

Khalifa, Nermin; Elghany, Mona Abd; Elghany, Marwa Abd

Article

Exploratory research on digitalization transformation practices within supply chain management context in developing countries specifically Egypt in the MENA region

Cogent Business & Management

Provided in Cooperation with:

Taylor & Francis Group

Suggested Citation: Khalifa, Nermin; Elghany, Mona Abd; Elghany, Marwa Abd (2021) : Exploratory research on digitalization transformation practices within supply chain management context in developing countries specifically Egypt in the MENA region, Cogent Business & Management, ISSN 2331-1975, Taylor & Francis, Abingdon, Vol. 8, Iss. 1, pp. 1-24, <https://doi.org/10.1080/23311975.2021.1965459>

This Version is available at:

<https://hdl.handle.net/10419/245115>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>

Exploratory research on digitalization transformation practices within supply chain management context in developing countries specifically Egypt in the MENA region

Nermin Khalifa, Mona Abd Elghany & Marwa Abd Elghany |

To cite this article: Nermin Khalifa, Mona Abd Elghany & Marwa Abd Elghany | (2021) Exploratory research on digitalization transformation practices within supply chain management context in developing countries specifically Egypt in the MENA region, Cogent Business & Management, 8:1, 1965459, DOI: [10.1080/23311975.2021.1965459](https://doi.org/10.1080/23311975.2021.1965459)

To link to this article: <https://doi.org/10.1080/23311975.2021.1965459>



© 2021 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.



Published online: 26 Aug 2021.



Submit your article to this journal [↗](#)



Article views: 569



View related articles [↗](#)



View Crossmark data [↗](#)



Received: 17 March 2021
Accepted: 31 July 2021

*Corresponding author: Marwa Abd Elghany, College of Management And Technology, Arab Academy For Science & Technology, Alexandria, Egypt
E-mail: marwam@aast.edu

Reviewing editor:
Albert W. K. Tan, Asia Pacific Graduate Institute, Shanghai Jiao Tong University, SINGAPORE

Additional information is available at the end of the article

OPERATIONS, INFORMATION & TECHNOLOGY | RESEARCH ARTICLE

Exploratory research on digitalization transformation practices within supply chain management context in developing countries specifically Egypt in the MENA region

Nermin Khalifa¹, Mona Abd Elghany² and Marwa Abd Elghany^{1*}

Abstract: With no doubt, the adoption of Artificial Intelligence applications in customer service reduces the time to market. Nevertheless, the question remains whether or not its adoption in production and logistics will transform the supply chain into a more agile one in developing countries context. Manufacturers are increasingly facing global competition to fulfil incoming orders within limited lead time, and in compliance with the international quality standards, also supporting a customised service. The emergence of industry 4.0 brought many promises to the leading firms. This research paper gives insight information for applying AI algorithms in production cycle then monitoring the production process and subsequently leading to strategic and tactical engineering decisions through the investigation of a number of case studies. The investigation demonstrates that incorporating AI technologies and machine learning opens up fresh perspectives on a variety of topics, including warehousing and logistics management, cooperation, and supply chain management. AI is embraced by business for productivity

ABOUT THE AUTHOR

Nermin M. Khalifa got her PhD in Engineering & Information Science in (2010) from Middlesex University, UK. She became an associate professor in College of Management & Technology in (2014) and holds the post of Deputy Dean for postgraduates studies and scientific research since (2015) till present.

Mona Abd Elghany graduated from College of Management & Technology in Arab Academy for Science & Technology with Bsc in Business Administration then earned a MSc in TQM and a PhD in Performance Measures from University of the West of England joint with the P&Q Institute and in the Analysis of the Relationship between Positional Advantage and Business Performance from University of Hertfordshire, UK.

Marwa M. Abd Elghany was awarded BSc in Electronics & Communications Engineering from College of Engineering and Technology and MSc in Engineering Management in 2003 from AAST, College of Postgraduates Studies. She has held a PhD in 2013 from Middlesex University's School of Computing Science in the United Kingdom.

PUBLIC INTEREST STATEMENT

Despite the abundance of new research, substantial investigations on the function of Artificial Intelligence AI applications in Supply Chain Management SCM remain sparse due to a lack of understanding of the issue. This work seeks to study the concept of AI and its applications in SCM in order to improve knowledge of AI in SCM in developing countries. It demonstrates how to incorporate various AI techniques and advanced technology future trends into the operational process, and how they work together to support cost-effective supply chain solutions and provide greater insight to high-level decision-makers. This study also looks at how AI-enabled SCM may help with everything from process automation to process improvement. The study gives an evaluation of AI in SCM by examining data collected from the investigated organisations and their solutions in real life in how they utilise AI in their supply chains. The goal is to build up a comprehensive view of the development of AI technology connected to SCM.

improvement, given the fact that the more AI adoption rate, the less employment rate and wages will be. Information & Communication Technology alignment model is endorsed in this paper in order to grant fostering of an environment that streamlines, incentivizes and supports AI expansion prior the implementation of any AI practices to ensure its successful and justified investments. The research concludes that the process is extremely challenging in the context of emerging economies which is restricted with low wages rate, inadequate labour skills and insufficient financial resources.

Subjects: Management of IT; Artificial Intelligence; Information & Communication Technology; ICT

Keywords: Artificial intelligence; supply chain; supply chain management; developing countries

1. Introduction

The Fourth Industrial Revolution is currently taking place around the world, and Artificial Intelligence (AI) is changing the lives of many people in both developing and developed countries. Substantial digital developments are impacting those countries' economies, bringing with them a slew of promised benefits as well as a slew of new concerns.

The impact of the Fourth Industrial Revolution, Artificial Intelligence, and Digital Transformation on the economy has been a major concern for both economists and policymakers in the era of the Fourth Industrial Revolution, Artificial Intelligence, and Digital Transformation. These changes are projected to have a significant impact on the economy's growth rate, employment rate, and labour productivity, among other things. For some, digital transformation might make life easier, while for others, it might make life more difficult. It has the potential to be an engine for accelerating economic progress while also having the potential to stifle growth if the necessary structure for its implementation is not in place.

As a modern new term in business and technological literature, digital transformation is typically defined as "the integration of digital technology into business that leads to changes in business operations and the value delivery to customers" (Micic, 2017). It also refers to the changes brought about by the widespread usage of digital technology, which generates processes, shares, and transfers data. It is based on the advancement of a number of technologies, including telecommunications networks, computer technology, software engineering, and the ramifications of their application. Artificial Intelligence is seen as a vital tool for accelerating digital transformation in this area.

2. AI state for Egypt and other developing countries

Following on the above; and in line for the globalisation and the competition facing producers in emerging markets, there is an emergent need to optimise supply chain activities, reduce-related cost and provide rapid responsiveness to survive in the global markets. Meanwhile the contemporary state of AI development in Egypt and the developing countries in the Middle East bounces its promising indicators; there is a great prospect for AI implementation success.

Parts of the MENA region have already embraced artificial intelligence (AI) and the new digital era. According to a study done by the International Data Corporation (IDC), spending on cognitive and artificial intelligence (AI) systems in the Middle East and Africa (MEA) area would increase by 2030, with growth rates ranging from 20 to 34 per cent per year, as shown in [Figure 1](#) below, with the UAE leading the way, followed by Saudi Arabia. Bahrain, Kuwait, Oman, and Qatar have been clubbed together. AI's impact on the business and society will almost probably grow beyond 2030, so the Middle East must be strategically located to serve as a springboard for the future (PwC, 2021).

Figure 1. The average annual growth in the contribution of AI by region between 2018 and 2030; Reference: (PwC, 2021).



The United Arab Emirates, Saudi Arabia, and Qatar, in particular, have shown a strong commitment to AI development and application. Businesses in certain sections of the region have been aggressively investing in new technologies, with governments acting as early adopters. However, adoption has been slower outside of the Gulf economies. Differences in adoption levels are caused by factors as infrastructure and access to skilled labour, both of which are important enabling variables for AI development. It is also worth noting that, while oil price volatility is wreaking havoc on the region's economic prospects, it is forcing those governments to seek alternative sources of revenue. Investment in AI technologies to promote non-oil sectors could strategically position the region in the years ahead (PwC, 2021).

In the United Arab Emirates, artificial intelligence is at the heart of the government's strategic initiatives. The government unveiled its AI plan in October 2017, demonstrating its dedication to the country's technological advancement. In support of this policy, HH Sheikh Mohammed Bin Rashid Al Maktoum, Vice President and Prime Minister of the United Arab Emirates and Ruler of Dubai, named HE Omar Bin Sultan Al Olama as the UAE's first Minister of State for Artificial Intelligence (PwC, 2021).

Dubai is a pioneer in the field of artificial intelligence in the UAE. Among the Emirate's strategies are the following: A Smart Dubai strategy intends to modernise the city through innovation and digital transformation, including the establishment of an AI smart lab in 2017 to teach public and private sector employees in the use of AI in their respective disciplines. A Dubai 3D Printing Strategy aimed at the construction, medical, and consumer product sectors, with a goal of using 3D printing technology to construct 25% of structures in Dubai by 2030. Furthermore, a Dubai Autonomous Transportation Strategy intends to reduce transportation expenses by 44%, carbon emissions by 12% and accidents by 12% by converting 25% of all modes of transportation in the city to autonomous modes by 2030 (PwC, 2021).

Saudi Arabia has a clear strategy for the future, which includes AI-based technology development. Saudi Arabia's Vision 2030 and National Transformation Programme 2020 define digital transformation as a crucial goal for energising economic sectors, supporting industries and private sector entities, advocating for the creation of public-private business models, and eventually reducing the country's reliance on oil income through economic diversification (PwC, 2021).

Artificial intelligence (AI) is a flourishing trend in Egypt, with companies embracing the latest developing technology to expand into new sectors, and IT vendors and start-up investors enthusiastically supporting the AI effort. Egypt government challenges to be one of the key players to build the AI capability in the region, developing its own national AI strategy to be used in education, smart cities, healthcare, infrastructure and transport, among others. Nowadays, Egypt is intensely supporting the AI education program with substantial financial resources to strengthen the capacity built in the field.

Egypt has kicked the ground for an AI strategy and its implementation in the MENA region. Indeed, it is very early days for AI in Egypt, a long way to go to be reaching its ICT vision of 2030 as “AI key contributor in the region”. Having the essential technological infrastructure is mandatory to power AI roadmap for the proposed strategy implementation in Egypt. The government set the roadmap AI initiatives and its constituents, to uplift the AI skills. The Head of ICT & Digital Transformation at global consultancy corporate believe that obtaining a right mix of software development and complex problem skills represents the first step towards driving AI use cases (Wright, 2019). The following section of literature review elaborates on the promises of smart production wave and AI adoption given the complexity of developing countries context.

3. Artificial intelligence and supply chain management

With the advancement and growth of information technology, worldwide competition has become increasingly intense. With artificial intelligence, many firms have predicted that the future of operations and supply chain management (SCM) will alter radically, from planning, scheduling, optimization, and transportation (AI). In terms of SCM, people will become increasingly interested in machine learning, AI, and other intelligent technologies. This research study presents outline of the concepts of AI and SCM and then focus on relevant examination of AI-driven supply chain research and applications. The evolving AI-based business models of various case companies are examined in this exploratory study. Their relevant AI solutions and associated business value are also assessed. As a result, this study outlines value-creation opportunities for the use of AI in the supply chain. It also recommends creating business models for AI supply chain applications.

The supply chain notion has been around for a long time, and it is as old as the products themselves. The supply chain is a broad and integrated term that encompasses all aspects of production and distribution, from suppliers to manufacturers to distributors to end customers. The supply chain’s typical goals are to meet customer demand, increase responsiveness, and build a network among many stakeholders. In terms of its business structure, business tasks, and stakeholders, the supply chain network is becoming increasingly spread, diversified, and transparent (Seyedghorban et al., 2020).

The visibility of the entire supply chain, as well as the degree of information available within a company, is a critical issue for many businesses (Seyedghorban et al., 2020). As a result, the goal of Supply Chain Management (SCM) is to digitize company processes, connect various stakeholders and assets to ensure that products are in synchronisation with consumer expectations, and accomplish overall system competitive advantage goals (Tammela et al., 2008).

ERP (Enterprise Resource Planning), MES (Manufacturing Execution System), PPC (Production Planning & Control), SCADA (Supervisory Control and Data Acquisition), and other traditional IT solutions are dedicated to supporting various business operations in logistics and supply chain (Haas, 2020). To oversee manufacturing throughout whole supply chains, advanced technologies have digitalized practically every operational function (Schiavone & Sprenger, 2017). Due to the dynamic nature of the supply chain, rapidly changing consumer demand, unstructured decision difficulties, and the continuously changing status of business processes, these fragmented solutions are not “intelligent” enough (i.e. not able to behave rationally depending on the environment) and are not very fit for contemporary SCM. It is critical to operate with the utmost efficiency in all important operations and business flows in the supply chain in order to develop intelligent, rapid, and effective business response systems. As a result, more modern IT solutions are needed to deal with multilevel, highly variable industrial operations difficulties in the digitalization process (Seyedghorban et al., 2020).

The applications of Artificial Intelligence (AI) technology have recently gained a lot of interest in several industries (Dubey et al., 2019). AI refers to a machine’s ability to learn from experience and make decisions based on a set of actions, much like a human thinking (Y. Duan et al., 2019). Due to recent advancements in deep neural networks, convolutional neural networks, mathematical optimization techniques are used in operations research, constraint programming, and several

numerical methods. AI also represents an emerging topic in computer science. These advancements have enabled computers to perform things that were previously only possible for humans. The goal of artificial intelligence, according to (Russell & Norvig, 2016), is to “build rational agents who can perceive and act in such a way that some objective function is optimised.” Machine vision, natural language processing, pattern recognition, problem-solving for decision support, and learning systems are examples of this type of work.

The Association for the Advancement of Artificial Intelligence (AAAI) defines AI as “advancing the scientific understanding of the mechanisms underlying thought and intelligent behaviour, as well as its embodiments.” This definition demonstrates that AI is tolerant of a variety of technologies, if not agnostic. As per Russell and Norvig’s Textbook in 2016, AI is the intelligence of machines and software, which is a discipline of computer science that is designed to produce this intelligence. The objective of AI is to comprehend intelligent entities (Soleimani, 2018).

Since the 1960s, the AI research community has been linked to Decision Support Systems DSS and other operations management concepts such as planning and scheduling (Calis & Bulkan, 2015; Nemati et al., 2002). Currently, AI has a broad impact on supply chain management because machine learning and the majority of intelligent technologies begin in SCM. The business case for incorporating AI into SCM is that it can improve supply chain visibility and transparency, as well as improve consumer products/services and customer satisfaction. Many major technology companies, including Amazon, Walmart, Philips, and eBay, have invested in AI for supply chain management (Dwivedi et al., 2019; Mahroof, 2019).

Artificial Intelligence (AI) is an extensive word that encounters a variety of technologies. This concept was coined by John McCarthy around the time of the famous Turing Test in 1950. Since the Dartmouth workshop in 1956, this field has a lengthy history. It did not, however, arouse much enthusiasm at first. AI has been revisited in research fields and applications in recent years, as it has made tremendous development and attracted new attention since the early 2000s. AI is the study and creation of a branch of intelligent agents that are being developed to rationally analyse the environment and execute intelligent actions (Russell & Norvig, 2016; Soleimani, 2018).

Philosophy, mathematics, cognitive science, economics, neurosciences, and linguistics are all origins in AI, and they intersect (Solomonoff, 1985). These fundamental ideas form the foundation of an intelligent system that can mimic human behaviour patterns and handle real-world issues (Min, 2010). For example, philosophy is an important part of how a mechanical or physical system can learn and operate according to a set of rules. Mathematics gives a formal formulation of these algorithms and probability-based rules. Cognitive science is the study of how people think and act, and when applied to AI, it demonstrates how computers think and learn. Linguistics studies the relationship between language and thought. The study of brain function and how brains and computers are (dis)similar is known as neuroscience. The scientific side of AI tries to explain how real humans think. Because of several organisational and environmental circumstances, such as dynamic customer demands, fierce global competition, overall digitization in firms, and a fast changing technology landscape, AI is growing and has become increasingly popular in recent years (Dubey et al., 2019).

Supply Chain Management (SCM) is a difficult topic to grasp. SCM is defined in a number of ways. A supply chain (SC) is a commercial process that frequently spans the globe and involves production, commerce, and logistical firms all over the world (Zijm & Klumpp, 2016). SC is concerned with the management and synchronisation of three flows, namely the product flow from suppliers to ultimate customers, the financial flow of money from customers to suppliers, and the information flow connecting suppliers and customers (Kochak & Sharma, 2015; Li & Liu, 2019). Supply Chain SC symbolises not only the products, but also the full system of organisations, people, resources, and even services from the standpoint of the business entity (Stefanovic & Stefanovic, 2009). SCM solutions are often built to support all key flows across different departments, both within and between corporate organisations, in order to achieve such a high level of sophistication.

According to Gartner, by 2023, at least half of all global enterprises will have integrated AI-related technologies into their IT infrastructure and transformed their supply chain operations (Panetta, 2018). To boost business process automation, companies can combine their SCM solutions with intelligent technology. With increased access into static and real-time data, businesses may make better planning decisions, boost the agility of their digital supply network, save costs, and acquire more comprehensive and broader insights into their supply chains. However, in the field of supply chain management, AI's potential has yet to be completely realised.

AI has surely moved at a glance in recent years. The value chain for supply chain management was established by AI. In today's sectors, AI is persuading business revenue growth and expense reductions. In their daily operations, businesses use a variety of applications. The usage of chatbots in procurement has been proved to be quite beneficial. Demand forecasting is becoming more accurate because to predictive capabilities. It helps to cut down on operational expenditures. Smart warehouses are becoming unique requirement for effective supply chain management activities in the modern day. The revenue of the firms is increasing as a result of automated warehouses. The deployment of AI technologies has improved the data collection and inventory process. Genetic algorithms can be used to strengthen the logistics industry by reducing costs and improving delivery times. In supply chain management, AI can assist in identifying and resolving major issues. Intelligent robotic sorting and AI-powered visual inspection have improved supply chain management significantly.

4. Background

Developing countries have some kind of special requirements with few studies investigating their supply chains (Abd Elghany & Khalifa, 2013). The proposed supply chain measures and approaches were established based on developed industries standards. Several deficiencies are facing producers in developing countries such as: lack of resources, non-integrated and underdevelopment ICT infrastructure, cultural and organisational issues, scarcity of skilled labours and labour-intensive supply chain operations (Khalifa et al., 2008; Ruteri and Xu, 2009; Georgise et al., 2017).

(Georgise et al., 2017) proposed that in order to implement new cutting-edge technologies in such context, it requires substantial financial investment to have a proper implementation. Magder in (2005) presented one of the main studies that well investigated the developing countries context especially in Egyptian apparel industry to end up with several deficiencies experienced due to infrastructure issues. (Rejc Buhovac & Slapnicar, 2007) pointed out, while investigating measurements in Eastern Europe, that any proposed ICT research model should have an intensive look at the context used to measure the impact of such external factors on its expected performance. (Holmes et al., 2006) reached similar outcome to show the influence of resources availability, country politics, and deficiency of the technical and physical infrastructure to significantly defect the production cycle.

Many studies confirmed the fact of having the developing countries suffering of lack of ICT resources and infrastructure, while governmental effort of other Arab developing countries such as Jordan had been paid off and resulted in high-quality ICT facilities (Khasawneh & Ibrahim, 2008). Challenges faced by such countries for further ICT adoption are considered as organizational culture issues of ICT acceptance. The environmental factors had a great effect on the applicability of a particular strategy or tool to be fruitful. The authors conducted previously a thorough investigation of developing countries deficiencies and its impact on supply chain performance (Abd Elghany & Khalifa, 2013; Khalifa et al., 2008). They concluded that the cultural factors impact the supply chain performance in developing countries. Their study outcome is aligned with that other researchers' claim like Barratt in (2004) who designated that the key enablers of supply chain success in developing countries are as follows: culture, trust, information exchange and supply chain performance measures. The study of Fawcett et al. in (2008) as well elaborated on obstacles that face supply chain to pay more attention for "people issues" and cultural issue. The fragmented ICT infrastructure imposes difficulties for implementing advanced technologies (Andersen

et al., 2006). Other factors related to internet services reliability, speed, and bandwidth should also be considered for proper implementation (Georgise et al., 2017).

Frequent supply chain improvements have been aimed such as: elasticity, competence and manufacturing robotics. Hence, there is an emergent need to reduce the production costs; improve the productivity; reduce the cycle times to anticipate rapidly to market changes (Cottyn et al., 2011). Manufacturers admit that digitalizing their production cycle would be the best way to cope with new wave of Industry 4.0 (Fatorachian & Kazemi, 2018). Smart supply chain is taking the lead for better supply chain productivity. The National Institute of Standards and Technology (NIST) defined the smart manufacturing: “fully integrated, collaborative manufacturing system that responds in real time to meet changing demands and conditions in the factory, in the supply network and in customer needs”. Industry 4.0 depends on the following technological aspects: the cloud, internet of things, cyber physical systems, big data, additive manufacturing, artificial intelligence, and autonomous robots (Fatorachian & Kazemi, 2018; Schumacher et al., 2016). (Schumacher et al., 2016) stresses that Industry 4.0 will get better productivity in supply network.

The early establishment of the Intelligent Manufacturing System (IMS) was led by Japan in 1995. Its footprint has been followed by the United States, Korea and European to be considered within Next Generation Manufacturing Systems (NGMS). The emergence of Internet of things into production cycle incorporates its assets with cyberspace. The automation levels differ within different production floor (Kusiak, 2018).

Establishing Industry 4.0 in any supply chain reflects its maturity with the exhibition of its associated resources (Schwab, 2017). “Smart factory” proposes that having “calm systems” will automate systematic process; such interconnected systems will easily enable more robust analytics (Lucke et al., 2008). It is predicted to support the move toward industry 4.0 with modular products and tools to automate its designated production process (Lasi et al., 2014).

The concept of “smart manufacturing” has been introduced as well by (Kusiak, 2018), he proposes that smart manufacturing deploys the internet of things, cloud computing, service-oriented computing, artificial intelligence, and data science. The six pillars of smart manufacturing are manufacturing technology and processes, materials, data, predictive engineering, sustainability, and resource sharing and networking as illustrated in the following.

Manufacturing technology and processes produce innovative materials leading to horizontal design. Deployment of robots, machine sensors will automate the operation and make it smarter. Newly introduced materials require different processes, and additive manufacturing will be beneficial for the handling of such materials. Massive amount of data for customers, material and production cycles can be easily captured by sensors and wireless technology as a basis for further data analysis. Predictive engineering signifies a new pattern of digital representation that helps to make production plan decisions matching market scenarios; for example models, which integrate productivity, product quality, energy and transport. Sustainability is the main criteria that should control the development process in order to grant a sustainable product design and production cycle. It acts as the intermediary between production and customer service. Smart manufacturing definitely requires resource sharing and networking; production machinery, applications, knowledge sometime even extended to joint modelling (Kusiak, 2018). Applications that enable cyber sharing in the production domain are needed.

One more initiative led by the dominant telecom operator in Egypt that provides all telecom services including fixed, mobile voice and data services developed via its deal with Ericsson, a cloud infrastructure that operates the telecom intelligently to enable the cloud Automation (Ericsson News, 2018). The Artificial Intelligence is deployed in such cooperation to visualize the cloud effectively and enable the traffic control inter-layers, in addition to fault detection. CEO at Telecom Egypt confirms that “We are keen to lead the way in the region when it comes to

Artificial Intelligence, as it paves the road for implementation of new technologies across all our markets. Partnering with Ericsson enables us to achieve our strategic goals when it comes to enhanced operational effectiveness and customer experience.” The advantage of cloud adoption is that Telecom Egypt can easily decide on software upgrades and manage them at a low interruption rate.

As clear example of how to optimize customer service, Elves app is another AI application that responds back to user promptly when they inquire the Facebook messaging service asking for help in booking, purchasing, or missing information. The application launched in the United States and extended later on to Egypt and Gulf area. The co-founder partnered with service providers as Rise Up Summit, Gourmet supermarkets and London Cab to guarantee a better and efficient service for the users (Digital Boom, 2017). The service is currently operating worldwide. He expressed that the service reply is operating through AI that is why the team is relatively small to indicate how Elves handle large numbers of messages sent on a daily basis.

One of the key Egyptian initiative led by FonYou to cooperate with the mobile operator in Egypt and provide a personalized service in banking sector, in addition to develop Arabic language chatbot. FonYou believes that the provided services will be a unique one. Fernando Nunez-Mendoza, founder and CEO of FonYou, indicates AI readiness in the Egyptian market and anticipated its potential in the context of their business (Wright, 2019). Number of initiatives led by Egypt in customer service space showed the great potential of Egypt market to explore more AI solutions and excel in its adoption. It was inspiring to elaborate more about AI practices in backend operations and supply chain activities. The motive is to know to what extent are the decision makers orientated and willing to invest in AI solutions. The authors aim to drill down in Artificial Intelligence adoption as a technology perception and the potential of its implementation. The paper questions the main key factors affecting the AI implementation for the supply chain in Egypt and other developing countries. The investigated case studies reveal these critical factors to enhance the supply chain performance in Egypt and similarly in developing countries.

5. Research questions

The research questions of the paper aim to further develop the state of AI adoption in Egypt encountering the standpoint of Supply Chain Management SCM area and its effective performance through conducting a review of several case studies in different industry sectors. The research questions and their objectives are presented below.

RQ1: Which research methodology is employed by the authors?

Objective: To conduct a review of multiple case studies across various industries.

RQ2: What are the Supply Chain Management areas addressed in the context of the AI adoption perspective?

Objective: To recognise the SCM areas; those are frequently linked with AI initiatives and scrutinise the AI application to improve its performance.

RQ3: How the AI adoption is engaged with the business processes across the Supply Chain?

Objective: To determine the AI integration into the Supply Chain business processes.

6. Theoretical foundation

Adoption is the process of using a practice, service, or product that was not developed by the organization adopting the technology (Van de Ven & Poole, 1989). The adoption process comprises problem recognition, solutions search, and course of action decision to address the identified

problem, solution implementation, and sustainable implementation, and in the long run termination (Hage & Aiken, 1970; Tornatzky & Fleischer, 1990; Van de Ven & Poole, 1989).

Innovation principles adoption has been reviewed at organization level by (Aboelmaged, 2014) and at personnel level by (Oliveira & Martins, 2011). Many frameworks have been checked out and e-readiness was created to show the advantages of e-innovation at organization level. Some examples of those frameworks are; e-business (Ifinedo, 2005; Molloy et al., 2010), e-maintenance (Aboelmaged, 2014), and cloud computing (Yang et al., 2015). (Alshawi, 2007) defines e-readiness as personnel or organizations readiness to participate in the development process (Alshawi, 2007). The literature conducted on e-readiness has showed that some factors should be taken into consideration when introducing or adopting new innovation. Those factors such as technology factors with reference to its benefits, compatibility, and its abilities influence the adoption of new technology (Aboelmaged, 2014; Hung, 2014; Idris, 2015; Ifinedo, 2005; Yang et al., 2015). In addition, there are other factors related to firms such as the support from top management (Ifinedo, 2005; Yan et al., 2009) and company size (Aboelmaged, 2014; Duan, 2010; Molla et al., 2010) representing basic organization factors that had direct impact on the e-readiness of Information Systems. Furthermore, there are also some environmental factors that could affect the adoption of new innovations. The environmental factors such as governmental regulations and the competitors pressure (Aboelmaged, 2014; Hung, 2014; Idris, 2015; Ifinedo, 2005; Yang et al., 2015).

(Choucri et al., 2003) stated that e-readiness in the perspective of IS/IT is related to the firm abilities to adopt and get advantage from IT/IS technology. (Salleh et al., 2011) demonstrated that AI contains many items such as firms' structure, strategies, data, operations, and skills in comprehensive sense. Therefore, AI-readiness is not just applying AI technology. Nowadays, many companies are still challenging the adoption of AI because many different issues, such as the implementation of AI that require special skills and the relatively unclear AI-readiness (Curran & Purcell, 2017). AI-readiness indicates the preparedness of the firms to make some changes when implementing the principles of AI technology and its applications. The following presents an in-depth examination of the two frameworks when adopting the AI technologies to proceed with some case studies of AI adoption framework at organization level.

Rogers (1995) concluded that communicating of new ideas by means of culture and established an essential model that was nearly generally present as innovation ideas widespread through a culture. Personnel aspects such as leadership and the firm internal and external aspects have an effect on the "Diffusion of Innovation" DOI innovation adoption (Rogers, 1995). DOI discipline defines five aspects of a new innovation that should be essential for new innovation adoption; the five aspects are relative benefit, compatibility, complexity, trial-ability, and observability. Relative benefit indicates the degree of additional advantages obtained in comparison with current situation. Compatibility related to the well alignment of innovation with the firm's needs and values. Complexity refers to the innovation adoption difficulties. Trial-ability refers to the simplicity of the innovation to use and testing. Finally, observability is related to the range to which the potential innovation is tangible (Rogers, 1995). Many studies was conducted to investigate the DOI at organizational level in different fields such as the adoption of firm resource planning in (Bradford & Florin, 2003), e-business in (Zhu et al., 2006), and cloud computing in (Yang et al., 2015).

(E.M. Rogers, 2003) asserts that innovation is diffused through a population in a social system that dependent on chief attributes such as compatibility conducted by early adopters and he concentrated on the social system from a macro level, which is the organizational level, along with the micro level involving the individual adopters. Rogers' views relied on these three concepts in alignment with the researchers of instructional technology models, which were developed through his studies in 1962, 1995, and 2003. The Technology Adoption Model that was acquired by Davies (1986) has different variables; the perceived usefulness, which is related to the individual's attitudes, beliefs, needs and values, is similar to Rogers' (1962) innovation technology's compatibility concept.

Moreover, the Concern Base Adoption Model emphasises the changes that occur in the system from a macro level but pays zero concern to individual adopters and their behavioural level when applying innovation technologies as change agents from a micro level perspective (G. E. Hall & Hord, 2006; G.E. Hall & Hord, 2014). Conversely, Rogers regarded the change agent as social system that is the organization from a macro perspective while stating that individual adopters convey change that is founded on the organisational changes. Roger's theory can be promoted from a macro level, social systems on a bigger scale, or micro level, concentrating on individual adopters as people. The concept of "People" elaborated in (Surry, 1997), and the model of Resources, Infrastructure, "People", Policies, Learning, Evaluation, and Support demonstrated in (Surry et al., 2003) is similar to the views of Davies (1989), (G.E. Hall & Hord, 2014). They revealed that individual adopters from a micro level perspective affect as well the adoption and diffusion of innovation technologies in the system from a macro level, which is also aligned with Rogers' three concepts.

The "Technology Organization Environment" TOE domain mainly used at the organisational level in order to illustrate the factors affecting the adoption decisions. (Tornatzky & Fleischer, 1990) concluded that the decision-making process for innovation at the organisational level, however, is not based solely on technological factors; it is also influenced by organisational and environmental circumstances. TOE framework examines the companies from three different scales: technology, organisation, and environment. The technological scale involves all the relevant technologies obtainable inside and outside the company. The organisational scale designates business aspects and resources that might have a direct impact on the adoption process such as decision-making and communication, managerial structure, and firm size. The environmental scale refers to the industry structure including the suppliers, competitors, customers, and environmental regulations (Tornatzky & Fleischer, 1990).

The TOE is essentially used in ICT and other domains examinations such as firms' resource planning in (Bradford & Florin, 2003), e-commerce in (Oliveira & Martins, 2011; Idris, 2015) and e-business in (Ifinedo, 2005) and Molloa et al. (2010). The other areas of investigations including e-marketing in Duan (2010), (Yan et al., 2009; Zhai, 2010), e-maintenance in (Aboelmaged, 2014), cloud computing in (Yang et al., 2015). Therefore, TOE has not formerly been used to review the AI adoption at organizational level, the results from recent studies show that the TOE discipline is suitable for the examination of the innovation adoption at organisational level (Aboelmaged, 2014). Accordingly, the e-readiness elements for AI adoption can be implemented with some adjustments such as AI-readiness. For example, individuals' issues and IT infrastructure resources in AI adoption should be considered due to its significant correlation with AI technology and concepts (Oxborough et al., 2018). Hence, enterprise, human, and technology resources constitute the critical elements affecting the AI-readiness.

The previous transformative technologies help SCM businesses in a number of ways. It would be beneficial to investigate AI applications in a variety of industries. A thorough literature review and exploratory case studies are done in this research work. Several examples and probable applications have been offered based on both theoretical and actual study. To compare the various properties of AI in SCM, several case studies are examined. Multiple AI technologies can be seen being employed to make the SC leaner (lower waste) and more efficient. This is consistent with the background section, which concluded that diverse AI technologies interact and are combined to implement an application.

7. Case studies analysis methodology

Analytical case study approach is exploited due its feasibility and attainability because insight could be revealed about organizational decisions and internal processes that contributed to organizational adoption of AI. The data about case studies was gathered after conducting a comprehensive review of organizational innovation and technological adoption. To proceed further in the direction of the organizational adoption of AI-related technologies, the case studies are presented in the following section.

There is a difference between adoption and generation. Adoption is referred firmly to the engagement of an organization of externally developed forms of AI; whereas, generation is related to the organizational efforts to create new and original forms of AI technology. The authors' principal aim was to provide research which precisely could offer insight on organizational readiness towards technological adoption; hence, continuing to confine investigation which is linked to data pertaining to organizational adoption in multi-sector of industry. Gathering data that pertains specifically to organizational adoption of AI was challenging. Information Access about intra-organizational efforts towards AI adoption was even more difficult as internal organizational processes are less transparently shared and not openly communicated.

The selection of the analytical case study approach employed was grounded intensely on what is sought to be known; that is why the qualitative approach was the best research method. Qualitative seeks the understanding of the underlying qualities of entities and processes and their implicit meanings (N. Denzin & Lincoln, 2000). Qualitative researchers point up the nature of reality, the intimate relationship between the researcher and what is studied and the situational constraints formulating inquiry. On the other hand, quantitative studies emphasize the measurement and analysis of causal relationships between variables (Norman K. Denzin & Lincoln, 2003). Quantitative research question typically looks like an interrogative sentence asking a question about the relation between two or more variables. Its purpose is to recognise the variables being investigated and to identify the type of relationship descriptive, predictive, or causal. There exists no clear cut sequence of procedures abide by a neat pattern nevertheless, a messy interaction between the conceptual and empirical world, deduction and induction at the same time (Bryman & Burgess, 1994).

A case study represents a common framework for conducting qualitative research (Stake, 2000). The purpose of case study approach is to get in-depth details about an event, person or process; it is a research method consisting of investigation, collection of data over time, then detailed framing of the phenomena within specific contexts (Hartley, 2004). This method empowers asking a "how" and "why" question concerning a specific event (Yin, 2003). (Yin, 2014) found that a multiple case study approach which is around two or more cases with similar issues is more robust in data analysis and produces more credible result. This method gives allowance to the researcher to choose multiple cases from several different perspectives on the issue. There occur a number of benefits and detriments to various case studies. Multiple case studies provide opportunity for interviewing and documenting real life situations.

(Baxter & Jack, 2008) explained that the case study approach lets the exploration of the issue from different viewpoints. Through the employment of the case study methodology, researchers are binding the case or explaining how the selected group, area or situation is legitimate regarding to parameters allocation on the case. Additionally, they recommended three approaches for case binding: time and activity, time and place, and by definition and context. Data collection in case study analysis is crucial because data collection determines the richness and depth of the insight, which will be deduced from the case study. Researchers identified six major sources in case analysis: direct observation; interview; documents; archival records; participant observation and physical artefacts. One or all of the sources could be used relying on the case nature and its relevance (Leedy & Ormrod, 2005; Stake, 1995; Yin, 1994).

Case study approach has limitations. In accordance with (Stake, 2005), the interest and persistence of a researcher to reveal insight depends on the ability to bring out the rich human attribute that is heavily liable on the researcher's skill to do so. A second possible limitation is the limited scope of the case study design approach. (Yin, 2014) argued that case studies had a restricted range in application to other organizations, or in other words, the transferability of results to other organizations.

8. Case Studies

The following sections attempt to cover multi-industry experience and challenges such as Automotive, Food, and Petroleum industries, of both national and multi-national ones. The sample

considered AI adopters, and non-adopters to understand the reasons hindering them to implement AI solutions and the perception of its implementation.

These case studies are considered an exploratory study to have a primitive finding on AI in Egyptian industries to enable the authors to investigate cases and capture the different perspectives. Interviews were used to learn about these case studies and get insight awareness of business context, applied strategy and experienced challenges and hinder unfold issues. The cross-industry case studies have been illustrated to probe the implication of AI implementation and its potential across the three industries.

8.1. Automotive case study

BMW is one of the world's best auto-makers with luxury sedans, SUVs, and sports cars. It focuses on engineering excellence while delivering cutting-edge design that ensures successful, profitable expansion. BMW is one of the "German Big 3" luxury automakers, along with Audi and Mercedes-Benz, three best-selling automakers for luxurious car in the world. BMW is represented in Egypt by Bavarian Auto Group.

Bavarian Auto Group constructed an assembly factory in 6th of October City, Cairo. The factory established essentially for CKD (Completely Knocked Down) assembly and considered one of the most modern automotive factories in the Middle East region. This factory introduces a new standard that was first implemented by the industry in the region. The total factory area is about 39,000 m² and contains 120 stations with an annual production capacity of 8,000 units of different models and brands. The assembly factory produces a wide range of BMW models (3 Series, 5 Series, 7 Series, X3, and X1).

BMW has implemented the "Assemble To Order" strategy ATO, pre-assembled model-specific components and component groups such as engines, seats or cockpits are delivered to the main assembly plant in Egypt as anticipation of customer orders. Commonly, the components found its way around the world from 17 production facilities around continents. At last, the final Assembly of Egypt is coming by the end. Particular parts are packaged in BMW home plant as kits in precisely defined assembly steps and exported for the assembly facility in Egypt. These kits are then supplemented with locally manufactured parts in the partner country "Egypt". Assembly takes place with adherence to the BMW Group's global quality standards and delivered to the end customer per specifications if any.

BMW has managed their production cycle, the flow of information needed in the production cycle, as well as its suppliers. My SAP automotive system is used by BMW as most recent technology, for data transfer and integration, and facilitates the transfer and integrates the electronic-data substitution between BMW and all its suppliers. My SAP Automotive receives custom-configured manufacturing orders from BMW's planning system. The orders include all the parts required to build each car. My SAP Automotive generates the delivery schedules for each part to match BMW's assembly line planning and sequencing directives. BMW sends these long forecasts and the short as well JIT delivery schedules to its suppliers. Larger suppliers receive the information via electronic data interchange (EDI). Other suppliers access my SAP Automotive Supplier Portal, where BMW posts the requirements to provide up-to-date information on its delivery needs. Using only an Internet browser, suppliers can view this information in real time, including release schedules, purchasing documents, invoices, and engineering documents.

Besides introducing the industry-specific solution, BMW is using SAP applications for its supply chain, financials processes, and human resources practices. BMW firm has also developed Internet applications for their supplier quotes setting-up and production parts analysis process, which have been added to my SAP Automotive Supplier Portal. The system gives the advantage of a great visibility throughout the production cycle: accelerated product development, manufacturing, and delivery. BMW uses XML technology, which allows the company to distribute information apparatus

through the whole company. The basic use of this technology is to design goals; highlight simplicity, generality, and usability over the Internet.

The interviewed persons indicated that the headquarters' high potential in AI adoption and steps undergone by them. BMW Group took the AI initiative forward in production and logistics optimization process. BMW home factory decided to use the state-of-the-art technology for the automotive production management. BMW believes that the use of AI and analytics applications offer the potential to detect sources of error at such an early stage where errors can hardly occur any more.

The automated image recognition was functioning to evaluate constituent images of the continuing production and compares them in milliseconds to hundreds of other images of the same sequence. BMW considers so a one of preventive procedure in which the AI application detects the deviations from the standard process in terms of number of assessable component and sequence of operation. In many cases, the AI technology saves employees effort for repetitive tasks. For example; a mobile standard camera is only needed to record production process. Picturing the module from different positions spots potential deviations on the images. Accordingly, a neural network can easily be fed to be used as reference for automated detection module deficiency detection. The neural network does the optimization process to detect on its own whether or not a component meets the specifications.

Artificial intelligence can assist as well in inspection procedures for the automaker. An AI application associates the vehicle order data with a live image of the model designation of the newly produced car. The generally approved combinations are stored in the image database. In case of discrepancy, warning will be forwarded to inspection unit. BMW showed a great intention to detect the pseudo-defects: deviations from the target, even though there was no actual fault. Using the neural network managed to sort-out the pseudo-defects.

The adoption of AI in logistics is recommended to prevent the transports of empties containers on conveyor belts. The AI application recognizes whether the container needs to be hit onto a pallet for more securing then it will be forwarded the shortest route to the removal station for the forklift truck. Furthermore, developing the virtual layout planning is also enabled by AI applications and accordingly allows engineers to easier simulation of the adaptations on the shop floor. The next section further elaborates on further AI implementation led by leading automaker world-wide to get the perception of the management on AI extension.

Successful adopters spent more than \$200 million on AI. Although most of automotive industry leader embrace AI in its principal strategy, a deliberate rate adoption is crystal clear. In China, the number of automotive companies working at scale with AI almost doubled, from 5% to 9%. It is obviously clear for instance, China's AI giants, such as Baidu's development of the open source Apollo platform. Reluctantly automotive adoption rate in AI might be referred to tangible outcome approached by AI adopter so far.

(Capgemini, 2019) defines "scale champions" as Substantial AI investment:

- Prototyping—General Motors uses machine learning in their product design operations;
- Modeling and simulation—as used by Continental to gather 5,000 miles of virtual vehicle test data per hour;
- Sales and marketing—Volkswagen uses machine learning to predict sales of 250 car models across 120 countries, using economic, political, and meteorological data;
- Quality control—Audi uses computer vision-equipped cameras to detect tiny cracks in sheet metal used in its manufacturing processes, which would not be visible to human eyes;

These demonstrated good enough examples of good AI governance, weighty investment, and willingness to “upskill” employees.

The above case study articulates that the adoption of AI in production and quality control are key concerns for them. Their ultimate dream of self-driving is not achievable so far, rolling back to the origin of AI initiation, efficiency improvement to traditional and manually driven vehicles is the key driver for such adoption. They showed the need of training and acquainting the staff to the AI solution to maximize its perceived value and they revealed as well an understanding of industry pattern of AI slow rate of AI adoption.

8.2. Food case study

A Market share local dominant business in food industries is almost 20 years operating in the Egyptian market and export insensitively to 25 worldwide countries. The Manufacturer is well-know of producing high quality pasta for different consumer segments. The manufacturer operates production lines with total capacity of 11,500 tons monthly.

All manufacturing processes are automatically controlled. After the milling process, semolina is mixed with purified water using a series of filters supplied with a high technology to pull out highly purified water. The Pasta is packed in double-layered polypropylene bags, assuring health preservation. There are 32 shapes of pasta; each type is packed separately in carton boxes to be distributed in the domestic and international market.

The main issues faced by the dominant manufacturer are:

- Unrealistic plan forecast that used to be transformed into overstock prior its marketing;
- Inspection control to optimize the production cycle;
- Nonexistence of IT infrastructure regulating the management process of shipment deliveries/ returns and fleet management.

The business showed a potential to invest in more ICT solutions that can sort-out existing issues, the next section illustrates the following AI solution adopted by food industry worldwide.

The artificial intelligence in the food and beverage market is anticipated to have more than 65.3% 2019–2024 (Mordor Intelligence, 2018). To meet customer expectations, Businesses are implementing artificial intelligence and machine learning to optimize supply chain operations and ensure quality. Usually, the storage of the food is done with the help of manual labour. AI can automate sorting process which would ultimately reduce the labour cost. Such as, Kewpie Corporation, a Japanese food processing company, uses AI enabled Tensor Flow machine learning that can detect anomalies in food. Food business having data analytics capabilities can easily develop its AI platform. The interviewer illustrated the AI adoption by food processing business in Japan as a successful model in food industry (Mordor Intelligence, 2018).

Kewpie, one of key food manufacturing in Japan used machine learning to detect defective potato cubes on their production line. It uses a Neural Networks (CNN) to identify defective versus quality potatoes. A Convolutional neural network was implemented on the Tensor Flow ML framework. A video streaming of the production line is fed to the network to detect the defective potatoes. The system monitors the video feed from the production line, and makes a sound when a defect is detected. The cost saving of such adoption reached \$100,000 per production line.

- AI application used for Weeding—Abundant Robotics developed to pick the right apples, while San-Diego-based Vision Robotics is working on a pair of robots that would labour through orchards plucking oranges.

- AI application to reduce food wastage, AgShift, a deep-learning startup used for food inspection system. It merges the deep learning with computer vision to inspect the produce and other commodities for defects. The deep learning models provide a dashboard of defect analysis, inspection reports and actionable decision.
- AI application used in cleaning processing equipment, SOCIP is a cleaning system that will use artificial intelligence to optimize the cleaning process for food manufacturing equipment.

Management shall demonstrate its willingness to use AI as an indicative measure to tightly control the production cycle, in particular in a sophisticated process (mixing, cutting, or weighting process within production) in order to ensure the quality of the product and avoid any export standard irregularity. Meanwhile, they show fears if the proposed solution to fit well within the business and if management would invest well in technology support especially in the training of human resources to control such solutions. They pointed their experience with SAP implementation and the timeline spent to ensure that such adoption will be successful for the business.

8.3. Petrochemicals case study

The Egyptian Petrochemicals Holding Company, established in 2002 under Egyptian Investment Law, is developing the Petrochemicals Industry in Egypt and implementing the Egyptian Petrochemicals Strategic Development Plan. The cooperative produces a wide range of Polypropylene Product Mix products covering a wide range of Polypropylene product mixes (Homopolymers, Random & Copolymers) that are popular with a wide range of End-User applications. Products are classified into eight major categories: pipe and sheet, extrusion and thermoforming, raffia, fiber, BOPP—film, cast film, injection molding, blow molding (extrusion and injection stretch). It owns two manufacturing plants to produce Polypropylene, one in Suez (Ain Sokhna) and the Other in Port Said in Eljameel Industrial Zone. Each plant consists of two production lines, one for producing products in jumbo bags for the local market and the second for producing products in 25 K for export market. Its production capacity is estimated with 600,000 Polypropylene MT/Year.

Its strategy is to have a flexible supply chain that support the fulfilment of customized orders from customers domestically and internationally with minimum cost and highest customer service level (i.e. balancing between efficient & responsive Supply Chain). Much of the criticism of plastics in recent years has been related to its environmental impact on its disposal to achieve Green Supply Chain. Reduce, Reuse, and Recycle (3 R's) is the hierarchy of solid waste management. IT Strategy is to Produce Polypropylene products that can be conveniently Recycled into new products ample number of times without any significant reduction in strength.

Industry 4.0 of machine learning algorithms and its application in similar industry such as plastic one is common (BiteRefine, 2017). Machine learning is an AI approach in which the machines acquire from its environment or the datasets given. Rather than the predictable parameter managed by operator's experience, main dataset referred to is the historical data, recorded by sensors from the particular moulding equipment.

Machine learning collects sets of intermediate readings from sensors within the cycle final to be compared with product required one. After running the learning process, it defines the dependencies between intermediate parameters and quality of the product. It sets the prediction model automatically; machine learning model is used solidly to predict types of fault. Such ML solution captured the interest of the decision maker in the case study to enable quality prediction in early stage of production and save time and cost for re-production process.

Another ML solution is the predictive maintenance systems, in which the industry player uses to avoid downtime by providing early warning for critical machine failures. ML models estimate the times when the equipment would need maintenance servicing. The decision makers have pointed

that such solution is promising one to be adopted by their side as a preventative maintenance for downtime minimization. This shall avoid any delay in production cycle and accelerate the lead time. The management expressed their willingness to invest more in AI especially in production process. They confirmed such proposed solution can address the challenging dilemma of how to reduce the production costs, production waste meanwhile enhancing the product quality. The interviewee articulated their concerns on financial investment and devotion of top management to support that investment.

9. Case studies summary key points

BMW has managed their production cycle and the flow of information through My SAP automotive system which is practiced by BMW as the most recent technology for data transfer. It facilitates its transfer and integrates the electronic-data substitution between BMW and all its suppliers. Nevertheless, BMW used to post the requirements in order to make up-to-date information available on its delivery needs. BMW firm has also developed Internet applications for their supplier quotes setting-up and production parts analysis process, which have been added to my SAP Automotive Supplier Portal. BMW Group took the AI initiative forward in production and logistics optimization process. BMW home factory was determinant to use the state-of-the-art technology for the automotive production management and thought that the use of AI and analytics applications provides the potential to discover sources of error at such an early stage where errors can be repeated more to grant better assessment in sequence of operation. Reluctantly automotive adoption rate in AI might be referred to tangible outcome approached by AI adopter so far.

Food industry showed a potential to invest in more ICT solutions such as Kewpie Corporation, a Japanese food processing company, which uses AI-enabled Tensor Flow machine learning for anomalies detection in food and also machine learning for defective potato cubes' detection as well on their production line. AI technology was applied to decrease food waste as AgShift, a deep-learning startup used for food inspection system, and to optimize the cleaning process for food manufacturing equipment as SOCIP. The management designates their readiness to take AI indicative to firmly control the production cycle, particularly when it comes to sophisticated processes such as mixing, cutting or weighting to ensure the product quality requirements and preclude any export standard irregularity.

The Petrochemical corporate produces a wide range of Polypropylene Product Mix including Homopolymers, Random & Copolymers which are identified as popular End-User applications. Each plant entails two production lines, one for producing products in jumbo bags for the local market and the second for producing products in 25 K for export market. IT Strategy is adopted to produce Polypropylene products that can be appropriately Recycled into new products several times without any substantial reduction in strength. Such ML solution enables quality prediction in early stage of production, lessens production waste, and saves time and cost for re-production process.

10. Case studies discussion

There is a great potential across industry to adopt AI solutions. There is as well an emphasis on considering the perception of the new technology adoption and its importance from user and management perspectives. Resistance to change and labour forces are the main common concern that faces case studies while moving forward in AI initiative. The technology acceptance model (TAM) introduced by (Davis, 1989) is strongly recommended to assess the applicability of AI prior adoption especially in developing countries context. It claims that perceived usefulness and perceived ease of use are the main determinant to detect the user intention to adopt an innovation (Lee, Kozar, & Larsen, 2003). (Alkalbani et al., 2013) used Davis's model in their study and indicated a number of barriers of ICT implementation in developing countries. "People issues" was listed as key consideration of new technology adoption in such context.

The management should pay consideration for organizational culture. The user-resistance may facilitate or inhibit the integration of AI systems. Managing change is vital for putting the system

in-practice and might be critical to the implementation success. Lack of technical expertise interferes to not having workable automated systems. For that reason, (Georgise et al., 2017) propose to have a “process-oriented model” through which the measurement of supply chain performance is applicable. They asserted that despite the value of internationally developed model, its adoption in the developing context will entail additional resource and management support.

Other issues related to financial resources: cost of systems and cost of training are indicated as well as key constraints on decision makers to have such investments. Moreover, authors believe that appropriateness of the technology is a key issue experienced by most of business in the developing countries. Most probably, developed countries adopt ICT to align their business process to their performance measure (Leonard-Barton, 1988). However, the trendy and newly released technologies are most common to be adopted in ad-hoc manner in developing countries (Archibugi & Pietrobelli, 2003).

Plugging newly introduced and trendy technology does not ensure its utilization (Dey et al., 2013), system users play crucial role of its successful implementation. Their involvement in decision making either in technology selection, customization phase’s redesign, is mandatory for system acceptance (Mackay & Gillespie, 1992). Degree of system usefulness may not be perceived equally by users, (Salovaara and Tamminen, 2009). Management should pay significant consideration to “user-defined technology use” or “technology appropriation” (Dey et al., 2013).

There is an interrelation between technology appropriation and the environment setting implementing the technology. User expertise and knowledge prior the technology adoption in business is crucial. Management should pay attention to users and their mutual support to the adopted technology (Draxler et al., 2012). It is admitted to have a significant gap in the perception and maturity of ICT in developing and developed countries (Yao et al., 2007). Management should focus on user acceptance as key enablement of ICT success (Davis, 1989). Davis’s model stresses on the necessity of user motivation, potentials of task-oriented performance, and advantages of end-users’ adoption (Davis, 1989).

Authors believe that it is necessary to have task-oriented performance and to guide users to AI practices prior to their adoption in order to ensure that the investment is justified. TAM is considered as solid theoretical model for associating technology and its user perception and performance. Considering these two determinants will enable decision makers to have a smooth adoption of AI technology as demonstrated in the three coming subsections.

10.1. AI implementation strategy in Egypt

AI is rapidly evolving as contemporary technology to enhance service provided by digital assistants and chat bots. Artificial intelligence is major target of ICT roadmap for 2030 vision for MENA region. GCC and Egypt’s economies are willing to invest \$320 billion. Such investment is expected to have a fruitful outcome that exceed Far East one. It has been estimated with \$6.6 trillion of increased productivity, while \$9.1 trillion of consumers benefits (Trade Arabia, 2019).

The Minister of Higher Education and Scientific Research in Egypt estimated that AI will contribute to 7.7 per cent of Egypt’s GDP in 2030, meanwhile the average of annual growth rate of AI in the region will reach 25.5 per cent between 2018 and 2030. He did highlight that Egypt seeks to be one of key producer in that field (Egypt Independent, 2019). It is predictable to have UAE and Saudi Arabia to particularly advantage from the adoption of AI to almost 14 per cent of UAE GDP by 2030 followed by KSA at 12.4 per cent and lastly Egypt at 7.7 per cent (Trade Arabia, 2019). The greatest substantial benefits of artificial intelligence will be obvious in construction and manufacturing sectors, which might reach a third of the entire benefits to MENA region, equivalent to almost \$100 billion by 2030 (Trade Arabia, 2019).

Egypt is one of the leading developing countries that targets the technological development via “Sustainable Development Strategy: Egypt’s Vision 2030”, Egypt is developing its national strategy in AI and established AI national council to set a roadmap for research and development of emerging technologies in multi-sector such as health care, agriculture, education, smart cities, energy, infrastructure and transport (Egypt Independent, 2019). Healthcare is one of the candidate sectors that Artificial intelligence can revolutionize in the upcoming 10 or 15 years. South Korea has spent \$2 billion in investments in artificial intelligence, particularly in health care (Egypt Today, 2019). Minister of Communications and Information Technology in Egypt highlighted the crucial role of ICT in development and the government endeavours to cope with technological trends and move towards the digital economy and announced that Egypt is looking forward to global partnerships for the implementation of a national strategy for artificial intelligence (AI) within three to five years (MCIT, 2019).

10.2. IT company perspective

IT vendor in Egyptian market showed a good indicator to follow government steps and adopt AI practices. The general manager of IBM in Egypt shows that his enterprise supports small and medium enterprises (SMEs) with cloud computing and data analytics solutions, IBM is contributing as well to make the New Administrative Capital as the capital to be the first smart city in Egypt (Daily News Egypt, 2017). As one of promising market to operate in, Egypt is one of the developing countries pursuing economic reform with steady measures. This resembles to international community and foreign investment. Its implications are obvious in governmental positive attitude for further investment in IT sector. IBM believes that “*The flotation of the pound has increased Egypt’s potential in the IT sector to be competitive against other strong countries, such as India, the Philippines, Poland, Vietnam, and Romania*” (Daily News Egypt, 2017). Several AI initiatives took place in the Egyptian market; Head of Ericsson Middle East and Africa declare its cooperation with Egypt telecom. This successful pilot presents an opportunity for operators to deploy Artificial Intelligence on a wider scale to build global standard agile networks and speed up the introduction of new services.

10.3. Human upskilling and orientation

The new trend of production automation will be triggered by next generation of low-cost robotics. Smart manufacturing has cons and pros. The main issue might face the smart manufacturing is user-acceptance. The adoption of production automation will imply “cyber” jobs instead of manual jobs which need skilled workforce (Kusiak, 2018). Egypt, similarly to other countries, experience shortage of AI experts and AI-knowledgeable managers. There will be challenging issue for the extensive adoption of AI (Wright, 2019). IT vendors signed an agreement with the Supreme Council of Universities to reach more than 30 universities to train more than 5,000 students on using technology in their fields of study (Daily News Egypt, 2017).

Since Clegg, Courpasson, and Phillips (2006) confirm that organizational theories’ main concerns were to be created within the postulation that the individual represent an element in an organization perceived as a system. AI skills supply is one part of the puzzle while the other part comes leveraging the skills like identifying projects, use cases, and developing a cohesive ecosystem where Egypt’s key challenges lie. Individuals are the principal building blocks of any organization (Alkalbani et al., 2013), EgyRobo first robotics facilities in the country and region, stressed on the need of AI resources accessibility and governmental support for AI capacity investments. There exist many young people working in this field who are eager to learn and upskill nevertheless, they lack resources. They need more support and encouragement to expand their activities and establish their companies. No doubt Egyptian enterprises embrace AI (Wright, 2019).

Meanwhile, the government is looking to develop AI capabilities in a number of ways, including launching its first AI faculty at Kafr El Sheikh University. Egypt is aiming to have 7.7 per cent of its GDP derived through AI by 2030, a figure touted in the PricewaterhouseCoopers (PwC) report, The Potential Impact of AI in the Middle East (Wright, 2019). Executive director at professional services

firm express that Egypt's greatest risk is success in the vision of training up Egyptians in AI. He also believes that Egypt needs a primary education plan to feed these higher education aspirations (Wright, 2019).

11. Contribution to knowledge

The purpose of this research paper is to examine the state of AI adoption research in supply chain management for the improvement of its performance and obtaining effective integrated processes. To achieve this, a systematic review is conducted on the basis of a qualitative case study analysis approach. Foremost results showed that AI implementation can be viewed as a leverage mechanism for the enhancement of intra and inter-activities across the supply chain; integration of supply chain; the reinforcement of data transfer in product development and the fulfilment of its quality standards; procurement/supplier management; supply chain collaboration; and customer relationship management. Other supply chain management areas such as inventory management, forecasting/demand planning, and risk management have been discovered to some extent. Findings concerning managerial issues theoretical perspectives are described below in the coming section.

This effort must be accomplished via the acceptance of AI adoption technology by practitioners and decision makers. The above puts in evidence that in order to carry on achieving a solid contribution to the theory construction in the AI field within the supply chain management context in Egypt and other developing countries leading to useable and reliable AI implementation frameworks.

12. Findings

With minimum human input, AI can streamline every aspect of demand, inventory, and supply. It's also good at precise planning, which makes supply chain management operations more dependable. The function of AI in logistics is remarkable, as it allows for speedier transportation than ever before. They are saving money and time by using autonomous vehicles in the logistical process. AI gives businesses access to real-time and multi-source data that they may utilise to transform supply chain management.

Process automation and process optimization for SC tasks are made easier with the right IT infrastructure. Reduced decision-making time or decision support appear to be some common aims for these intended and predicted outcomes. Computers can pre-screen order paperwork, anticipate sales, and plan manufacturing, but the final decision is made by a human. Better planning has been done, although the processes are still not completely self-contained. A single individual can manage a huge number of cases while focusing on higher-level issues. This results in a faster response time and higher throughput of the process. Repetitive jobs will require less human resources. This has an impact on back-office work, which is required to complete the paperwork between company units such as client front end, production, and services. Process automation, when integrated with decision assistance, has a direct influence on professions that require little knowledge and are primarily concerned with managing goods. Increasing capacity utilisation is a typical goal for many planning initiatives. Artificial intelligence can carry out operations that provide humans with near-real-time advice on how to improve the current setting. Learning from the past and predicting future situations are two examples of practical applications. Smart connected equipment, as well as production-related assets and other resources, all strive for higher utilisation.

The supply chain (SC) is critical for transporting items over long distances and for interconnectivity among various stakeholders, including raw material suppliers, manufacturers, retailers, logistics businesses, and consumers. As a result, a good and efficient SC means that these connections can be created accurately, fast, and cheaply. Information exchange, process integration, and collaboration are essential success elements for SC (Fatorachian & Kazemi, 2020). As a result, SC will have to become more digitalized and reliant on technology in the form of IoT and sensors across the SC, allowing them to collect data in real time. The research was prompted by the current increase in AI implementation. Many studies show that AI has been widely implemented in SC and has generated the highest value in the manufacturing business (Chui & Malhotra, 2018).

The outcomes of widespread AI use have been helpful in enhancing supply chain management. AI and AI applications are, in general, some of the most fascinating and valuable current academic disciplines. Artificial intelligence is used not just in humans' daily lives, but also in operations and supply chain management. AI-based SC is a fully integrated technology and management solution that uses data and intelligent technology to achieve intelligent outcomes: automation, intelligence, integration, network, and synergy.

Supply chain management is evolving into an autonomous SC with self-awareness, self-governing and self-determining, and self-optimizing qualities as a result of AI integration. The research study fills a vacuum in the literature by summarising recent research and investigating real-world instances in supply chain management. The findings provide a comprehensive and useful understanding of AI adoption in dynamic situations for supply chain management. This study adds to both theory and practical management techniques.

Because this research was conducted using exploratory case studies, it has the potential to pave the way for the growth and emergence of AI in SCM, as well as impact SCM's commercial performance. It may also open up new research possibilities in the future. It addresses the important success elements of AI deployment in SCM, for example. Future research should look into the organisational and cultural elements that influence the adoption of an AI operational view in supply chain management. Although AI has a lot of potential in SCM, it still has a long way to go before it realises its full potential.

13. Conclusion

The development of digital skills and higher cognitive skills as a national advantage is a long complex effort and requires a 30-year vision and associated strategy. Egypt should set a more holistic strategy that articulate to MENA to comprehend its ambitions and endeavours of AI initiative (Wright, 2019). Establishment of AI programmes is desperately needed for the initiative in Egypt. The expected joint collaboration between academia and ICT vendors to define AI key pillars and government support of fund of potential AI projects will strengthen this initiative. Egypt should address the risk of AI brain drain (Wright, 2019). The Management is eager to upgrade the production system to improve the productivity even with that fact of having outdated technology in number of production floors. Limited connectivity and resources besides needs to have more trained labour are still a challenge for emergence of new technologies and tools (Georgise et al., 2017).

Supply chain managers could find the results of this paper useful in the improvements that could be applied to supply chain coordination. An interesting finding is that the cultural environmental aspect influencing the AI technology adoption including readiness, skills, companies' operating setting up, and resources, which makes appealing implications for managers to take into consideration in the evaluation of coordination mechanisms. The role of IT support and organisation strategy embraced is found to be extremely significant in effective supply chain collaborations and its performance. The fundamental identified benefits are: cost saving, inventory reduction, visibility increase, time waste lessening etc.

Indigenous knowledge is the interesting knowledge limited to a specific culture or society. It is additionally known as local knowledge, society knowledge, people's knowledge, conventional shrewdness, or conventional science. This knowledge is produced and transmitted by communities, over time, to manage with their socio-economic situations and surroundings (Fernandez, 1994). It is created through a precise process of local conditions' observations, carrying out experiments with solutions, and readapting already recognized solutions to altered natural, socio-economic, and innovative circumstances.

The culture has a significant impact on the development, adaptation, and use of indigenous knowledge. Indigenous knowledge is likewise influenced by economic, social, political, and geographic circumstances, albeit to a lesser extent. As a result, indigenous knowledge systems vary

greatly not only across ethnic groups but also between geographical places. The indigenous knowledge systems of the local people can teach us a lot. Academics, policymakers, and planners all need to pay more attention to this priceless wealth of information that is on the verge of extinction. It is needed to learn a lot from the experts/specialists, the indigenous knowledge gurus, in case of moving away from the traditional transfer of technology approach and going forward to the development of interactive technology.

The limitation of research paper encompasses the aspects of search period and the case study qualitative approach drawbacks as described in the methodology section. Moreover, its implication for Egypt which is needed to be widened to other developing countries. Accordingly, it can be concluded that there is a greater need to study more in supply chain management and its integrated performance in other developing countries. Further studies are essential on how to align the AI perceived value to developing countries context to maximize its benefits and engage the businesses there in the global competition.

Funding

The authors received no direct funding for this research.

Author details

Nermin Khalifa¹

E-mail: nermine_khalifa@aast.edu

Mona Abd Elghany²

E-mail: monam@aast.edu

Marwa Abd Elghany¹

E-mail: marwam@aast.edu

ORCID ID: <http://orcid.org/0000-0001-9128-0703>

¹ Business Information Systems Department, College of Management And Technology, Arab Academy For Science and Technology, Alexandria, Egypt.

² Marketing And International Business Department, College of Management And Technology, Arab Academy For Science and Technology, Egypt.

Citation information

Cite this article as: Exploratory research on digitalization transformation practices within supply chain management context in developing countries specifically Egypt in the MENA region, Nermin Khalifa, Mona Abd Elghany & Marwa Abd Elghany, *Cogent Business & Management* (2021), 8: 1965459.

References

- Abd Elghany, M., & Khalifa, N. (2013). "A survey of the challenges facing textile fabrication in Egypt", *International Conference on Manufacturing, Mining and Automobile Engineering (ICMMAE'2013)*, Phuket Thailand, pp. 65–69.
- Aboelmaged, M. G. (2014). Predicting E-readiness at firm-level: An analysis of Technological, Organizational and Environmental (TOE) effects on E-maintenance readiness in manufacturing firms. *International Journal of Information Management*, 34(5), 639–651. <https://doi.org/10.1016/j.ijinfomgt.2014.05.002>
- Alkalbani, S., Rezgui, Y., Vorakulpipat, C., & Wilson, I. E. (2013). ICT adoption and diffusion in the construction industry of a developing economy: The case of the sultanate of Oman. *Architectural Engineering and Design Management*, 9(1), 62–75. <https://doi.org/10.1080/17452007.2012.718861>
- Alshawi, M. (2007). *Rethinking IT in construction and engineering: Organisational readiness*. Routledge.
- Archibugi, D., & Pietrobelli, C. (2003). "The globalisation of technology and its implications for developing countries windows of opportunity or further burden? *Technological Forecasting & Social Change*, 70(9), 861–883. [https://doi.org/10.1016/S0040-1625\(02\)00409-2](https://doi.org/10.1016/S0040-1625(02)00409-2)
- Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, 13, 544–559.
- BiteRefine, (2017, November 30), "Machine learning: The innovation in plastic industry", Accessible through: <https://bitrefine.group/industries/big-data-manufacturing/107-articles/ml-articles/manufacturing-ml-article/267-source-of-innovation-for-plastic-industry>
- Bradford, M., & Florin, J. (2003). Examining the role of innovation diffusion factors on the implementation success of enterprise resource planning systems. *International Journal of Accounting Information Systems*, 4(3), 205–225. [https://doi.org/10.1016/S1467-0895\(03\)00026-5](https://doi.org/10.1016/S1467-0895(03)00026-5)
- Bryman, A., & Burgess, R. G. (1994). *Analysing qualitative data*. Routledge. <https://doi.org/10.4324/9780203413081>
- Calis, B., & Bulkan, S. (2015). A research survey: Review of AI solution strategies of job shop scheduling problem. *Journal of Intelligent Manufacturing*, 26(5), 961–973. <https://doi.org/10.1007/s10845-013-0837-8>
- Capgemini (2019, March 26), "Uptake on large scale AI projects stalls, however research shows successful adoption can add millions to operating profit", Accessible through: <https://www.capgemini.com/news/ai-in-automotive-report/#>
- Choucri, N., Maugis, V., Madnick, S., Siegel, M., Gillet, S., & O'Donnel, S. (2003). *Global E-Readiness - for What*. Center for eBusiness at MIT.
- Chui, M., & Malhotra, S. (2018). *AI adoption advances, but foundational barriers remain*. McKinsey & Company.
- Cottyn, J., Van, L. H., Stockman, K., & Derammelaere, S. (2011). A method to align a manufacturing execution system with lean objectives. *International Journal of Production Research*, 49(14), 4397–4413. <https://doi.org/10.1080/00207543.2010.548409>
- Curran, R., & Purcell, B. (2017). The forrester wave: Artificial intelligence technologies. *Q1*, 2017, 5.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340. <https://doi.org/10.2307/249008>
- Denzin, N., & Lincoln, Y. (2000). The discipline and practice of qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 1–32). Sage.
- Denzin, N. K., & Lincoln, Y. S. (2003). *Collecting and Interpreting Qualitative Materials*. SAGE Publications.
- Dey, B. L., Binsardi, B., Prendergast, R., Saren, M., & Slater and Constantine Andriopoulos, S. (2013). A qualitative enquiry into the appropriation of mobile telephony at the bottom of the pyramid. *International Marketing Review*, 30(4), 297–322. <https://doi.org/10.1108/IMR-03-2012-0058>

- Duan, Y., Edwards, J. S., & Dwivedi, Y. K. (2019). Artificial intelligence for decision making in the era of Big Data – Evolution, challenges and research agenda. *International Journal of Information Management*, 48, 63–71. <https://doi.org/10.1016/j.ijinfomgt.2019.01.021>
- Dubey, R., Gunasekaran, A., Childe, S. J., Bryde, D. J., Giannakis, M., Foropon, C., Hazen, B. T., & Hazen, B. T. (2019). Big Data Analytics And Artificial Intelligence Pathway To Operational Performance Under The Effects Of Entrepreneurial Orientation And Environmental Dynamism: A study of manufacturing organisations. *International Journal of Production Economics*, 226, 107599. <https://doi.org/10.1016/j.ijpe.2019.107599>
- Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick Galanos, T. (2019). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, 101994.
- Egypt Today, (2019, March 17), “Investing in artificial intelligence is essential for health care: British entrepreneur”, Accessible through <https://www.egypttoday.com/Article/1/67167/Investing-in-artificial-intelligence-is-essential-for-health-care-British>
- Fatorachian, H., & Kazemi, H. (2018). A critical investigation of industry 4.0 in manufacturing: Theoretical operationalisation framework. *Production Planning and Control*, 29(8), 1–12. <https://doi.org/10.1080/09537287.2018.1424960>
- Fatorachian, H., & Kazemi, H. (2020). Impact of Industry 4.0 on Supply Chain Performance. *Production Planning & Control*, 32(1), 1–19.
- Fernandez, M. E. (1994). Gender and indigenous knowledge, indigenous knowledge & development monitor. 2, 6–7.
- Georgise, F. B., Wuest, T., & Thoben, K.-D. (2017). SCOR model application in developing countries: Challenges & requirements. *Production Planning & Control*, 28(1), 17–32. <https://doi.org/10.1080/09537287.2016.1230790>
- Haas, A. (2020). Logistics and supply chain intelligence. In A. Kolinski, D. Dujak, & P. Golinska-Dawson (Eds.), *In integration of information flow for greening supply chain management* (pp. 111–129). Springer.
- Hage, J., & Aiken, M. (1970). *Social change in complex organizations*. Prentice-Hall.
- Hall, G. E., & Hord, S. M. (2006). *Implementing change: Patterns, principles, and potholes* (2nd ed.). Allyn and Bacon.
- Hall, G. E., & Hord, S. M. (2014). *Implementing Change: Patterns, Principles and Potholes* (4th ed.). Pearson.
- Hartley, J. (2004). Case study research. In C. Cassell & G. Symon (Eds.), *Essential guide to qualitative methods in organizational research* (pp. 323–333). Sage Publications Ltd.
- Holmes, J., de Gutierrez, P., Sheila, A., & Kiel, L. D. (2006). Reforming government agencies internationally: Is there a role for the balanced scorecard? *International Journal of Public Administration*, 29(12), 25–45. <https://doi.org/10.1080/01900690600854803>
- Idris, A. O. (2015). Assessing a theoretically-derived E-readiness framework for E-commerce in a Nigerian SMEs. *Evidence Based Information Systems Journal*, 1(1).
- Ifinedo, P. (2005). Measuring Africa’s E-readiness in the global networked economy: A nine-country data analysis. *International Journal of Education and Development Using ICT*, 1(1).
- Khalifa, N., White, A., & ElSayed, A., (2008), “Supply chain challenges in developing countries: Cross industry case studies”, *7th IEEE International Conference on Cybernetic Intelligent Systems, CIS Cybernetic Intelligent Systems 2008*, pp. 1–8.
- Khasawneh, M. M. F., & Ibrahim, H. B. H. (2008). Toward an information and communication technology development in developing countries. *Communications of the IBIMA*, 4(17), 135–140.
- Kochak, A., & Sharma, S. (2015). Demand forecasting using neural network for supply chain management. *International Journal of Mechanical Engineering and Robotics Research*, 4(1), 96–104.
- Kusiak, A. (2018). Smart manufacturing. *International Journal of Production Research*, 56(1–2), 508–517. <https://doi.org/10.1080/00207543.2017.1351644>
- Lasi, H., Fettke, P., Kemper, H.-G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business and Information Systems Engineering*, 6(4), 239–242. <https://doi.org/10.1007/s12599-014-0334-4>
- Leedy, P. D., & Ormrod, J. E. (2005). *Practical research: Planning and design*. Prentice Hall.
- Leonard-Barton, D. (1988). Implementation as mutual adaptation of technology and organization. *Research Policy*, 17(5), 251–267. [https://doi.org/10.1016/0048-7333\(88\)90006-6](https://doi.org/10.1016/0048-7333(88)90006-6)
- Li, Q., & Liu, A. (2019). Big data driven supply chain management. *Procedia CIRP*, 81, 1089–1094. <https://doi.org/10.1016/j.procir.2019.03.258>
- Lucke, D., Constantinescu, C., & Westkämper, E. (2008). Smart factory a step towards the next generation of manufacturing. *Manufacturing Systems and Technologies: The 41st CIRP Conference on Manufacturing Systems*, 1 (1), 115–118. Tokyo Japan
- Mackay, H., & Gillespie, G. (1992). Extending the social shaping of technology approach: ideology and appropriation. *Social Studies of Science*, 22(4), 685–716. <https://doi.org/10.1177/030631292022004006>
- Mahroof, K. (2019). A human-centric perspective exploring the readiness towards smart warehousing: The case of a large retail distribution warehouse. *International Journal of Information Management*, 45, 176–190. <https://doi.org/10.1016/j.ijinfomgt.2018.11.008>
- Micic, L. (2017). Digital transformation and its influence on GDP. *ECONOMICS*, 5(2), 135–147. <https://doi.org/10.1515/eoik-2017-0028>
- Min, H. (2010). Artificial intelligence in supply chain management: Theory and applications. *International Journal of Logistics Research and Applications*, 13(1), 13–39. <https://doi.org/10.1080/13675560902736537>
- Mordor Intelligence (2018), “ARTIFICIAL INTELLIGENCE (AI) IN FOOD & BEVERAGES MARKET - GROWTH, TRENDS, AND FORECAST (2019-2024)”, Accessible through: <https://www.mordorintelligence.com/industry-reports/artificial-intelligence-in-food-and-beverages-market>
- Nemati, H. R., Steiger, D. M., Iyer, L. S., & Herschel, R. T. (2002). Knowledge warehouse: An architectural integration of knowledge management, decision support, artificial intelligence and DATA WAREhousing. *Decision Support Systems*, 33(2), 143–161. [https://doi.org/10.1016/S0167-9236\(01\)00141-5](https://doi.org/10.1016/S0167-9236(01)00141-5)
- Oliveira, T., & Martins, M. F. (2011). Literature review of information technology adoption models at firm level. *The Electronic Journal Information Systems Evaluation*, 14(1), 110–121.
- Oxborough, C., Cameron, E., Rao, A., Birchall, A., Townsend, A., & Westermann, C., (2018), *Explainable AI: Driving business value through greater understanding*. Retrieved from PWC website: <https://www.pwc.co.uk/audit-assurance/assets/explainable-ai.pdf>
- Panetta, K., (2018), “Gartner Predicts 2019 for Supply Chain Operations,” Smarter with Gartner. Available at:

- <https://www.gartner.com/smarterwithgartner/gartner-predicts-2019-for-supply-chain-operations/>
- Rejc Buhovac, A., & Slapnicar, S. (2007). The role of balanced, strategic, cascaded and aligned performance measurement in enhancing firm performance. *Economic and Business Review for Central and South-Eastern Europe*, 9(1), 47–59.
- Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). Free Press.
- Russell, S. J., & Norvig, P. (2016). *Artificial intelligence: A modern approach*. Pearson Education Limited.
- Salleh, H., Alshawi, M., Sabli, N. A. M., Zolkafli, U. K., & Judi, S. S. (2011). Measuring readiness for successful Information Technology/Information System (IT/IS) project implementation: A conceptual model. *African Journal of Business Management*, 5(23), 9770–9778.
- Schiavone, F., & Sprenger, S. (2017). Operations management and digital technologies. *Production Planning & Control*, 28(16), 1281–1283. <https://doi.org/10.1080/09537287.2017.1375151>
- Schumacher, A., . S., Erol, S., & Sihm, W. (2016). A maturity model for assessing industry 4.0 readiness and maturity of manufacturing enterprises. *Procedia CIRP - Changeable, Agile, Reconfigurable and Virtual Production*, 52(1), 161–166.
- Schwab, K. (2017). *The fourth industrial revolution*. Crown Business.
- Seyedghorban, Z., Tahernejad, H., Meriton, R., & Graham, G. (2020). Supply chain digitalization: Past, present and future. *Production Planning & Control*, 31(2–3), 96–114. <https://doi.org/10.1080/09537287.2019.1631461>
- Soleimani, S. (2018). A perfect triangle with: artificial intelligence, supply chain management, and financial technology. *Archives of Business Research*, 6(11), 5681. <https://doi.org/10.14738/abr.611.5681>
- Stake, R. E. (1995). *The art of case study research*. SAGE.
- Stake, R. E. (2000). Case Studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 435–453). Sage.
- Stake, R. E. (2005). Case Studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (3rd ed., pp. 443–454). Sage Publications.
- Stefanovic, N., & Stefanovic, D. (2009). Supply chain business intelligence: Technologies, issues and trends. In *In Artificial Intelligence: An international perspective* (pp. 217–245). Springer.
- Surry, D. W., (1997), “Diffusion theory and instructional technology”, *Proceedings of the Annual Conference of the Association for Educational Communications and Technology (AECT)*, Albuquerque, New Mexico February 12–15, 1997.
- Surry, D. W., Ensminger, D. C., & Jones, M., (2003), *A model for integrating instructional technology into higher education*, Retrieved from <http://iphase.org/papers/RIPPLES.rtf>
- Tammela, I., Canen, A. G., & Helo, P. (2008). Time-based competition and multiculturalism: A Comparative Approach to the Brazilian, Danish and Finnish furniture industries. *Management Decision*, 46(3), 349–364. <https://doi.org/10.1108/00251740810863834>
- Tornatzky, L. G., & Fleischer, M. (1990). *The Processes of Technological Innovation*. Lexington Books.
- Van de Ven, A. H., & Poole, M. S. (1989). *Methods for studying innovation processes*. In A. H. Van de Ven, H. L. Angle, & M. S. Poole (Eds.), *Research on the management of innovation* (pp. 31–54). Harper & Row.
- Wright, B. (2019, September 10), “Egypt sets its sights on artificial intelligence”, *CIO*, Accessible through: <https://www.cio.com/article/3435110/egypt-sets-its-sights-on-artificial-intelligence.html>
- Yan, J., Zhai, C., & Zhao, F., (2009), “An empirical study on influence factors for Organizations to Adopt B2B E-Marketplace in China,” *Management and service science, 2009 MASS’09 International Conference on: IEEE*, pp. 1–6.
- Yang, Z., Sun, J., Zhang, Y., & Wang, Y. (2015). Understanding SaaS adoption from the perspective of organizational users: A tripod readiness model. *Computers in Human Behavior*, 45(45), 254–264. <https://doi.org/10.1016/j.chb.2014.12.022>
- Yao, L. J., Kam, T. H. Y., & Chan, S. H. (2007). Knowledge sharing in Asian public administration sector: The case of Hong Kong. *Journal of Enterprise Information Management*, 20(1), 51–69. <https://doi.org/10.1108/17410390710717138>
- Yin, R. K. (1994). *Case study research: Design and method*. Sage Publications.
- Yin, R. K. (2003). *Case study research: Design and methods*. Sage.
- Yin, R. K. (2014). *Case study research design and methods* (5th ed., pp. 282). Sage.
- Zhai, C., (2010), “Research on post-adoption behavior of B2B E-Marketplace in China,” *Management and Service Science (MASS), 2010 International Conference on: IEEE*, pp. 1–5.
- Zhu, K., Kraemer, K. L., & Xu, S., (2006). The process of innovation assimilation by firms in different countries: A technology diffusion perspective on E-Business. *Management Science*, 52 (10), 1557–1576. 0025-1909, e 1526-5501 06 5210 1557. <https://doi.org/10.1287/mnsc.1050.0487>
- Zijm, H., & Klumpp, M. (2016). Logistics and supply chain management: Developments and trends. In H. Zijm, M. Klumpp, & U. Clausen (Eds.), *In logistics and supply chain innovation* (pp. 1–20). Springer.



© 2021 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.

You are free to:

Share — copy and redistribute the material in any medium or format.

Adapt — remix, transform, and build upon the material for any purpose, even commercially.

The licensor cannot revoke these freedoms as long as you follow the license terms.

Under the following terms:

Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made.

You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

No additional restrictions

You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.



***Cogent Business & Management* (ISSN: 2331-1975) is published by Cogent OA, part of Taylor & Francis Group.**

Publishing with Cogent OA ensures:

- Immediate, universal access to your article on publication
- High visibility and discoverability via the Cogent OA website as well as Taylor & Francis Online
- Download and citation statistics for your article
- Rapid online publication
- Input from, and dialog with, expert editors and editorial boards
- Retention of full copyright of your article
- Guaranteed legacy preservation of your article
- Discounts and waivers for authors in developing regions

Submit your manuscript to a Cogent OA journal at www.CogentOA.com

