library (library department)</b>
<b>Online payment /Admission/Registration</b>
<b>Mobile connectivity</b>
<b>Phase (2) :</b> Extended learning resources to distance students and facilitate distance learning projects :
<b>Online admission</b>
<b>Virtual classroom</b>
<b>Website student E – learning</b>
<b>Online and contents</b>
<b>Exam proctoring</b>

Source: [www.ubt.edu.sa/.../Applications-Development-Division/E-learning](http://www.ubt.edu.sa/.../Applications-Development-Division/E-learning).

as gold, silver, copper, and vanadium dioxide is simulated in this work. Analyte material is used as a surrounded medium of a plasmonic nanoparticle for its sensitivity of gas concentration in contact with its surface. Using the proposed structure I notice that, gold nanoparticles gives the highest sensitivity and vanadium dioxide has the lowest sensitivity of 359.3 and 150.13 nm/RIU respectively, in case of using single plasmonic nanoparticle. FWHM of Au nanoparticle is 77.86 nm at SPR 593.66 nm and VO<sub>2</sub> has 110.01 nm at 549.78 nm for analyte refractive index 1.1. Refractive index sensitivity of a gold nanoparticle is obtained at radius 80 nm.

In case of using two different nanoparticles of different size, the maximum average sensitivity is obtained for gold–gold nanoparticles of 556.04 nm/RIU and the optimum nanoparticles radius are 80 and 100 nm due to the second resonance wavelength group with high sensitivity G2. The given refractive index sensitivity for gold, as a first nanoparticle, and silver or copper, as a second nanoparticle, is 504.11 nm/RIU.

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# Study of Plasmonic Exponential Nano-Hole Arrays and Its Application as an Optical Sensor

Ali Elrashidi<sup>1,2,\*</sup>, Marwa M. Tharwat<sup>3</sup>, and Amr Mahros<sup>2,4</sup>

<sup>1</sup>Department of Electrical Engineering, University of Business and Technology, Jeddah 21432, Saudi Arabia

<sup>2</sup>Department of Engineering Physics, Alexandria University, Alexandria, 21544, Egypt

<sup>3</sup>Department of Electrical and Computer Engineering, King Abdulaziz University, Jeddah, 21432, Saudi Arabia

<sup>4</sup>Department of Physics, King Abdulaziz University, Jeddah, 21432, Saudi Arabia

In this paper, we investigate the impact of taper coefficient, imperfection ratio and nano-hole depth on the resonance wavelength and peak intensity in transmission spectra of the Exponential nano-hole array by using FDTD method. The numerical simulation was done with reasonably-established mode and the effects of the three key parameters were investigated in detail. It was found that the asymmetry between the two openings of the circular nano-holes or bending to their side walls strongly modifies both of the intensity and resonance positions of the transmission spectra. By extension, we present this plasmonic structure as a refractive index optical sensor.

**Keywords:** Finite Difference Time Domain (FDTD), Nano-Hole Arrays.

## 1. INTRODUCTION

Metallic films perforated with periodic nano-hole arrays is considered as one of the most interesting plasmonic structures received a significant amount of attention since their optical transmission spectra of such structures are extraordinary optical transmission (EOT). Discovery of EOT was first reported by Ebbesen et al.<sup>1</sup> It has been a focus of researchers to carry out considerable amount of theoretical and experimental work about these structures.

The extraordinary behaviors of the perforated metallic film are largely due to the presence of surface plasmons (SPs), which can be excited by illuminating the film using a Gaussian beam. It was found in the literature, the coupling/decoupling phenomenon between SPs of patterned metallic film and incident light results in appearance of multiple resonance peaks in the transmission spectrum.<sup>2</sup>

The EOT can be tuned through many physical and geometrical parameters including the hole shape,<sup>3</sup> size<sup>4</sup> and depth<sup>5</sup> as well as film material,<sup>6</sup> substrate refractive index,<sup>7</sup> and array period.<sup>8</sup> Arrays with simple aperture shapes can be tuned to resonate at much shorter wavelengths than those of complex hole shapes, such as annular,<sup>9</sup> cross-shaped,<sup>10</sup> and X-shaped<sup>7</sup> apertures. However, more tunability had been achieved by applying a magnetic field.<sup>11</sup>

The key parameters of these plasmonic structures are metal type, holes shape and dimensions, refractive index of

surrounding environment, and structural periodicity which have significant impact on the resonance wavelength and its intensity. However, the impact of fabricating imperfect nano-holes on the transmission spectrum has not yet been investigated in the literature. Nano-holes fabrication imperfection may result in disparity between their two apertures or bending to their side walls.

Surface plasmons (SPs) and EOT have been recently employed in a myriad of applications including biomedical sensing,<sup>12</sup> efficient solar cells,<sup>13</sup> fluorescence microscopy,<sup>14</sup> photothermal therapy<sup>15</sup> and fabrication of nano-antennas.<sup>16</sup>

In this paper, we use the 3D finite difference time domain (FDTD) method for the first time to investigate the optical transmission spectrum of gold films patterned with imperfect circular nano-holes. We study the impact of changing the shape of imperfection on transmission spectra as a function of the nano-hole length, side walls taper coefficient, and the imperfection ratio of asymmetric openings, showing that large modification can be achieved with realistic parameters. The impacts of independently varying these parameters are separately considered in our simulations, and the results are summarized in the following subsections.

This paper is organized as follows: the reported structure and FDTD simulation parameters are described in Section 2. Section 3 represents the optical transmission spectral responses of the designed plasmonic arrays and discussions for the effect of varying different key

\*Author to whom correspondence should be addressed.

parameters. Finally, Section 4 provides conclusions of the obtained results.

## 2. STRUCTURE DESCRIPTION AND FDTD SIMULATION

In this work, optical transmission spectra of the reported plasmonic arrays are obtained using the FDTD algorithm which is trustworthy in solving Maxwell's equations for different materials. The FDTD method is applied by using the OptiFDTD simulation tool from Optiwave Inc. The designed plasmonic structure layout is a circular nano-hole array perforated in gold thin film "sandwiched" between glass substrate and air cladding as shown in Figure 1(a). The structural periodicity was 400 nm and the gold film thickness was 100 nm.

In Cartesian coordinates  $x$ ,  $y$ , and  $z$ , periodic boundary conditions were used in the  $x$  and  $y$  directions, while, anisotropic perfect matching layer was used in the  $z$ -direction to serve as absorbing boundary condition.

The relative permittivity  $\epsilon_r(\omega)$  of the dispersive gold film was determined using the Lorentz-Drude model:

$$\epsilon_r(\omega) = \epsilon_\infty + \sum_{m=1}^N \frac{f_m \omega_{om}^2}{\omega_{om}^2 - \omega^2 + i\omega\Gamma_m} \quad (1)$$

where  $\epsilon_\infty$  denotes the permittivity at infinite frequency,  $f_m$  is a function of position specifying the oscillator strengths, and  $\Gamma_m$  is the damping coefficient. The incident wave frequency and the resonant frequencies are respectively represented by  $\omega$  and  $\omega_{om}$ . For substrate layer,  $\epsilon(\omega)$  was assumed as  $n^2$  ( $n$  is the refractive index).

In order to realize a broadband simulation on the dispersive gold film, Gaussian modulated electromagnetic plane wave source was used. The continuous waves are centered at 680 nm, linearly polarized in  $y$ -direction, and convoluted with a Gaussian envelope function. The light pulse in time domain has an offset time of  $0.8 \times 10^{-14}$  s and half width of  $0.8 \times 10^{-14}$  s.

The simulation was performed at normal incidence ( $z$ -direction) of the plane wave through the nano-hole arrays. The calculation mesh resolution was as high as 5 nm ( $<0.1 \lambda$ ). The simulation runs for 5,000 time step for

a calculation time of 100 fs. An  $x-y$  observation area will perform and calculate the transmission spectral analysis at 400 nm away from the air/film interface.

Figure 1(b) shows the shape of the imperfect hole used during this simulation. Exponential shape for the nano-hole side wall is used to express imperfection according to the following equation:

$$W(Z) = W_S + \frac{W_E - W_S}{e^\alpha - 1} (e^{(\alpha/d)Z} - 1) \quad (2)$$

where  $W(z)$  represents the diameter of the nano-hole along its axis such that  $z = 0$  at the air/gold interface and  $z = d$  at the gold/substrate interface.  $W_S$  and  $W_E$  denote the diameter of the nano-hole at the air/gold and gold/substrate interfaces, respectively, and  $d$  is the thickness of the gold layer (length of the nano-hole). The side wall exponential taper coefficient is represented by  $\alpha$ .

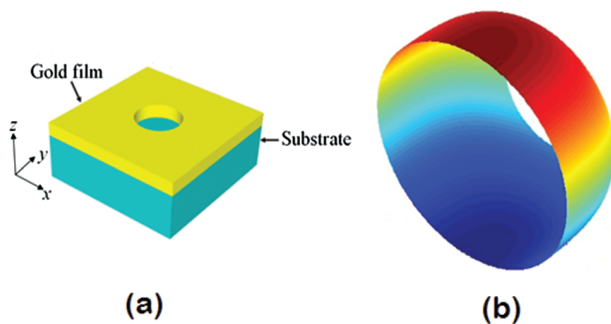
## 3. OPTICAL TRANSMISSION SPECTRAL RESPONSES

In our simulations, we vary three distinct structural parameters: the side walls taper coefficient, the imperfection ratio of asymmetric openings, and nano-hole length. The impacts of independently varying these parameters are separately considered in our simulations, and the results are summarized in the following subsections. The imperfection ratio is defined as the difference between the two openings' radii to the initial radius ( $\delta W/W_S$ ).

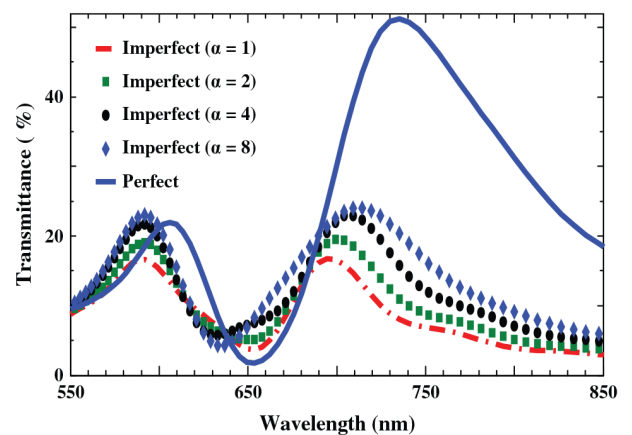
### 3.1. Taper Coefficient

In this subsection, we investigate modifying the transmission spectra of the gold-perforated imperfect nano-hole arrays by changing the side walls taper coefficient within a range of 1–10. During this study, the imperfection ratio and gold film thickness are kept constants at 50% and 100 nm respectively.

Figure 2(a) shows some examples of the transmission spectra of the designed structure at different values of the



**Fig. 1.** (a) A unit cell of a circular nano-hole array perforated in a gold film. (b) Imperfect nano-holes of asymmetric openings and side walls of exponential shape.



**Fig. 2.** Optical transmission spectra of gold thin film perforated with imperfect nano-holes with different side walls taper coefficient.

taper coefficient  $\alpha$ . The results of Figure 2 exhibit the presence of two groups of resonance. The first peak “P1” is located at wavelengths less than 650 nm, while, the second group “P2” is found at wavelengths larger than 650 nm. It was found in the literature, these two sets of resonance wavelengths associated with the metal/substrate and metal/superstrate interfaces. At normal incidence, the SP resonance wavelengths  $\lambda_{SP}$  of a circular nano-hole array can be approximated by Eq. (3):

$$\lambda_{SP}(i, j) = Re\left(\frac{\Lambda}{\sqrt{i^2 + j^2}} \sqrt{\frac{\epsilon_d \epsilon_m}{\epsilon_d + \epsilon_m}}\right) \quad (3)$$

where  $\epsilon_d$  and  $\epsilon_m$  respectively represent the relative permittivity of the adjacent medium and the metal and  $(i, j)$  are integers.  $\Lambda$  represents the structural periodicity value.

The SP resonance wavelengths in the range of 550–650 nm “P1” can be assigned to the air/gold interface, while, the resonance wavelengths found at values larger than 650 nm “P2” are related to the gold/substrate interface.

As demonstrated in Figures 3(a and b), a clear red shift is observed in the transmission resonance wavelengths of

P2 with the increase of  $\alpha$ . The red shift saturates at higher values of the taper coefficient. In sharp contrast to this behavior, the transmission resonance wavelengths of P1 do not change.

That red shift may be attributed to the resonance in the nano-hole, the increase of  $\alpha$ , increases the length of the resonator till it saturates.

Additionally, the impacts of changing  $\alpha$  on the transmission peak intensity of P1 and P2 are shown respectively in Figures 3(c and d). The results shown in these figures demonstrate that the peak intensity values of P1 and P2 monotonically increase with increasing  $\alpha$  till it saturates at higher values of the taper coefficient.

In comparison to the perfect circular nano-hole arrays, Be the predicted that the transmission peak intensity values of such structures are proportional to  $R^4$ . Therefore, the difference in peak transmission coefficient can perhaps be attributed to the differences in “effective” hole radius.

### 3.2. Imperfection Ratio

In this subsection, we investigate the effect of changing the imperfection ratio ( $\delta W/W_s$ ) between the two openings on the transmission spectra of the gold-perforated

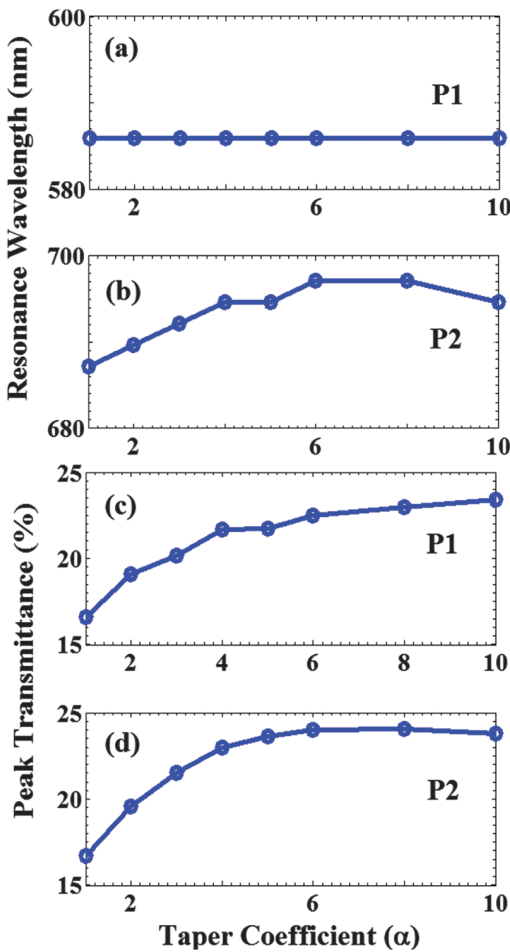


Fig. 3. Effect of changing  $\alpha$  on the position of resonance wavelengths of (a) P1 and (b) P2. Impact of changing  $\alpha$  on the transmission peak intensity of (c) P1 and (d) P2.

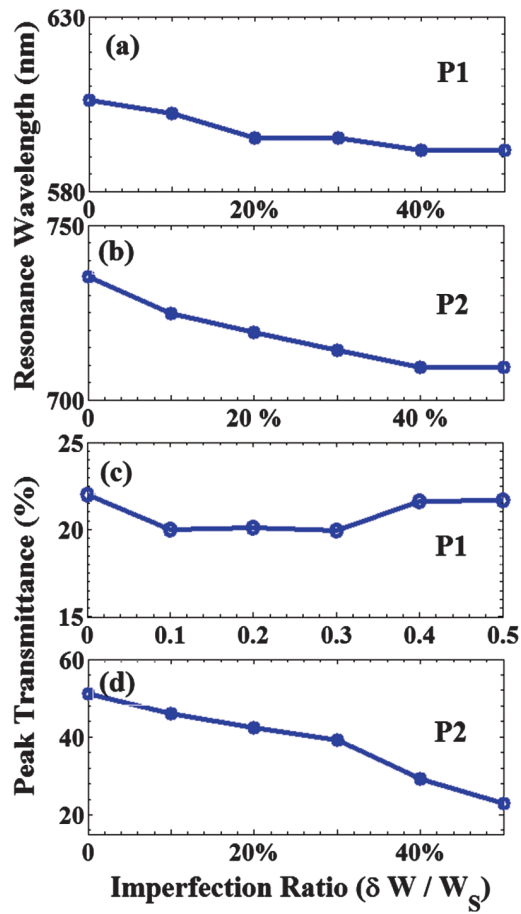


Fig. 4. Effect of changing the imperfection ratio on the position of resonance wavelengths of (a) P1 and (b) P2. Impact of changing  $\delta W/W_s$  on the transmission peak intensity of (c) P1 and (d) P2.



imperfect nano-hole arrays. During this investigation, side walls taper coefficient, radius of the nano-hole at air/film interface and gold film thickness remain constants at 4, 100 nm and 100 nm, respectively.

Figure 4 demonstrates the modifying the intensity and resonance positions of the transmission spectra with the imperfection ratio. As can be seen from Figures 4(a and c), the peak transmittance and resonance wavelength of P1 slightly change with increasing imperfection ratio. In sharp contrast, a blue shift in the resonance position and dramatically drop in the intensity of P2 as clear in Figures 4(b and d).

The negligible shift in the resonance wavelengths and intensities of P1 is because the air/film interface opening has a constant circular cross-section. This shift is due to the sidewall bending.

At the gold/substrate interface, however, the resonance wavelengths and intensities of P2 are imperfection ratio dependent because the nano-hole opening at this interface is changing with the imperfection ratio. That would make difference “effective” hole radius resulting in intensity degradation and short resonator length resulting in a blue shift.

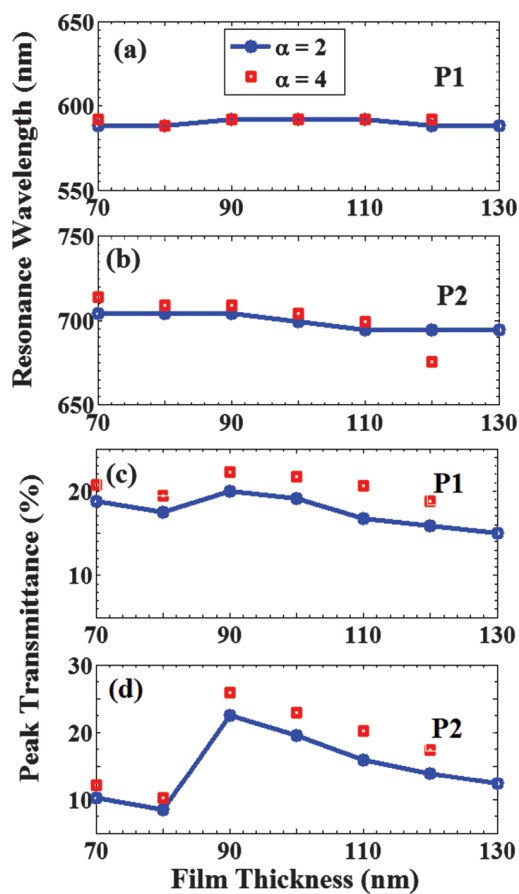


Fig. 5. Effect of changing the imperfect nano-hole length on the position of resonance wavelengths of (a) P1 and (b) P2. Impact of changing film thickness on the transmission peak intensity of (c) P1 and (d) P2.

### 3.3. Nano-Hole Length

In this subsection, the behavior of optical transmission spectra of the reported plasmonic structure is introduced with changing the distance between the two asymmetry openings of the circular nano-holes. We here fix the imperfection ratio film at 50% and use side walls exponential taper coefficient of 2 and 4.

The impact of changing film thickness on the intensity and resonance positions of the transmission spectra is shown in Figure 5.

Figures 5(a and c) illustrate that the resonance wavelength and peak transmittances of P1 slightly change with increasing film thickness. Similar behavior is obtained in case of  $\alpha = 4$  (red squares) but with a little bit higher transmittance due to differences in the effective radius.

Figure 5(b) demonstrates that the resonance wavelength of P2 slightly blue shifts with increasing film thickness. The value of that shift is increased in case of  $\alpha = 4$  (red squares).

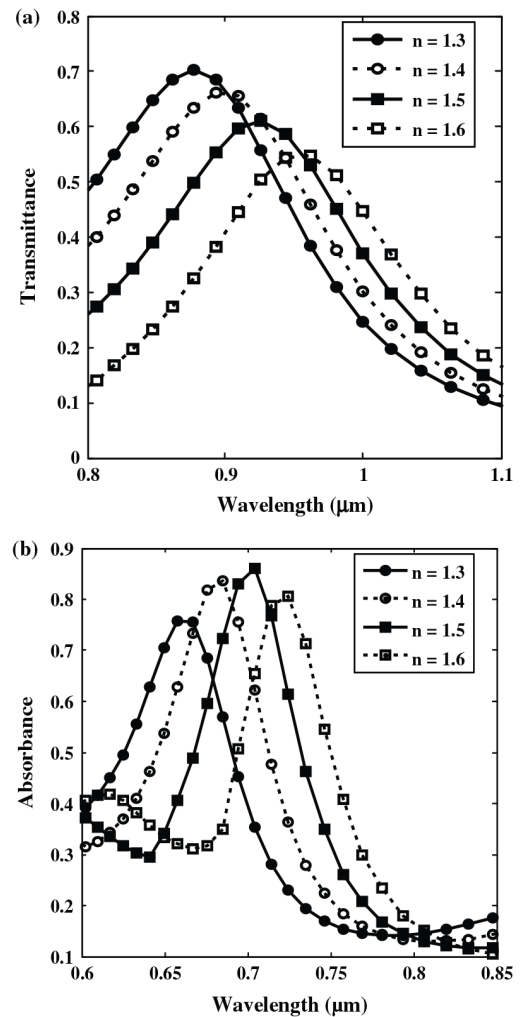


Fig. 6. The impact of changing the substrate refractive index on the optical (a) transmission (b) absorption spectra of the gold-perforated exponential nano-hole arrays.



Figure 5(d) shows that the intensity of P2 suffers degradation with increasing the length due to curvature and bending of the side walls.

#### 4. EXPONENTIAL NANO-HOLE ARRAYS AS AN OPTICAL SENSOR

We here investigate the effect of changing the refractive index of the substrate in the range of 1.3–1.6 on both the transmission and absorption spectra of the gold-perforated exponential nano-hole array. Figures 6(a and b) exhibit the transmission and absorption spectra, respectively, at different values of the refractive index of the substrate. As can be seen from these figures, the resonance wavelengths show a linear red shift with nearly constant slope with increasing the substrate refractive index. In particular, the refractive index sensitivities  $S_n = \partial\lambda_{sp}/\partial n$  of the designed structures at the resonance wavelengths are 282.1 and 219.5 nm/RIU when transmission and absorption spectra are considered, respectively.

#### 5. CONCLUSIONS

In this work, we comprehensively investigate the EOT properties of the imperfect circular plasmonic nano-hole arrays. Using the FDTD method, we investigate the impact of several key parameters including hole length, ratio between the asymmetric openings, side walls taper on the transmission spectra of thin gold films perforated with imperfect nano-hole arrays. Increasing taper coefficient

values causes red shift to the resonance wavelength of the plasmonic wave at the gold/substrate interface. However, increasing either imperfection ratio or film thickness causes blue shift.

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# Numerical characterization of InP-based quantum dot semiconductor optical amplifier

## Numerical characterization of quantum dot semiconductor optical amplifier

NAWWAR,<sup>1,4</sup> AHMED EMARA,<sup>1,2,\*</sup> MOUSTAFA H. ALY,<sup>3,5</sup> AND ALI M. OKAZ<sup>1,6</sup>

<sup>1</sup>and Engineering Physics Department, Faculty of Engineering, Alexandria University, Alexandria, Egypt  
<sup>2</sup>Engineering and Information Technology, University of Business and Technology, Jeddah, Saudi Arabia  
<sup>3</sup>Engineering and Technology, Arab Academy for Science, Technology & Maritime Transport, Alexandria, Egypt  
 nawwar@hotmail.com  
 aemara@uqaast.edu  
 maly@yahoo.com  
 author: a\_emara@yahoo.com

OMNIA M. I

<sup>1</sup>Mathematics and  
<sup>2</sup>College of Engi  
<sup>3</sup>College of Engi  
<sup>4</sup>e-mail: om.naw  
<sup>5</sup>e-mail: mosaly@  
<sup>6</sup>e-mail: Ali\_okaz  
 \*Corresponding

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This paper is devoted to the development of a steady-state behavior of a quantum dot-semiconductor optical amplifier (QD-SOA). The investigated performance characteristics cover a wide range that includes material gain coefficient, spatial distribution of the occupation probabilities, fiber to fiber gain, gain spectrum as a function of current, relaxation time, and capture time. A set of traveling-wave equations is used to model the signal propagation of spontaneous photons along the device active region. The obtained results indicate a high gain that reaches 34 dB for an InAs/InGaAsP/InP-based QD-SOA, with a corresponding device length of 4 mm. The obtained signal-to-noise ratio is larger than 75 dB for all input powers without using an output filter. © 2016 Optical Society of America

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**Key words:** (230.0230) Optical devices; (230.0250) Optoelectronics; (230.5590) Quantum-well, -wire and -dot devices; (250.5980) Semiconductor optical amplifiers.

**OCIS codes:**  
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## INTRODUCTION

Optical amplification for light signals are introduced: repeaters and optical amplifiers (OAs) [1]. Repeater depend on electro-optic conversion, in which optical signal is converted to an electrical signal, then amplified and converted back to the optical domain. This is a bottleneck problem that may restrict both optical bandwidth and the quality of the transmitted signal. To be made for a specified bit-rate of transmission, the entire network to be uniform in order to work properly. To avoid all these problems, OAs amplify incident light through stimulated emission without interconversion between electrical and optical domain, the same mechanism as in semiconductor lasers. In general, OAs can be divided into two classes: fiber amplifiers and semiconductor optical amplifiers. Due to advances in optical techniques for semiconductor device design, SOAs are showing a great potential to be used in optical communication networks for signal processing and optical logic gates [5–7]. Quantum dots are used extensively in laser fabrication with a wide range of materials to enhance their quantum efficiency and threshold current and meet the desired specifications [6,8].

In this work, a simulation of an InP-based QD-SOA is carried out. The homogeneous and inhomogeneous broadening of the amplifier to take into account the variety of QD properties during the manufacture process.

InP-based QD-SOAs are not widely investigated like GaAs-based QD-SOAs. We provide a full characterization and performance characteristics of InP, including material gain coefficient, spatial distribution of the occupation probabilities, fiber to fiber gain, gain spectrum as a function of the bias current, relaxation time, and capture time. A schematic diagram of the QD-SOA is shown in Fig. 1. The model used cannot be applied for a high number of QD layers as the coupling between layers becomes significant and cannot be neglected in this case. The model is first applied to a GaAs-based QD-SOA to verify its validity by comparing to previous results in the literature. After that, it is used to investigate the new case of an InP-based QD-SOA.

The remainder of this paper is organized as follows. In Section 2, the theory behind electron-photon interaction in QDs are used to deduce the gain coefficient in QD material is presented, followed by the description of the steady-state algorithm in lasing current.

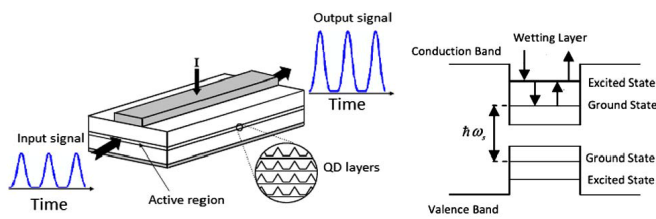


Fig. 1. Schematic diagram of device structure.

Section 3. Section 4 is devoted for the results and discussion. This is followed by the main conclusions of the study in Section 5.

## 2. THEORY

### A. Electron-Photon Interaction

The gain coefficient of a QD material can be driven starting from the Hamiltonian that describes the interaction between an electron and a photon [9]:

$$H = \frac{1}{2m_0}(\mathbf{P} - e\mathbf{A})^2 + V(\mathbf{r}), \quad (1)$$

where  $m_0$  is the free electron mass,  $e = -|e|$  for electrons,  $\mathbf{A}$  is the potential vector accounting for the presence of the electromagnetic field,  $\mathbf{P}$  is the electron momentum, and  $V(\mathbf{r})$  is the periodic crystal potential.

Assuming that, the vector potential for the optical electric field is in the sinusoidal form

$$\mathbf{A} = \hat{e}A_0 \cos(\mathbf{k}\cdot\mathbf{r} - \omega t), \quad (2)$$

where  $\mathbf{k}$  is the wave vector,  $\omega$  is the optical angular frequency, and  $\hat{e}$  is a unit vector in the direction of the optical electric field. The electric and magnetic fields can be calculated directly from Eq. (2).

The Poynting vector, which represents the flow of electromagnetic energy per unit area, is given by [10]

$$\mathbf{S}(\mathbf{r}, t) = \mathbf{E}(\mathbf{r}, t) \times \mathbf{H}_m(\mathbf{r}, t) = \mathbf{k} \frac{\omega A_0^2}{\mu} \sin^2(\mathbf{k}\cdot\mathbf{r} - \omega t), \quad (3)$$

which is pointing along the direction of energy propagation  $\mathbf{k}$ . The magnitude of the optical intensity is then

$$S = |\langle \mathbf{S}(\mathbf{r}, t) \rangle| = \frac{\omega A_0^2}{2\mu_0} k = \frac{n_r c \epsilon_0 \omega^2 A_0^2}{2}, \quad (4)$$

where the permeability  $\mu = \mu_0$ ,  $c$  is the speed of light in free space, and  $n_r$  is the refractive index of the material.

### B. Transition Rate Due to Electron-Photon Interaction

The transition rate for the absorption or emission of a photon can be deduced using the time-dependent perturbation theory. Consider the Schrödinger equation

$$H\Psi(\mathbf{r}, t) = -\frac{\hbar}{i} \frac{\partial}{\partial t} \Psi(\mathbf{r}, t), \quad (5)$$

where the unperturbed part of  $H$ ,  $H_0$ , is time-independent, and the perturbation part,  $H'$ , depends on time. The time-dependent perturbation is assumed to have the form

$$H'(\mathbf{r}, t) = H'(\mathbf{r}) \exp(-i\omega t) + H'^*(\mathbf{r}) \exp(i\omega t), \quad (6)$$

for  $t \geq 0$ . The superscript  $*$  means the Hermitian adjoint operator of  $H'(\mathbf{r})$ .

To find the solution to the time-dependent Schrödinger equation, the wave function will be expanded in terms of the unperturbed solutions as

$$\Psi(\mathbf{r}, t) = \sum_n a_n(t) \varphi_n(\mathbf{r}) \exp\left(-\frac{iE_n t}{\hbar}\right), \quad (7)$$

where  $|a_n(t)|^2$  gives the probability that the electron is in the state  $n$  at time  $t$ . Solving Eqs. (5), (6) and (7), one obtains

$$|a_f^{(1)}(t)|^2 = \frac{4|H'_{fi}|^2 \sin^2[(\omega_{fi} - \omega)t/2]}{\hbar^2 (\omega_{fi} - \omega)^2} + \frac{4|H'_{fi}|^2 \sin^2[(\omega_{fi} + \omega)t/2]}{\hbar^2 (\omega_{fi} + \omega)^2}. \quad (8)$$

When the interaction time is long enough, we found that

$$|a_f^{(1)}(t)|^2 = \frac{2\pi t}{\hbar^2} |H'_{fi}|^2 \delta(\omega_{fi} - \omega) + \frac{2\pi t}{\hbar^2} |H'_{fi}|^2 \delta(\omega_{fi} + \omega). \quad (9)$$

The transition rate is given by the time derivative of the transition probability as

$$W_{i \rightarrow f} = \frac{d}{dt} |a_f^{(1)}(t)|^2 = \frac{2\pi}{\hbar} |H'_{fi}|^2 \delta(E_f - E_i - \hbar\omega) + \frac{2\pi}{\hbar} |H'_{fi}|^2 \delta(E_f - E_i + \hbar\omega). \quad (10)$$

The net upward transition rate per unit volume can be written as

$$R = R_{1 \rightarrow 2} - R_{2 \rightarrow 1} = \frac{2}{V} \sum_{k_1} \sum_{k_2} \frac{2\pi}{\hbar} |H'_{21}|^2 \delta(E_2 - E_1 - \hbar\omega) (f_1 - f_2). \quad (11)$$

The two summations take into account all the initial and final states.

### C. Optical Absorption Coefficient

The absorption coefficient  $\alpha(\hbar\omega)$  is defined as the fraction of photons absorbed per unit distance, which is given by

$$\alpha(\hbar\omega) = \frac{R}{S/\hbar\omega} = \frac{\hbar\omega}{n_r \omega^2 A_0^2} \frac{2}{V} \sum_{k_1} \sum_{k_2} \frac{2\pi}{\hbar} |H'_{21}|^2 \times \delta(E_2 - E_1 - \hbar\omega) (f_1 - f_2). \quad (12)$$

The matrix elements  $H'_{21}$  can be written in terms of the momentum matrix element  $\mathbf{p}$ , which is a measure for the strength of stimulated electron transitions in a given material [10]:

$$H'_{21} = -\frac{e}{m_0} \mathbf{A} \cdot 2\langle \mathbf{p} | 1 \rangle = -\frac{eA_0}{2m_0} \hat{e} \cdot \mathbf{p}_{21}. \quad (13)$$

Substituting Eq. (20) in Eq. (19), the absorption coefficient becomes



$$\alpha(\hbar\omega) = \frac{\pi e^2}{n_r c \epsilon_0 m_0^2 \omega} \frac{2}{V} \sum_{k_1} \sum_{k_2} |\hat{z} \cdot \mathbf{p}_{21}|^2 \times \delta(E_2 - E_1 - \hbar\omega)(f_1 - f_2). \quad (14)$$

Electrons and holes frequently interact with other carriers and with phonons, thereby changing their energy within the (sub) band. Thus, scattering leads to an uncertainty of the electron energy, which can be accounted for by replacing the delta function by a Lorentzian function with a FWHM of  $2\hbar\Gamma_{\text{in}}$  [11]:

$$\delta(E_2 - E_1 - \hbar\omega) \rightarrow \text{Lorentz}(E, \hbar\omega) = \frac{1}{\pi} \frac{\hbar\Gamma_{\text{in}}}{(\hbar\omega - E)^2 + (\hbar\Gamma_{\text{in}})^2}. \quad (15)$$

When  $\alpha(\hbar\omega)$  becomes negative, the gain in the medium is

$$g(E) = -\alpha(E) = \frac{\pi e^2}{n_r c \epsilon_0 m_0^2 \omega} \frac{2}{V} \sum_{k_1} \sum_{k_2} |\mathbf{p}_{21}|^2 \text{Lorentz}(E, \hbar\omega) \times (f_2 - f_1). \quad (16)$$

Dots are grouped by their resonant energy into  $2M + 1$  group in order to treat the spectral hole in the inhomogeneously broadened gain spectra due to dot size distribution. The homogeneous broadening of gain is taken into account, which determines the channel spacing in the multi-wavelength processing, and is also the origin of cross-gain modulation.

Carriers are injected into the wetting layer (WL), from where they are captured into the excited state (ES) within a capture time. Then, they relax from the ES to the ground state (GS). Also, carriers can thermally escape from the GS to the ES and from the ES to the WL.

The linear optical gains of the  $m$ th group QDs at frequency  $\nu$  can be developed from Eq. (16) by multiplying it by the degeneracy of each state and the overlap integral between envelope functions of electrons and holes. So,

$$g_{i,m}(z, t, \nu) = \frac{e^2 \hbar N_m}{c n_r \epsilon_0 m_0^2 V E_{i,m}} |\mathbf{p}_b|^2 |M_{\text{env}}|^2 \times [f_{i,m}(z \cdot t) - f_{i,m}^V(z \cdot t)] \times \text{Lorentz}(E_{i,m}, \hbar\nu), \quad (17)$$

where  $i = \text{GS}, \text{ES}$ ;  $z$  is the longitudinal position in the QD-SOAs;  $t$  is the time;  $\hbar$  is Planck's constant;  $\epsilon_0$  is permittivity of vacuum;  $m_0$  is electron mass;  $V$  is the active region volume;  $\epsilon_{\text{GS}}$  and  $\epsilon_{\text{ES}}$  are the degeneracy of the GS and ES, respectively.  $|\mathbf{p}_b|$  is the bulk matrix element.  $|M_{\text{env}}|$  is the overlap integral between the envelope functions of an electron and a hole,  $f_{\text{GS}}$  and  $f_{\text{ES}}$  are the electron occupation probabilities of GS and ES states in the  $m$ th group QDs, respectively. The GS and ES resonant energies  $E_{\text{GS},m}$  and  $E_{\text{ES},m}$  of the  $m$ th group QDs can be defined as

$$E_{i,m} = E_{i,tr} - (M - m)\Delta E, \quad (18)$$

where  $m = 0, 1, 2, \dots, 2M$  and  $E_{i,tr}$  is the resonant energy of the most probable size of QDs.  $E_{i,tr}$  is the separation energy interval between groups.

The QD number in the  $m$ th group,  $N_m$ , is related to the total number of QDs as

$$N_m = N_{\text{QD}} \text{Gauss}(E_{\text{GS},m}, E_{\text{GS},tr}), \quad (19)$$

where  $N_{\text{QD}} = n_l n_{\text{QD}} L W$  with QD layer number  $n_l$ , surface density  $n_{\text{QD}}$ , device length  $L$ , and stripe width  $W$ . The inhomogeneous broadening of the QDs could be described by a Gaussian distribution as [12]

$$\text{Gauss}(E', E) = \frac{2}{\sqrt{2\pi}\sigma} \exp\left(-\frac{2}{2\sigma^2}(E' - E)^2\right), \quad (20)$$

with the FWHM of  $2.35\sigma$ . The linear optical gain  $g$  at frequency  $\nu$  is obtained by summing all the individual contribution of ES and GS carriers over all QDs:

$$g(z, t, \nu) = \sum_{i=\text{ES,GS}} \sum_{m=0}^{2M} g_{i,m}(z, t, \nu). \quad (21)$$

#### D. Traveling-Wave Equations for Signal Field and Spontaneous Emission Intensity

Coupling a transverse-electric-mode continuous-wave signal with optical frequency  $\nu_s$  and power  $P_s$  into the QD-SOA at the facet  $z = 0$ , one can have two complex traveling-waves  $E_s^+$  and  $E_s^-$  for the signal fields propagating in the forward and backward directions. These satisfy the following traveling-wave equations [13]:

$$\frac{c}{n_r} \frac{\partial E_s^\pm(z, t, \nu_s)}{\partial t} \pm \frac{\partial E_s^\pm(z, t, \nu_s)}{\partial z} = \left\{ \mp i\beta \pm \frac{1}{2} [\Gamma g(z, t, \nu_s) - \alpha] \right\} E_s^\pm(z, t, \nu_s), \quad (22)$$

where  $i = \sqrt{-1}$ ,  $\beta = 2\pi n_r \nu_s / c$  is the propagation constant of the signal,  $\alpha$  is the loss coefficient, and  $\Gamma$  is the optical confinement factor. The boundary conditions are given by [14]

$$E_s^+(0, t, \nu_s) = \sqrt{1 - R_1} \sqrt{\frac{P_s}{\hbar\nu_s}} + \sqrt{R_1} E_s^-(0, t, \nu_s), \quad (23)$$

$$E_s^-(L, t, \nu_s) = \sqrt{R_2} E_s^+(L, t, \nu_s), \quad (24)$$

where  $R_1$  and  $R_2$  are power reflectivity at the input and output facets, respectively. The square modulus of the traveling-wave amplitude is taken to be the signal photon rate (in photons/s):

$$S_s^\pm = |E_s^\pm|^2. \quad (25)$$

The spontaneous emission photon rates  $S_{\text{sp}}^\pm$  (in photons/s), with polarization in a frequency interval  $\Delta\nu$  centered at frequency traveling in the positive and negative  $z$ -directions, obey the following equation [15]:

$$\frac{c}{n_r} \frac{\partial S_{\text{sp}}^\pm(z, t, \nu_{\text{sp}})}{\partial t} \pm \frac{\partial S_{\text{sp}}^\pm(z, t, \nu_{\text{sp}})}{\partial z} = \{[\Gamma g(z, t, \nu_{\text{sp}}) - \alpha]\} S_{\text{sp}}^\pm + R_{\text{sp}}(z, t, \nu_{\text{sp}}). \quad (26)$$

The spontaneous emission term,  $R_{\text{sp}}$ , is obtained by comparing the noise output of an ideal amplifier obtained from Eq. (35) with the quantum mechanical expression:

$$R_{\text{sp}} = \Gamma g' \Delta\nu, \quad (27)$$



where  $g'$  is the gain coefficient defined as the rate of downward transitions and is given by [13]

$$g' = \sum_{i=ES,GS} \sum_{m=0}^{2M} g_{i,m}(z, t, \nu_{sp}) \frac{f_{i,m}(1 - f_{i,m}^V)}{(f_{i,m} - f_{i,m}^V)}. \quad (28)$$

The boundary conditions of the spontaneous emission photon rates are given by

$$S_{sp}^+(0, t, \nu_{sp}) = R_1 S_{sp}^-(0, t, \nu_{sp}), \quad (29)$$

$$S_{sp}^-(L, t, \nu_{sp}) = R_2 S_{sp}^+(L, t, \nu_{sp}). \quad (30)$$

Equation (26) has two solutions in the steady state for the forward and backward directions.

### E. Carrier Rate Equation

To account for the longitudinal distribution of the carrier density, the segmentation method is used by splitting the QD-SOA into  $K_s$  sections ( $k = 1:K_s$ ) of equal length in the longitudinal direction. The carrier rate equations are considered for the position-dependent occupation probabilities in the WL, ES, and GS, respectively, as

$$\frac{df_{WL}}{dt} = \frac{\eta I_k}{e\rho_{WL,k}} - \frac{f_{WL}}{\tau_{sp}} - \frac{f_{WL}}{\bar{\tau}_{W-E}} + \sum_{m=0}^{2M} \frac{2\epsilon_{ES} N_m f_{ES,m}}{\rho_{WL,k} \tau_{E-W}}, \quad (31)$$

$$\begin{aligned} \frac{df_{ES,m}}{dt} = & \frac{N_m}{N_{QD,k}} \frac{\rho_{WL,k} f_{WL}}{2\epsilon_{ES} N_m \tau_{W-E}} - \frac{f_{ES,m}}{\tau_{E-W}} \\ & + \frac{2\epsilon_{GS} f_{GS,m}}{2\epsilon_{ES} \tau_{G-E}} - \frac{f_{ES,m}}{\tau_{E-G}} - \frac{f_{ES,m}}{\tau_r} - R_{stim}^{ES,m}, \end{aligned} \quad (32)$$

$$\frac{df_{GS,m}}{dt} = \frac{2\epsilon_{ES} f_{ES,m}}{2\epsilon_{GS} \tau_{E-G}} - \frac{f_{GS,m}}{\tau_{G-E}} - \frac{f_{GS,m}}{\tau_r} - R_{stim}^{GS,m}. \quad (33)$$

Equation (31) for WL carrier occupation probability is related to the bias current and the WL spontaneous emission. The third and fourth terms are the WL carrier captured by QD ES, and escaping from QD ES to the WL, respectively. The terms from left to right in the ES carrier Eq. (32) are the WL carriers acting as a reservoir captured by the ES, carriers escaping from ES to WL, intradot carrier excitation from GS to ES, carrier relaxing from ES to GS, ES spontaneous emission, and ES stimulated emission, respectively. The first term of the GS carrier in Eq. (33) represents the carrier relaxation to GS from ES. The second term is the intradot carrier excitation from GS to ES. The following terms are GS spontaneous emission and stimulated emission [including signal photon and amplified spontaneous emission (ASE) photon], respectively. Carrier capture directly from WL into the GS is neglected due to the large energy separation between the GS and the WL band edge and fast intradot carrier relaxation.

The parameter  $\eta$  in Eq. (31) is the injection efficiency of the bias current. A uniform bias current is assumed across the QD-SOA. Here  $I$  denotes the total bias current. The stimulated emission recombination terms at Eqs. (32) and (33) can be expressed as [16]

$$\begin{aligned} R_{stim}^{i,m} = & \frac{\Gamma}{2\epsilon_i N_m} \Delta z \cdot g_{i,m}(z, t, \nu_s) [S_s^+(z) + S_s^-(z)] \\ & + \frac{\Gamma}{2\epsilon_i N_m} \Delta z \sum_{sp} g_{i,m}(z, t, \nu_s) [S_{sp}^+(z) + S_{sp}^-(z)], \end{aligned} \quad (34)$$

where  $\Delta z$  is the section length of the QD-SOA.

Taking into account the ‘‘Pauli blocking’’ factor  $(1 - f_{i,m})$ , carrier capture lifetime  $\tau_{W-E}$ , carrier escape lifetime  $\tau_{E-W}$ , intradot relaxation lifetime  $\tau_{E-G}$ , and intradot excitation lifetime  $\tau_{G-E}$  in the  $k$ th section, all are affected by the occupation probabilities of terminal-state energy levels in each section. These times are given through

$$\frac{1}{\tau_{W-E}} = \frac{1 - f_{ES,m}}{\tau_{W-E,0}}, \quad (35)$$

$$\frac{1}{\tau_{E-W}} = \frac{1 - f_{WL}}{\tau_{E-W,0}}, \quad (36)$$

$$\frac{1}{\tau_{E-G}} = \frac{1 - f_{GS,m}}{\tau_{E-G,0}}, \quad (37)$$

$$\frac{1}{\tau_{G-E}} = \frac{1 - f_{ES,m}}{\tau_{G-E,0}}, \quad (38)$$

and

$$\frac{1}{\bar{\tau}_{W-E}} = \sum_{m=0}^{2M} \frac{1}{\tau_{W-E}} \frac{N_m}{N_{QD}}. \quad (39)$$

$\tau_{W-E,0}$ ,  $\tau_{E-W,0}$ ,  $\tau_{E-G,0}$ ,  $\tau_{G-E,0}$  are the corresponding characteristic times in the absence of the related occupations. Balance relationship between the relaxation and emission rates of carriers is adopted as

$$\tau_{E-W,0} = \tau_{W-E,0} \exp\left(\frac{E_{WL} - E_{ES,m}}{k_B T}\right), \quad (40)$$

$$\tau_{G-E,0} = \tau_{E-G,0} \frac{\epsilon_{GS}}{\epsilon_{ES}} \exp\left(\frac{E_{ES,tr} - E_{GS,tr}}{k_B T}\right), \quad (41)$$

where  $E_{WL}$  is the energy level of the WL,  $k_B$  is the Boltzmann constant, and  $T$  is the absolute temperature. Finally, the WL degeneracy in each section is expressed as

$$\rho_{WL,k} = \frac{m^*}{\pi \hbar^2} k_B T A_{WL,k}, \quad (42)$$

where  $m^*$  is the electron effective mass of WL, and  $A_{WL,k}$  is the WL area of the  $k$ th section.

### 3. STEADY-STATE ALGORITHM

The steady-state algorithm is based on the idea of no time change of all occupation probabilities. It consists of dual iteration processes, external and internal iterations. In the internal iteration process, we get steady-state solutions for rate equations, Eqs. (31)–(33), by setting the time derivatives equal to zero.

It is done by a two-step process. First, giving the value of the injection current in each section, we calculate  $f_{WL}$  from Eq. (31) with given values of  $f_{ES,m}$  (the starting values are zero). Second, the photon iterative method is used to solve Eqs. (32)

and (33) with the value obtained for  $f_{WL}$  at a given output power. Proceeding in the backward direction from a section to another, the input power can be calculated. Then, we proceed in the forward direction again until getting  $S_{sp,out}$ . By this way, one can obtain the z-directional distributions of ASE spectrum  $S_{sp}(z, \nu_{sp})$ , signal field  $E_s(z, \nu_s)$ ,  $f_{GS,m}$ , and  $f_{ES,m}$ .

Then, we examine whether  $S_{sp,out}$  obtained from two consecutive processes is less than the error tolerance. If not, the process is repeated again with the same value of  $f_{ES,m}$ . If  $S_{sp,out}$  reaches the error tolerance, the new value of the  $f_{ES,m}$  is used in the repeated process until the difference between two consecutive  $f_{ES,m}$  is less than the error tolerance.

This process enables convergence toward the correct value of carrier density. The iteration continues until the change in the excited-state occupation probability throughout the SOA is less than the desired tolerance.

Here,  $\Delta E$ , the separation between QD groups, is chosen to be a function of the number of groups ( $M$ ) and the inhomogeneously broadening parameter  $\sigma$ .

#### 4. RESULTS AND DISCUSSION

The values of the parameters used in the simulation are listed in Table 1.

The role of the SOA active region length and number of layers is investigated to choose the best structure constants for the simulation. Figure 2 displays the effect of the device active region length on the gain at a bias current of 250, 500, and 600 mA. The gain increases with length until a maximum value then starts to decrease. As the ASE accumulates in long devices, the gain is decreased with the length. Increasing the current will increase the maximum gain and the corresponding length value of the device.

Figure 3 displays gain change with the number of layers. The maximum gain is obtained at three layers. Further increase in the layers decreases the gain value. In [17], it is expected that increasing the number of layers will increase the gain until a maximum value. Further increase will not affect the gain.

The model presented is not suited for number of layers greater than three. The results for the following sections are simulated with three layers and the length of the amplifier is 4 mm to get the highest gain at 500 mA bias current. The results at 250 mA show the poor performance of the device at this value of current and indicate the starting current value for good operation. Figures 4(a) and 4(b) show the longitudinal position

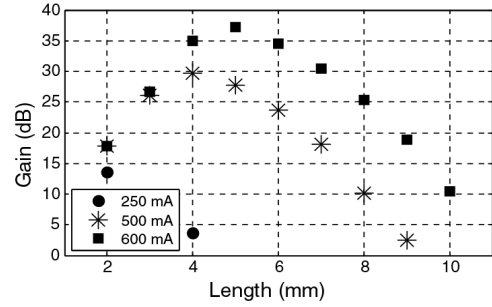


Fig. 2. Gain in the QD-SOA as a function of the amplifier length at different bias currents.

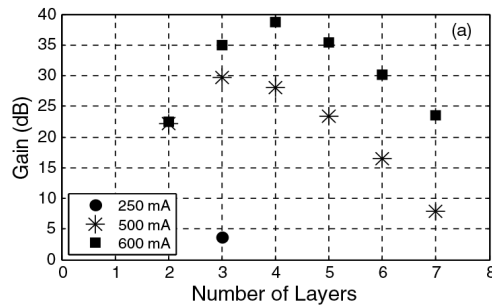


Fig. 3. Gain in the QD-SOA as a function of the QD layers number.

and carrier resonant energy dependence of the carrier occupation probabilities in the ES and GS, respectively, for the QD-SOA with the bias current of 500 mA and the output signal power of 1.7 dBm. The corresponding values at the QD-SOA input and output facets are presented in Figs. 5(a) and 5(b).

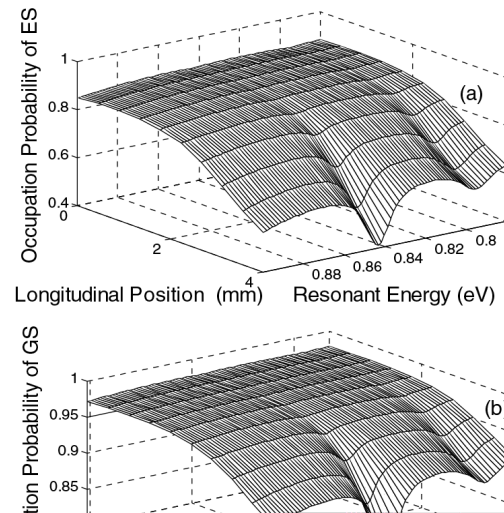
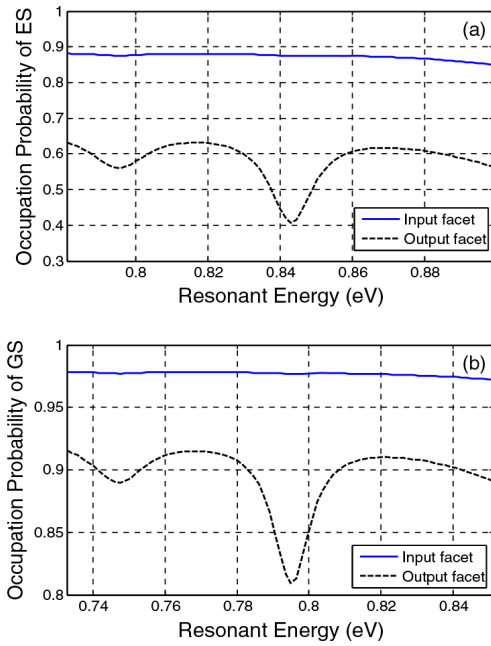


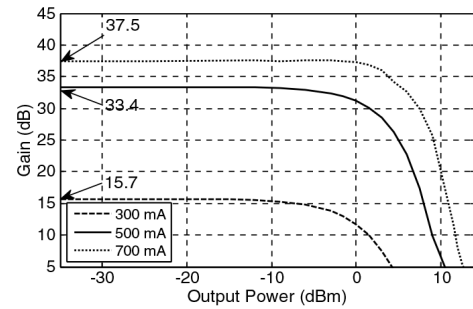
Table 1. Common Parameter Values of QD-SOAs [1]

Symbol	Value	Symbol	Value
$\sigma$	20 meV	$\eta$	0.7
$2\hbar\Gamma_{in}$	12 meV	$m^*$	0.024 $m_0$
$n_{QD}$	$3 \times 10^{10} \text{ cm}^{-2}$	$M$	40
$\Gamma$	0.006	$K$	10



**Fig. 5.** Carrier resonant energy dependence of occupation probabilities for (a) ES and (b) GS at the input and output facets.

At the end of the device length, the signal is amplified causing the population to be reduced around the signal energy within the homogeneous broadening value and hence a distinct sink around the input signal photon energy at the output facet can be observed due to the strong stimulated emission. At the input signal photon energy, the GS occupation probability is 0.9780 and 0.8089 at the input and output facets, respectively. As the current increases, the occupation probabilities for the GS for all the dot groups are improved and the occupation probabilities are much closer to 1, as indicated in Figs. 6(a) and 6(b).



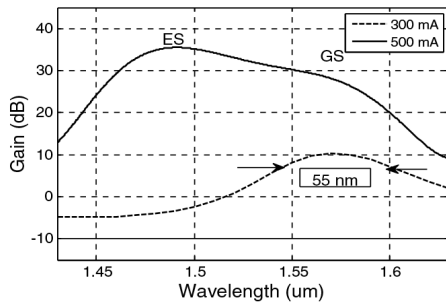
**Fig. 7.** Gain versus output signal power at different bias currents.

This is because more carriers are available in the reservoir to refill the QD states at the higher current and the depletion of total carrier density is greatly relieved.

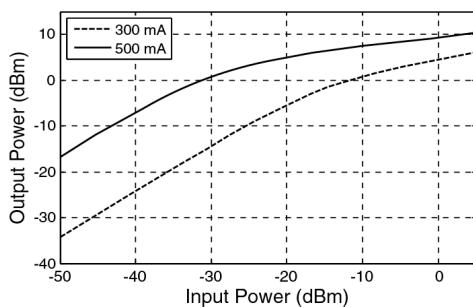
In order to use the SOA as an amplifier, one should make sure that the signal will be in the linear region of the amplifier (before saturation). Figure 7 shows the simulated gain curve versus output power for a 4 mm long SOA. The small signal gain is 37.50 dB for 700 mA. To the best of our knowledge, this is the first reported study of an InP-based QD that emits at 1550 nm. A similar study provided in [18] indicates the same order of magnitude of the gain for a GaAs-based QD, which emits at 1300 nm.

The rate of gain increase is decreased as the current increases from 300 to 700 mA. This is indicated better in Fig. 8, where the gain increases approximately linearly until 500 mA then starts to saturate gradually. The maximum gain is 37.50 dB reached at 650 mA.

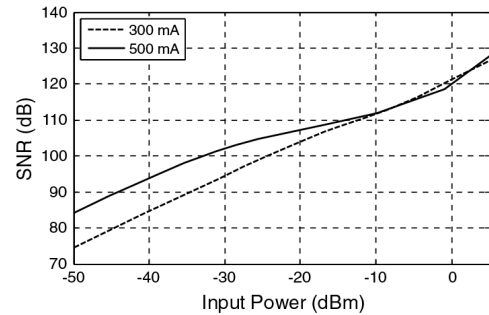
As shown in Fig. 8, the linear region of the SOA is limited to current values below 700 mA. To investigate a wide range of this region, we have chosen current values of 300 and 500 mA, and the obtained gain spectra is displayed in Fig. 9. It shows a broadening on the gain peak toward the shorter wavelength as the current increases. This behavior can be attributed to the upcoming ES gain with increasing bias current. At low bias cur-



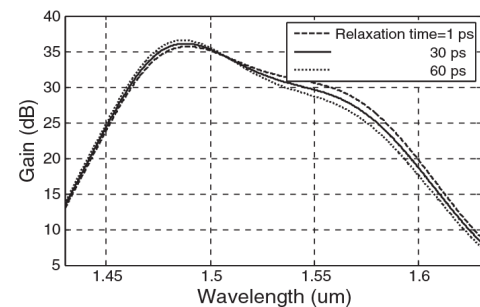
**Fig. 9.** Gain spectra of small input signal at different bias currents.



**Fig. 10.** Optical power transfer curve at different currents.



**Fig. 12.** SNR versus input power at different bias currents.

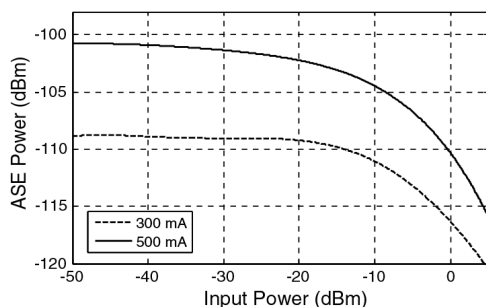


**Fig. 13.** Gain spectra of small input signal at different relaxation times.

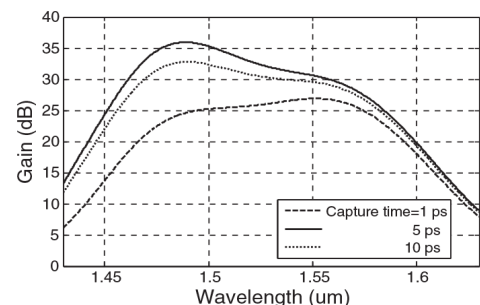
broadening in the measured gain spectrum can be assigned to this upcoming gain from the ES. Figure 10 presents the optical power transfer function of the device as a function of the bias current. One can see the linear and nonlinear regions of the amplifier. The total ASE power emitted from the amplifier is shown in Fig. 11.

It is apparent that the noise output from the amplifier is not equal in the presence of high input signal power. Using Figs. 10 and 11, one can deduce that the SNR for the amplifier is larger than 75 dB for a wide range of input power even without the use of an output filter, as indicated in Fig. 12. After -10 dBm, the SNR at 300 and 500 mA is approximately the same. This can be attributed to the higher rate of noise increase at 500 mA after -10 dBm.

The relaxation time effect on the gain spectrum is shown in Fig. 13 for different relaxation times and bias current at



**Fig. 11.** Total ASE power versus input power at different bias currents.



**Fig. 14.** Gain spectra of small input signal at different capture times.

500 mA. Phonon scattering and Auger recombination are considered the main factors to determine the relaxation time from ES to GS. These recombination mechanisms are complex to be determined theoretically for certain QD energy spectrum and population probabilities [19]. We have chosen the values 1, 30, and 60 ps based on the experimental data reported in [20] for three QD layers.

The gain at the GS decreases and increases at the ES as the relaxation time increases. The GS gain decreases from 29.73 to 27.57 dB with the relaxation time increasing from 1 to 60 ps while the ES gain increases from 34.43 to 35.45 dB. The capture time effect from the WL to the ES is shown in Fig. 14. The gain at both the GS and ES increases with the capture time from 1 to 5 ps then decreases at 10 ps capture time.



## 5. CONCLUSION

This work focuses on the numerical characterization of QD-SOAs in the 1.55  $\mu\text{m}$  telecommunication window using an InP-based QD-SOA. Two bound states are considered for each QD. The inhomogeneous broadening of the QDs is described by a Gaussian distribution, while the homogeneous broadening is described by Lorentzian distribution. It is found that this model is not valid for a large number of layers ( $\geq 3$ ). The gain increases from 30 to 37 dB with increasing the length from 4 to 5  $\mu\text{m}$  and the current from 500 to 600 mA.

The gain spectrum of the QD-SOA shows a shift to a lower wavelength as the current increases. The ES gain peak starts to appear with increasing the current. The GS gain decreases from 29.73 to 27.57 dB ( $\sim 2$  dB decrease) with the intradot relaxation time increase from 1 to 60 ps, while the ES gain increases from 34.43 to 35.45 dB ( $\sim 1$  dB increase).

The capture time from the WL into the ES also affects the gain spectrum. The change in the gain spectrum is more pronounced at the ES wavelength as the carrier density in the ES is directly affected by the capture time.

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# A new clustering algorithm for scanning electron microscope images

Amr Yousef<sup>1</sup>, Prakash Duraisamy<sup>2</sup>, and Mohammad Karim<sup>3</sup>

<sup>1</sup>Electronics and Communications Dept., University of Business and Technology, KSA

<sup>1</sup>Engineering Mathematics Dept., Alexandria University, Egypt

<sup>2</sup>Department of Computer Science & Software Engineering, Miami University, USA

<sup>3</sup>Department of Electrical Engineering, University of Massachusetts Dartmouth, USA

## ABSTRACT

A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with the sample atoms, producing various signals that are collected by detectors. The gathered signals contain information about the sample's surface topography and composition. The electron beam is generally scanned in a raster scan pattern, and the beam's position is combined with the detected signal to produce an image. The most common configuration for an SEM produces a single value per pixel, with the results usually rendered as grayscale images. The captured images may be produced with insufficient brightness, anomalous contrast, jagged edges, and poor quality due to low signal-to-noise ratio, grained topography and poor surface details. The segmentation of the SEM images is a tackling problems in the presence of the previously mentioned distortions. In this paper, we are stressing on the clustering of these type of images. In that sense, we evaluate the performance of the well-known unsupervised clustering and classification techniques such as connectivity based clustering (hierarchical clustering), centroid-based clustering, distribution-based clustering and density-based clustering. Furthermore, we propose a new spatial fuzzy clustering technique that works efficiently on this type of images and compare its results against these regular techniques in terms of clustering validation metrics.

## 1. INTRODUCTION

The scanning electron microscope (SEM) characterizes various organic and inorganic materials. The SEM images can characterize both micro and nano scale features of a material based on a model represents the interaction between the electron beam and the specimen. Examples of the utilized models that provide quantitative analysis of such interaction include: backscattered electrons, secondary electrons, characteristic and bremsstrahlung x-rays and absorbed current. The area of a specimen is exposed to a finely focused electron beam that performs a raster scan of the specimen surface producing an image that can characterize different material features such as: surface topography, crystallography, composition, etc. The resolution of the gathered images is close to the focused electron beam diameter.<sup>1</sup>

The SEM image is a 2D digital representation of the reflected signal intensity. Every point on the specimen is related to a pixel inside the SEM image and is directly proportional to the reflected signal intensity gathered by the detector. SEM is different from optical microscope which produces true images. The focused electron beam on the specimen reflects an analog signal intensity that is measured by the detector. The detector output voltage is amplified, quantized and stored as digital values. Commonly, the voltage signal intensity is quantized into 256, 4096 or 65,536 levels.<sup>2</sup>

The captured images may be produced with insufficient brightness, anomalous contrast, jagged edges, and poor quality due to low signal-to-noise ratio, grained topography and poor surface details. Extracting different

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Contact: Amr Yousef ([a.yousef@ubt.edu.sa](mailto:a.yousef@ubt.edu.sa)) is an assistant professor at University of Business and Technology, Dahban, KSA and an assistant professor at Alexandria University, Egypt. Prakash Duraisamy ([duraisp@miamioh.edu](mailto:duraisp@miamioh.edu)) is an assistant professor at Miami University. Mohammad Karim ([mkarim@umassd.edu](mailto:mkarim@umassd.edu)) is Provost and Executive Vice Chancellor for Academic and Student Affairs at University of Massachusetts Dartmouth.

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features from SEM images by means of clustering is a tackling problems in the presence of the previously mentioned distortions and noise.

Data clustering refers to segmenting unlabeled data set into a certain number of clusters or groups that are internally homogeneous and externally have great inter-separation between their centers.<sup>3</sup> Both the clustering algorithm and its execution parameters can extremely affect the performance of clustering process on the same data set. The topic of data clustering has been widely researched.<sup>4</sup> Data Clustering has several interesting applications in image segmentation, information retrieval, pattern recognition, pattern classification, network analysis, etc.<sup>5</sup> Numerous data clustering techniques have been developed in the literature. They can be generally categorized into probabilistic methods, partitioning methods, hierarchical methods, and density-based methods.

In this work, we are stressing on the segmentation of SEM images by means of clustering. We evaluate the performance of well-known unsupervised clustering techniques such as centroid-based clustering as in k-means and fuzzy c-means, distribution-based clustering as in Gaussian mixture model and density-based clustering as in DBSCAN. Furthermore, we propose a new spatial fuzzy c-means clustering technique that works efficiently on this type of images and compare its results against these well known techniques in terms of internal clustering validation metrics.

The rest of this paper is organized as follows: In Section 2 , we briefly review some of the well known clustering techniques. Section 3 proposes an improved spatial fuzzy clustering technique version. Section 4 discusses different metrics that can be used to evaluate the FCM clustering techniques. Section 5 presents simulations and results while section 6 concludes this study.

## 2. DATA CLUSTERING BRIEF REVIEW

Data clustering is an important aspect in data analysis. It is defined as classifying unlabeled data in two a number of distinctive groups or classes in which elements belong to the same class have high similarity among them, while elements belong to different classes have high dissimilarities. Clustering techniques can be classified into the following groups: (1) Partitional Clustering, (2) Hierarchical Clustering, (3) Density-based Clustering, and (4) Probabilistic models for clustering. In the following subsections we are going to briefly describe these different approaches of clustering.<sup>5</sup>

### 2.1 Probabilistic models for clustering

Probabilistic models for clustering have been broadly investigated by researchers since they achieve very promising results. The basic idea behind this type of clustering is to fit the observed data to a mixture of a certain probability distribution. Each cluster is represented by a parametric probability distribution and the clustering problem is switched to a distribution parameter estimation.<sup>6</sup>

Suppose that the observed data  $X = x_1, x_2, \dots, x_N$  consists of  $N$  observations of a  $D$ -dimensional random variable  $x$ . The data is assumed to be extracted from a mixture of  $K$  probability distribution. Each parametric distribution represents a cluster. The probability distribution of each  $x_i$  is given by:

$$p(x_i) = \sum_{k=1}^K \pi_k p(x_i | \theta_k) \quad (1)$$

where  $\pi_k$ 's are the mixing probabilities,  $\theta_k$  is the  $k$ 's probability distribution parameters and  $p(x_i | \theta_k)$  is the  $k^{th}$  distribution. The number of underlying distribution is assumed to be fixed and has to be drawn from the observed data. The overall parameters of the mixture of model  $\Theta = \pi_1, \dots, \pi_k, \theta_1, \dots, \theta_k$ . Since the data is assumed to be independent, the probability of all the data points is given by:

$$p(X | \Theta) = \prod_{n=1}^N \sum_{k=1}^K \pi_k p(x_n | \theta_k) \quad (2)$$



The logarithmic form of Eq.2 is given by:

$$\log p(X|\Theta) = \sum_{n=1}^N \sum_{k=1}^K \pi_k p(x_n|\theta_k) \quad (3)$$

To estimate the unknown parameters, Maximum Likelihood Estimation (MLE) is utilized as given by:

$$\Theta_{ML} = \arg \max_{\Theta} \log p(X|\Theta) \quad (4)$$

If a priori information  $p(\theta)$  about the parameters is known, then it can be reflected into the mixture model and the maximum a posteriori (MAP) is given by:<sup>5</sup>

$$\Theta_{MAP} = \arg \max_{\Theta} \log p(X|\Theta) + \log p(\Theta) \quad (5)$$

## 2.2 Partitional Clustering Techniques

Owing to their simplicity and ease of implementation, partitional techniques are the most familiar clustering approaches. They cluster the data by minimizing certain objective function and iteratively improving the clustering results until reaching a certain threshold. K-means is an example of partitional clustering approaches and it is widely used since it is simple and efficient.

Initially, K-means algorithm starts by randomly selecting K cluster centers. Then, each sample is assigned to a cluster satisfying the minimum distance between the sample point the cluster center. Once all the data points are assigned to clusters, the center of the clusters are updated. Afterward, k-means repeats these two steps until a certain criteria is achieved. K-means clustering always converges to a local minimum, however the optimization of the objective function is NP-Hard.<sup>7</sup> Suppose  $D = x_1, x_2, \dots, x_N$  is a dataset consists of N data points. K-means applies an objective function called Sum of Squared Errors (SSE) as defined by:

$$SSE(C) = \sum_{k=1}^K \sum_{x_i \in C_k} \|x_i - c_k\|^2 \quad (6)$$

where  $C = C_1, C_2, \dots, C_K$  is the set of the clustering results and  $c_k$  is the  $k^{th}$  cluster center. This cluster center is updated according to the following equation:

$$c_k = \frac{\sum_{x_i \in C_k} x_i}{|C_k|} \quad (7)$$

The iterative process of redefining the cluster centers aims to minimize the above mentioned objective function. The clustering can be either hard or fuzzy. In hard clustering, each object is assigned to only one cluster while in fuzzy clustering, every item belongs to all clusters with a certain degree of membership. The advantages of the fuzzy clustering over hard clustering are: (1) it can be used when boundaries between clusters are not well separated and (2) the membership function can help in discovering some sophisticated relationship between the objects and the clusters.<sup>8</sup>

Fuzzy C-means (FCM) is one of the most popular fuzzy clustering algorithms and it can be regarded as a generalization of the iterative self organizing data analysis technique (ISODATA).<sup>9</sup> For a given data set  $\mathbf{x}_j \in \mathbb{R}^d$ ,  $j = 1, \dots, N$ , FCM finds  $c$  clusters such that the cost function

$$J(\mathbf{U}, \mathbf{M}) = \sum_{i=1}^c \sum_{j=1}^N (u_{ij})^\alpha L_{ij} \quad (8)$$

is minimized.  $\mathbf{U} = [u_{ij}]_{c \times N}$  if the membership function,  $u_{ij} \in [0, 1]$  are the membership coefficients,  $\mathbf{M} = [m_1, m_2, \dots, m_c]$  are the cluster centers,  $m \in [1, \infty]$  is the fuzziness parameter and  $L_{ij} = L(\mathbf{x}_j, m_i)$  is the

distance measure between the object  $\mathbf{x}_j$  and the cluster center  $m_i$ . FCM involves two steps:

(1) Calculate the partition matrix  $\mathbf{M}$  as given by:

$$u_{ij}^{(t+1)} = \frac{1}{\sum_{l=1}^c \left(\frac{\mathbf{L}_{lj}}{\mathbf{L}_{ij}}\right)^{\frac{1}{1-\alpha}}} \quad \text{for } i = 1, \dots, c \quad \text{and } j = 1, \dots, N. \quad (9)$$

(2) Update the centers matrix  $\mathbf{M}$  as given by:

$$m_i^{(t+1)} = \frac{\sum_{j=1}^N \left(u_{ij}^{(t+1)}\right)^\alpha \mathbf{x}_j}{\sum_{j=1}^N \left(u_{ij}^{(t+1)}\right)^\alpha} \quad \text{for } i = 1, \dots, c. \quad (10)$$

Both steps are repeated until  $\|\mathbf{M}^{(t+1)} - \mathbf{M}^{(t)}\| < \varepsilon$  where  $\varepsilon$  is small positive number. Like hard clustering, a number of FCM variants has been developed as FCM suffers from noise, outliers and the difficulty of its initialization.<sup>10</sup> Pedrycz and Waletzky took advantage of the available classified information and actively applied it as part of their optimization procedures. Ahmed et al.<sup>11</sup> modified the objective function of the standard FCM algorithm to allow the labels in the immediate neighborhood of a pixel to influence its labeling. The modified FCM algorithm improved the results of conventional FCM methods on noisy images. However, the way in which they incorporate the neighboring information limits their application to single-feature inputs. Chuang et al.<sup>12</sup> incorporate the spatial information around every pixel into the membership function to obtain homogeneous clustering. Because the pixel and its surroundings are highly correlated, then there is a great probability that they belong to the same cluster. They defined a spatial function given by:

$$h_{ij} = \sum_{k \in W(\mathbf{x}_j)} u_{ik} \quad (11)$$

where  $W(\mathbf{x}_j)$  represents a square window centered on the pixel. The spatial function is incorporated into membership function as given by:

$$u'_{ij} = \frac{u_{ij}^p h_{ij}^q}{\sum_{k=1}^c u_{kj}^p h_{kj}^q} \quad (12)$$

In homogeneous region, the clustering will remain unchanged while in noisy spots the misclassified pixels can be correctly adjusted. Their clustering scheme performs two steps: (1) performing the standard FCM to calculate the membership function and (2) adjusting the membership information of each pixel based on its spatial neighborhood. We call their algorithm as SFCM.

### 2.3 Hierarchical Clustering Techniques

Hierarchical clustering algorithms evolve what is called a dendrogram which is a binary tree-based data structure. After creating the dendrogram, the right number of clusters is selected by breaking the tree structure at different levels to create several clustering results without the need of reevaluating the clustering algorithm. Two different hierarchical clustering ways are known in the literature, namely, bottom-up (or agglomerative) and top-down clustering (or divisive). Agglomerative approaches start by a single data point in a cluster at the bottom level and continuously combine two clusters at a time to construct a bottom-up dendrogram. On the other hand, divisive methods start with all the data points in one big cluster and continuously break in it small clusters to create a top-down hierarchy of clusters.<sup>5</sup>

### 2.4 Density-based Clustering

Most of the previously mentioned clustering techniques assume implicitly or explicitly that the datasets follow spherical shapes and in non-spherical shapes of datasets, their performance degrades.<sup>5</sup> On the other hand, density-based clustering can work efficiently with non-spherical shapes of the a dataset.

In density-based clustering,<sup>13</sup> areas with higher density of points are defined as clusters. Data points in scattered areas are defined as noises and outliers. The most well known density based-clustering technique is

DBSCAN.<sup>14</sup> A competitive property of DBSCAN is that it has low complexity. DBSCAN technique has been extended to OPTICS<sup>15</sup> which is a generalization of it.

The main drawback of DBSCAN and OPTICS is that they assume a drop in the points density at the border of the classes and they can not classify intrinsic cluster structures.

### 3. IMPROVED SPATIAL FCM (ISFCM)

In this section we propose an efficient FCM clustering scheme that exploits the spatial neighborhood into the membership function to: (1) improve the compactness within the same clusters; (2) increase the separation between different clusters and (3) work on heavily noisy data. Compactness means that the members of each cluster should be close to each other and the separation is that the different clusters are spaced sufficiently in the feature space. Let  $V_{r \times r}^{(j)}$  is a window of dimension  $r$  and  $W_{s \times s}^{(j)}$  is a hollow square window of dimensions  $r + 1$  and  $s$  around the pixel  $\mathbf{x}_j$  under test with  $s > r$ . The membership function  $\mathbf{M}$  will be updated at every pixel  $\mathbf{x}_j$  in nonlinear fashion as follows:

1. The membership coefficients around the pixel  $\mathbf{x}_j$  are weighted by two Gaussian kernels  $\aleph(0, \sigma^2 = k \times r)$  and  $\aleph(0, \sigma^2 = l \times s)$ . The variance of the Gaussian applied to  $V_{r \times r}^{(j)}$  is larger than the variance of the Gaussian kernel applied to  $W_{s \times s}^{(j)}$ . The idea here is that the membership coefficients close to the pixel has more weight than the ones far from it. Also, when the variance is large, the weights will be smooth enough to avoid sudden changes in the coefficients values. The new membership coefficients  $\mathbf{M}_r$  and  $\mathbf{M}_s$  in  $V_{r \times r}^{(j)}$  and  $W_{s \times s}^{(j)}$  are updated as follows:

$$\mathbf{M}_r = \mathbf{M} \times \aleph(0, \sigma^2 = k \times r)_{r \times r \times c} \quad (13)$$

and

$$\mathbf{M}_s = \mathbf{M} \times \aleph(0, \sigma^2 = l \times s)_{s \times s \times c} \quad (14)$$

where the multiplication is pointwise multiplication between the Gaussian weights and the membership coefficients in the vector space  $\Re^c$  where  $c$  is the number of clusters.

2. Both  $\mathbf{M}_r$  and  $\mathbf{M}_s$  are divided into 4 quadrants:  $\mathbf{M}_r^{11}, \mathbf{M}_r^{12}, \mathbf{M}_r^{21}, \mathbf{M}_r^{22}$  and  $\mathbf{M}_s^{11}, \mathbf{M}_s^{12}, \mathbf{M}_s^{21}, \mathbf{M}_s^{22}$ . All the layer that represents different clusters weighted memberships are summed individually so that every summed layer is proportional to the strength of a certain cluster around the examined pixel.
3. Let the summed memberships in the different quadrants are:  $\mathbf{M}_{r_s}^{11}, \mathbf{M}_{r_s}^{12}, \mathbf{M}_{r_s}^{21}, \mathbf{M}_{r_s}^{22}$  and  $\mathbf{M}_{s_s}^{11}, \mathbf{M}_{s_s}^{12}, \mathbf{M}_{s_s}^{21}, \mathbf{M}_{s_s}^{22}$ , then the nonlinear weighting coefficient  $\mathbf{w}_j$  at the pixel  $\mathbf{x}_j$  is given by:

$$\mathbf{w}_j = \sum_{m=1}^2 \sum_{n=1}^2 (\mathbf{M}_{r_s}^{mn})^\alpha (\mathbf{M}_{s_s}^{mn})^\beta \quad \text{for } i = 1, \dots, c \quad (15)$$

4. The membership coefficients at the pixel  $\mathbf{x}_j$  are modulated by  $\mathbf{w}_j$  as given by:

$$\mathbf{m}_{ij} = \mathbf{m}_{ij} \times \mathbf{w}_j \quad (16)$$

5. The new membership coefficients at pixel  $\mathbf{x}_j$  are normalized as given by:

$$\mathbf{m}'_{ij} = \frac{\mathbf{m}_{ij}}{\sum_{i=1}^c \mathbf{m}_{ij}} \quad \text{for } i = 1, \dots, c \quad (17)$$

The exponents  $\alpha$  and  $\beta$  control the strength of the neighborhood pixels and their effect on the updating process of the membership coefficients at the pixel under test. The premise of this approach is that it assumes that the pixels close to the center of the windows are highly correlated and have stronger neighborhood connections to the center than the pixel far from it. This approach is better than the one proposed by Chuang et al.<sup>12</sup> as the update process is nonlinear and it modulates the membership coefficients in an inverse distance scheme as will be seen in the results section.

## 4. FCM CLUSTERING VALIDITY INDICES

Clustering validity indices can be divided into two categories. The first group uses only the membership coefficients  $u_{ij}$  while the second group utilizes the matrix  $U$  and data itself. Through out simulations, 2 of each group are utilized. The first category indices are proposed by Bezdek.<sup>16,17</sup> while the second group indices are proposed by Xie and Beni<sup>18</sup>

Bezdek et al. defined the partition coefficient and the partition entropy coefficient as:

$$VPc = \frac{1}{N} \sum_{i=1}^N \sum_{j=1}^c u_{ij}^2 \quad (18)$$

and

$$VPe = -\frac{1}{N} \sum_{i=1}^N \sum_{j=1}^c u_{ij} \log(u_{ij}) \quad (19)$$

respectively. The closer VPc to unity or VPe to zero the better is the performance of clustering. Xie and Beni defined a validity index as given by:

$$Vxb = -\frac{\sum_j^N \sum_i^c u_{ij} \|x_j x_j - m_i\|^2}{N * \min_{i \neq k} \{\|m_k - m_i\|^2\}} \quad (20)$$

Small values of Vxb indicate the existence of compact clusters.

## 5. SIMULATIONS AND RESULTS

### 5.1 Synthetic Image

We used a synthetic image that contains three clusters of data to demonstrate the effectiveness of the proposed FCM approach. We corrupt the image with Gaussian noise with zero mean and variance  $\sigma_{Noise}^2 = \sigma_{Image}^2 / SNR$  where SNR is the signal-to-noise ratio and  $\sigma_{Image}^2$  is the variance of the image. We tested the algorithms for three cases: (1) SNR = 0.7; (2) SNR = 1 and (3) SNR = 2. We compared the performance of FCM, SFCM and ISFCM in terms of the clustering validity indices and the quality of the clustering. Figures 1, 2 and 3 depict the outputs of having used FCM, SFCM and ISFCM on the corrupted synthetic image with SNR = 2, 1 and 0.7 respectively. It can be shown that the ISFCM outperforms both FCM and SFCM and the clustered images have roughly homogeneous regions even when the data is highly corrupted with noise. Because the number of clusters is already known, we can calculate the confusion matrix that represents the successfully clustered data points. Table 1 presents the percentages of the correct cluster points for the different algorithms. The correct clustering rate (CC) is defined as the successfully clustered points divided by the total clustered points. It can be seen from Table 2 that ISFCM attains higher CC values than both the FCM and SFCM. In addition we calculate the clustering validity indices: VPc, VPe and Vxb as depicted in Table 2. The ISFCM provides better performance than both FCM and SFCM.

### 5.2 Real SEM images

Figure 4 depicts the two SEM images utilized in the simulations. We evaluated the performance of k-means, GMM, DBSCAN, FCM, SFCM and ISFCM algorithms in terms of the Silhouette<sup>19</sup> and Davis-Bouldin indices.<sup>20</sup> Additionally, we compare the performance of FCM, SFCM and ISFCM in terms of VPc, VPe and Vxb. Figure 5 and 6 show the results of validation indices for different clustering algorithms for the utilized datasets. It can be inferred that the proposed ISFCM provides competitive results compared to other algorithms. In terms of both VPc and VPe, ISFCM has superior performance compared to both FCM and SFCM algorithms. According to Vxb, ISFCM has slightly better performance than FCM algorithm and good results compared to SFCM algorithm. The Silhouette index depicts that the proposed ISFCM proves better results than K-means, GMM, DBSCAN, FCM and SFCM. According to Davies Bouldin, GMM has the worst results. The proposed ISFCM shows slightly better performance than the other techniques.

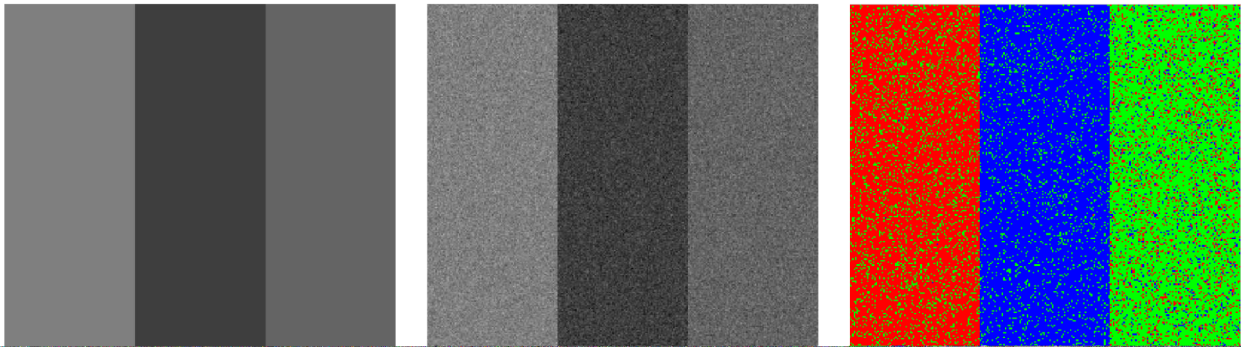


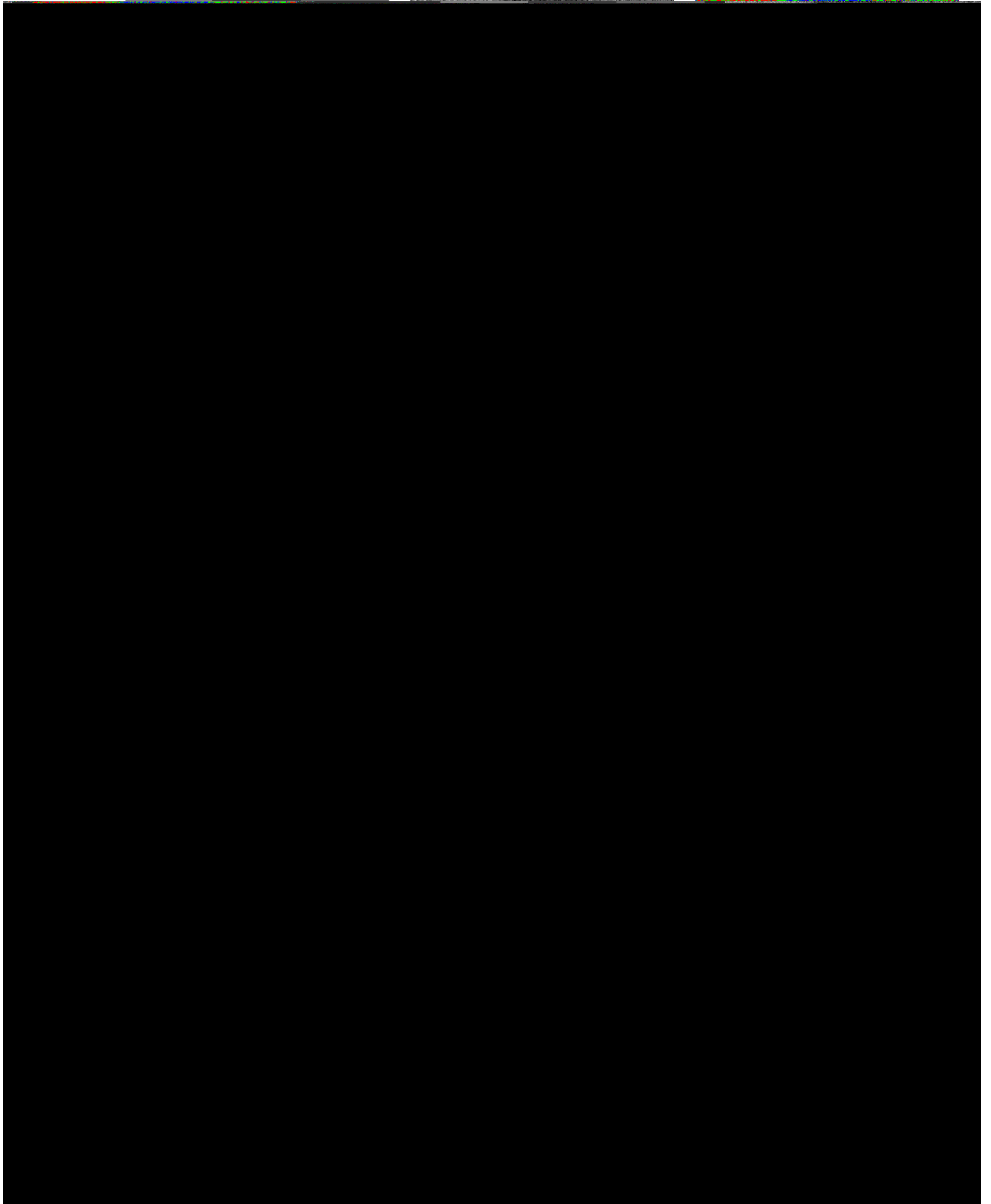
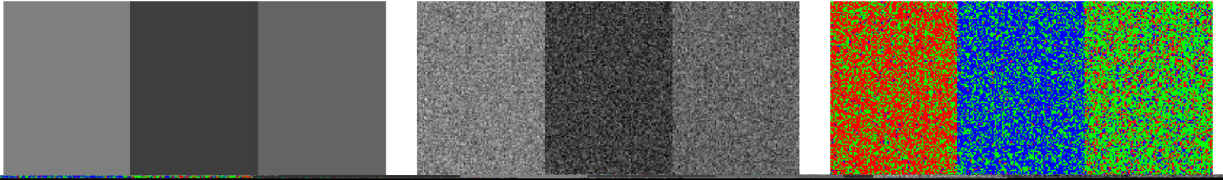
Table 1: Confusion matrix for different SNR.

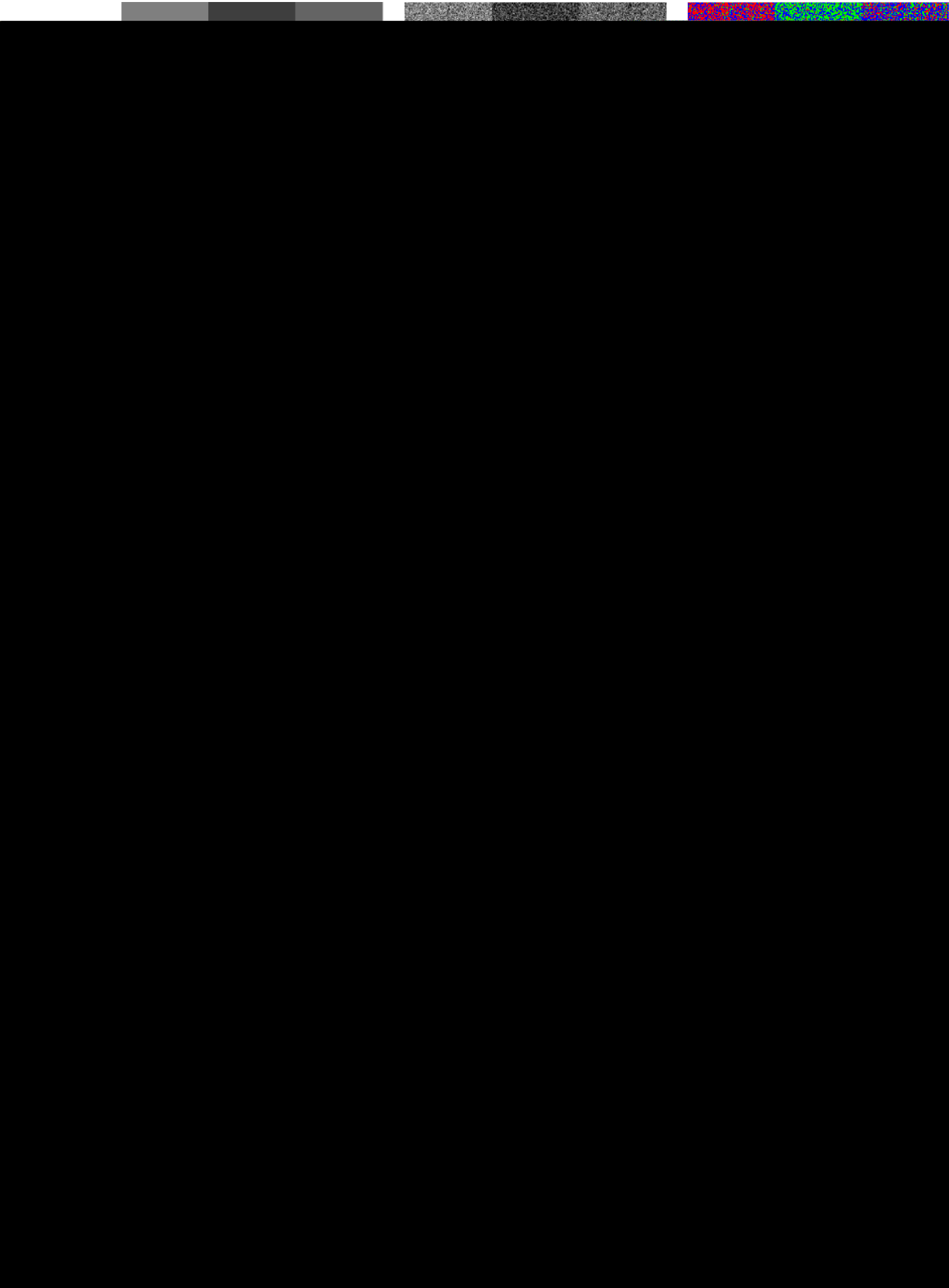
		SNR = 2			SNR = 1			SNR = 0.7		
		C1	C2	C3	C1	C2	C3	C1	C2	C3
FCM	C1	84%	0%	16%	60%	25%	15%	56%	5%	39%
	C2	0%	90%	10%	35%	63%	2%	6%	53%	41%
	C3	14%	6%	80%	34%	1%	65%	20%	26%	54%
SFCM	C1	99%	0	1%	95%	2%	3%	94%	0%	6%
	C2	1%	97%	2%	1%	99%	0%	0%	88%	12%
	C3	2%	0%	98%	4%	1%	95%	4%	8%	88%
ISFCM	C1	100%	0%	0%	99.9%	0%	0.1%	96%	0%	4%
	C2	0%	99%	1%	0%	99%	1%	1%	93%	6%
	C3	0.31%	0.01%	99.68%	0.68%	0.01%	99.31%	0.02%	0%	99.97%

Table 2: Different clustering validity indices for different SNR

	SNR=2			SNR=1			SNR=0.7		
	FCM	SFCM	ISFCM	FCM	SFCM	ISFCM	FCM	SFCM	ISFCM
CC Rate	0.844	0.981	0.995	0.627	0.964	0.994	0.546	0.901	0.965
VPc	0.796	0.988	0.9995	0.771	0.949	0.999	0.766	0.901	0.988
VPe	0.372	0.024	0.00079	0.413	0.0969	0.0019	0.419	0.176	0.021
Vxb	0.084	0.011	0.00078	0.089	0.0317	0.0017	0.0923	0.0499	0.00144







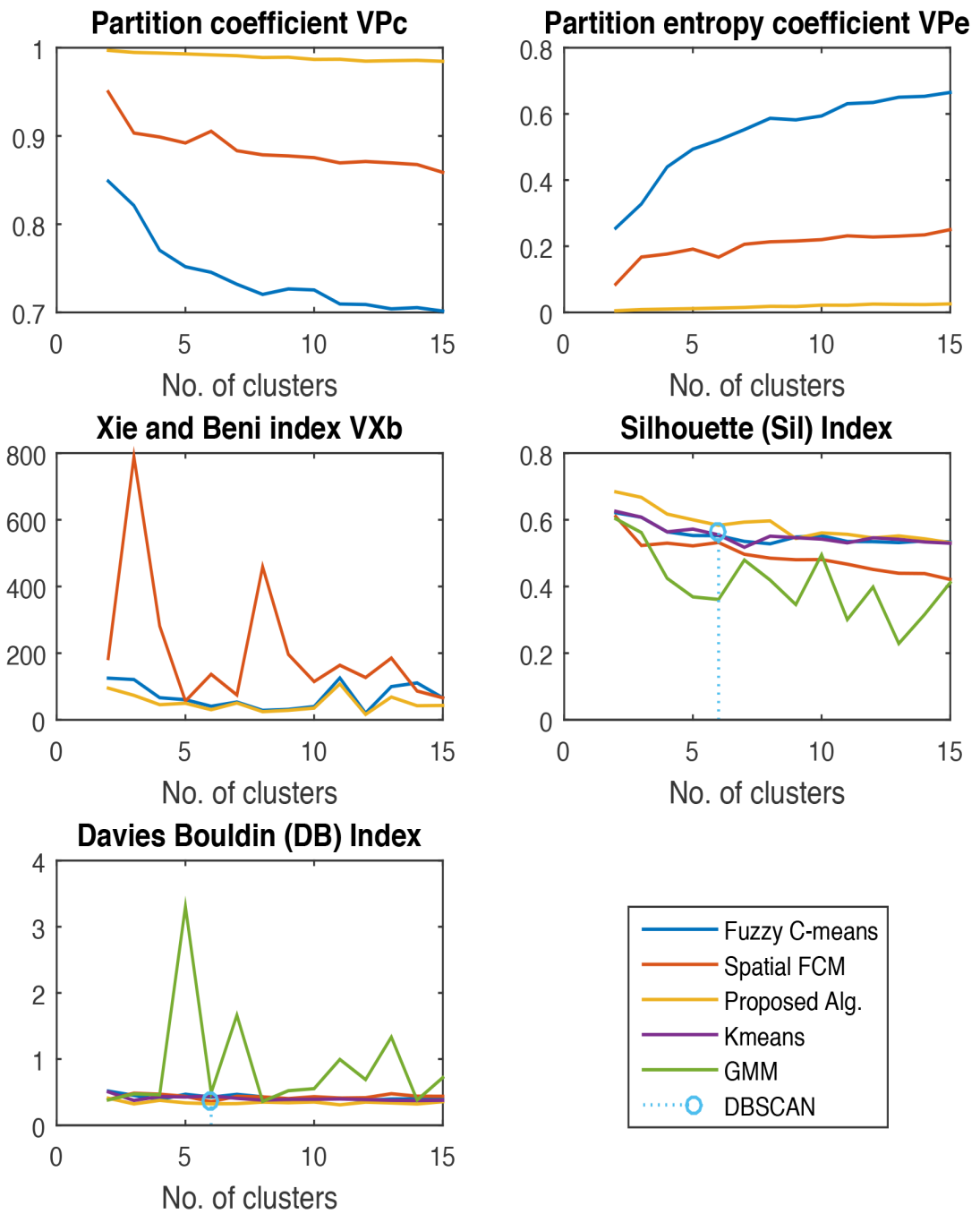
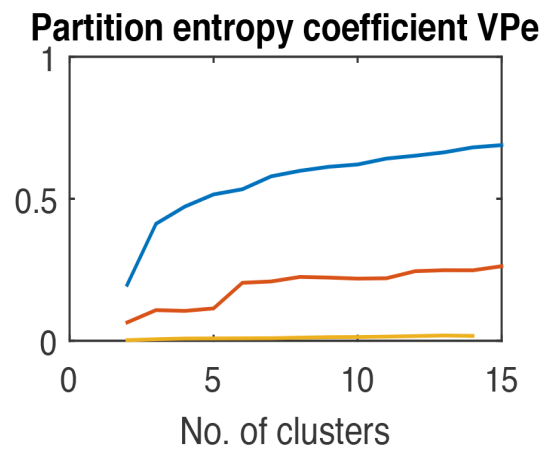
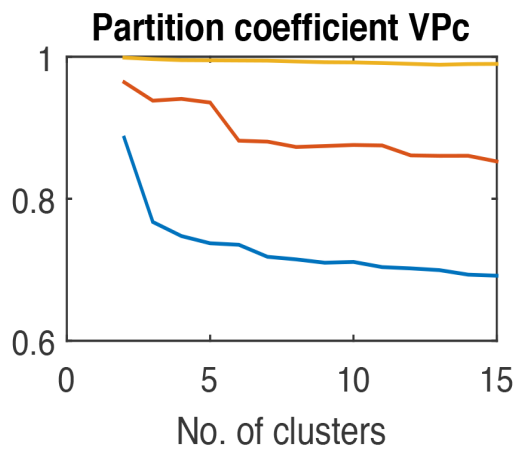


Figure 5: Validation indices for image 1.





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EMRS 2016

# Optical Absorption Enhancement of a-si:H Solar Cells using Plasmonic Nanoparticles and Nanoantennas

Ali Elrashidi\*

*Department of Electrical Engineering, University of Business and Technology, Jeddah 21432, Saudi Arabia  
Department of Engineering Mathematics and Physics, Faculty of Engineering, Alexandria University, Alexandria 21526, Egypt*

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## Abstract

In this work, I proposed a new structure for amorphous solar cell with improved light harvesting and power conversion efficiency using plasmonic nanoparticles distributed inside the solar cell active layer and nanoantennas distributed on the top surface with a metallic grating as back reflectors. Different metals will be used as plasmonic nanoparticles such as gold, copper, silver and vanadium dioxide. The optimum shape, size and position of plasmonic materials are determined using a finite difference time domain (FDTD) simulation tool. Nanoantennas height, position, separation distance between them will be also optimized using FDTD method. Improving the light absorption in the wavelength range 600-800 nm is obtained.

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*Keywords:* FDTD; Plasmonics; Nanoantennas; Optical absorption; Organic solar cell.

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## 1. Introduction

Photovoltaic devices that convert solar energy into electrical energy have the potential to provide an unlimited

[3], with film thicknesses of a few hundred nanometers, which can be deposited on different substrates like glass and plastics. Hence, the using of thin film results in insufficient carrier generation and low power conversion efficiency.

Light trapping strategies may be used to overcome this thickness limitation to achieve high optical absorption. The traditional light trapping strategy in bulk solar cells typically employs random surface textures at the micrometer level [4–6], which are larger than the active layer of OPVs and no longer suitable for thin film photovoltaics. Plasmonic nanoparticles are considered as one of the promising methods for increasing the optical absorption of solar cells [7–11]. The metal nanoparticles cannot only scatter and couple the incident light into the active layer [12–14] but also confine the light surrounding their surfaces [15], which results in the light absorption enhancement of solar cells.

On the other hand, textured surfaces at the front or back contact of a solar cell cause increased light trapping yield important improvement of the over-all efficiency [16]. Nanoantennas on the front surface and gratings on the back

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L. Yousefi and A. Foster introduced a novel optical hybrid plasmonic patch nanoantennas operate at 1550 nm [29]. The proposed device has a very high efficiency of 87% and a gain of 5.6 dB at more than 15 GHz bandwidth. Gold nanoparticles were distributed in SnO<sub>2</sub> substrates with various diameters to increase the light absorption [30]. The absorption is enhanced near infrared region 600-800nm.

In this paper, a new structure of amorphous solar cell with a plasmonic nanoparticles distributed in the active layer is introduced to enhance the absorption efficiency. Nanoantennas distributed on the top surface of the solar cell and gratings as back reflectors are used to improve the absorption efficiency. Gold, silver, copper and vanadium dioxide plasmonic nanoparticles with optimum shape, size and position are used in this work. Finite difference time domain simulation tool is used to optimize the nanoantennas height, position, separation distance between them.

## 2. Absorption Spectrum of Nanoparticles Array

The absorption spectrum of plasmonic nanoparticles is depending on surrounding material dielectric constant, nanoparticles dielectric constant, and proposed structure periodicity. The position at maximum value of the absorbed power is located at wavelength  $\lambda_{max}$  according to the condition [31]:

$$\lambda_{max} = \frac{L}{q} \left( \frac{\epsilon_d \epsilon_m(\lambda_{max})}{\epsilon_d + \epsilon_m(\lambda_{max})} \right)^{1/2} \quad (1)$$

where  $q$  is an integer. A metallic nanoparticles dielectric permittivity can be described by using a multi-oscillator Drude-Lorentz model [31]:

$$\epsilon_m = \epsilon_\infty - \frac{\omega_D^2}{\omega^2 + j\omega\gamma_D} - \sum_{k=1}^6 \frac{\delta_k \omega_k^2}{\omega^2 - \omega_k^2 + 2j\omega\gamma_k} \quad (2)$$

where  $k$  value from 1 to 6 for gold, silver nanoparticles, from 1 to 5 for copper, and from 1 to 4 for vanadium dioxide.

### Nomenclature

$\lambda_{max}$	Wavelength at maximum value of the absorbed power
$L$	Structural periodicity
$\epsilon_d$	Permittivity of the surrounding medium
$\epsilon_m$	Gold nanoparticles dielectric permittivity at maximum wavelength
$\epsilon_\infty$	Dielectric constant at high frequency regime in the Drude model
$\omega_D$	Plasma frequency
$\gamma_D$	Collision frequency
$\delta_k$	Amplitude of Lorentz oscillator
$\omega_k$	Resonance angular frequencies
$\gamma_k$	Damping constants for $k$ value from 1 to 6

## 3. The Proposed Structure

In this work, I simulate amorphous silicon solar cell using plasmonic metallic nanoparticles distributed inside the active layer, nanoantennas on the top surface of the solar cell and back reflector. OptiFDTD simulation tool by Optiwave Inc. is used in this analysis. In my design, Cartesian coordinates  $x$ , and  $y$  are satisfy periodicity in boundary conditions, while, anisotropic perfect matching layer was used in the  $z$ -direction to serve as absorbing boundary condition.

In the first section, I compare the absorption ratio of a-si without using nanoantennas or plasmonics and with using different shapes of nanoantennas and plasmonic nanoparticles. The impact of using different plasmonics

concentrations with different radii is also studies in this section. In the second section, I study the absorption for two layers plasmonic nanoparticles using different materials such as gold, silver, copper and vanadium dioxide with dielectric permittivity can be described by using a multi-oscillator Drude-Lorentz model. Figure 1 illustrates the proposed structure of a single cell. The dimension of the cell is 100 nm length “L”, 100 nm width “W”, thickness of substrate material is 100 nm, thickness of active layer is 100 nm, P+ and n+ heights are 10 nm each, and a back reflector with 10 nm height and 30 nm width. In this part, I simulated different types of metallic materials and spherical shape of plasmonic nanoparticles and different nanoantenna lengths and densities. Gold, silver, copper and vanadium dioxide metallic materials are used in this work. In the second section, I study the absorbance of the proposed structure in case of using two layers of plasmonic nanoparticles as shown in Figure 2.

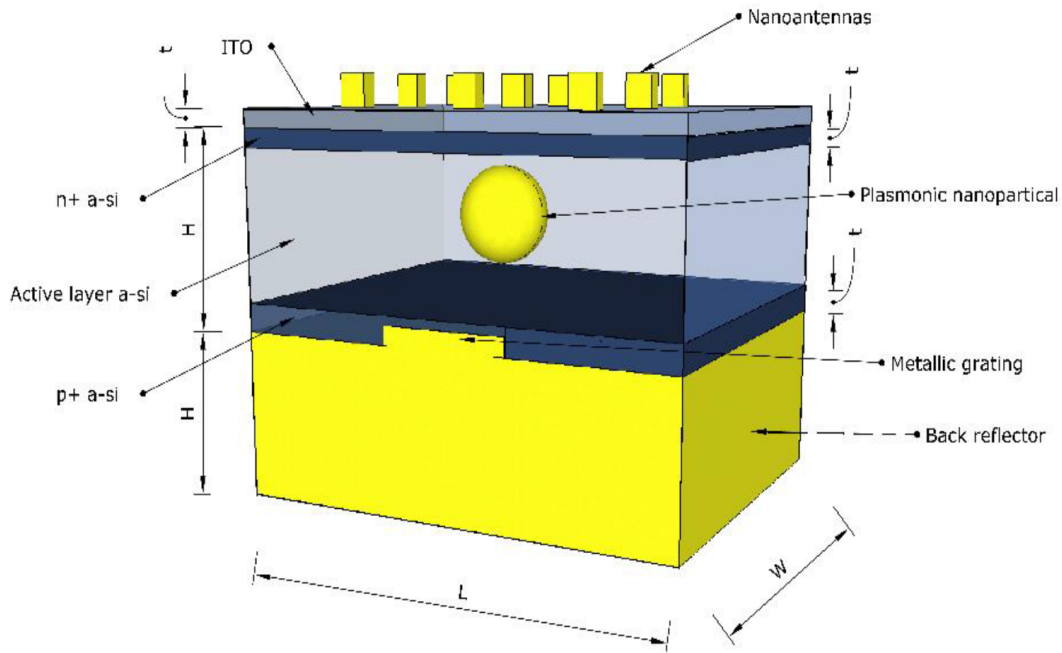


Fig. 1. Proposed cell structure of a-si solar cell using one layer plasmonic nanoparticles.

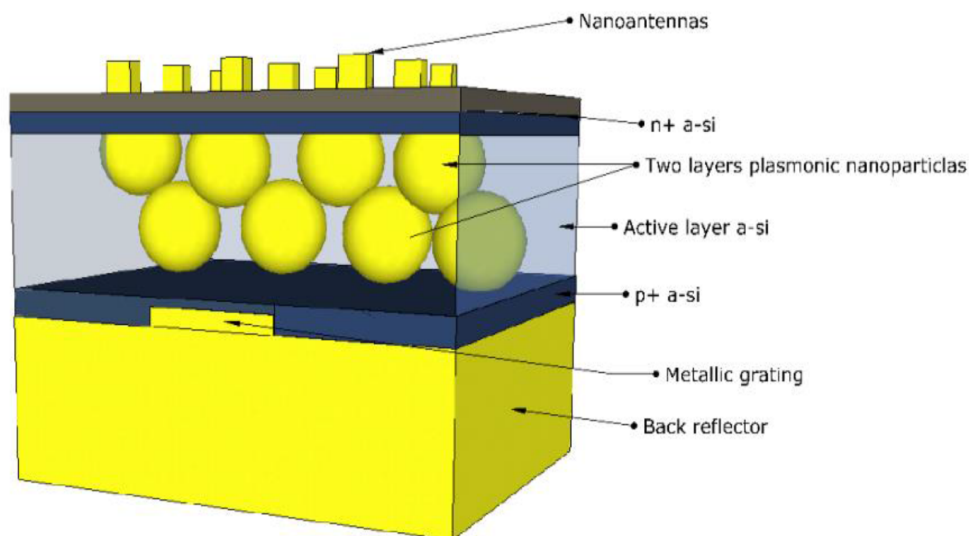


Fig. 2. Two layers plasmonic nanoparticles a-si cell structure.

## 4. Results and Discussion

In order to measure the spectral characteristic of nanoparticles in an amorphous silicon solar cells (a-si), I start the analysis by considering a back reflector gold material with  $L=W=H=100$  nm length, width and height. A metallic grating with 30 nm length, 100 nm width and 10 nm height. p+ a-si layer is  $t=10$  nm height, active layer is 80 nm and n+ a-si layer is 10 nm height. ITO material with a height  $t=10$  nm is used on the top of a-si layer as illustrated in Figure 1. Nanoantenna length, width and height are determined according to simulation optimization results for maximum light absorption. The optical properties of different nanoparticles is described using Drude-Lorentz model with four, five or six resonance frequencies according to Equation (2) using  $\epsilon_{\infty} = 1$ .

### 4.1. Impact of using plasmonic nanoparticles and nanoantennas

In this section, using the FDTD simulations, I study the effect of adding plasmonic nanoparticles inside the active layer a-si solar cell and nanoantennas on the top of the cell structure. In the designed unit cell, I used plasmonic nanoparticles of gold with spherical shape distributed in the active layer. In my simulation I used FDTD method when linearly polarized Gaussian modulated electromagnetic plane wave source was used at 680 nm center wavelength,  $0.8 \times 10^{-14}$  s offset time, and  $0.1 \times 10^{-14}$  s half width. Normal incidence, in the z-direction, of the plane wave is considered. As illustrated in Figure 3, the normalized absorbance versus wavelength in case of using a-si solar cell without nanoantennas or plasmonic nanoparticles, solar cell using plasmonic nanoparticles, and using different shapes of nanoantennas, rectangular, cylindrical and spherical shapes.

The radius of plasmonic nanoparticles inside active layer is 30 nm, spherical shape nanoantenna radius is 20 nm, rectangular shape nanoantenna is 20, 85, 10 nm length, width, and height respectively, and 20 nm radius of cylindrical shape nanoantenna with height 10 nm. In the high optical range, 600-800 nm, using spherical and rectangular antenna shapes give a higher absorbance than using plasmonic nanoparticles without nanoantennas. On the other hand, using plasmonic nanoparticles without nanoantennas gives a high absorbance in the lower wavelength range, 450-600 nm. Table 1 shows the peak value of the normalized absorbance and corresponding wavelength value.

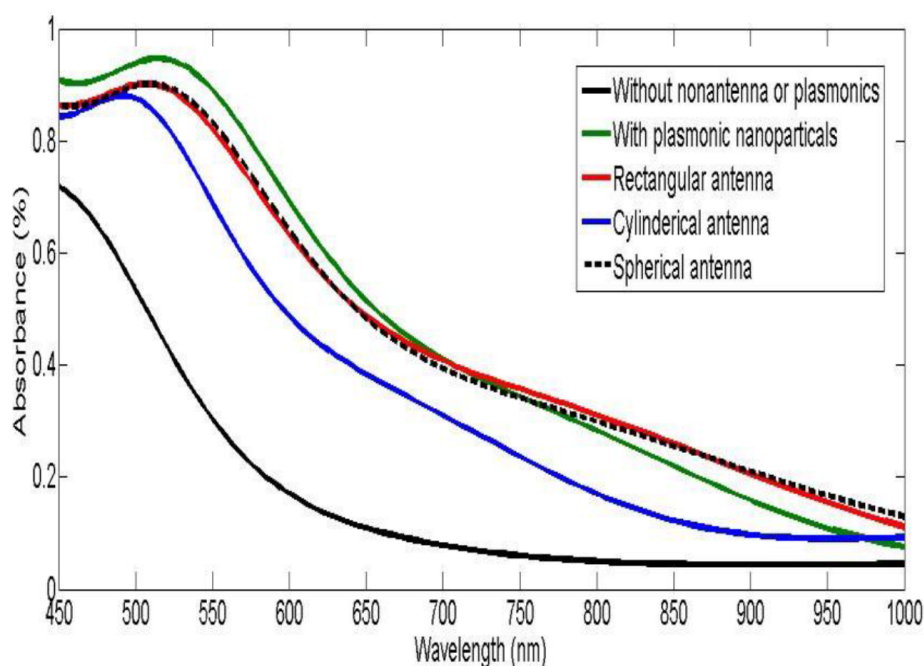


Fig. 3. Absorbance with and without nanoantennas and plasmonic nanoparticles and different shapes of nanoantenna.

Table 1 SPR value for different nanoantennas shape and without nanoantennas.

	Absorbance (%)	SPR (nm)
Without nanoantennas or plasmonic nanoparticles	90.77	450
With plasmonic nanoparticles	97.39	512
Rectangular antenna	90.19	505.6
Cylindrical antenna	88.03	503.7
Spherical antenna	90.13	508.7

#### 4.2. Changing nanoantenna radius and concentration

The absorbance is simulated for a spherical shape nanoantenna with radius 10 nm and 20 nm using 1-sphere and 4-sphere distributed on the surface. For radius 10 nm, I used 1, 4 and 9 spherical shape gold nanoantennas and 1-sphere and 4-spheres with radius 20 nm. As illustrated in Figure 4, the absorbance of a-si solar cell in the 600-800 nm range is getting higher with increasing the nanoantennas concentration, from 1 to 9 and with decreasing the nanoantennas radius from 2 nm to 10 nm. The maximum absorbance is obtained at 10 nm radius of spherical nanoantenna when 9 spheres are distributed on the surface.

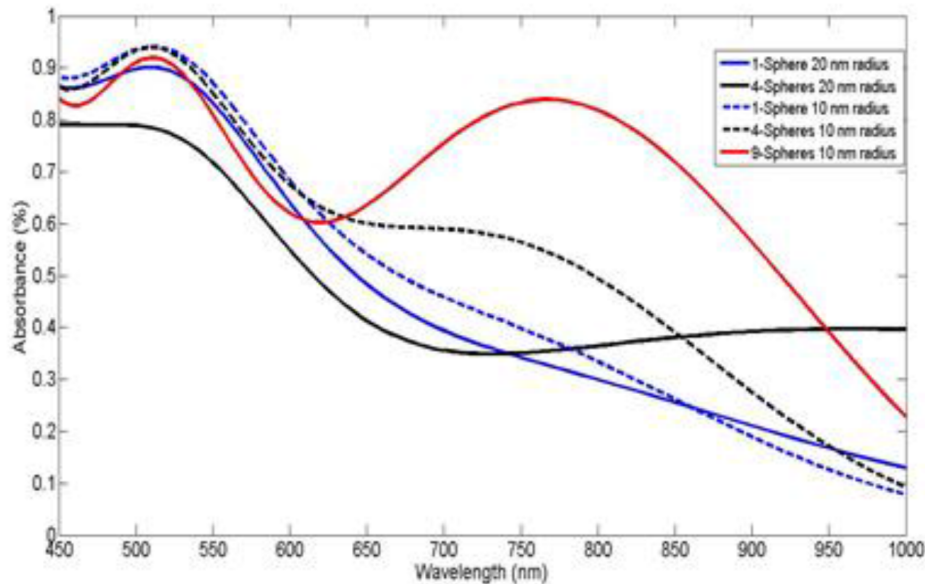
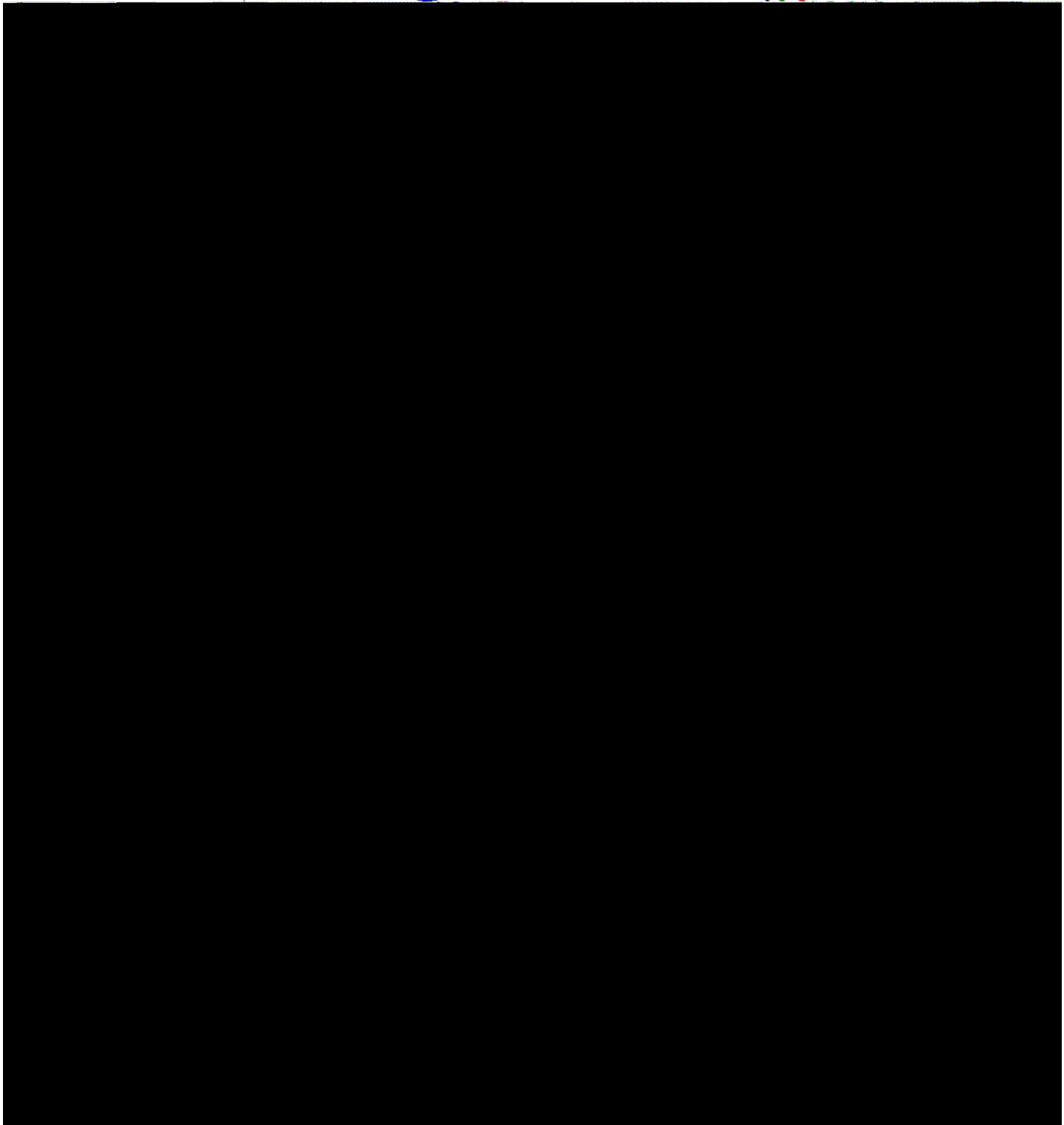
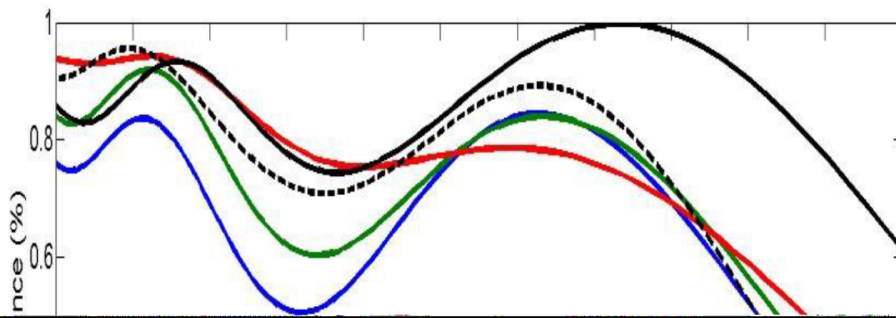


Fig. 4. Absorbance of gold nanoantenna for 10 nm and 20 nm and different concentration.

Figure 5 shows the effect of using different plasmonic nanoparticles and radius with different concentration, number of plasmonic nanoparticles per unit cell. As clearly illustrated, the improvement of optical absorption occurs in the optical band from 600 nm to 800 nm for a plasmonic radius 10 nm and 16 plasmonic nanoparticles per unit cell.





The using of different metallic materials such as silver copper and vanadium dioxide as a plasmonic nanoparticles and nanoantennas is illustrated in Figure 7. For two layers 10 m plasmonic nanoparticles, gold gives a high values of absorption in the 600-800 nm wavelength band, and copper the most closest one to the gold plasmonic nanoparticles.

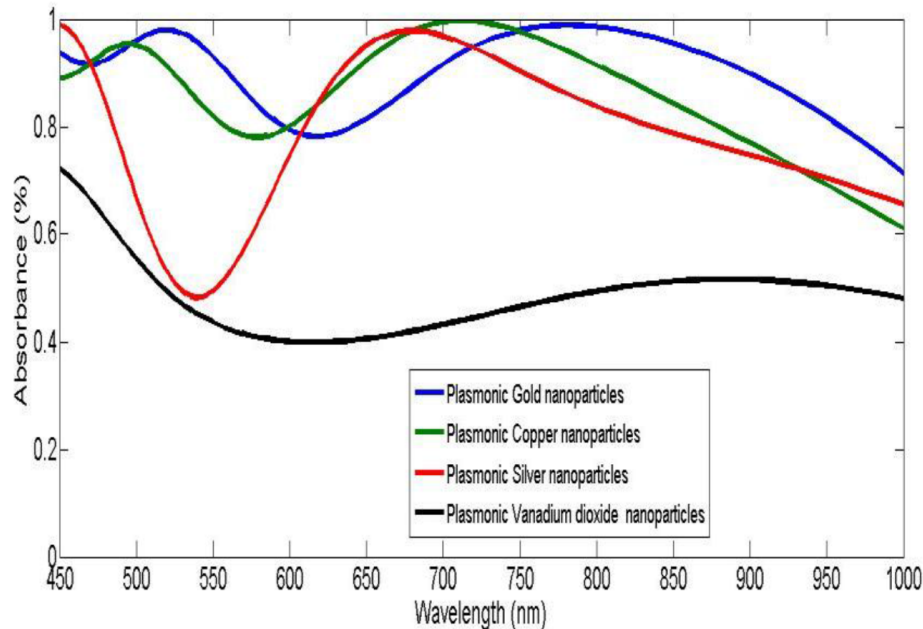


Fig. 7. Absorbance of gold nanoantenna at different radius for 9 and 16 plasmonic nanoparticles per unit cell.

## 5. Conclusion

Using FDTD method, I investigate the absorbance of amorphous silicon solar cell using different plasmonic nanoparticles distributed inside the active layer and different shapes nanoantennas distributed on the top surface with a metallic grating as back reflectors. In this paper, I proposed a new structure of spherical shape plasmonic nanoparticles and nanoantenna with different radius for one and two layers. For nanoantennas, the optimum, gives higher absorbance, shape is a spherical with radius 10 nm and with 9 spheres distributed on the surface, which increase the absorbance from 40% to 75% in the 600-800 nm range. On the other hand, the optimum plasmonic nanoparticles radius is 10 nm with 16 nanoparticles distributed on one layer, which enhance the absorption by 80%.

In case of using two layers of plasmonic nanoparticles, the maximum value of absorption, almost 90%, is obtained for 32 plasmonic nanoparticles per unit cell distributed on two layers with radius 10 nm. Gold and copper nanoparticles give the optimum values of absorption in case of using two layers 10 nm radius with spherical antennas of 10 nm radius in the optical range 600-800 nm.

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## ORIGINAL RESEARCH ARTICLE

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### **How to Produce an Academic Scientific Paper/Research**

**Abdullah Y. Samarah, Ph.D.**

Department of Advertising Communication  
Jeddah College of Advertising, University of Business and Technology

#### **Abstract**

Since sometimes ago I have realized the need and necessity to introduce the following topic. Due to the lack of interest, information, awareness etc. for many academic and non-academic institutions and centers, at many places in the world, we have decided to shed the light onto this important subject that many students nowadays need to learn i.e., how to produce, introduce and submit (any) academic and scientific paper/article/research in the proper way to make it recognized word wide. I also will try to give some ideas of the contents of various chapters. In addition the present paper will be useful to describe the typical structure for those who aim to go on with their postgraduate researches e.g., doctoral and master theses. Therefore, we've selected case study (in communication area) based on an empirical data, as example, for better clarifications and support.

**Keywords:** Preface, Introduction, Background, Results, Discussion, Conclusion, Bibliographies

#### **Introduction**

In this short paper I will try to describe the typical structure of a 'Normal Paper/Article', 'Doctoral or Master Theses' to serve several subjects e.g., scientific,

### III) ACKNOWLEDGEMENTS or PREFACE

You have written your paper/thesis in a professional and social context. You should mention the people who have helped you in different ways with your paper/thesis, these people might be formulated as follows:

1. Your chief supervisor
2. Your assistant supervisor
3. If you have received a grant/scholarship to assist you to complete writing your paper/thesis, this is the place to mention it
4. Teachers, colleagues, and fellow students who have taught you advertising communication, linguistics, etc. and have taken part in discussions over your paper/thesis (especially people who have been participating in work seminars where your work has been discussed)
5. Secretaries, technicians, librarians, etc. who have helped you with e.g., recordings, computers, photocopying, the printing of manuscripts, finding literature, etc.
6. Your family, friends, and others who may have supported you morally and economically during your studies.

### IV) TERMS or TERMINOLOGY

Since you are writing a paper/thesis the overall subject of which is language, it is especially important that you respect the *use-mention* distinction. Observe that two different roles of *has* in the examples below:

- (1)  
Lyons *has* analyzed this problem  
**USE**  
*has*: is the present tense form of *have*

**MENTION**

**MENTION**

In the *mention-case* above I have used italics (some writers prefer underlining). Anyhow, you must observe this distinction systematically.

Another question pertains to the *translation* of terms. If, for instance, you are using examples from the Chinese language, and your paper/thesis is written in English, then you should always translate them into English. The usual way of representing translation is by means of single quotation marks:

advertising, business literature, etc. I also will try to clarify some ideas regarding each content chapter.

**Firstly**, the main object of our paper is to make a *contribution to theoretical knowledge* in different fields of studies. There are a number of ways of doing this, we will illustrate them below:

You might open up an entirely new field of research in advertising, economy, linguistics etc. not embodied in any previous theory. What you would then be doing is an *explorative study*.

More often it is the case that you are interested in an area of advertising or linguistic for which there is a considerable amount of knowledge formulated in a *theory* (or a set of competing theories). You could then contribute to knowledge in your chosen area by at least one of the following:

1. Presenting a rival theory
2. Improving the details of an existing theory
3. Providing empirical support for an existing theory
4. Integrating an existing theory in linguistics with a theory in some other area
5. Refuting an existing theory

In point '4' above one could imagine a situation where, for example, a linguistic theory might benefit by being shown to be compatible with a psychological theory.

In relation to item '5' above, it is important to remember that you can increase knowledge by showing that previous knowledge is erroneous or unjustified, even if you cannot provide an alternative.

**Secondly**, there is really no qualitative difference between a paper or a thesis. The difference is really one of quantity. Both in a paper and in a thesis you should be explicit about at least the following things:

- *What you are doing?*
- *Why it is worth doing?*
- *What is known previously?*
- *What your contribution to knowledge is?*

### **Your justification for what you are claiming**

It is important to observe that the order of presentation of the various chapters and conventions in the present guide does not, of course, have to reflect your work process when doing research. For instance, it is obvious that you would not start by inventing a *title* and then think about *a problem in linguistics*. You will probably discover a problem in linguistic theory, then proceed to find out what people have written of relevance to your problem (the theoretical background). Next, you will perhaps do an empirical study,

and so on... . It might be the case that the exact wording of the title is left until the end of your work.

## **I) TITLE**

Choose a suitable title for your paper or thesis. There may be several criteria to consider. Hopefully a good title should in consisted of:

- *Arouse interest*
- *Be comprehensible*
- *Be specific enough*
- *Be true*

You may use a catchy title to arouse interest for your paper/thesis but the title should not be misleading, ambiguous, or even unspecific. See the below example that the writer used in 2002:

**'FEEDBACK PHENOMENON IN ARABIC SPOKEN COMMUNICATION'**

Feedback Phenomenon in the title above was chosen in order to arouse interest. The title is quite catchy. However, it would be too general because it promises too much as it stands, so I had to make the title more specific by adding "In Arabic", "Spoken". The use of the word "In Arabic" indicates a healthy degree of modesty on the part of the writer's choice.

As we can see, the last observation is also worth consideration.

## **II) KEY WORDS**

It has become obligatory to give a number of key words (in the very beginning of the thesis) relating to the content of the thesis. These key words are put into a large data base which the university libraries are connected to. Let us suppose you have written a paper/thesis about the phenomenon of 'feedback' in spoken Arabic. You could then give, for example, the following key words:

FEEDBACK  
ARABIC  
SPOKEN LANGUAGE  
COMMUNICATION

A researcher is doing a computer aided search in a library and looking for linguistic literature about 'feedback', 'Arabic', 'spoken discourse' and 'communication' would, if he/she conjoined these four key words, probably end up by finding your paper/thesis. So consider carefully the key words to use for making your paper/thesis accessible to others.



By thinking about these points you may avoid a number of unnecessary misunderstandings.

## V) ABBREVIATIONS IN THE THESIS

In order to make your text more smooth running you should avoid repeating long and cumbersome names or titles like e.g., *Government & Binding Theory*. If you frequently have to refer to such a title you might use an abbreviation. It might also be the case that you have yourself invented a technical term for a certain purpose and will make use of it repeatedly. Let us suppose that you are doing research in bodily communication and will have use for a term for 'walking with lowered shoulders'. Then WWLS could work as a convenient abbreviation.

It has now become customary to give a list of such abbreviations at the beginning of the paper/thesis.

Examples (2),

**AC**= Advertising Communication

**AM**= Advertising Management

**ACD**= Advertising Creative Design

**FB**= Feed-Back

**Newinfo**= New Information

**GB**= Government & Binding Theory

**Aspects**= Noam Chomsky's *Aspects of the Theory of Syntax*; published in (1965)

## VI) TABLE OF CONTENTS

A paper/thesis should contain a table of contents with page references so that a reader can directly look up what interest him/her the most

Let us see the following examples (3):

CHAPTER 2: Theoretical Background	22
2. Introduction	22
2.1 Donald Duck's theory of advertising	23
2.2 Jack the Ripper's theory of creativity	24
2.3 Dracula's theory of management	26
2.4 Schwarzenegger's theory of communication	28
2.5 The writer's theory of advertising	30

## VII) A CHAPTER WHICH STATES THE 'AIM/GOAL/PURPOSE' OF THE THESIS

There are several ways of writing the opening chapter of the paper/thesis. You could write a very short chapter (perhaps between 4 to 5 pages, in case of paper will be shorter) where you state shortly but clearly the following points:

1. Your subject
2. The problems(s) you hope to solve
3. The theoretical contribution you hope to make
4. An alternative way is to extend the short chapter by giving an introduction, i.e. putting your problem into a wider context and thus providing motivations for your study (see section 'VIII' below which discusses 'introduction').

However, you might perhaps also describe your *data and method* already in this chapter. This may be the natural thing to do if you have discovered new ways of obtaining data or if you have analyzed data was/were neglected so far. You must then say so in the title of the chapter and the chapter will of course become much longer than the five pages I suggested above.

I would suggest, however, that you describe your data and method in a later chapter. You could, instead, put in a well-chosen example from your data in order to give the reader a chance of really understanding what kind of advertising communication data you are interested in, without your having to start with a description of data and method right away.

Whatever way you choose to write this chapter it is most important that you finish (since it is the first chapter) by giving *an outline of the paper/thesis*,

i.e. A SHORT DESCRIPTION OF WHAT EACH SUBSEQUENT CHAPTER WILL DEAL WITH.

### VIII) A CHAPTER OF 'INTRODUCTION'

If you did not write an introduction in the first chapter, you could write an introduction chapter as your second chapter.

In the introduction you should place your study in a wider context. More specifically, you should convince the reader that your research problem has theoretical interest. Briefly, provide your *theoretical motivations* for making the study.

Examples (4):

- If your subject is 'advertising communication' you should argue for the importance of advertising communication in advertising area and may be in human communication as well;

- If our subject is ‘meaning change’ in Chinese you could argue that your study will contribute more specifically to a theory of historical semantics and, ultimately, to a deeper understanding of semantics in general.

Returning to the subject of ‘advertising communication’, the following questions might help to indicate how to write this chapter:

1. What is the *role of communication in advertising*?
2. *What kind/s of communication in advertising* will you discuss? Restrict the subject of the enquiry
3. Can you *characterize* communication in advertising?
4. How do we *recognize it*?
5. Can you give a *definition* of communication in advertising?
6. What is *advertising communication expression*?

Note that ‘characterizing’, ‘recognizing’, or ‘defining’ advertising communication may be slightly different things.

## IX) A CHAPTER OF ‘THEORETICAL BACKGROUND’

In this chapter you should state what scholars/academics know about your subset. This is important in order to give the reader a chance of evaluating your contribution to the knowledge of the subject.

Let us see the below examples (5),

1. What is *known* about advertising communication?
2. What are the key concepts?
3. Give a *fair* review of the most important theories and writers
4. Discuss the theories *critically*
5. You may also choose a difficult example and suggest how this would be treated in different theories
6. Make a *summary* of your critical review, this may to include:
  - To *expose* the weak and the strong points

- Also say where you agree and disagree (give *arguments* and *evidence*)

7. Say how you can make a theoretical contribution:

- a) Will you present a new theory of 'communication in advertising'? Or
- b) Will you improve on the details of some current theory of 'communication in advertising'? Or
- c) Will you content yourself with providing devastating criticism of the existing theories of 'communication in advertising'? Or
- d) Will your study perhaps support some existing theory through *expanding its empirical base* by applying it to different places not investigated so far?

This might prove to be the most difficult chapter to write. The main problem is to assume an independent attitude. If you accept the ideas of a certain writer, say Professor X, you cannot bluntly state: "I will use X's theory of 'communication' because he is my teacher and he seems to know much about 'communication' ("argument by authority"!)" Instead, you should write something like: "I will use X's theory of 'communication' because this theory can handle also troublesome examples like a, b, c, etc.

## **X) CROSS-REFERENCES IN/THROUGH THE TEXT**

Occasionally, you may wish to get support in your argumentations or discussions from another writer. Then you will refer to that writer only using his/her second name in the running text. Do not use the full title of the work (book, article, paper, etc.) Thus, if you will refer to what, for instance, John Lyons has written on page 634 in *Semantics*, published in 1977, you will do it like this:

Example (6),

... this is also the view held by Lyons (1977: 634)... Etc.

For further details concerned with bibliography, see section 'XVI' of the present study.

## **XI) A CHAPTER ON 'DATA' AND 'METHOD' (Example of Case Study 1)**

If you have carried out an empirical study you must describe your data and method. If you did not do this in the first chapter you might do it in a separate one. Let us see the following important points which represent the main criteria that you have relied and based your research on:

1. What kind of data have you got? Is it Arabic? Classic, Modern Standard or Spoken?



2. What kind of situations?
3. How it has recorded?
4. What and how many persons?
5. Did you face any problems with your data?
6. Would you change your method of data collection if you had done it all over again?
7. What methods have you used in *analyzing* data? (Statistics, intuition, survey, or what?)

Of course, you may have '*data*' and '*method*' in different chapters if that is more convenient'

### Example of Case Study 1

We are going to use the following data analyses as practical example for data I have collected and analyzed myself from Jeddah/Saudi Arabia sometimes ago

## METHOD

### Data Collection

#### 1. Recording: Setting and Informants

The data was collected at 2000-01-12 in Jeddah, Saudi Arabia. The conversation lasted one hour. The recording was audio tape recording. Originally video recordings work planned as well. However, for political and religious reasons, this was deemed difficult.

The researcher did not inform the participants beforehand that their conversation was to be recorded. Afterwards, the researcher informed the participants offering to destroy the recording if anyone objected to being recorded. This procedure (not informing the participants in advance) was motivated by the wish to have more natural and reliable data.

The researcher was one of the participants in the conversation and took a very passive role, being mainly a listener. This was based on the view that if the researcher had tried to control or influence the conversations, they would have lost some of their value. So the most important thing was to let the speakers talk freely, while the main job of the researcher was to prepare and organize the recordings in advance.

Anyhow, the recording gave very rich data. Recording was made in people's homes. Below, a brief description of the conversation and each participant's social features will be given.

## 2. Summary of Participant Characteristics

In an attempt to summarize and complement the information given above, we now present a table giving the main characteristics of the present recording in terms of setting and participants.

The following information is given for each recording: Place of recording, number of informants, and for each informant: sex, age, nationality, religion, education, occupation, income, family status, temporary psychological state. The following abbreviations are used:

**Table. X: Setting and Participants**

<u>Codes</u>	<u>Interpretation</u>
Rec	Recording (1, 2, etc)
Pla H	Place Home
Num	Number of informants
Par	Participants (A, B, C, etc.)
Sex M	Gender Male
Nat P J Y	Nationality Palestinian Jordanian Yemen
Rel M	Religion Muslim
Edu H S P	Education Higher education Secondary education Primary education
Occ E UE	Occupation Employed Unemployed

Inc	H	Income
	M	High
	—	Middle
		No income
Fam	S	Family status
	M	Single
		Married
TPS	N	Temporary psychological state
	S	Normal
		Stress

**Table. X: A description of conversation**

Rec	Pla	Num	Inf	Sex	Age	Nat	Rel	Edu	Occ	Inc	Fam	TPS
1	H	5	A	M	35	J	M	H	E	M	M	N
			B	M	37	Y	M	S	E	H	M	S
			C	M	27	P	M	H	E	M	S	S
			D	M	70	P	M	P	E	H	M	N
			E	M	66	P	M	H	E	M	M	N

The present conversation included five adult subjects, three from Palestine, one from Yemen, and one from Jordan. All were males, and their native language was Arabic. Three of the subjects were between 27 and 37 years old. The other two were 66 and 70. The group was diverse in terms of education and occupation, and included the middle and upper middle classes. Three of the participants were professionals (one economist, one geologist engineer, and one linguist), one building engineer, and one mechanical engineer.

## XII) A CHAPTER OF 'RESULTS' (Example of Case Study 1)

Present your results as clearly as possible. Remember that the reader has not been musing over your tables and figures for months as you have. It is therefore better to be over-explicit than the reverse.

1. *Introduce* every table and figure
2. *Comment* on your tables and figures

3. Give an *overall view* of your results
4. *Point out* crucial cases
5. Also *point out problems* you cannot explain  
(there is no use in sweeping such things under the mat!)
6. Try to *avoid repetitions*
7. If you have large amounts of data of the same kind you could put them in an *appendix* in the end of the paper/thesis.

### Example of Case Study 1

The following case study is a continuation of the same was given above under the 'Method' chapter. Here is to discuss the Result's issue

### Results

#### Alternative expressions for apology in ordinary conversation

In the present section I will demonstrate a table that shows the apology forms were occurred throughout the recorded conversation. In addition, our classifications of the examples were founded will be analyzed in terms of speech act theory (Austin 1962). These are the main two points will be discussed in the following section. Moreover, a sum of these apology forms will be given, as well as a few comments of the result/the main findings.

The following keys will be used in the table below:  
INF= informants, CAF= common apology forms, UAF= uncommon apology forms, AAF= account of all apology forms given in the conversation.

Table. X: Apology forms in ordinary Arabic conversation

<u>INF</u>	<u>CAF</u>	<u>UAF</u>	<u>AAF</u>
A	[u'Dran] 'to apologize' [afwan] 'to pardon'	[ismahli] 'forgive me' 'allow me' (originally)	3
B	[afwak] 'pardon me' [u'Durni] 'I apologize'	[lahDah] 'one second'	3
C	[la mu/aXaDah] 'nevermind'		1



D	[afwan] 'to pardon'	[ish asawi lak] 'what I do to you' question form implicating apology 'what I do for you'	
		[ya ammi] 'Oh Uncle' interrupting by vocative form implicating apology.'excuse me','pardon me'	
	(roughly)	ma - ilnaash - dawah neg-interrupting form implicating apology 'I'm sorry'	4
E	[ana aasif] 'I am sorry'		1

Total are= 12 apology instances

### XIII) A CHAPTER OF 'DISCUSSION OF RESULTS' (Example of Case Study 1)

1. What have you learnt (theoretically) from your results?
2. What surprises you? e.g., (does for instance the apology expressions in Arabic differ from English ones?)
3. Expected results (apology functions in the same way in Arabic as in English, for example)
4. Do your results support current theories in the field? (What then is the value of your study?)

Perhaps your will have reason here to *remind the reader* of something you have been discussing in the 'introduction' or in the 'theoretical background'. Do not repeat the whole argumentation then but refer to the place where you wrote that important thing, like:

Example (7),  
... this was also discussed in p. 33 ....

#### Example of Case Study 1

The same case study we've demonstrated above, we are discussing in the following item under Discussion.

### Discussion

## General Comments of the Conversation

I would like to point out that half of the length of this recording was passed without occurring any expression of apology. I have realized that reasons like, several scientific topics were discussed, as well as later in the conversation topics were turn to be more natural/normal were we find some expressions of apology occurred.

Moreover, I would like to add the following observations to justify the reasons behind not giving many apology forms during the conversation:

1. In the beginning the talk was between two persons and the topics were discussed of general facts and information
2. Misunderstanding, different views, etc was not occurred between the speakers, thereby it was not much apology expressions occurred during the conversation
3. The approval and agreement from each informant's view to the other speakers
4. Interruption was occurred but mostly as an agreement statement cases

## XIV) A CHAPTER OF 'CONCLUSIONS AND SUGGESTIONS FOR FURTHER STUDY (Example of Case Study 1)

It is not absolutely necessary to state your conclusions in a separate chapter. In some cases it could be more convenient to merge some of your conclusions with 'discussion of results' (section 'XII' above).

It might, however, be advantageous to leave some of the more general conclusions until the final chapter. If you have decided to do so you should make sure that this chapter is explicitly related to the questions and problems you formulated at the beginning of the paper/thesis. So this is where you should give the more *general answers* to the questions asked there (do not enter into too much detail here, you do not want to recapitulate the whole thesis!).

1. Write *a conclusion on what you have found* in your study
2. Show clearly what *your theoretical contribution* is
3. Also point out *what problems remain* to be studied in the future.

### Example of Case Study 1

To give an example of the conclusion that is related to the same example illustrated above

## Conclusion

We do not claim that, through the present study, we have covered every item that deserves to be discussed regarding apology phenomenon in Arabic, however, we have tried as much as possible to discuss this phenomenon from different concepts which we hope in doing this, we have given an explicit picture of apology in 'spoken Arabic'. Moreover, for further suggestions in the future, we would suggest that a social, phonetical, etc. comparison of the study of apology phenomenon between several languages e.g. Arabic, English, French, Swedish, etc will be useful to add a new linguistic information into the communication area, and to remove, in some extent, the ambiguity between the speakers who came from different cultures to interact each others, as well as to rise a successful contact/communicating away of any misunderstandings, misinterpreting, or even misjudging each others. As we would suggest that video recording/s of such empirical studies will support our this studies, especially, by including a non-verbal communication

## XV) NOTES

You will sometimes feel the need to expand a little or to put in some interesting observations which may not, however, be part of our heavy argumentation. In such cases you may use a *footnote*, i.e. a note at the "foot" of the page where you put in this extra information. Study how this is done.

An alternative way is to collect all such notes in a special *note section* at the end of the paper/thesis where all notes are numbered to correspond to numbers used in the running text.

For example (8),

25

The text: ... Frege's concept of 'intension'...

Note section: 25: Frege, in fact, used the term Sinn ... .

If you use notes in your text you should study how this can be done elegantly with the help of the computer.

## XVI) REFERENCES/BIBLIOGRAPHY

Find out how linguistic writers write their bibliographies. This is one usual way:

Example (9),

**Lyons, J. (1977) *Semantics* Volume 1. Cambridge University Press. England**

As you see in the example the bibliographical information is structured as follows:

1. Second name
2. A comma after the second name

3. Abbreviated first name
4. A full-stop
5. Year of publication in parentheses
6. Title written in italics
7. If the book is part of a series of volumes, you should also give that information
8. Publishing company
9. City or country of publication

Sometimes you will have occasion to refer to a paper and then you might have to respect different conventions. In the example below you will see that the author's name and the year of publication are represented as before. Notice, however, that the title of the paper is placed within single quotation marks.

Davidson, D. (1986) 'A nice Derangement of Epitaphs'. In E. LePore (ed.), *Truth and Interpretation*. Oxford: Blackwell, 433-46.

After the title indicate where the paper can be found: this particular one was published in a book titled *Truth and Interpretation* edited by E. LePore (observe the different order of first and second name now!), on pages 433-446. Also observe that in this case the place of publication is mentioned before the name of the publishing company.

This is not, however, the place to stipulate what conventions you should adhere to. Observe what seems to be the most common method and stick to it *systematically*.

## **XVII) APPENDIX**

If you want to exhibit *large amounts of data* it is a good idea to put the data in an appendix (or several appendices) at the end of the paper/thesis. Only take care that you do not introduce new labels or category names which have not been discussed previously in the paper/thesis.

## **XVIII) INDEX**

With the aid of the modern computer it should not be too difficult to make an index of subjects or writers. Such indexes will make your paper/thesis extremely valuable as a handbook. A writer doing an investigation of what different writers have said about, for example, 'extension' can then consult your index and directly find what he is after.

### **A) SUBJECT INDEX**

The subject index will also make it possible for you to check that you are coherent throughout the paper/thesis. If, for example, you have been writing about 'denotation' on page 18, you do not want to contradict yourself in a subsequent discussion on P: 129.



Let us suppose that the following concepts are important in your paper/thesis: 'reference', 'word', 'morpheme', 'intension', 'extension', 'truth'. You can then make an alphabetically ordered list of where these words occur in the text.

Example (10),

- a) extension: 3, 5, 11, 57, 122
- b) intension: 3, 5, 57-59, 122-124
- c) morpheme: 6, 18, 44-46, 87, 138
- d) reference: 3-5, 11-13, 45-47, 133-136
- e) truth: 2-5, 33, 56-60, 134-137

Note, that certain page references on the list above are underlined. This is done to show where the relevant items are defined or discussed in detail.

## **B) WRITER INDEX**

In the same way you may set up an alphabetical list of the names of writers which occur in your paper/thesis:

Example (11),

- Ahlsén, E: 3, 5, 18
- Allwood, J: 3, 5, 18, 66, 143
- Nivre, J: 3, 5, 18

## **XIX) ABSTRACT**

By now it has become obligatory for a paper/thesis to contain an abstract. These abstracts are collected and published annually which means that your paper/thesis may become more easily known to students all over the world.

An abstract is a short (perhaps only one-page) description of the contents of your paper/thesis. In the abstract you state – in the most general terms – what you have done. The abstract is always placed at the beginning of the paper/thesis – before the acknowledgements and the table of contents. By the time you enter upon this task (when you have more or less finished your paper/thesis) it should be quite easy to do. The abstract should say something about the following:

1. Purpose/aim/goal of the study, or problem
2. Motivation for the study
3. Theoretical background
4. Data and method
5. Results
6. Discussion of results
7. Conclusion

It goes without saying that only very general statements can be made at each point if you want to give an overall view of your paper/thesis within the space of one page. In order to avoid mentioning too much detail, reflect on the points worth incorporating in the abstract at different stages of your writing.

### **Acknowledgement:**

First of all, thanks to **God** who gives me the well and strength to complete the following article, I am deeply in debted to my **Parents**, for their support and prayers all the time.

Thanks to the **University of Business and Technology/UBT** especially to the Research and the Consultation Center/RCC for opening the door to such a research competition and for their continuously support to the researchers: faculties and students.

My special thanks to **Jeddah College of Advertising/JCA** in Saudi Arabia who has given me the confident to submit the present article represented by the head of JCA Prof. *Munir Al Sayed*.

I thank all **Participates** in the conversations which are used in the present study as case study.

My special gratitude goes to my **Wife and Kids** who were and still give me all inspiration and support I need till I complete the present research.

I am also obliged to thank my co-advisor, **Sören Sjöström** from the Department of Linguistics at Göteborg University/Sweden for his guidance and supervision.

### **XX) References or Bibliography**

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<http://www.depts.washington.edu/owrc> Adapted from  
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3. Essay Structure | - The Writing Center - Harvard University  
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[https://www.tcd.ie/Student\\_Counselling/student-learning/.../structure/](https://www.tcd.ie/Student_Counselling/student-learning/.../structure/)

### **Author's Biography**

**Self, Education and Experience background.**

Abdullah Yaqub Samarah, Swedish nationality and Palestinian by origin, he was born on the 1<sup>st</sup> of March/1967 in Jeddah/Saudi Arabia where he received his basic and university studies. In 1988 he got his BA from the KAUV, in 1992 he decided to move to Gothenburg University/Sweden to continue his PG studies where he completed: his MA in 1995, M.Phil in 2002 and all his compulsory PhD courses, major of 'General/Theoretical Linguistics', subject of 'Spoken Language Communication'. In 2004 he moved his dissertation to Exeter University/UK to work on his PhD. In 2006 he completed his Defense/Viva Vocia successfully. On the 6<sup>th</sup> of May/2008 he received his PhD officially in 'Linguistic Communication and Discourse Analysis'.

Dr. Samarah, and between 2004 and 2011, taught as Senior Eng Instructor and Assistant Professor in English, Linguistics, and Research Methodology in the Kingdom of Saudi Arabia. He is working now as Assistant Professor at the University of Business and Technology, Jeddah/Saudi Arabia.

He has several publications as listed:

through the JAAR Journal, are:

**TASK 1:** examine the theses published at the department. Make a summary in tabular form (i.e. in a table) of how different writers have organized their theses. What are the contents of the theses?

Key words?

Abstract?

Acknowledgements?

Abbreviations used?

Table of contents?

'Aim', 'purpose', or 'problem'?

'Introduction'?

'Theoretical background'?

'Data'?

'Method'?

'Results'?

'Discussion'?

'Conclusions' and 'suggestions for further research'?

Notes?

Bibliography?

Index?

Appendixes?

Having done the suggested task you may now have found that some conventions and chapter titles occur in several of the theses investigated. You should also note that some writers have organized their thesis in several parts, each consisting of a number of chapters.

**TASK 2-8:** choose one thesis within your field of interest and examine it with the questions below in mind.

**TASK 2:** how does the writer state his/her purpose, aim, goal, or problem?

**TASK 3:** what kind of motivation does the writer give for doing his/her study?

**TASK 4:** how does the writer represent previous knowledge in his/her chosen area of interest?

**TASK 5:** what are the data?

**TASK 6:** what methods are used in the analysis of data?

**TASK 7:** which are the most important conclusions? Do they relate to the questions formulated in the beginning of the thesis?

**TASK 8:** criticize the thesis you have read. You could use the task questions 1-7 as a starting point.





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[rcc-researchservices@ubt.edu.sa](mailto:rcc-researchservices@ubt.edu.sa)