Examining the Readiness to Adopt the Internet of Things and Big Data in Egyptian Companies

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Abstract

Recently most companies have realized the importance of using digital technologies, especially the internet of things and big data, as it has a great impact on several industries such as Fast-moving consumer goods (FMCG), Transportation/Logistics, Automotive, Textiles and ready-made garments, Pharmaceuticals, etc. Before applying the internet of things and big data, companies must first assess the readiness to ensure successful implementation and avoid organization failure. The purpose of this research is to investigate the readiness of Egyptian companies to adopt the internet of things and big data. Thus, this research proposes the readiness model for the internet of things and big data which consists of nine factors: strategy, top management involvement and commitment, financial readiness, team readiness, technical richness/ skills, IT readiness, data architecture, security, and data quality. This is a work in process research that will study the readiness of Egyptian companies to adopt the internet of things (IoT) and big data (BD). In this paper, the literature review and theoretical framework for assessing the IoT and BD readiness of Egyptian companies are presented.

Keywords
Internet of Things (IoT), Big Data (BD), Egyptian Companies, Readiness Model.

1. Introduction

In recent years, as economic changes, world fluctuations, and rapid technological development have taken place, many companies looked forward to be more innovative and shift to digital transformation/ digitalization, especially using two main technologies the internet of things and big data in different sectors. According to IDC (2019), around 79.4 ZB of data will be generated and more than 50 billion sensors and devices will be connected to the internet by 2025. Internet of things is an innovative technology, in other words, "an intelligent network, an invisible network fabric that can be sensed, controlled, and programmed. IoT-enabled products employ embedded technology that allows them to communicate, directly or indirectly, with each other or the Internet" (Chase 2013). It's worth noting that the data produced from IoT can be managed and analyzed by big data technology.

Internet of things and big data technologies play a vital role in the industrial and business sector. For instance, IoT and BD can help companies in improving efficiency, cost-saving, enhancing production, increasing profitability, increasing flexibility, eliminating the breaks, improving the quality and level of safety, improving the product variety, and increasing customer satisfaction, etc. Examples of Global companies that have adopted digital technologies (IoT

and BD) are DHL, DB Schenker, Bosch, Cisco, Microsoft, Samsung, IBM, BMW, Amazon, etc. Despite the importance of the internet of things and big data, its adoption is a new and relatively complex issue due to a lack of understanding regarding how to start the adoption. Thus, organizations need to assess their readiness before the initial step by evaluating an organization's ability, identifying the key success factors and potential issues to understand if the organization is ready for IoT and BD adoption.

Therefore, this research aims to investigate the readiness of Egyptian companies to adopt the internet of things and big data. The study proposed a readiness model that can be used to assess the readiness of Egyptian companies for IoT and BD and determine the key success factors that would support the internet of things and big data projects in Egyptian industries.

2. Literature Review

2.1 Internet of Things

The term IoT (Internet of things) also, known as machine-to-machine (M2M) or Industrial 4.0, was initially introduced in 1999, by Kevin Ashton and several other scholars at Massachusetts Institute of Technology that describes smart transformation and connection of objects (Greengard 2015; Weinberger et al. 2016). As regards to the definition of IoT, Miorandi et al. (2012) mentioned the ''Internet-of-Things'' acts as an umbrella keyword that blends of intelligent devices or communication sensors and physical entities. Also, Madakam et al. (2015) described internet of things as "An open and comprehensive network of intelligent objects that have the capacity to auto organize, share information, data, and resources, reacting and acting in face of situations and changes in the environment". In the context of supply chain management (SCM), the internet of things is defined as "The Internet of Things is a network of physical objects that are digitally connected to sense, monitor and interact within a company and between the company and its supply chain enabling agility, visibility, tracking and information sharing to facilitate timely planning, control, and coordination of the supply chain processes." (Ben-Daya et al. 2019)

Leading researchers argue that the internet of things will shape businesses in the future. For instance, Zhou et al. (2015) pointed out that IoT can aid manufacturers as a solution to enhance productivity and improve efficiency, which characterized supply chain management with transparency, traceability, capability, reliability, and agility that enables to improve operational processes and minimize cost. Kamble et al. (2019) mentioned the potential benefits of the IoT in the food retail supply chain regarding quality management, waste management, temperature management, and energy consumption management. Chukwuekwe et al. (2016) examined the other positive side from adopted the IoT in industries, as it plays a role as remote preventative maintenance that will contribute to increase productivity and profitability, improve the level of safety, and increase the product life cycle. Wang et al. (2016) showed how to leverage from radio frequency identification (i.e., IoT technology) in inventory management. This study mentioned the benefits of RFID as a tool that solves the inaccuracies of inventory, reduce inventory errors, optimize service level, and ordering quantity with expected profit. As pointed out by Braccini and Margherita (2018) Industry 4.0 like the 'Internet of things' (IoT) enables the organization to act sustainability. It has a profound and significant impact on manufacturing, which leads to improve productivity and higher quality, reduce energy consumption and less production waste and increase safety in the work environment. Manavalan and Jayakrishna (2019) proved the use of IoT in satisfying customer, meeting customer requirements, and achieving the organization's goals by reducing time-to-market, responding faster to customer demand, and reducing the lead-time.

2.2 Big Data

The term Big Data (BD) is a new phenomenon to develop and maturity information technology sector (Vera-Baquero et al. 2015). Big Data was first used by NASA scientists in 1997, to refer to the challenge for computer systems to control large data sets (Assuncao et al. 2014). Manyika et al. (2011) described the Big Data approach as "the next frontier for innovation, competition, and productivity". The Global Big Data market has expected to grow from 138.9 billion euros in 2020 to 229.4 billion euros by 2025, growing on a Compound Annual Growth Rate (CAGR) of 10.6% (Research and Markets, 2020).

The big data has several approaches, namely the "5Vs" volume, velocity, variety, veracity, or reliability of collected data, and value (Hadi et al.2015). From the point view of Davenport (2014), Big Data is defined as "the collection, and interpretation of massive data sets, made possible by vast computing power that monitors a variety of digital streams such as sensors, marketplace interactions and social information exchanges and analyze them using 'smart' algorithms". In the context of SCM, big data analytics (BDA) is defined as: "the ability of organizations to collect and

organize supply chain data from heterogeneous systems distributed across organizational boundaries, analyses it either batch-wise or real-time or near real-time and visualize it intuitively to create proactive supply chain system and support decision making" (Richey et al. 2016).

BDA can play a pivotal role as used to support decision-making and improve organizations' performance (Oliveira et al. 2012; Popovič et al. 2018). As Wilkin et al. (2020) cited the positive impact of BD on SCM decision-making by surveyed 84 SC managers in which indicated the importance of Big Data prioritization and investment in the database and analytical tools to achieve decision making. Besides, Big Data can help SC organizations to target and satisfy customers with their needs, increase sales and revenue, and compete in new markets (Zhong 2016). According to Vasan (2015) stated that Big Data can help firms to increase efficiency and profitability in the SC, i.e., BD can increase the productivity and visibility, improve the relationships between supply chain entities, improve responsiveness and enhance SC agility. BDA also can enable companies to enhance quality management (Davenport et al. 2012); improve the forecasting, optimizing price setting, enhance SC planning (Kessinger and Pieper 2013); improve customer relationships, evaluate SC risks, improve operational efficiency and effectiveness (Kiron 2013; Zelbst et al. 2011).
According to recent surveys, McKinsey in 2011 pointed out the value of Big Data for manufacturing industries that reduce the cost of production (i.e., manufacturing and assembly costs) by 50% and can decrease working capital by 7% (Manyika et al. 2011). While a report published by McKinsey in 2016 emphasized that data have the power to create new value across supply chain functions by improving decision making. OECD report in (2014) mentioned the positive impact of big data on organizations regarding create value added by optimizing the value chain, improving the efficiency of production via talented factor, and enhancing customer relationships. Wamba et al. (2015); Ittmann (2015) mentioned the importance, which is summarized in increase the operational performance, improve decision making to be in real-time, improve planning, as well as increase customer satisfaction.

2.3 Readiness for Adoption the Internet of Things and Big Data

The readiness model is important as a starting point that assesses the current status of the organizations, gauge organizations' understanding of a change. In other words, it's such a management tool to contribute to reconfiguring, restructuring, and expanding a firm's capability (Schumacher et al. 2016; Felch et al. 2019). Hence, organizations have to establish the readiness model before making the decision for adopting IoT and BD to know if the company is ready for it or not.

Several literature reviews discussed the readiness for adoption of the internet of things, for instance, Savoury (2019) examined the determinants that influence the intent to adopt IoT in the manufacturing sector. The dimensions involve relative advantage, compatibility, technology readiness, top management, firm size, competitive pressure, and regulatory support. The findings revealed that technology readiness, top management support, and competitive pressure are the most important factors that enable the adoption of IoT. Tu (2018) studied the determinant factors affecting IoT adoption in logistics and supply chain management. The findings revealed that the significant factors are perceived benefits, perceived costs, and external pressure, while technology trust are insignificant factor and indirect influence IoT adoption intention. Affia et al. (2019) mentioned the factors affecting IoT adoption in the food supply chain are: performance perceived benefit, cost, security and privacy, level of willingness, the complexity of data, government support, technical Knowledge, and Combability or interoperability. Tripathi and pandit (2019) studied the factors influencing IoT adoption and proposed a model of successful IoT in organizations, which is classified the factors in three categories: technical, personal and organizational. The result showed that communication, control and automation, efficient business processes, self-configuration, and cost savings factors are positively influencing IoT adoption. However, security and privacy, IT employees' skills, Interoperability, infrastructure, reliability and vendor credibility factors are negatively influencing IoT adoption. Ben-Daya et al. (2019); Tadejko (2015) identified that the potential challenges face by the adoption of IoT on supply chain management are related to technological and managerial perspectives. While Machado et al. (2019) evaluated the digital readiness of a set of manufacturing companies finding that the obstacles which are faced the adoption: 1) strategy, 2) Technical and managerial, 3) lack of knowledge and skills, 4) lack of training and internal competence.
With regard to Readiness for Implementation of Big Data, Kalema et al. (2017) discussed the readiness for big data analytics in developing countries organizations by identifying the effective model, which consists of significant dimensions: top management support, ICT infrastructure, firm size, financial resources, employees' e-skills, data management and analytics, security, organization's customers' and vendors. Moreover, Popovic et al. (2018) pointed out that BDA strategy, top management support, financial resources, engaging people. Kabir and Carayannis (2013) emphasized the importance of people, tools, data, and management support merged correctly to gain competitiveness from big data. Nasrollahi and Ramazani (2020) posited an organization's readiness evaluation model for big data by

identifying twelve main criteria i.e., technological, wisdom, features, cultural, financial, managerial, stakeholders, skills, utility, environmental, organizational, and processing that affects organizational readiness. Finding that the most strength and significant criterion is BD features (including trailability, perceived simplicity, complexity, observability, data quality, and integration), while the weakness criterion is wisdom (including IT expertise, knowledge about BD, BD awareness) for adopting Big Data. Olszak and Mach-Król (2018) proposed a conceptual framework for evaluating an organization's readiness for Big Data adoption. This framework measured the data/knowledge, IT solutions, functionalities offered by IT solutions, and sustainable development. EY (2014) report highlighted the successful drivers for implementation of Big Data and evaluated the risk of each factor: Data Governance, Data Management, Data Quality, Architecture, usage, and security.

In conducting this literature review, it was found that there is a lack of studies that examine the factors that support the adoption of the Internet of Things (IoT) and Big Data, particularly in developing countries. Most organizations, especially in developing countries are challenged with IoT projects as they often lack the required knowledge for the starting phase and the important elements that will support its success. Therefore, this research will attempt to provide a readiness model for IoT implementation in Egyptian companies.

3. Theoretical Framework

This section identifies the key success factors for being ready to start the internet of things and big data project that Egyptian companies need to take before beginning any step. The readiness model is divided into three perspectives namely, organizational, technological, and infrastructure. The figure 1 illustrates the research model

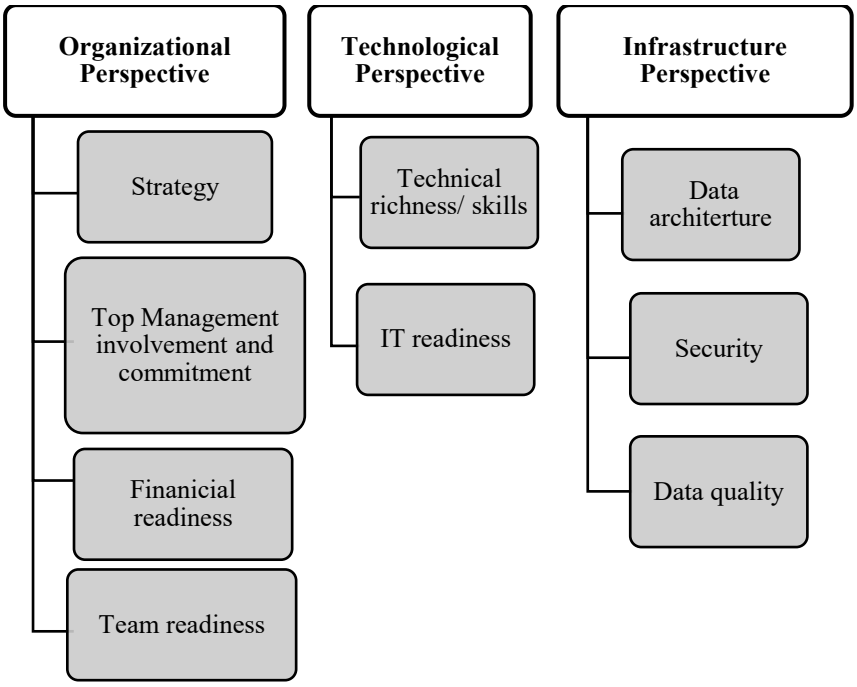

Figure 1. Research Model

3.1 Organizational Perspective

Strategy: Organization strategy is decisive acts as a framework for all business decisions, which have those elements: vision, mission, values, long-term and short-term goals, action plans, KPI's, SWOT analysis, etc (Driouchi and Bennett 2012; Schumacher et al. 2016). When organizations tend to adopt IoT and big data, it has to put a clear vision about how to collect, how to manage each type of data, either structured or unstructured from internal or external sources and how to analyze it. Without a clear data strategy, organizations will be facing various risks e.g., selecting

the target data, extracting the value from data, data analytics, security, and privacy across individuals and participants (DalleMule and Davenport 2017; Michael and Miller 2013). The prior studies have shown that the strategy plays a good role to adopt the internet of things and big data (Olushola 2019; Song and Naik 2019a; Sony and Naik 2019b; Michael and Miller 2013).

Top management involvement and commitment: This factor refers to "The degree to which top management intends to adopt new technology and create a supportive climate" (Chen et al. 2011). The success of the internet of things and big data focuses on the commitment and support of top management (Sony 2018; Burcharth et al. 2014; Wang and Wang 2016). It is worth mentioning that top management (TM) is a crucial part of IoT and BD adoption, which is responsible for identifying the level of adoption, managing the organization processes, recruiting the skilled staff, solving the problems, and reducing resistance related to IoT and BD adoption (Haddud et al. 2017; Wang and Wang 2016). Shamim et al. (2016) noted that the significant impact of sustained support of top management for the readiness of the organization i.e., any company needs particular organizational resources when trends to transformation. If there is not support from Top management, organizations may be failing to adopt IoT and BD technologies (Wang and Wang 2016).

Financial readiness: The finance/ cost factor is one of the most critical factors driving the idea of investing in any company by spending on new requirements such as hardware, software, equipment and tools, professional development (Bagale 2014). Financial readiness has a positive effect on the adoption of the internet of things and big data (Kalema and Mokgadi 2017; Olushola 2019; Nasrollahi and Ramezani 2020). According to Maduku et al. (2016) when an organization has a lack of financial resources, the organization may face a problem to adopt the new technologies and manage the change to digitalization.

Team readiness: Companies need to know "Are the team or Employees Ready." i.e., professional employees or workers are available in organizations to support the adoption of IoT technology and big data (Halper and Russom 2018). Neumann and Dul (2010) emphasized that human factor / professional employee is critical to ensure the successful implementation of new technology.

3.2 Technological Perspective

Technological perspective refers to technology infrastructure, relevant systems and technical skills, and a firm that has IT knowledge and professional employees are more willing to adopt IoT and BD (Partala and Saari 2015; Martins et al. 2016). As indicated by several authors (Kiel et al. 2017; Martins et al. 2016) the higher degree of technological readiness and competency, the more successful the adoption. Thus, technological readiness has a positive impact on the adoption of IoT and BD. The technological perspective has two factors as the following:

Technical richness/ skills: The skills of employees play a vital role in the success of IoT and Big data adoption (Leitão et al. 2016; Kalema and Mokgadi 2017; Goss and Veeramuthu 2013). Leitão et al. (2016) indicated that employees should have technical skills while implementing the IoT. Bongomin et al. (2020) indicated the skills needed to manage digital transformation: technical skills, which are involved as theorical and professional skills, hardware skills, and digital skills or software skills. And personal/ soft skills are related to interactions in the work environment and might for solving the issues affecting the field of the Internet of Things (IoT).

IT readiness: IT readiness refers to availability of internal and external resources and ability of legacy system to integrate with the IoT and BD systems (Rosas et al. 2017; Haug et al. 2011). IT readiness involves the assessment of an organization 's technical environment, infrastructure, IT service capabilities (USAID 2019). A firm that tends to implement the IoT and BD have to evaluate the IT infrastructure and improve the IT system to match accuracy, the speed of connection, and secure exchange in real-time (Kloch et al. 2011; Leitão 2016).

3.3 Infrastructure Perspective

Data architecture: Data architecture refers to capability of IT infrastructure to integrate massive volumes of data, data storage and data process in real-time with highly secured from disruption of service or network. Data architecture builds to eliminate the barriers or obstacles, facilitating the sharing of data within the organization to the right person at the right time with accuracy (EY 2014, Davenport and Dyché 2013).

Security: The security factor is a vital a part of new technology, especially IoT and big data in order to protect software attacks, cyberattacks, malfunctions, cryptography, privacy and compromise or spoil devices. (Roman et al. 2011; Li et al. 2016). In other words, IoT security must consider a wider range of issues than traditional cybersecurity, including authorization, data confidentiality, service availability and integrity, integrity of information, privacy protection,

access control, system configuration, information storage, and management (Keoh et al. 2014; Tu 2018). The adoption of the internet of things and big data comes with security concerns (Bughin et al. 2015; Porter and Heppelmann 2015; Ahlmeyer and Chircu 2016; Weber 2015; Yuchen et al. 2017).

Data quality: This factor refers to "ensure quality in the acquisition, transformation, manipulation, and analysis of data, as well as in the validity of the results" (Orenga-Roglá and Chalmeta 2019). Data quality is widely used a set of "characteristics" data, such as its accuracy, completeness, consistency, and timeliness (Fu and Easton 2017). As big data technology consists of data sets, organizations have to consider the importance of quality of data to avoid fault data that may cause high costs. Thus, organizations need to build quality standards and monitoring functions for big data (EY 2014). Karkouch et al. (2016) explained the role of data quality to enhance the IoT and BD technologies. Orenga-Roglá and Chalmeta (2019) indicated the positive significance of data quality to adopt the big data. Hazen et al. (2014); Fu and Easton (2017) stated that poor data quality can prevent the data from being analyzed correctly, and that will affect decision-making. Data, unlike a physical product, is intangible, and assessing data quality is a multifaceted task.

4. Conclusion

This study proposes a readiness model that can used to assess the readiness of Egyptian companies for the internet of things and big data. The readiness model consists of four perspectives: Organizational, Technological, Infrastructure, Data. Each of these perspectives identify the critical factors which help any organization to assess the readiness, in order to predict the success of IoT and BD adoption in their organizations. The findings of this study will assist organizations to understand the readiness by identifying the factors that affect the internet of things and big data. This research attempts to fill the gap facing the internet of things and Big Data readiness in Egyptian companies, it also serves as a reference or guideline for Egyptian companies.

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