The Impact of Big Data on Building the Knowledge Base at Makkah Techno Valley (MTV): An Exploratory Study

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Abstract. Saudi Vision 2030 is seeking to support the national industry for creativity, innovation and technology localization. The expanding in the utilization of Techno Valleys that are distributed around many universities in Saudi Arabia would help to achieve this vision. Those techno valleys could be utilized to convert the outcomes researches from universities and research centers into products to build up the knowledge base in the society. To do so, Vision 2030 would need to rely on modern and advanced Internet protocols to align with major developments in the field of digital evolution, such as the Internet of Things (IoT) and Big Data. Since the importance and relationship between Techno Valleys, building knowledge base and Big Data analysis are not well acknowledged in Vision 2030, this paper aim to study this relation and address the impact of applying Big Data analysis to build the knowledge base in Makkah Techno Valley (MTV). Basically, the study is focused to answer the following research question: what is the impact of applying big data to enhance the knowledge base building in MTV? Also, the challenges and opportunities of applying big data in MTV will be discussed. To achieve the above objective, an exploratory research has been conducted, where three previous studies were selected and analyzed using the SWOT analysis method, to determine the strength, weaknesses, opportunities and threats. Preliminary result shows that MTV should start narrowing the gap and put the necessary mechanisms in place to make use of big data in building the knowledge base. The study found that the main opportunities of applying big data in MTV, is the potential for making faster advances in many scientific disciplines and improving the profitability and success of many enterprises. However, many technical challenges must be addressed before this potential can be realized fully. The challenges include not just the obvious issues of scale, but also heterogeneity, lack of structure, error handling, privacy, timeliness, provenance, and visualization, at all stages of the analysis pipeline from data acquisition to result interpretation.

Keywords: Knowledge, Knowledge Base, Digital Evolution, Big Data, Makkah Techno Valley (MTV), SWOT.

1 INTRODUCTION

Nowadays, the strategic decision of the Kingdom of Saudi Arabia is to transform its economy to rely on intellectual assets like knowledge rather than natural resources like oil. That was clearly indicated in the part of Saudi Vision 2030 known as National Transformation Plan (NTP), where Crown Prince Mohammed bin Salman said: "the country will exist without any dependence on oil by 2020 and would soon be a global player in the world investment stage".[1]

Saudi Vision 2030 is seeking to support the national industry for creativity, innovation technology localization. The expanding in the utilization of Techno Valleys that are

distributed around many universities in Saudi Arabia would help to achieve this vision. Those techno valleys could be utilized to convert the outcomes researches from universities and research centers into products to build up the knowledge base in the society. To do so, Vision 2030 would need to rely on modern and advanced Internet protocols to align with major developments in the field of digital evolution, such as the Internet of Things (IoT) and Big Data. [2]

From one hand, Saudi government already issued the approval for four Saudi Universities in Riyadh, Makkah, Jeddah and Dhahran to establish four Techno Valleys. Those Valleys are considered as an executive mechanism for achieving the plans and direction of the Kingdom toward the knowledge economy. Actually, all of those Valleys are intersected in one similar aim, which is the contribution in developing the knowledge base economy in Saudi Arabia. From the other hand, Big Data is a relatively new term that has attracted great attention in science, technology, industry and society. The importance of the Big Data term is highlighted in many researches statement, such as: Anderson & Rainie (2012) stated that "We swim in a sea of data … and the sea level is rising rapidly" [3]. Gartner (2012) also indicated that 85% of the companies' infrastructure will be overloaded by big data until 2015 [4]. In fact, researches have pointed out that there is a clear lack in academic studies related to big date under broader and integrative analysis [5].

The characterization of big data and the relationship with knowledge base development in Makkah Techno Valley (MTV) become the purposes of this article, as regards: 1) highlighting the importance and purpose of big data analysis; 2) addressing the impact of big data analysis in knowledge base development in MTV; 3) discussing the challenges and opportunities that may face MTV to apply big data analysis effectively. The choice of this specific topic is motivated by identifying only one Techno Valley out of the four Valleys that are distributed around many universities in Saudi Arabia, which is Makkah Techno Valley (MTV), with the focus to understand the big data and its impact on knowledge base development. Moreover, the topic is aligned with the strategic decision of the Kingdom to rely on intellectual assets like knowledge.

This study includes several sections. It begins by literature review, where three previous studies were selected and analyzed using SWOT approach to identify strengths and weaknesses as well as opportunities and threats. After that, general background was given to understand the main terms used in the study, such as knowledge, knowledge base, big data and Makkah Techno Valley (MTV). Then the research problem has been identified as well as the methodology and the research tools. Finally, the study outcomes and the proposed recommendations were specified.

2 LITERATURE REVIEW

In this section of the study, we will go over some researches that cover and focus mainly on "Big Data" and "Knowledge base". Since the topic is new, there were some difficulty to find research that relate the above topics with the R&D organization like Makkah Techno Valley (MTV).

In the following we will go over some of those researches that is closely relevant to the topic of this study:

- **Study of Palade and others (2016) titled by "Model of handling Big Data and Knowledge Management in Automotive Industry"** [6]**:**

The study aimed to present the importance of knowledge management and Big Data inside automotive industry. It aims to propose a model of integrating those two emerging concepts. The study also analyses the mapping of potential Big Data stages for automotive industry onto the DIKW pyramid.

The study was based on the bibliographic research and observational study inside an automotive company. Also, Big Data approaches were investigated and structured in order to find new ways that can prove valuable for the customer, business and innovation.

The study concluded by expanding and extrapolating the following pivotal point: "a probable statement in the near future refers to the fact that Knowledge, as a whole concept derived from Information and Data after effort or algorithms, could become obsolete; generic awareness (or other naming) will replace the quality factor with the quantitative sufficient one". The study stated clearly that large quantities of raw data, even so unstructured could provide the evolutionary leap to the classical DIKW pyramid; where a 99.999% percent on large population will begin to feel like 100% for almost any, normal user, and the rare, unattended 0.001% percent rare events will begin to pile up, as data grows and group up, adding another decimal 9 after the comma, another precision point.

By applying the analytical method of SWOT analysis, the strengths, weaknesses, opportunities and threads were identified. The strengths are concentrated in the following: Big Data will enhance the results and will improve the supply chain and reduce the lean time of quality approaches, through Big Data customer becomes part of the control board of project decision, and Big Data management platform can be used to check the know-how distribution inside companies or inside departments. The weaknesses are concentrated on the needs to be patience to the time that it would be possible to transform the information into knowledge. In term of the opportunities, big data in automotive industry would promote accident prevention, improve vehicles safety and enrich the driving experience by having the same level of connectivity in a vehicle whether driver or passenger as one would enjoy in its home. However, the threads stated are the risk that is facing organizations on the unknown impact that BD has over the intangible assets. Also, Big Data project will face all the risks that a new field would face, such as commonly IT proprietary, and field expertise.

- **Study of Poleto and others (2015) titled by "The Roles of Big Data in the Decision-Support Process: An Empirical Investigation"** [7]**:**

This study highlights a subset of the elements that combined to defined an integrated model of decision making using big data. Those subset elements are business intelligence (BI), decision support systems (DSS), and organizational learning. The study assumed when all of those elements are working together, they would provide the decision maker with a reliable visualization of the decision-related opportunities.

The study was accomplished by performing a theoretical analysis and discussion about business intelligence (BI), decision support systems (DSS), and organizational learning, thus providing an understanding of how and why they are working together. The study based on an empirical investigation, which is a way of gaining knowledge by means of direct and indirect observation or experience.

The study concluded by considering that the Big Data has become a generic term, where it presents two challenges for organizations. First, business leaders must implement new technologies and then prepare for a potential revolution in the collection and measurement of information. Second, and most important, the organization as a whole must adapt to this new philosophy about how decisions are made by understanding the real value of Big Data. The main contribution of this study is to promote the integrated view of Big Data, BI and DSS inside the context of decision-making process, assisting managers to create new opportunities to resolve a specific problem.

Applying the analytical method of SWOT analysis, the strengths, weaknesses, opportunities and threads were identified as follow. The strengths include, promoting

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opportunities related to decision, allowed understanding the social context of individuals' and organizations' actions. Also, a company can track not only what their customers do but also get much closer to learning why they do what they do. Gaining a better understanding of the students' knowledge and an assessment of their progress, assist users and cities to resolving the traffic problems in big cities. The weaknesses concentrate on: ability to collect, stored and manage data, the difficulty to analysis and extract information with significant value for the organization. In term of the opportunities: big data can be aligned with the application of Business Intelligence (BI) tools to provide an intelligent aid for organizational processes, Big data can bring new opportunities for the discovery of new values that are temporarily hidden. For example, it helps to identify groups of students with similar learning styles or their difficulties. Big data defining a new form of personalized learning resources based on and supported by computational models. However, the threads mentioned are as follow: The larger a database becomes, the higher the cost of processing and labor, a modern infrastructure is needed to overcome the limitations related to language and methodology. Different channels through which data are collected daily increases the difficulties of companies in identifying which is the right solution to get relevant results from the data path.

- **Study of Sukumar and others (2013) titled by "Concept of Operations for Knowledge Discovery from "Big Data" Across Enterprise Data Warehouses"** [8]**:**

The study aimed to present a concept of operations for enabling knowledge discovery that data-driven organizations can leverage towards making their investment decisions. The study was organized to answer the following main question: how can we systematically approach the design of systems for multi-agency analytics?

The recommendation of the study was based on the experience gained from integrating multi-agency enterprise data warehouses at the Oak Ridge National Laboratory to design the foundation of future knowledge nurturing data-system. Also, the study provides a summary of the current approaches to multi-warehouse integration and argued the advantages and disadvantages of the popular models.

The study reaching the result that the concept of operations for knowledge discovery from multi-agency warehouses is a multi-dimensional problem – one that cannot be completely solved with technological solutions alone. The success in such multi-agency data integration projects is a function of organization, personnel, technology and the characteristics of the data that is being brought together for analysis. The study concludes by listing some requirements that should be considered in dealing with the concept of operations for future data systems:

1. Design for seamless integration of current and future data
2. Architecture that is flexible and scalable to newer data models
3. Collaborative meta-data information layer for analysts to record evolving enterprise knowledge
4. Ability to run scalable analysis algorithms for automation towards data integration
5. Infrastructure that supports analysis for data integration, predictive model building and model deployment
6. Analyst friendly tools and interfaces

3 BACKGROUND OVERVIEW

There is a great deal of published information available about Big Data. Some of those information focuses on the technical developments of Big Data such as creation, acquisition, storage and analysis. Other information looks at the operational impact of Big Data on companies, primarily in customer facing functions such as marketing and customer services. So to fully understand the impact of big data on building the knowledge base in Makkah Valley Technology (MVT), various terms must be understood and clarified such as, Knowledge, knowledge base, big data and Makkah Techno Valley (MVT).

3.1 Knowledge Term

Knowledge is one of the terms that have various definitions in the literature. In Cambridge dictionary knowledge is defined as: "understanding of or information about a subject that you get by experience or study, either known by one person or people generally" [9]. While Oxford dictionary defined knowledge as: "facts, information and skills acquired through experience or education; the theoretical or practical understanding of a subject" [10]. It is clear that the above two definitions are intersected in many similar terms, such as information, experience and/or education. Based on that we may define the term knowledge simply as the information that we gain through experience and/or education and remained in the mind to be used whenever it is needed.

Those many definitions led to many taxonomies that specify various kinds of knowledge. The most fundamental distinction is between tacit and explicit knowledge. Tacit knowledge inhabits the minds of people that is impossible or difficult to articulate. Explicit knowledge exists in the form of words, sentence, documents, organized data, computer programs and in other explicit forms. Other researcher also distinguishes among "know what", "know how" and "know why" levels of knowledge [11].

Knowledge is embedded in business processes, activities, and relationship that have been created over time in organization. Knowledge base in organization plays a crucial role in identifying those hidden knowledge, which would be guiding the organizations actions and establishing a sustainable competitive advantage. Actually, during the product development process, there are several types of data that are generated and often in large volumes. Those data can be processed and used as a reusable knowledge base, which provide real time intelligence to product development teams. Recently, many product development organizations are critically analyzing Big Data (product failure, service data, warranty data, historical design data, material data etc.) to extract information patterns that can be fed back into product development process.

3.2 Knowledge Base

Generally, knowledge base is defined as a collection of information about a particular subject [9]. Knowledge base is a technology that used to store complex structured and unstructured information used by computer system. Initially, the term knowledge base was used to describe one of the two sub systems of knowledge base system. A knowledge-based system consists of a knowledge-base that represents facts about the world and an inference engine that can reason about those facts and use rules and other forms of logic to deduce new facts or highlight inconsistencies [12].

A knowledge base (KB) typically contains a set of concepts, instances, and relations. Well-known examples of KBs include DBLP, Google Scholar, Internet Movie Database, YAGO, DBpedia, Wolfram Alpha, and Freebase. In recent years, numerous KBs have been built, and the topic has received significant and growing attention, in both industry and academia. This

attention comes from the fact that KBs are increasingly found to be critical to a wide variety of applications [13].

Knowledge management products adopted the term knowledge base to describe their repositories. With knowledge management products the knowledge is primarily meant for humans, for example to serve as a repository of manuals, procedures, policies, best practices, reusable designs and code, etc. Knowledge base in the sense of knowledge management provides knowledge in the form of documents and media that could be leveraged by humans [12].

knowledge base in organization is considered as a centralized repository for information, public library or a database of related information about a particular subject. It is consisting of concepts, data, objective, requirements, rules and specification about specific object. Organizational data, information and knowledge are all emerge from the social process of an organization, and are not private. Actually, the product data in the organization provides a huge amount of information about how specific component was designed and what challenges were encountered. Extracting this information in a usable format is the first step in the process of making this knowledge available for reuse. The second step is to convert or present this knowledge in the form of business or technical rules. Then, this knowledge can be used by the designers, planner, etc. during the execution of a project of building the knowledge base.

3.3 Big Data

Big Data is a newly concept that is receiving great recognition and is being highlighted both in academics and business. Figure-1 shows that the interest for searching about the term "Big Data" had been started since 2011 and keep raising up to now.
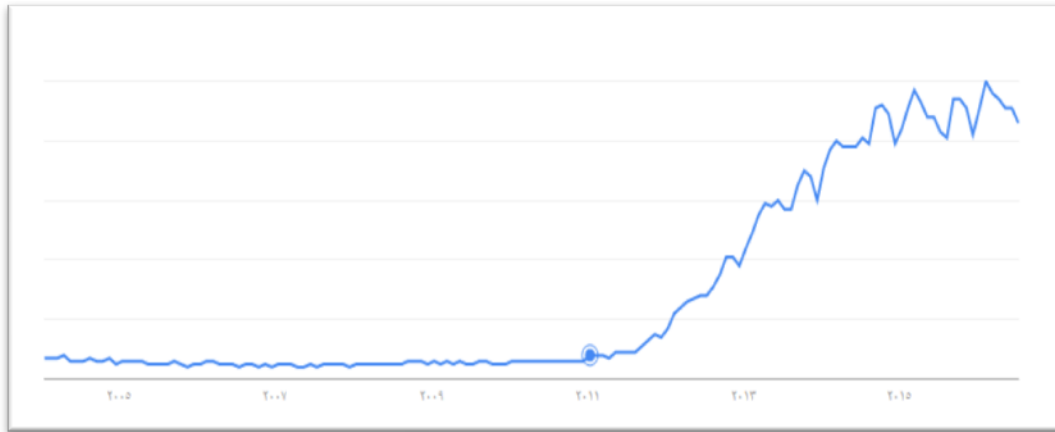
Figure 1: Interest over Time for Specific Tech Trends, 2004-2016, Google Trends.

The term big data is defined based on the Tech American Foundation (2004) as a "term that describes large volumes of high velocity, complex and variable data that require advanced techniques and technologies to enable the capture storage, distribution, management and analysis of information" [14].

Most often big data is referred to the conception that the volume of data cannot be treated, processed and analyzed in a simplified way, requiring much more robust technologies, techniques and people with new skills for managing these large data sets. The most common understanding about the term of big data refers to the vast amount of data continually

collected through devices and technology such as, Internet, credit cards and increasingly WiFi sensors and electronic tags. The common misunderstanding related to neglecting the truth that all of those data collected is "unstructured" data and dose not confirm a specific pre-defined data mode.

Palade (2016) argue that due to digital evolution, a massive amount of data is regularly being generated from various source, through different channels and every minute. Big data has emerged from the increasing volumes of external and internal data from organizations, that are differentiate from other databases in five aspects, called (5Vs): 1) volume, 2) variety, 3) velocity, 4) value, 5) veracity [6].

Volume considers the data amount, variety describes the different kinds and sources of data that may be structured, velocity refers to the speediness with which data may be analyzed and processed and value refers to valuable discoveries hidden in great datasets, and veracity refers to the reliability, integrity, relevance, and usability of data. big data compared with other traditional databases includes a large amount of unstructured data that must be analyzed in real time. Big Data also brings new opportunities for the discovery of new values that are temporarily hidden [15].

Big data actions have reached various sectors in many organizations and being utilized for specific purposes, such as [16]:

1. Commercial marketing evaluating the actions of people through social networks in order to understand the behavior of their potential customers.
2. Public sector organizations monitoring health research and various networks to evaluate and to treat epidemics;
3. Governments and business tracking contents of several Web social networks to perform sentiment analysis;

There are many values that might come from big data analysis as highlighted in a 2011 industry report by global management consulting firm McKinsey [3]:

1. Creating transparency in organizational activities that can be used to increase efficiency;
2. Enabling more thorough analysis of employee and systems performances in ways that allow experiments and feedback;
3. Segmenting populations in order to customize actions;
4. Replacing/supporting human decision making with automated algorithms; and
5. Innovating new business models, products, and services.

Organizations should particularly consider five areas to manage Big Data [17]:

1. Leadership, since the era of big data means not just more data, but the ability to extract results;
2. Talent management, considering that the most crucial are the data scientists and professionals with skills to deal with the vast volume of data, organizing large data sets that are not only in structured format;
3. Technology, as an important component of the strategy for big data; although the available technology has improved significantly for managing big data, it should be considered novel for many IT departments and integration should be performed;
4. Decision-making, reflects the need to maximize cross-functional cooperation between people who manage the data and the people who use them, people who understand business problems must be close to certain data and with people who know effective techniques for extracting the best results; and,

5. Company culture, a data-driven organization should cease to be guided solely by hunches and stop using the hippo traditional approaches.

Big Data can be thought of as having two stages: data-building and knowledge creation. In the data-building stage, the raw records are transformed into "information", that is, data in a usable format. In the knowledge creation stage, the analysis of such data produces "knowledge", that is, useful insights from that information. That knowledge asset is then used as an input in final production of goods and services, along with other intangible knowledge, tangible assets and labor [18].

Big data environment considers several technologies and technique for collecting, storing, processing and analyzing data, which include: [18]:

1. Hadoop - the open source framework for processing large volumes of data in distributed systems, inspired by tools such as MapReduce and GFS (Google File System) from Google company;

2. MapReduce - software framework introduced by Google company to process high volumes of data is also part of the implementation of the Hadoop technology.

3. Business Intelligence - refers to a type of application based on software developed to display and to analyze the data;

4. Cloud Computing - technology refers to a computing paradigm with a high level of computational resources sometimes configured as distributed systems to provide services through digital networks.

3.4 Makkah Techno Valley (MTV)

Makkah Technology Valley (MTV) at Umm Al Qura University (UQU) was established in 2012 with a capital of one hundred million Riyals (SR100.000.000) [19].

MTV is considered as a science park that will foster innovation and entrepreneurship through partnership between the university, Saudi entrepreneurs and international knowledge-based companies. MTV is acting as an interdisciplinary technology, innovation, and research hub contributing to the development of sustainable innovative solutions. MTVC focuses on technology localization, development and transfer in order to serve the national economy and achieve sustainable development [20].

MTV aims to contribute effectively in developing a knowledge-base economy in Saudi Arabia through partnership between educational and research institutions, and business communities. The goal of MTV is to provide services to UQU faculty, students and researchers, entrepreneurs, Saudi SMEs, foreign companies and large Saudi corporations through a knowledge transfer mechanism. That would help to translate innovative ideas into practical feasible products and services, marketable in the marketplace [21].

Alamri (2013) stated that Hajj provides a unique test-bed for understanding, analyzing and developing innovative solutions to scenarios that may exist elsewhere around the world. Hence, the innovative solutions developed at MTV for Hajj-related challenges will be applicable and valuable not only to the local context, but also to the international level.

The operations of MTV will be guided through five main principles [20].

1. high-impact research,
2. innovation,
3. technology transfer,
4. high-quality students training,
5. society outreach, and

6. high-value healthy working environment.

The main objectives of MTV include the following [21]:

1. Management and commercialization of university innovation, thus directing world class technology to the local economy.

2. Commercialize university research to yield economic benefits and help accelerate the transformation of technical innovations to commercial products.

3. Establish programs for business incubators and business accelerators to provide technical, financial and managerial assistance for small and medium sized companies

4. Benefit from the presence of industrial companies next to the university to provide students with the opportunity of practically recognizing the industrial problems

5. Provide students with job opportunities during their university studies and after graduation, which allows them to participate in the emerging industrial projects

6. Help Saudi Arabia achieve advanced positioning on the international level in the fields of economically viable industrial research and innovative programs

4 PROBLEM STATEMENT

Great attention must be paid by Saudi government overly and the researcher specially to focus on the research topic of big data its impact on knowledge base development. The main goal of this study is to investigate the impact of big data on building the knowledge base in MTV. That is to provide researchers and practitioners with a clear vision of the challenges and opportunities of applying big data to build the knowledge base in Makkah Techno Valley (MTV).

5 METHODOLOGY

This study used a survey method with a view to comprehensive collection of information that relate to the topic of the current study and to the impact of big data on knowledge base development in Makkah Techno Valley (MTV). The study used a quadruple analysis tool called SWOT. It is a general strategic analysis tool used in many areas of analysis and aims to highlight the strengths and weaknesses. It also helps to focus on the opportunities and threats.

The SWOT analysis emerged as a result of the research that was carried out in the Institute of Stanford from 1960 to 1970 by Albert Humphrey and other associates of the Institute. The purpose of conducting that research was to find out the reasons for failure of corporate planning and the economic problems that emerged out from this failure, in addition to know ways to avoid these problems. This method is used in the analysis in various areas. It is a tool used in strategic planning to assess the strengths and weaknesses, opportunities and threats points.

The strengths and weaknesses points represent the internal characteristics of the project. While the opportunities and threats represent the external conditions for the project. This study sample is concentrated in that the researcher chooses a specific practical sample represented in Makkah Techno Valley. He carried out a study about the impact of big data on knowledge management in Makkah Techno Valley. The limits of the objective study lie in the Makkah Techno Valley. While the spatiality limits of the study lie in big data and knowledge management. And the temporal limits cover the first semester of the year 2016 and the time period to cover the studies and scientific research was between the years 2013 to 2016.

6 STUDY FINDINGS

Since MTV is considered as a science park that will foster innovation in various discipline, the knowledge base being build has to occupied with all of the information and facts about those different discipline. Also, as big data is considered as a valuable source of various knowledge and information, it would have positive impact to enrich the knowledge base in MTV. Actually, Big data influences public and private sectors, science and economy, areas such as education and healthcare, among others.

The scenario of the impact of big data would structure many important actions in MTV related to the provision of new technologies and techniques and its integration with existing technologies. That would promote the expected results to develop the knowledge base in MTV.

When big data is effectively and efficiently captured, processed, and analyzed, MTV would gain more complete understanding of their business, customers, products, competitors, etc. which can lead to efficiency improvements, increased sales, lower costs, better customer service, and/or improved products and services.

There are many opportunities that would be gained by MTV during the application of big data to develop the knowledge base. MTV can use big data analysis to improve the performance of their R&D function. Also, to invite ideas from customer that would be integrated with externals expert's collaboration to develop new products.

The following points describe some of those opportunities:

1. Big data application to develop the knowledge base is a way of turning imperfect, complex, often unstructured data into actionable information.
2. Big data in MTV can provides real-time awareness and real-time feedback from the society.

Many challenges may encounter MTV during the application of big data to develop the knowledge base. The challenges refer mainly to structural problems of managing large volumes of data, and especially the difficulties inherent to the ability of extract meaning from this mass of data. However, the challenges are not only restricted to extracting, storing and managing vast amounts of data, but also refer to semantic analysis of these data. So MTV would need to have new skills related to technology professionals, experts' users, changing in organizational culture and integration environment.

There are two classes of primary challenges to big data need to be considered by MTV:

1. Engineering - efficiency in data management at unimaginable scales, and
2. Semantic - identification of meaning, considering the information that is relevant to specific goals.

7 CONCLUSION

In conclusion, for MTV to succeed in today's business world, t must adopt not just the technologies and talent to manage big data, but also the organizational culture. The culture of innovation would need to allow open-source technologies and put data at the heart of every decision they make. It is also important that all the valleys, universities and academia in Saudi Arabia continue working together to feel the existing skill and cultural gaps in the field of big data and knowledge base development.

References

[1] Oakford, S. (2016, April 25). *VICE NEWS*. Retrieved 20 8, 2016, from Saudi Arabia Reveals How It Will End Its Oil 'Addiction' by 2020: https://news.vice.com/article/saudi-arabia-reveals-how-it-will-end-its-oil-addiction-by-2020

[2] Saudi VISION 2030. (2016, Aug 20). *Saudi Vision 2030*. Retrieved 8 20, 2016, from Vision2030: http://www.vision2030.gov.sa/en/node

[3] Anderson, J., & Rainie, L. (2012). The Future of Big Data. *PewResearchCenter*. Retrieved 9 17, 2016, from http://www.pewinternet.org/2012/07/20/the-future-of-big-data/

[4] Newsroom, G. (2011). Gartner Reveals Top Predictions for IT Organizations and Users for 2012 and Beyond. STAMFORD. Retrieved 9 9, 2016, from http://www.gartner.com/newsroom/id/1862714

[5] Thakker, C., & Dhole, K. (2016). Big Data with Knowledge Extraxtion. *IOSR Journal of Computer Engineering (IOSR-JCE)*, 38 - 41. Retrieved 7 24, 2016, from http://www.iosrjournals.org/iosr-jce/papers/conf.15013/Volume%203/8.%2038-41.pdf?id=7557

[6] Palade, H. C., Nicolaescu, S. S., & Kifor, C. V. (2016). Model of Handling Big Data and Knowledge Mangement in Automotive Industry. *Management, Knowledge and Learning*, 731 - 740. Retrieved 8 8, 2016, from http://www.toknowpress.net/ISBN/978-961-6914-16-1/papers/ML16-141.pdf

[7] Poleto, T. (2015). The Roles of Big Data in the Decision-Support Process: An Empirical Investigation. Springer International Publishing Switzrland. Retrieved 10 9, 2016, from http://webcache.googleusercontent.com/search?q=cache:Y78dlsKANHcJ:www.springer.com/cda/content/document/cda_downloaddocument/9783319185323-c2.pdf%3FSGWID%3D0-0-45-1508080-p177368414+&cd=1&hl=ar&ct=clnk&gl=sa

[8] Sukumar, S. R., Olama, M. M., McNair, A. W., & Nutraro, J. J. (2013). Concept of Operations for Knowledge Discovery from "Big Data" Across Enterprise Data Warehouses. *Oak Tidge National Labortory, Computational Sciences and Engineering Division*, 1 - 9. Retrieved 7 22, 2016, from http://aser.ornl.gov/publications_2013/Publication%2039879.pdf

[9] Cambridgedictionary. (2016, 9 9). *Cambridge University Press*. Retrieved 9 9, 2016, from Meaning of "knowledge" in the English Dictionary: http://dictionary.cambridge.org/dictionary/english/knowledge

[10] Oxforddictionary. (2016, 9 9). *Definition of knowledge in English*. Retrieved 9 9, 2016, from Oxford Dictionaries: http://www.oxforddictionaries.com/definition/english/knowledge

[11] King, W. R. (2009). Knowledge Management and Organizational Learning. Springer
      Science + Business Media, 3 - 13. Retrieved 9 12, 2016, from
      http://www.uky.edu/~gmswan3/575/KM_and_OL.pdf

[12] Wikipedia. (2016, 9 23). Knowledge base. Retrieved from en.wikipedia.org:
      https://en.wikipedia.org/wiki/Knowledge_base

[13] Deshpande, O., Lamba, D., & others. (2013). Building, Maintaining and Using
      Knowledge Bases: A Report from the Trenches. @*WalmartLabs, Google University
      of Wisconsin-Madison*. Retrieved 9 23, 2016, from
      http://pages.cs.wisc.edu/~anhai/papers/kcs-sigmod13.pdf

[14] Grishikashvili, K., Dibb, S., & Meadows, M. (2014). Investigation into Big Data Impact
      on Digital Marketing. *International Conference on Communication, Media,
      Technology and Design*, 146 -150. Retrieved 9 20, 2016, from
      http://www.cmdconf.net/2014/pdf/24.pdf

[15] Wu, X., Zhu, X., Wu, G.-Q., & Ding, W. (2014). Data Mining with Big Data. School of
      Computer Science and Information Engineering, Hefei University of Technology,
      China, 1 - 26. Retrieved 7 19, 2016, from http://lansainformatics.com/wp-
      content/plugins/project-mgt/file/upload/pdf/2440Data-mining-with-big-data-pdf.pdf

[16] Rossi, R., & Hirama, K. (2015). Characterizing Big Data Management. *Issues in
      Informing Science and Information Technology*, pp. 165 - 180.

[17] Goodridge, P., & Haskel, J. (2015). How does big data affect GDP? Theory and evidence
      for the UK. *Imperial College London Business School*, 1 - 52. Retrieved 9 17, 2016,
      from
      https://spiral.imperial.ac.uk/bitstream/10044/1/25156/2/Goodridge_2015_06.pdf

[18] WadiMakkah. (2016, 8 4). *Wadi Makkah*. Retrieved from About Company:
      http://wadimakkah.sa/?lang=en

[19] Alamri, O. (2013). Makkah Techno Valley (MTV): Fostering Sustainable Innovation for
      a Local Context of International Significance. *30th IASP World Conference*, 1-14.
      Retrieved 10 1, 2016, from
      http://inhalt.com.br/portodigital/Workshop5OSAMAH(ALAMRI)SAU.pdf

[20] SETS. (2014, June 3). *setsintl*. Retrieved 8 23, 2016, from Makkah Techno Vally (MTV)
      Science and Technology Innovation Park: http://www.setsintl.net/makkah-techno-
      valley-mtv-science-and-technology-innovation-park/