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Advances in Knowledge Management: A systematic review of big data perspective

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Abstract. Big data represents the challenges in which the enterprises are facing to respond to the big volume of data being collected on a daily basis, as well as, the velocity and variety of data which is exponentially growing day by day. This systematic review analyzes the knowledge management studies and its relationship with big data. The study elaborates on the concepts studied, the main and key findings, in addition to the research methods used. A total of 191 articles were identified. Out of those, only 18 articles fulfilled the inclusion and exclusion criteria. The results of this study could serve further research in the domain of knowledge management and its interrelationship with big data.

Keywords: *Knowledge management, big data, IOT, systematic review.*

1. Introduction

Big data refers to the process of collecting and processing a very large volume of data with high velocity and variety of formats. Big data also includes the associated systems and algorithms used to analyze these massive datasets. The big data infrastructure uses multiple machines/nodes where the big data echo system software is installed and clustered. Combined with knowledge management (KM), big data offers many unique opportunities that can positively impact businesses (Beyer & Laney, 2012). KM makes it possible to manage the knowledge across a number of information systems (Al-Maroof & Al-Emran, 2018; Salloum, Al-Emran, & Shaalan, 2018; Salloum, Al-Emran, Shaalan, & Tarhini, 2018).

In this paper, we report on a systematic review of the advances in the knowledge management era in response to the big data phenomena, and rapid increase in the volume, velocity, and variety of data being collected every day. Our goal is to provide an overview of the researches studies within this field, what main concepts were studied, what were the main findings, and what research methods were used. More specifically we ask the following questions:

RQ1. What is the effect of the new trends such as big data and IOT on knowledge management?

RQ2. How to ensure effective knowledge discovery from big data?

RQ3. How to secure knowledge management in the big data era?

This review could be useful for three categories of readers. First, knowledge management domain experts who would like to be up-to-date with external factors that might affect their field. Second, big data domain experts who would be interested in knowing how their field is affecting other businesses such as knowledge management in general. Third, enterprises management, who will be interested in knowing how they can make full use of the new trends to ensure effective knowledge management practices in their organizations.

The following sections of this report are structured as follows: section 2 presents a general background on both the big data and knowledge management. Section 3 describes the systematic review approach. In section 4, we will show the results of the systematic review according to our review strategy. Section 5 provides the final discussions and conclusions.

2. Background and Literature Review

Big data is actually correctly named, it is huge in size to the extent the traditional data management systems and technologies cannot afford. New technologies were introduced to manage this volume and enhance the processing capabilities. Big data wasn't that popular before 2009, and then it became a real challenge for IT leaders. Google search on Big data resulted in 2.9 million hits By February 2011, and since then, vendors are focusing to deliver their products in order to solve the big data challenge (Beyer, Lapkin, Gall, Feinberg, & Sribar, 2011).

This great focus on big data emerged from the huge increase in data volumes generation caused by systems transactions, in addition to new types of data generated from the latest trends in the technology such as social networking (Mhamdi, Al-Emran, & Salloum, 2018; Salloum, Al-Emran, Abdallah, & Shaalan, 2017; Salloum, Al-Emran, & Shaalan, 2017a, 2017b; Salloum, Mhamdi, Al-Emran, & Shaalan, 2017), which can generate huge datasets from Twitter, LinkedIn, Facebook, YouTube, and others. In addition to the volume, the most critical factor is the analytics processing power needed to analyze such huge data. Moreover, Internet of things, context-aware applications could bring in another huge set of data in many formats such as images, videos, and audio, as well as contextual data such as location data, previous searches, preferences, reviews, and ratings (Beyer et al., 2011; Vera-Baquero, Colomo-Palacios, & Molloy, 2013).

Knowledge management (KM) is concerned with identifying and managing knowledge assets effectively through combination, sharing, and other methods in order to gain this competitive advantage (Al-Emran, Mezhuyev, & Kamaludin, 2018a; Erickson & Rothberg, 2014). Originally, organizations used to address the knowledge management using one solution which can cover all the organization cases; however, considering big data huge volume challenge, organizations cannot follow the same pattern, where big data requires other approaches to address the distributed parallel processing, such as MapReduce. In this review, we will work on identifying the effect on big data on knowledge management in our efforts to answer the first survey question. The volume challenge also caused difficulty in analyzing such large datasets. Big data presents unique systems engineering and architectural challenges. To face this challenge, researchers presented the system's design principles which may assist organizations on achieving effective and efficient analytic and data collection processes, data dissemination, and system organization data practices. In this systematic review, we will review these design principles to answer our second review question (Begoli & Horey, 2012; Sukumar & Ferrell, 2013; Zhang, Chen, Ooi, Tan, & Zhang, 2015).

There is an essential need for organizations to secure their knowledge management to protect their intellectual assets. Not all of the information in an organization may appropriately be shared amongst multiple stakeholders, and some information may be protected from unauthorized modifications. Integrating Big data with security in knowledge management delivers an inimitable opportunity for consolidating and analyzing data logs and events from multiple sources rather than evaluate them in isolation (Hota, Upadhyaya, & Al-Karaki, 2015).

Integrating data and information from several sources will result in generating valuable knowledge about security enhancement which was not obtainable to traditional business environments (Al Emran & Shaalan, 2014b). By integrating information from logs of Intrusion Detection Systems, IP-enabled smart CCTVs, data from biometric systems, or other sources, etc., organizations can tap into the Big data and enhance the security in Knowledge Management Systems (KMS) significantly. The advantage of the availability of such knowledge is that organizations can have advanced detection of frauds, insider threats, and criminal activities. The big volume of information also creates challenges of identifying the

actual security threats for an organization, and not get lost in a wave of false positives (Hota et al., 2015). This systematic review will then review different aspects of security in KMS in the Big data era in our efforts to answer the third research question.

2.1. Knowledge management strategy

Knowledge is a vital resource to the organization; therefore, the Knowledge management strategy should be affiliated with the business strategy (Al-Emran & Al Chalabi, 2014). The KM strategy includes the processes of deploying and planning methodology for knowledge creation, acquisition, distribution, integration, storage and replication in addition to the utilization (Al-Emran, Mezhuyev, Kamaludin, & Shaalan, 2018b). However, harmonizing between internal and external factors related to the organization's goals should be considered (Kabir & Carayannis, 2013). Research argued that big data would lead to extreme information management; thus, 12 dimensions of data were identified under three main categories including quantification, access, and quality assurance (Beyer & Laney, 2012). In that, the interaction of these dimensions with each other will increase the challenges of IT leaders while managing information. The pattern-based strategy will assist the organizations in analyzing the pattern of data and support business decisions. Organizations should identify the challenges of managing extreme data by having metadata management capability and strategy.

Competitive intelligence and enterprise intelligence have a clear connection with knowledge management. Therefore, this connection will reflect how knowledge is vital to the organization through the application of big data and business analytics. The variables of the nature of knowledge and whether it's tacit or explicit will assist in identifying the knowledge in different industries and will enable further dimensions to be assessed such as protection of intangible assets and identifying data risks (Erickson & Rothberg, 2014). Knowledge Discovery from Data (KDD) refers to a set of activities designed to extract new knowledge from complex datasets. This has been strategically important for the big sized organizations to be able to have the right strategy and system in place. The organization should have a deep domain understanding in addition to the source and size of their data with the right analytical methods and tools in place.

2.2. Big data strategy

The appearance of big data as a strong input of knowledge, intuitions, innovation increased the competency of many organizations. It is a great opportunity that organizations leadership can have a holistic view of their overall businesses and hence convert such knowledge into an informed decision. This will for sure lead to improve organizational performance which is forcing companies now to adopt big data related knowledge strategies. However, weak adoption of such strategies is not good enough. Knowledge strategy, in such case, must be correlated with the organization vision and knowledge received from big data, so that this received knowledge can be implemented across the board. This means focusing not only on understanding how the insights and knowledge can be implemented in the business processes but also consider taking the needed actions to embed the new knowledge in the current critical business (Kabir & Carayannis, 2013).

The organization needs a solid infrastructure to be able to store and analyze the tremendous amount of data collected. Hence, Begoli and Horey (2012) presented their experience for the big data application ORNL; several principles for the development of a comprehensive, valuable, and flexible infrastructure. These principles indicate that no system size fits all; the system should support various analysis methods and allow the accessibility of the data. These principles are considered a guideline when discussing the big data infrastructure needed in an organization.

According to Sukumar and Ferrell (2013), the SEEKER software suite provides a powerful toolset for analysts to explore and visualize different data sets together in a single view. The added capabilities to help search for potential linkages in datasets provides an important first step in putting data from

different repositories together. The value of SEEKER is to connect and map massive amounts of institutional/enterprise data across disparate silos to enable analysis for better decision making. By providing the user with this powerful tool for exploring and linking disparate data sets, the time now required to integrate new data constructs for analysis will be greatly reduced. With these additions, an analyst will be able to share insights with team members, who can then verify the insight, make comments, brainstorm about overlooked possibilities, and generate new questions of their own enabling analysts to know what data to put together for strategic business value.

3. Method

3.1. Planning the review

Surveying the literature is an essential step before conducting any research study (Al-Emran, 2015; Al-Emran & Salloum, 2017; Al-Emran & Shaalan, 2015, 2017; Al Emran & Shaalan, 2014a; Salloum, Al-Emran, & Shaalan, 2016; Salloum, AlHamad, Al-Emran, & Shaalan, 2018). It identifies and covers the gaps in the existing literature (Al-Emran & Malik, 2016; Al-Emran, Zaza, & Shaalan, 2015; Al-Qaysi & Al-Emran, 2017; Salloum, Al-Emran, Monem, & Shaalan, 2018, 2017). According to Kitchenham and Charters (2007), we started planning our systematic review by developing a protocol, where we initially specified the method we will use to answer our survey questions. The protocol included our review questions, the search strategy, the criteria for the inclusion and exclusion of papers, and method of synthesis. This was the same procedure followed in previous systematic reviews (Al-Emran, Mezhuyev, & Kamaludin, 2018b; Al-Qaysi, Mohamad-Nordin, & Al-Emran, 2018; Bjørnson & Dingsøyr, 2008). The purpose of this systematic review is to touch on the advances in knowledge management as a result of the big data boom and to answer the research questions listed in the introduction.

3.2. Identification of research

One significant advantage of a systematic review is reaching an unbiased review which is a major factor that distinguishes systematic reviews from traditional ones. First, we decided on our search keywords, and tried to use generic search terms in order to identify as many related papers as we can. Table 1 shows the list of search keywords.

Then, we moved to the step of deciding on the search target database. We considered google scholar database as the main source for articles collection. In addition, we also referred to Gartner database, where it always contains up-to-date articles being the world's leading IT research and advisory company. The initial research based on the above keywords resulted in 191 relevant articles.

Knowledge Management	Big Data
Knowledge extraction	IOT
Tacit knowledge	Data Volume
Explicit knowledge	Information Management
Knowledge creation	Data Management
Knowledge discovery	Data Security
Knowledge sharing	Knowledge Discovery from Data
Knowledge application	

Table 1. Search keywords.

3.3. Selection of primary studies

After the articles have been selected, we went through the first refinement process, where all of us met together to decide on removing duplicate articles and non-relevant ones, this process resulted in 64 articles. Then we took the 64 articles and started reading the abstract of each article, and applied the following inclusion and exclusion criteria:

- Exclude if the paper is obviously not focusing on big data.
- Exclude if the paper is obviously not focusing on knowledge management.
- Exclude if the paper is not mentioning the effect of the big data on knowledge management.

After all of us went through the 64 articles, we excluded several papers, and we got a 73% agreement percentage, then we analyzed further the disagreements until we reached those 18 papers.

3.4. Synthesis

In each of the 18 papers, we extracted the covered concepts, main findings and the research methods used in our efforts to find answers to our research questions.

4. Results

4.1. The effect of big data and IOT on knowledge management

Knowledge management is the ability to integrate information from several perceptions to provide solid insights essential for effective decision-making not based on one factor (Al-Emran, Mezhuyev, Kamaludin, & AlSinani, 2018a). Big data is the new trend which is generating a tremendous amount of data such as social media and IOT. Big data is always overemphasizing on the volume of information and data. However, other multiple dimensions are required in modern information management strategy. Extreme aspects of information management start with quantification of big data and addressing access and qualification. The pattern-based strategy will assist the organizations in analyzing the pattern of data and support business decisions. Organizations should identify the challenges of managing extreme data by having metadata management capability and strategy.

The massive interest in big data exaggerate the challenges that will overwhelm existing knowledge management practices and information technology. The ability to manage and analyze big data creates the challenge of supporting big data and the increase in the complexity of knowledge management solutions. Therefore, identifying 12 dimensions of the data under three main categories which are quantification, access, and quality assurance will allow IT leaders in the organizations to identify the suitable knowledge management technology for their organizations (Manogaran et al., 2017). One of the significant challenges resulting from the new technologies for big data is the need to be able to analyze all the existing data and information without the need to sample it. However, other challenges accrue when dealing with big data such as but not limited to challenges to personal privacy, systems complexity, and over expectations of higher management and customers (Viceconti, Hunter, & Hose, 2015). Table 2 demonstrates the main concepts related to the effect of big data and IOT on knowledge management.

Concept	Main findings	Reference
Big data direct effect on information management solutions	Knowledge management leaders usually believe that the challenge of "big data" is only related to Volume. This affects the quality of the architecture design of knowledge management solutions in organizations and limits the benefit that can be brought to business when making full use of big data sources.	(Beyer et al., 2011)
Big data effect on knowledge management practices	The massive interest in big data exaggerate the challenges that will overwhelm existing knowledge management practices and information technology.	(Beyer et al., 2011; Kaivo-Oja, Virtanen, Jalonen, & Stenvall, 2015)
Information management issues	Information management issues can be classified into more than ten dimensions and categorized into one of 3 categories: quantification, access, and quality assurance.	(Beyer et al., 2011)
Advantages of enterprises who are up to date with new trends such as big data.	The ability to manage big data will be an added value for organizations who are already using new formats of information including text, social, context, etc., to look for patterns that can support business decisions in a way to follow a pattern-based strategy.	(Barnaghi, Sheth, & Henson, 2013; Beyer et al., 2011)
Big data effect on knowledge management complexity.	Supporting big data will increase the complexity of knowledge management solutions.	(Beyer et al., 2011)
Big data challenges.	Currently, all organizations focus only on the volume of data, and they are discarding all other challenges. Big data introduces challenges to personal privacy, systems complexity	(Beyer et al., 2011; Kaivo-Oja et al., 2015)

	and over expectations of customers.	
Knowledge management new challenges implications.	The new information management challenges will increase the need for information sharing which will exponentially increase the need for metadata management capability in organizations.	(Beyer et al., 2011; Kaivo-Oja et al., 2015)

Table 2. Concepts related to the effect of big data and IOT on knowledge management.

4.2. Ensure effective knowledge discovery from Big Data

Knowledge Discovery from Data (KDD) refers to the activities to extract new knowledge from multifaceted datasets. Due to the large quantities of data availability, KDD has become strategically important for organizations. Thus, they have to ensure effective organizational and technological practices for data collection, storage, and organization practices, effective application of the modern data analytic methods and the problem domain and nature, and the structure and meaning of the underlying data.

The IT leaders and experts in the organization should have a deep domain understanding in addition to the source and size of their data with the right analytical methods and tools in place. Principles of the establishment of effective architectures for knowledge discovery over big data; design principles inform organizations on effective analytic and data collection processes, system organization, and data dissemination practices. KDD design should support a variety of analysis methods rather than limiting the organization to one tool; analytic tools used might be a combination not limited to statistical analysis; data mining and machine learning, visualization and visual analysis (Zaza & Al-Emran, 2015).

Another KDD architecture principle is that there is no unified architecture or system size that fits all organizations; the architecture should be the mean for storing and processing the data at all stages including data preparation and batch analytics; processing structured data and processing semi-structured data. The third principles address the accessibility of the data at any time, enabling the organization to visualize and access to data summaries and insights. This can be achieved by the use of open, popular standards; the use of lightweight architectures and the ability to expose results using an API. Table 3 demonstrates the main concepts on the knowledge discovery from big data.

Concept	Main findings	Reference
knowledge discovery processes	Knowledge discovery processes are comprised of: • Data collection, storage and organization practices. • An effective application of the modern data analytic methods (including tools). • Understanding the problem domain and the nature, structure, and meaning of the underlying data.	(Begoli & Horey, 2012)
Knowledge discovery common design principles	• Principle 1: Support a variety of analysis methods. • Principle 2: One size does not fit all. • Principle 3: make data accessible.	
Common analysis methods	1. Statistical analysis. 2. Machine learning and data mining. 3. Visualization and visual analysis.	
KDD means for sorting and processing data	1. Data preparation and batch analytics. 2. Processing structured data. 3. Processing semi-structured data.	
End product provisioning	1. Usage of open and popular standards. 2. Usage of lightweight architectures. 3. API results exposition.	

Table 3. Concepts of knowledge discovery from big data.

4.3. Secure knowledge management in the big data era

The integration of big data with security in knowledge management brings unique opportunities for analyzing and consolidation of data generated from multiple sources. This integration generates valuable knowledge about enhancing security which was not available to traditional business environments.

Organizations can improve the security in knowledge management systems by integrating data from smart devices such as CCTV, information from biometric systems, logs, or other sources.

A novel "mission survivability" architecture against Advanced Persistent Threats (APT) has been proposed in distributed environments. If a threat is perceived, the system continues to record observations for a better understanding of the attacker's intent, objectives, and strategies, instead of sending clear signals to the attackers raising alerts or terminating a session. Social media data analysis such as Twitter's tweets needs to recognize several features of tweets as an important to the dissemination such as types of messages, the reaction time of the tweet, hashtags usage if tweets and number of followers to be able to have solid analysis on Twitter data. The knowledge management system should be capable of developing a rule-based data sanitization scheme for detecting and removing personal identifiable and other sensitive information from the datasets of the user. Table 4 demonstrates the main concepts on knowledge management in big data.

Concept	Main findings	Reference
Integrating information from different sources	Consolidating information from different sources provides security opportunities where this was not possible in old cases. Organizations can improve the security in knowledge management systems by integrating data from smart devices such as CCTV, information from biometric systems, logs, or other sources.	(Baek, Vu, Liu, Huang, & Xiang, 2015; Hota et al., 2015)
Advanced Persistent Threats (APT)	If a threat is detected, the system continues to record observations to better understand the attacker's intent, objectives, and strategies instead of sending clear signals to the attackers raising alerts or terminating a session.	
Message diffusion on Twitter	Sentiment analysis of Twitter messages to identify several features of tweets which are important to diffusion: • Tweet reaction time. • Message type. • Followers number. • Usage of tweet hashtag.	(Hota et al., 2015)
Rule-based data sanitization scheme	This schema provides privacy preservative data processing support for active verification and authentication and its adoption as a secure mechanism of authentication in the real world.	
The analysis of a multi-stage attack using video files	Some video files contain distrusted link which is a threat if downloaded into the client machine. This allows an attack in several stages which can be detected using API calls.	

Table 4. Concepts of knowledge management in big data.

5. Discussion and conclusion

In this paper, we reported on a systematic review of the advancements in knowledge management in response to the updates in the digital world including advances in big data, and fast growth in data volume, data velocity, and the variety of data being collected. We conducted a systematic review to provide an overview of the researches within this field in an attempt to answer the following questions:

RQ1. What is the effect of the new trends such as big data and IOT on knowledge management?

RQ2. How to ensure effective knowledge discovery from big data?

RQ3. How to secure knowledge management in the big data era?

Based on our review, we have summarized the following findings:

1. Big data supports knowledge management processes by enabling:
    - More focus on analytics while giving more options in selecting the related applications and tools (Beyer et al., 2011).

- Making full use of context-aware decisions which in turn supports the customer experience (Gehl, 2015).
- Giving the ability to all employees to be part of the collaboration in every organization, which in turn can be translated into more aware recognition and motivation (Zhang et al., 2015).
- Implementing security, access rights, and identity management to ease the job of accessing the right information all the time (Kaivo-Oja et al., 2015).

2. Big data strategies support the knowledge management framework through:
    - Focusing on the organizational culture, which can be the base for understanding the knowledge management requirements.
    - Enhance the user experience by being able to understand the user needs based on the factual retrieved information.
    - Providing an open environment with emphasized transparency and trust.
    - Encouraging skills advances and facilitating employees' commitment to new training to cope with the new digital world.

3. The digital world and big data brought much complexity to our lives including our systems, our infrastructure, and also our work processes, but these advances made it more realistic to build a more user-centric knowledge management system.

4. When building a knowledge management system, organizations should first think of a business case before approaching building a system without having a real business scenario.

5. The new digital world is transforming all the interactions within an organization into knowledge assets. Now all information can be tracked through consumer transactions, which in turn can be used to handle proactive future transactions and make it easy for consumers to manage those transactions more conveniently. In addition to other solutions such as that can enhance the following:
        - Knowledge generation: using context-aware devices to help users generate more relevant content.
        - Knowledge discovery: to increase the availability of data, information, and knowledge.
        - Socialization: helping increase the ability to transform the tacit knowledge into explicit forms.

6. Big data touches all elements of knowledge management security aspects such as:
        - It promotes new approaches to security and identity and access management to make it easier for employees to access and share corporate information and services (Baek et al., 2015; Hota et al., 2015).
        - New approaches to the IT services desk with more consumerized services such as walk-up support, self-service and community support, call-back services and loaner programs.
        - New approaches to application development with a focus on user experience design constructs, agile development, persona creation and a concentration on mobile apps.

7. In summary, in this systematic review, we concluded that big data is critical to the success of knowledge management in organizations through:
    - Increasing workforce productivity.
    - Enabling new ways of working.
    - Enhancing agility.
    - Improving knowledge access and discovery.
    - Promoting collaborative decision making.
    - Increasing employee satisfaction and retention.
    - Increasing innovation and creativity.

References

Al-Emran, M. (2015). Hierarchical Reinforcement Learning: A Survey. *International Journal of Computing and Digital Systems*, *4*(2), 137–143.

Al-Emran, M., & Al Chalabi, H. (2014). Developing an IT Help Desk Troubleshooter Expert System for diagnosing and solving IT Problems. In *BCS International IT Conference* (pp. 1–5). https://doi.org/10.14236/ewic/bcsme2014.16

Al-Emran, M., & Malik, S. I. (2016). The Impact of Google Apps at Work: Higher Educational Perspective. *International Journal of Interactive Mobile Technologies*, *10*(4), 85–88. https://doi.org/10.3991/ijim.v10i4.6181

Al-Emran, M., Mezhuyev, V., & Kamaludin, A. (2018a). Students' Perceptions towards the Integration of Knowledge Management Processes in M-learning Systems: A Preliminary Study. *International Journal of Engineering Education*, *34*(2), 371–380.

Al-Emran, M., Mezhuyev, V., & Kamaludin, A. (2018b). Technology Acceptance Model in M-learning context: A systematic review. *Computers & Education*, *125*, 389–412.

Al-Emran, M., Mezhuyev, V., Kamaludin, A., & AlSinani, M. (2018a). Development of M-learning Application based on Knowledge Management Processes. In *2018 7th International conference on Software and Computer Applications (ICSCA 2018)* (pp. 248–253). Malaysia: ACM.

Al-Emran, M., Mezhuyev, V., Kamaludin, A., & Shaalan, K. (2018b). The impact of knowledge management processes on information systems: A systematic review. *International Journal of Information Management*, *43*, 173–187.

Al-Emran, M., & Salloum, S. A. (2017). Students' Attitudes Towards the Use of Mobile Technologies in e-Evaluation. *International Journal of Interactive Mobile Technologies (IJIM)*, *11*(5), 195–202. https://doi.org/10.3991/ijim.v11i5.6879

Al-Emran, M., & Shaalan, K. (2015). Learners and educators attitudes towards mobile learning in higher education: State of the art. In *2015 International Conference on Advances in Computing, Communications and Informatics, ICACCI 2015* (pp. 907–913). IEEE. https://doi.org/10.1109/ICACCI.2015.7275726

Al-Emran, M., & Shaalan, K. (2017). Academics' Awareness Towards Mobile Learning in Oman. *International Journal of Computing and Digital Systems*, *6*(1), 45–50. https://doi.org/10.12785/IJCDS/060105

Al-Emran, M., Zaza, S., & Shaalan, K. (2015). Parsing modern standard Arabic using Treebank resources. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015*. https://doi.org/10.1109/ICTRC.2015.7156426

Al-Maroof, R. A. S., & Al-Emran, M. (2018). Students Acceptance of Google Classroom: An Exploratory Study using PLS-SEM Approach. *International Journal of Emerging Technologies in Learning (IJET)*, *13*(6), 112–123.

Al-Qaysi, N., & Al-Emran, M. (2017). Code-switching Usage in Social Media: A Case Study from Oman. *International Journal of Information Technology and Language Studies*, *1*(1), 25–38.

Al-Qaysi, N., Mohamad-Nordin, N., & Al-Emran, M. (2018). A Systematic Review of Social Media Acceptance from the Perspective of Educational and Information Systems Theories and Models. *Journal*

of Educational Computing Research. https://doi.org/https://doi.org/10.1177/0735633118817879

Al Emran, M., & Shaalan, K. (2014a). A Survey of Intelligent Language Tutoring Systems. In *Proceedings of the 2014 International Conference on Advances in Computing, Communications and Informatics, ICACCI 2014* (pp. 393–399). IEEE. https://doi.org/10.1109/ICACCI.2014.6968503

Al Emran, M., & Shaalan, K. (2014b). E-podium Technology: A medium of managing Knowledge at Al Buraimi University College via M-learning. In *BCS International IT Conference* (pp. 1–4). UAE. https://doi.org/10.14236/ewic/bcsme2014.14

Baek, J., Vu, Q. H., Liu, J. K., Huang, X., & Xiang, Y. (2015). A secure cloud computing based framework for big data information management of smart grid. *IEEE Transactions on Cloud Computing*. https://doi.org/10.1109/TCC.2014.2359460

Barnaghi, P., Sheth, A., & Henson, C. (2013). From data to actionable knowledge: Big data challenges in the web of things. *IEEE Intelligent Systems*. https://doi.org/10.1109/MIS.2013.142

Begoli, E., & Horey, J. (2012). Design principles for effective knowledge discovery from big data. In *Proceedings of the 2012 Joint Working Conference on Software Architecture and 6th European Conference on Software Architecture, WICSA/ECSA 2012*. https://doi.org/10.1109/WICSA-ECSA.212.32

Beyer, M. A., & Laney, D. (2012). *The Importance of "Big Data": A Definition*. *Gartner Research Note*. https://doi.org/G00235055

Beyer, M. A., Lapkin, A., Gall, N., Feinberg, D., & Sribar, V. T. (2011). *Big Data Is Only the Beginning of Extreme Information Management*. *Gartner Research Note*.

Bjørnson, F. O., & Dingsøyr, T. (2008). Knowledge management in software engineering: A systematic review of studied concepts, findings and research methods used. *Information and Software Technology*. https://doi.org/10.1016/j.infsof.2008.03.006

Erickson, S., & Rothberg, H. (2014). Big Data and Knowledge Management: Establishing a Conceptual Foundation. *Electronic Journal of Knowledge Management*.

Gehl, R. W. (2015). Sharing, knowledge management and big data: A partial genealogy of the data scientist. *European Journal of Cultural Studies*. https://doi.org/10.1177/1367549415577385

Hota, C., Upadhyaya, S., & Al-Karaki, J. N. (2015). Advances in secure knowledge management in the big data era. *Information Systems Frontiers*. https://doi.org/10.1007/s10796-015-9593-y

Kabir, N., & Carayannis, E. (2013). Big Data, Tacit Knowledge and Organizational Competitiveness. In *Proceedings of the International Conference on Intellectual Capital, Knowledge Management & Organizational Learning*. https://doi.org/10.13140/RG.2.1.4183.6960

Kaivo-Oja, J., Virtanen, P., Jalonen, H., & Stenvall, J. (2015). The effects of the internet of things and big data to organizations and their knowledge management practices. *Lecture Notes in Business Information Processing*. https://doi.org/10.1007/978-3-319-21009-4_38

Kitchenham, B., & Charters, S. (2007). Guidelines for performing Systematic Literature Reviews in Software Engineering. *Software Engineering Group, School of Computer Science and Mathematics, Keele University*, 1–57. https://doi.org/10.1.1.117.471

Manogaran, G., Thota, C., Lopez, D., Vijayakumar, V., Abbas, K. M., & Sundarsekar, R. (2017). Big data knowledge system in healthcare. In *Internet of things and big data technologies for next generation healthcare* (pp. 133–157). Springer.

Mhamdi, C., Al-Emran, M., & Salloum, S. A. (2018). *Text mining and analytics: A case study from news channels posts on Facebook*. *Studies in Computational Intelligence* (Vol. 740). https://doi.org/10.1007/978-3-319-67056-0_19

Salloum, S. A., Al-Emran, M., Abdallah, S., & Shaalan, K. (2017). Analyzing the Arab Gulf Newspapers Using Text Mining Techniques. In *International Conference on Advanced Intelligent Systems and Informatics* (pp. 396–405). Springer. https://doi.org/10.1007/978-3-319-64861-3_37

Salloum, S. A., Al-Emran, M., Monem, A. A., & Shaalan, K. (2018). Using text mining techniques for extracting information from research articles. In *Studies in Computational Intelligence* (Vol. 740). Springer. https://doi.org/10.1007/978-3-319-67056-0_18

Salloum, S. A., Al-Emran, M., Monem, A., & Shaalan, K. (2017). A Survey of Text Mining in Social Media: Facebook and Twitter Perspectives. *Advances in Science, Technology and Engineering Systems Journal*, *2*(1), 127–133. Retrieved from http://astesj.com/archive/volume-2/volume-2-issue-1/survey-text-mining-social-media-facebook-twitter-perspectives/

Salloum, S. A., Al-Emran, M., & Shaalan, K. (2016). A Survey of Lexical Functional Grammar in the Arabic Context. *International Journal of Computing and Network Technology*, *4*(3), 141–147.

Salloum, S. A., Al-Emran, M., & Shaalan, K. (2017a). Mining Social Media Text: Extracting Knowledge from Facebook. *International Journal of Computing and Digital Systems*, *6*(2), 73–81. https://doi.org/10.12785/ijcds/060203

Salloum, S. A., Al-Emran, M., & Shaalan, K. (2017b). Mining Text in News Channels: A Case Study from Facebook. *International Journal of Information Technology and Language Studies*, *1*(1), 1–9.

Salloum, S. A., Al-Emran, M., & Shaalan, K. (2018). The Impact of Knowledge Sharing on Information Systems: A Review. In *13th International Conference, KMO 2018*. Slovakia.

Salloum, S. A., Al-Emran, M., Shaalan, K., & Tarhini, A. (2018). Factors affecting the E-learning acceptance: A case study from UAE. *Education and Information Technologies*. https://doi.org/https://doi.org/10.1007/s10639-018-9786-3

Salloum, S. A., AlHamad, A. Q., Al-Emran, M., & Shaalan, K. (2018). A survey of Arabic text mining. In *Studies in Computational Intelligence* (Vol. 740). Springer. https://doi.org/10.1007/978-3-319-67056-0_20

Salloum, S. A., Mhamdi, C., Al-Emran, M., & Shaalan, K. (2017). Analysis and Classification of Arabic Newspapers' Facebook Pages using Text Mining Techniques. *International Journal of Information Technology and Language Studies*, *1*(2), 8–17.

Sukumar, S. R., & Ferrell, R. K. (2013). "Big Data" collaboration: Exploring, recording and sharing enterprise knowledge. *Information Services and Use*. https://doi.org/10.3233/ISU-130712

Vera-Baquero, A., Colomo-Palacios, R., & Molloy, O. (2013). Business process analytics using a big data approach. *IT Professional*. https://doi.org/10.1109/MITP.2013.60

Viceconti, M., Hunter, P., & Hose, R. (2015). Big Data, Big Knowledge: Big Data for Personalized Healthcare. *IEEE Journal of Biomedical and Health Informatics*. https://doi.org/10.1109/JBHI.2015.2406883

Zaza, S., & Al-Emran, M. (2015). Mining and exploration of credit cards data in UAE. In *Proceedings - 2015 5th International Conference on e-Learning, ECONF 2015* (pp. 275–279). IEEE. https://doi.org/10.1109/ECONF.2015.57

Zhang, H., Chen, G., Ooi, B. C., Tan, K. L., & Zhang, M. (2015). In-Memory Big Data Management and Processing: A Survey. *IEEE Transactions on Knowledge and Data Engineering*. https://doi.org/10.1109/TKDE.2015.2427795