

IDENTIFY CHALLENGE FACTORS IN THE ADOPTION OF BIG DATA MINING TECHNOLOGY IN SAUDI BANKS

¹NUHA ALMOQREN, ²MOHAMMED ALTAYAR

^{1,2}Department of Information Studies, Al Imam Mohammad Ibn Saud Islamic University (IMSIU), Saudi Arabia
E-mail: ¹nuha@ccis.imamu.edu.sa, ²msaltayar@imamu.edu.sa

Abstract- Nowadays data mining technology in the finance industry is growing tremendously, especially with the growth of ubiquitous data in different forms. Big data mining technology helps banks to acquire new knowledge that leads to business efficiency. This paper focuses on big data mining technology and aims to investigate the factors affecting its adoption in Saudi Banks. A conceptual model was proposed based on the technology, organization and environment (TOE) framework. A quantitative approach was used to collect and analyze data, then to validate the research model. The paper highlights the importance of some issues that negatively affect adoption of big data mining technology such as technological, organizational and environmental factors. The paper concludes with a summary of the main findings and provides suggestions for future research.

Keywords- Data Mining, Big Data, Adoption, Banking Sector, Saudi Banks, Saudi Arabia.

I. INTRODUCTION

Recently, the acquisition of knowledge from big data analysis has become an essential feature of business efficiency [1] [2]. Wielki [3] reported that big data has become more common in organizations associated with the field of Business Intelligence (BI) and analytics that play an important role in organizations and provides numerous possibilities and new opportunities. The data nowadays has become increasingly diverse, more granular, real-time and iterative, and that has led to some analysis tools' inability to handle it.

BI applications are used in data mining techniques and statistical methods to analyze the grounded data [4]. Big data mining technologies can identify useful information, can identify patterns in the information, and can provide an insight, which would otherwise not be possible because of the volume, variability and velocity of the data [5]. Wu et al [6] proposed a big data processing model from the data mining perspective, as shown in Figure 1.

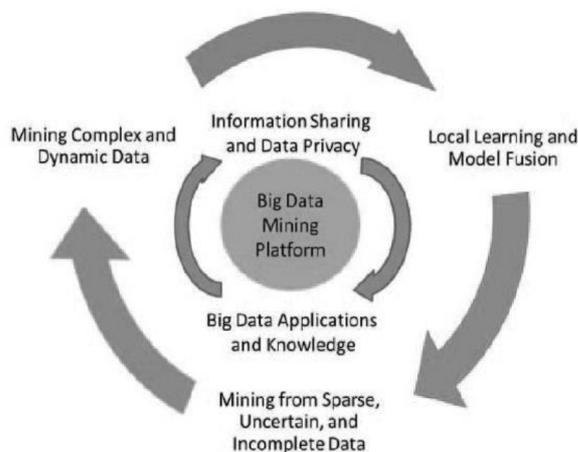


Fig.1. Data mining processing framework at center around the "Big Data platform".

Figure 1 shows a conceptual view of the big data processing framework, which includes three challenges. The first challenge focuses on access to the data; the big data is stored in different places and in different formats. The second challenge is related to semantics and domain knowledge, which is located between the data acquisition and the knowledge extraction.

The third challenge is a data mining algorithm that if used to handle big data, may be ineffective. The big data is a set of characteristics including complexity and volumes, distributions, and dynamic data. Therefore, it is important to design an algorithm to deal with these characteristics of big data effectively. In the era of big data, the need for big data mining has arisen in all science and engineering domains [6]. Therefore, this paper attempts to shed some light on Big Data Mining adoption in Saudi Arabia in order to investigate the challenge factors and develop a conceptual model of Big Data Mining adoption based on the technology-organization-environment (TOE) framework.

II. LITERATURE REVIEW

The arrival of big data in society has prompted businesses and governments to take action to exploit its value and application. The banking sector has realized the need for technological solutions, which has led to the use of Big Data (BD) and Data Mining (DM) tools, where both are playing significant and effective roles to create business value.

Zikopoulos et al [7] defined big data as a series of large and complex bodies of digital information that cannot be analyzed by using traditional tools. There are three characteristics known as the 3Vs that define Big Data: volume, variety, and velocity [7], as shown in Figure 2:

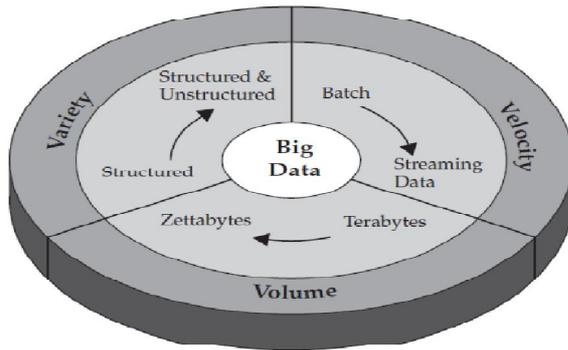


Fig.2. Three characteristics of Big Data

Laney [8] described the 3 Vs as follows:

Volume: The volume of data has increased dramatically meaning that the data can no longer be processed simply.

Variety: There are many forms of data such as text, sensor data, audio, video, and graph.

Velocity: Streams of data arrive continuously; and information becomes valuable when it arrives in a timely fashion.

Several important trends contributed to the increase in the generation of data. Wielki [3] identified three trends: the first is the growth of traditional transactions that are associated mainly with an expansion of granularity and frequency that produce various forms of data. This has led to a disturbance in the work environment, a high level of competition, and customers demanding more than before. Organizations must face these challenges by making analysis tools more accurate and detailed. The second trend is the increase of multimedia content in the contemporary economy. The third trend is the growth of "The Internet of Things", which is defined as the number of physical objects or devices that act with each other without any human interference [3]. With the growth of data in different forms, data mining tools enable effective, scalable, and flexible data analysis [9].

Data mining emerged in the late 1980s through an extension of the fields of artificial intelligence, pattern recognition, database systems and statistics. Data mining has been defined as a mechanism that helps to discover hidden patterns in large complex amounts of data in order to acquire new knowledge [10]. Different data mining techniques help to find different types of pattern. In general, techniques can be classified in two categories: Descriptive and Predictive. Descriptive mining tasks help to analyze, summarize, and describe the data by characterization and discrimination. Predictive mining tasks use current data to create forecasts of the future [9].

2.1. Factors Affecting Big Data Mining Adoption

To address information technology and its adoption and implementation in organizations, it is necessary to consider theoretical models [11]. For the purpose

of this study, the researchers used the Technology, Organization, and Environment (TOE) framework. The use of the TOE model can be justified as follows. First, measuring the success of information systems is complex because the impacts of information technology are influenced by human, organizational, and environmental factors [12], and these factors are present in the TOE framework. Second, as reported by Oliveira and Martins [11] several researchers used the TOE framework to understand different IT adoptions such as business to business (B2B), e-commerce, enterprise resource planning (ERP), and knowledge management systems (KMS). Third, this model can be used at an organizational level [11], which is suitable for this study. The framework is utilized to build the theoretical framework for this study and to identify previous research and studies. Based on the literature, several factors have been identified and they are organized into three categories: organizational, technological, and environmental. The following is a description of these issues.

Organizational Context: Organizational factors are important in promoting success in the organization [13] [14]. The organizational context refers to descriptive measures of the organization that includes different elements such as top management, human resources, IT training programs, and information management level [11] [15]. With the variety of data sources including the Internet, mobile devices, sensors, social media, and geospatial devices, big data has become a new revolution in the new economy that is driven by data with high volume, velocity, variety, and veracity [16]. Nunan and Domenico [17] identified a set of perspectives for big data from a commercial value; one of the perspectives facing organizations is the management level of information. Huge amounts of data need an unprecedented level of advanced analysis in terms of storing, analyzing, and retrieving [17]. Accordingly, this study assumes that successful information management has an impact on the adoption of big data mining technology, as the following hypothesis is proposed:

H1-a: Successful information management has an impact on the adoption of big data mining technology.

One approach to the planning of relatively new technologies is to formalize another issue related to innovation and flexibility in the information system planning approach. Khan et al. [18] represented the factors that influenced the adoption of IT in Saudi Banks. They found that some bank managers do not review their plans, policies, and procedures to keep up to date with technology. This study suggested the banks should review their plans at least annually based on changes in technology and activities [18]. Therefore, we believe that change management has an effect on the adoption of big data mining technology in banking sector.

H1-b: A lack of good Change Management can negatively affect the adoption of big data mining.

Kugel [2] explained that top management plays an important role in supporting big data and big data analysis; that gives finance organizations greater scope to play a more strategic role in corporate management and allows for more flexible and agile forms in business organization [2]. Coumaros et al [21] also illustrate how the failure of top management to consider big data strategically impedes the successful adoption of big data: therefore;

H1-c: The top management in banks can negatively affect the adoption of big data mining.

The study by Askool and Nakata [19] revealed the factors that affect integration of Web 2.0 technologies with traditional Customers Relation Management (CRM) systems in Saudi banks based on the TOE framework. They found the centralization and formalization of organizational structure played a key role in the decision to integrate social media [19]; this may be a consideration in relation to big data. Consequently, the following hypothesis is proposed:

H1-d: A centralized organizational structure negatively affects the adoption of big data mining.

Al Ruwaili et al [20] reported that the human resource management (HRM) in Saudi banks has moved from a traditional framework to become focused on talent-driven management. They found that there is a large presence of talented management in Saudi banks as a result of training and that this enhances employees' skills and allows them to acquire new knowledge [20]. In addition, Kugel's study [2] revealed several challenges and obstacles that may prevent the utilization of big data in financial organizations including staffing and training. As a result, it seems that knowledge and awareness of this technology may help in its adoption.

H1-e: Staffing and training are linked with the assimilation of big data mining technology.

Technological Context: Technological factors play a significant role in ensuring successful information systems [13]; these include technology integration, IT infrastructure, technology readiness, and technology resources [11]. The era of wireless technology is associated with many devices that are self-controlled data generating entities [22]. These devices are a key source of big data, so wireless technology is an important issue in the adoption of big data mining technology. Ahmad et al [22] explain that wireless technology data "is transmitted in the form of signals carried by electromagnetic waves over a communication path" and it is an important factor in the big data industry [22]. Accordingly, we believe that adoption of wireless technology will be the

gateway to the adoption of data mining technology, therefore;

H2-a: Wireless technology affects the adoption of big data mining

Systems integration in a capital market can be considered key to business leadership when using big data technologies. Coumaros et al [21] found that one of the biggest obstacles to the adoption of big data was the data not being pooled for the benefit of the entire organization. Therefore the following hypothesis is proposed:

H2-b: The lack of Systems integration can negatively affect the adoption of big data mining.

With wireless technology and systems integration, there is a need to control and coordinate data from inside and outside sources. Askool and Nakata [19] found internal control is one of the factors that affects adoption in social media, and one of the main sources of big data. In addition, there are concerns related to internal controls regarding the time employees will spend on social media and thus have a detrimental effect on the overall workplace productivity [19]. Consequently, it can be argued that coordinating data from inside and outside can increase the effectiveness of data management, which may in turn affect the adoption of big data tools, and thus;

H2-c: The level of inside and outside data control is related to the adoption of big data mining.

When organizations seek to extract descriptive and predictive knowledge from the great mass of data, they face a number of technological issues. These include efficient and reliable storage, fast processing, and integration; these require a novel infrastructure for distributed data mining and data integration [23] [24]. Therefore the following hypothesis is proposed:

H2-d: Weak IT infrastructure of the bank negatively affects the adoption of big data mining.

Unstructured textual data is being generated via wireless technology and web 2.0 technology; powerful tools are necessary to mine it. Coumaros et al [21] explored the impediments to the successful adoption of big data from the technical side and finds that one of them is the difficulty in interpreting unstructured data [21]. As a result, it seems that a big data platform needs a powerful mining tool that contributes to the interpretation of those data. Thus, we assume:

H2-e: The ability to interpret unstructured data affects the adoption of big data mining.

Environmental Context: The environmental context is that in which an organization conducts its business, including the competitors, information intensity, and government promotion [11], [14] and [15]. Infosys [25] published a report that contains the key business drivers for using big data technologies in a capital market. The report also covers whether the adoption

of big data changes the regulatory landscape to face new regulations (Basel II, EMIR, Dodd Frank etc). The Saudi Arabian Monetary Agency (SAMA) contributed actively to promoting and supporting the standards announced by the Basel Committee for Banking Supervision (BCBS) [26]. Consequently, the following hypothesis is proposed:

H3-a: The SAMA regulations affect the adoption of big data mining.

In addition to new marketing strategies to deal with unstructured data such as Twitter-based data, there is an increase in the number of other data sources (social media, Internet, mobile technology), which has led to an increase in the size of the data (information intensity) [26]. Accordingly, this study assumes that the increase in information intensity has an impact on the adoption of big data mining technology

H3-b: Information intensity is associated with the adoption big data mining technology.

Sundarrajan and Pearson [24] reported that some banks are beginning to deal with unstructured data from social media; there was a lot of activity on Facebook, Twitter, and YouTube. Furthermore, Alotaibi [27] conducted an evaluative study on the impact of Twitter on the Saudi banking sector and found that Twitter can be a useful resource for promoting the products and services of banks and for encouraging interaction between banks and their customers. The opening of the Saudi banking market to global markets is inevitable and will lead to increasing competition among all Saudi banks [19] [28]. The IBM Institute found that 71% of banking and financial market firms use big data and analytics to create a competitive advantage for their organizations. The banks can use data mining to gain a competitive advantage because data mining has become widely acceptable for modern organizations to meet the challenge of competition [29]. As a result, the following hypotheses are proposed:

H3-c: Market strategies promote the adoption of big data mining.

H3-d: Competitive pressures promote the adoption of big data mining.

Figure 3 illustrates the conceptual model of the factors affecting the adoption of big data mining technology.

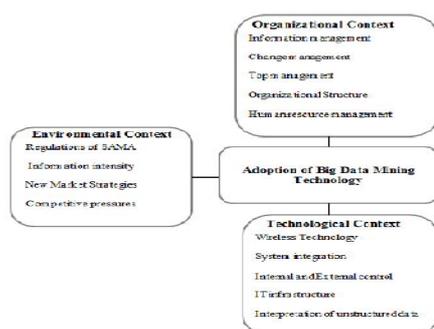


Fig.3. Conceptual model of the factors affecting the adoption of big data mining technology

III. RESEARCH METHODOLOGY

The purpose of this study is to explore the factors affecting the adoption and implementation of data mining techniques to harness big data in Saudi banks. Exploration research is suitable where a small amount of information exists and there is little understanding of the research issues [30]. A survey is the most widely used method for data-gathering in business and management research [31]. Surveys provide a method of collecting data and opinions from a sample across population groups, and they allow the researcher to discover knowledge about the phenomena under study [32]. Thus, it is a suitable method for gathering descriptive data and it facilitates the measurement of many variables by collecting primary data via a questionnaire. The researchers conducted this survey on-line and collected data over the Internet. The survey was completed by 54 participants who work in data processing and business intelligence in IT departments in Saudi banks, over two months from August 2014 to October 2014. To test the conceptual model (Figure 3), the researchers used statistical techniques that are based on Chi-square test at significant level (95%).

IV. RESULTS AND DISCUSSION

This section reports the results of the study and discusses them in the light of the literature and related work.

4.1. Factors Influencing the Adoption of Big Data Mining

The Saudi banks believe that their banking system faces several challenges with respect to modern technologies. The study revealed that these affect the adoption of big data mining technology. The following table summarizes the results of the hypotheses, which are discussed in the next section.

Table1: Results of research hypotheses.

Hypothesis	df	Chi-Square > 9.488	Sig.< 0.05	Result
H1-a	4	35.51	0.000	Supported
H1-b	4	34.35	0.000	Supported
H1-c	4	24.49	0.000	Supported
H1-d	4	22	0.000	Supported
H1-e	4	33.81	0.000	Supported
H2-a	4	12.29	0.015	Supported
H2-b	4	12.54	0.006	Supported
H2-c	4	40.67	0.000	Supported
H2-d	4	14.40	0.002	Supported
H2-e	4	4.11	0.128	Not Supported
H3-a	4	8.65	0.053	Not Supported
H3-b	4	24.00	0.000	Supported
H3-c	4	14.96	0.002	Supported
H3-d	4	24.20	0.000	Supported

Organizational Context: The arrival of big data in society requires the banking sector to re-think how it deals with data management. Saudi banking systems are not able to deal with big data characteristics (the 3Vs); this may be due to a lack of awareness or a lack of support from top management. Top management is crucial in the adoption of any project because it issues project approval. This study found varying levels of support among the Saudi banks toward the adoption of big data mining technology, and that most Saudi banks do not encourage ongoing technical projects in the way they support those that are related to business and profitability. This study revealed that the presence of talented management in Saudi banks lies in the business rather than the technology sector. So the lack of support from top management and the lack of technologically talented management may be an obstacle to the adoption of big data mining, which is consistent with results of previous studies [21]. From Table 1, the result indicates that top management, information management, and human resource management have an effect on the adoption of big data mining. Hence, H1-a, H1-c, H1-e are supported.

Most of the respondents highlighted the fact that Saudi banks' organizational structure is centralized and that as a result project approval takes a long time and involves inflexible steps, which supports hypotheses H1-d. This result was also highlighted by Askool and Nakata's [19] findings, where centralize of organization structure is hindering technology adoption.

This study found that Saudi banks are inflexible in their plans to change when they adopt big data mining technology. In addition, most of the respondents agreed that there are concerns in terms of change management in Saudi banks. First, the adoption of new technology may not be compatible with the legacy system and so can be an impediment to system performance. Second, there are new responsibilities that appear with new technology such as training and the development of staff skills. Finally, the use of new technology requires constant monitoring of tasks and controlling of costs, schedules, risks, and quality. This is consistent with a previous study [18] and supports H1-b.

Furthermore, the results indicate that women are less involved in the area of data mining and big data, which leads us to believe that the segregation of men and women is a new organizational issue that affects the adoption of big data mining. In addition, experience with banking information management systems helps to give an understanding of what the system needs, and what technologies it would be necessary to adopt in the information system in order to achieve the bank's objectives. The results reveal that staff members' experience in information management systems encourages the adoption of

relatively new technologies such as big data and data mining.

Technological Context: The results reveal that there is an urgent need for the presence of advanced wireless technology to help banks make the right decisions based on contextual data. So wireless technology is an important issue in the adoption of big data mining technology ($p < 0.05$) Hence, H2-a is supported, which confirms the results of Ahmad et al.'s study [22].

The findings show that the Saudi banking system has the ability to collect and store data from multiple and heterogeneous sources. It may help to remove redundant data and improve the consistency and speed of data. The system integration issue is discussed by Coumaros et al study [21] as a negative impact that can be considered an obstacle to the adoption of big data mining technology; that does not agree with this study. However, H2-b is confirmed since system integration will have a major positive influence on the adoption of big data mining technology. The external data that comes from the wireless technology are needed to monitor and control operations. The results indicate the control between multiple-channels for the flow of inside and outside data affect the adoption of big data mining technology by ($\text{sig.} < 0.05$), this result was also highlighted by Askool and Nakata study [19]. Hence H2-c is supported.

The most important technological issue is IT infrastructure. The study found that Saudi banks have concerns about the lack of efficient infrastructure in the area of data as they begin to turn from structured to unstructured data and to handling data in real-time. Therefore, H2-d is acceptable, ($\text{sig.} = 0.002 < 0.05$), as IT infrastructure is a factor affecting the adoption of big data mining technology, which is consistent with Sundarajan and Pearson's findings [24]. An adequate IT infrastructure helps to bring about a more holistic view of data when it is connected with wireless technology.

The results revealed that H2-e is not supported ($\text{sig.} = 0.128 > 0.05$). Some banks use advanced analysis tools in collaboration with global vendors such as IBM, SAP, and Oracle. The issue of the interpretation of unstructured data does not affect the adoption of big data mining and this does not agree with Coumaros et al [21].

Environmental Context: The Saudi Arabian Monetary Agency encouraged Saudi banks to change strategies in order to keep up to date with the regulatory landscape of Basel III. However, the Monetary Agency does not impose any regulations on how to apply specific technologies. From table 1 the H3-a is rejected because the value of sig. is more 0.05.

Today, Saudi banks are using new data sources as channels to acquire valuable data; using these channels in effective ways brings about perceived benefits. The new data sources (such as sensors and social media) provide huge amounts of data that can be called information intensity. The results revealed an increase in information intensity was one of the factors affecting the adoption of big data mining technology, which agrees with [25]. So H3-) is accepted, big data mining technology can turn the huge volume of data into useful knowledge that contributes to finding effective future marketing strategies for the perfect banking operations.

H3-c and H3-d are confirmed because the value of the Chi-square test is more than 9.488. The results reveal an increase in the adoption of big data mining technology due to the increased competition and new market strategies. Saudi banks are witnessing increasing competition [33], so the competition issue constitutes a motivation to adopt big data mining technology.

Based on the results of this study, it can be said that Saudi banks are taking the conscious decision to adopt the best available banking technology to meet the customers' needs in terms of service quality improvement and availability. The Banking Information System (BIS) in Saudi banks is built with the following components: Core banking system, backend systems, Middleware, integration tools, and Business Intelligence (BI) system. The BI system contains the data warehouse and data mining tools, and it plays a vital role in supporting optimal management of resources, information, and knowledge. In addition, the results reveal that Saudi banks rely on structured data, while the unstructured data is considered a new source and the banks have limited ways of taking advantage of it. Furthermore, while big data platforms are still under construction in most Saudi banks, the banks use advanced analysis tools that contain data mining algorithms to reveal hidden patterns and trends. The adoption of big data mining technology is an intelligent strategy in planning how to improve results across the bank, internally and externally in decisions management, customer management, and risk management.

4.2. Limitation and Future Research

Like other research, this study suffers from several limitations. First, the study was constrained to IT departments within the banking sector and to one country, Saudi Arabia. Thus, the results may not be generalizable for other countries where the adoption of the technology varies. As a result, further research is recommended in other countries and sectors to know more about issues influencing the adoption of data mining techniques. In addition, future research should focus on the contribution of effective changes

in data management in keeping pace with the latest technologies.

CONCLUSIONS

This study has shed light on a set of issues that are related to the challenges associated with the adoption of big data mining technology within the banking sector. In this research, information management, change management, human resource management, and data coordinating are the main factors that influence the adoption of big data mining. There are new factors that should be involved when adopting big data mining technology, which include experience with information system and gender. This paper can be used as a framework to investigate further factors and as a foundation of future work in terms of data mining tools and big data.

REFERENCES

- [1] Ryohei, F & Satoshi, M 2012,' The Most Advanced Data Mining of the Big Data Era', NEC technical journal, Vol.7, No, 2, 2012
- [2] Kugel, R ' Finance Can Get a Big Advantage from Big Data ', VENTANA RESEARCH.[Online]. Available from: <http://robertkugel.ventanaresearch.com/2013/11/16/finance-can-get-a-big-advantage-from-big-data/>, 2013.
- [3] Wielki, J, 'Implementation of the Big Data concept in organizations possibilities, impediments and challenges', Proceedings of the 2013 Federated Conference on Computer Science and Information Systems, IEEE pp. 985–989, 2013.
- [4] NEAGA, I. & HAO, Y. Towards Big Data Mining and Discovery. Short Research Papers on Knowledge, Innovation and Enterprise, Part 2-Innovation, KIE Conference Book Series, International Conference on Knowledge, Innovation & Enterprise, 35-43, 2013.
- [5] Fan, W & Bifet, A, 'Mining Big Data: Current Status, and Forecast to the future, SIGKDD Explorations, Vol.14, No, 2, 2013.
- [6] Wu, X, Zhu, X, Wu, G, Ding, W, ' Data Mining with Big Data', IEEE Transactions On Knowledge And Data Engineering, VOL. 26, NO. 1, January 2014.
- [7] Zikopoulos, P. & Eaton, C, ' Understanding big data: Analytics for enterprise class hadoop and streaming data', McGraw-Hill Osborne Media, 2011
- [8] Laney, D. 3-D Data Management: Controlling DataVolume, Velocity and Variety. META Group Research, 2001.
- [9] Han, J., Kamber, M. and Pei, J. Data Mining: Concepts and Techniques 3rd Edition, Elsevier, 2012.
- [10] Kirkos E., Manolopoulos Y, Data Mining in Finance and Accounting: a Review of Current Research Trends, Proceedings of the 1st International Conference on Enterprise Systems & Accounting, pp. 63-78, Thessaloniki, 2004.
- [11] Oliveira, T., Martins, M., Literature Review of Information Technology Adoption Models at Firm Level, Electronic Journal Information Systems Evaluation, Vol 14, Issue 1, 2011.
- [12] Petter, S, Delone, W, Mclean, E, Measuring Information System Success: Models, Dimensions, Measures, and Interrelationships, European Journal of Information System, Vol.17, P236-263, 2008.
- [13] Hussein, R., Shahriza, A, & Hasan, S. The impact of technological factors on information systems success in the electronic-government context. Business Process Management Journal, Vol 13, pp 613-627, 2007.

- [14] Rosca, D., Banica, L., Sirbu, M., Building Successful Information Systems- a Key for Successful Organization, Economics and Applied Informatics, 2010.
- [15] Tornatzky, L. and Fleischer, M.. The processes of technological innovation. Massachusetts: Lexington Books, 1990.
- [16] Chan, J,' An Architecture for Big Data Analytics', Communications of the IIMA, Vol. 13 Issue 2, 2013.
- [17] Nunan, D, Domenico, M 2013, ' Market research and the ethics of big data', International Journal of Market Research, Vol. 55, No. 4, 2013.
- [18] Khan, M., Zedan, H., Al Ghadeer, A., "Influential factors in adoption of information technology in financial business sector in Saudi Arabia", Canadian Journal of Pure and Applied Sciences, Vol. 5, No. 1, pp. 1413-1417, Feb 2011
- [19] Askool, S. & Nakata, K. Investigation into the adoption intention of social CRM in Saudi banks. International Conference on Information Society (i-Society), IEEE, 402-407, 2012.
- [20] Al Ruwaili, N., Bright, D., Alhameed, A., "To What Extent Talent Management in Saudi Arabian Banks", International Journal of Advances in Management Science, Vol. 2, No.1, February 2013.
- [21] Coumaros, J., Buvat, J., Auliard, O., Roys, S. D., Kvj, S., Chretien, L., Clerk, V. & Digital Transformation Research Institute, ' Big Data Alchemy: How can Banks Maximize the Value of their Customer Data? ', Capgemini Consulting, 2014.
- [22] Ahmad, M., Rashid, T., Mishra, D., Impact of Wireless Technology on Future of Big Data Industry, IEEE (2014).
- [23] Brezany, P., Hofer, J., Tjoa, A. M. & Woehrer, A, 'Gridminer: An infrastructure for data mining on computational grids', Proceedings of Australian Partnership for Advanced Computing Conference (APAC), 2003.
- [24] Sundarajan, S, Pearson, M. How digital technologies, social media and the explosion of data are redefining customer engagement models. In: efma & Wipro. Ed. The Global Retail Banking Digital Marketing Report, 2013.
- [25] InfoSys, "Finacle to Power Arab National Bank Saudi Arabia Core Banking Initiative", Available from: <http://www.infosys.com/finacle/mediaroom/press-releases/Pages/core-banking-initiative.aspx>, 2005.
- [26] Al Kalaf, A., "Announcement of the Basel III Accord and SAMA Plans for its Implementation of Basel II and III in 2011", Saudi Arabian Monetary Agency (SAMA), February 2011.
- [27] Alotaibi, M., The Impact of Twitter on Saudi Banking Sectors in the Presence Of Social Media: An Evaluative Study, International Research: Journal of Library & Information Science, Vol. 3, No. 4, Dec. 2013
- [28] Alshetwi, A., "Quality of high Tech marketing of Saudi Arabia banks", international conference on economic and management (ICEM), 2014
- [29] Taghva, M, Bamakanb, S, Toufanic, S, 'A data mining method for service marketing: A case study of banking industry' , Management Science Letters, Vol.1 , Issue 3, P253–262, 2011.
- [30] Neuman, W. L, Social research methods: Quantitative and qualitative approaches, Allyn and Bacon Boston, 2011.
- [31] Saunders, M. N., Saunders, M., Lewis, P. & Thornhill, A, Research methods for business students, 5/e, Pearson Education India, 2011.
- [32] Schutt, R. K, Investigating the social world: The process and practice of research, Pine Forge Press, 2011
- [33] Saudi Arabia Information Technology Report Q3 2015, BMI Research, July 15, 2015.

★ ★ ★