A Literature-Based Survey on Industry 4.0 Technologies for Procurement Optimization

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A Literature-Based Survey on Industry 4.0 Technologies for Procurement Optimization

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Abstract

To survive in the market and acquire a competitive edge, industries need to invest in advanced technology. However, most companies fail due to poor integration of technology in their supply chain. The concept of Procurement 4.0 has emerged to optimize supply chain performance developing new value propositions and meeting new business needs. It is the integration of Industry 4.0 concepts in procurement. Although Industry 4.0 concepts have been studied in different industrial contexts, a limited number of researches have been conducted on the use of emerging technologies such as Internet of Things (IoT), Robotic Process Automation (RPA), Big data and Cognitive analytics, Artificial Intelligence (AI) and Cloud technologies, etc. in relation procurement while more existing researchers have focused web-based applications which facilitates real-time communication across supply chains. Therefore, the applicability of industry 4.0 technologies in procurement should be investigated. In this research, a literature survey involving systematic identification and review of 45 articles published in different sources between 2000 and 2019 was carried out to identify different emerging technologies that can be used across the procurement process. Further, the results include the applications of these technologies in the different areas of procurement that supports procurement optimization.

Keywords: Procurement process, Industry 4.0, Procurement 4.0, Procurement Optimization

1. Introduction

Supply chain management (SCM) has become a key driver of competitiveness in the textile and apparel industry and purchasing and procurement management are playing a crucial role in SCM. Procurement involves the process of selecting vendors, establishing payment terms, strategic vetting, selection, the negotiation of contracts and actual purchasing of goods. Procurement is concerned with acquiring (procuring) all of the goods, services, and work that is vital to an organization. (Burt et al. 2003).

The role of procurement extends far beyond the belief that procurement's primary function is to obtain goods and services in response to internal needs. A world-class procurement process aims to optimize the whole process to create significant business value. Efficient procurement is crucial since the demand for and price of a product is largely time dependent. Hence the procurement optimization is a must. The leading manufacturers in different industries have already optimized their procurement process to a certain extent with the emerging technologies while small players are not. However, procurement can be further optimized for leading manufacturers too with new concepts from Industry 4.0.

Industry 4.0 is the 4th industrial revolution which can be defined as a current trend of automation and data exchange in manufacturing technologies. The key driver of Industry 4.0 is Digitization. It includes technologies

such as big data analytics, cyber-physical systems, the internet of things, cloud computing and cognitive computing. etc. In order to facilitate procurement optimization, these novel technologies can be applied in any industry. Also, the concept is now applying for different functions in the value chain and procurement 4.0 is one of the latest approaches that develop new value propositions, meet new business needs and integrate data across functions and value chains. To make the most of the potential of procurement 4.0, reshaping the procurement organization and its capabilities will be required. Industry 4.0 solutions give businesses greater insight, control, and data visibility across their entire supply chain. By optimizing the procurement process with these new technologies, companies can deliver products and services to market faster, cheaper, and with better quality to gain an advantage over less-efficient competitors. (Bienhaus and Haddud 2018)

Procurement optimization is crucial for an organization to achieve several benefits an add remarkable value. Since the procurement process links with every other department in an organization it impacts revenue directly. Hence, it is important to keep the procurement process smooth eliminating inefficiencies in it. It ensures efficiency in entire organizational operations as a whole. An optimized procurement process will help an organization to make cost savings by procuring items, services and contracts at the best price possible. Procurement optimization will help to reduce material wastage and to optimize inventory through that. A performing procurement function will also allow for better visibility into company spending and budgets which will allow organizations to negotiate better contracts with vendors, enabling a company to take full advantage of discounts that might have previously appeared unavailable to them.

This research will be carried out to find methods for procurement optimization through digitization. The research will be conducted through a survey of evidence-based literature. Companies can gain a huge advantage by minimizing supply chain costs through procurement optimization. Hence it is important.

2. Methodology

A productive literature review has the power to lay down the foundation for advancing knowledge while unveiling the unsought research areas for future studies. Hence, in developing a systematic and comprehensive literature review, the prime importance should be given to the process of selecting research articles. First, articles were researched via a simple web search based on keywords related to the study area and based on the year of publication which is targeted to be between 2000 and 2019 in order to ensure the relevance of the study to the current context. This resulted in a total of 45 articles. Then, the articles were screened based on their title and abstract, to examine the applicability in the area of concern. This phase resulted in the rejection of 10 articles. In the next step, full scripts of the remaining articles were thoroughly examined to identify the relevance and the contribution to the study area. This secondary screening process resulted in the rejection of 5 more articles thus leaving 30 articles as the final sample taken for the literature review. The selection process followed is given in Figure 1 and all the studied articles are in the list of references.

3. Main Results of the Reviewed Studies

3.1 Industry 4.0 and Procurement 4.0

Industry 4.0 is not very popular in the Sri Lankan manufacturing and service sectors. This is mainly due to the lack of infrastructural facilities and knowledge base.

With the evolution of industry 4.0, procurement 4.0 has recently emerged with higher advantages. With these higher advantages, procurement 4.0 plays a major role in the domain of the organization value chain. In an organization, procurement division can create new business models for itself and more from being a cost center to a profit center whereas changing what they buy as well as the ways in which they buy. (Rasanjani et. al. 2019)

The base of the Procurement 4.0 is the move from supply chain to a value network. Intelligent machines and computer applications connect all the functions and share information in real-time. There is also a need to optimize procurement processes. Procurement 4.0 is the integration of information and communication technology and automation in support of procurement. (Nicoletti 2018)

Electronic procurement, also known as **e-procurement**, is the business-to-business (B2B) requisitioning, ordering and purchasing of goods and services over the internet. E-procurement is an enabler of Procurement 4.0. The study "*methodology for developing a model for the analysis of e-procurement capability maturity of construction organisations*" (Perera1 et. al., 2010) presents an e-procurement capability maturity model to establish the state of readiness of construction organizations to adopt e-procurement (e-readiness). This type of model can be applied to the apparel industry as well. The results of the pilot study identify the drivers and barriers to e-procurement as follows.

3.2 Emerging Procurement Technologies

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Electronic procurement, also known as **e-procurement**, is the business-to-business (B2B) requisitioning, ordering and purchasing of goods and services over the internet. E-procurement is an enabler of Procurement 4.0. The drivers and barriers to e-procurement as follows.

Table 1. Drivers and barriers of E-Procurement

Drivers	Barriers
Improving Communication	Security of Transactions
Reduced Administration Costs	Lack of e-procurement knowledge/Skilled Personnel
Price reduction in Tendering	Company Culture
Gaining Competitive Advantage	Upper Management Support
Reduction in time to Source Materials	IT systems too costly
Reduced Operating and Inventory Costs	Do not have the IT infrastructure
Reduced Staffing Levels in Procurement	Unsure as to the legal position of e-procurement
Enhanced Decision Making and Market Intelligence	Interoperability Concerns

Source: (Perera1 et. al. 2010)

The study by (Chang et al. 2011) identifies partner relationships, information sharing, and supply chain integration can represent the processes through which e-procurement contributes to supply chain performance. Further, it provides a framework for e-procurement. The buyer firms implementing a Web-based e-procurement system for conducting purchasing activities can reduce transaction cycle time and error rate and facilitate to integrate processes of purchase, inventory, and supplier delivery. (Tai et al. 2009)

The key driver of Industry 4.0 is the digitization. Digitization of the procurement process can yield several benefits including supporting daily business and administrative tasks, supporting complex decision-making processes. Artificial Intelligence, Big Data, and the Internet of Things are core elements with regard to procurement to automatize operative activities and create space for more strategic initiatives driven by a human. (Bienhaus and Haddud 2018)

The study by (Ardito et al. 2018) presents information about which digital technologies may enable SCM-M integration like Cloud computing, Data Analytics. Specifically, the authors highlight the role those solutions play in terms of information acquisition, storage and elaboration for SCM-M integration by relying on illustrative actual examples.

In internal procurement processes with Industry 4.0, there is a move away from traditional forklifts toward automated guided vehicles (AGVs) that cooperate with the production machines, which themselves are strongly supported by different types of robots. (Nicoletti 2018)

As one of many diverse applications of business analytics, procurement analytics denotes a data-driven approach to derive solutions to supply management-related problems. There currently exists a low usage of advanced procurement analytics, and data integrity and quality issues are preventing significant advances in analytics. (Handfield et al. 2019) In procurement analytics, typical problems and decisions are related to the management of spending and budgets, cost reduction, supplier management, cost modelling, category market intelligence, supplier evaluation, procurement-led innovation, market strategies, supply chain risk, and stakeholder value improvement. (Monczka et al. 2016)

The blockchain is a powerful support to the digital transformation of procurement. A shared database can support the various stakeholders associated with the procurement processes of an organization. The blockchain is able to provide good visibility of shared data. It can provide a seamless, reliable, and uninterrupted messaging service to support an ecosystem of organization supply. (Nicoletti 2018)

Mobile technology can clearly complement existing applications and infrastructure by adding an ad hoc element for data processing, information access, communication, and notification. (Gebauer and Shaw 2015) and (Gebauer et al. 2002). The study by (Kießling et al. 2004) has presented several novel middleware components for sales automation in e-procurement, whose sophisticated interplay achieves to automate skills that so far could be executed only by human vendors.

Procurement Optimization

Back offices from highly competitive industries like telecommunications, utilities, financial services and health care through to government agencies worldwide are ever under pressure to contain costs. But cost efficiency must be balanced with other performance imperatives such as service excellence, business enablement, scalability, flexibility, security, and compliance. From 25 years of research, we learned that low-performing back offices can be transformed to high performance through five main transformation levers: centralize physical facilities and budgets, standardize processes across business units, optimize processes to reduce errors and waste, relocate from high-cost to low-cost destinations, and technology enable with, for example, self-service portals. Further developments in automation, including software robots, have added a sixth lever. (Willcocks et. al., 2015)

The results of the study "*Performance impact of implementing Web-based e-procurement systems*" (Yi-Ming Tai a et. al., 2009) verify that the electronic execution of purchasing activities improves both the operational efficiency dimension and the strategic dimension. Furthermore, the results confirm that buyer firms implementing a Web-based e-procurement system for conducting purchasing activities can reduce transaction cycle time and error rate and facilitate to integrate processes of purchase, inventory, and supplier delivery. Therefore, E-procurement systems have a positive impact on supplier performance and buyer performance.

Initially started as an automation device, procurement eventually leads to the provision of value-added services such as sharing information and technology support. By adopting a strategic-oriented Web-based procurement solution, buyers can enhance their partnerships with suppliers with respect to information sharing and technology dependence in measuring the direct impact by implementing procurement automation, one of the most important benefits is the lower transaction cost. In addition, automation and acceleration of data handling, storage, and transmission activities can enhance data accuracy and reduce the number of errors.

4. Discussion

The discussion of the articles summarized under the main results of the reviewed studies is analyzed based on Procurement Optimization Approaches with emerging procurement technologies.

The optimization approaches discussed in literature have utilized diverse methodologies in diverse aspects and they have resulted in procurement optimization from different angles. This discussion is on the applicability of the industry 4.0 technologies as observed by the authors with related to the different approaches used in procurement optimization. The summary related to this analysis made up of a few selected articles is available

in Table 1. Industry 4.0 technologies were categorized according to their similarity to obtain 8 technology categories. Literature present in the context of procurement optimization focuses mainly on technology and best practices. But, in this research, the priority is given to the industry 4.0 technologies which are not very much observed.

Table 2. Analysis of selected Literature

Study	Technologies								Applications
	Analytics Big data / Cognitive	IOT / RFID	RPA/ AI	Cloud Computing	Internet/ EDI/ web based platforms	Blockchain	Automated Vehicles	Mobile	
(Ardito et al. 2018)	*	*		*					**IoT:** Real-time acquisition of market data (customer data and product - customer interactions) **Cloud:** Storing and structuring market information acquired through IoT solutions. Real-time sharing of market information. **Analytics:** Customer profiling, Targeted marketing (e.g. product recommendations), Predictive analytics (e.g. customer needs foresight) Improved customer relationship management Forecasting the demand and replenishment quantity
(Handfield et al. 2019)	*								Spend analysis Contract Management Predictive Analytics Data governance and management Supply Market Risk Assessment
(Chang et al. 2011)					*				E-Design E-Sourcing E- Negotiation E-Evaluation
(Tai et al. 2014)					*				Integrate processes of purchase, inventory and supplier delivery Partner relationships handling Information sharing
(Bienhaus and Haddud 2018)	*	*	*						Supporting daily business and administrative tasks, operational tasks
(Nicoletti 2018)	*		*			*	*		**Big data:** Predictive Procurement Supporting procurement decision

Reference									Description
									making **AGV/ drones:** Vehicles used inside the factories, for delivery of products **Blockchain:** Smart contracts Information sharing with stakeholders Manage cash flows
(Willcocks et al. 2015)			*						Centralize physical facilities and budgets Standardize processes Optimize processes to reduce waste Managing the demand pipeline scheduling and reporting on the delivery lifecycle
(Majeed and Rupasinghe 2017)		*							Goods receipt, Inbound delivery, Purchase Order, Transfer order handling
(Hammond and Kohler 2000)				*					To place replenishment orders quickly and accurately Information sharing
(Gebauer and Shaw 2014)								*	support approval, requisitioning and, receiving processes. Notification
(Finch et al. 2017)	*								**Cognitive:** Decision making in procurement Global sourcing and integration of suppliers Automation of repetitive procurement tasks Handling returns and replacements activities.
(Ibem and Laryea 2013)		*		*	*				**Cloud:** e-tendering information sharing **RFID:** To tracking of materials, identification, automated data acquisition **EDI**: Automated linkage between buyers and suppliers to transmit orders, receipts, and payments electronically. Information sharing between contractors and material suppliers of manufacturers.
(Gebauer et al. 2002)								*	wirelessly enable users to create purchase requisitions/ PO s, to

								approve requisitions, and to check requisition status, notification and approval purposes
								data processing, information access, communication.

Arising from findings of the survey, we can observe that there is a high usage of Internet technologies in the areas of partner, supplier relationship handling and data analytics in the areas of spend analytics, demand and supply management, contract management etc. currently exists in procurement functions while a low usage of other technologies in procurement functions. Many technologies can be used in a single process to achieve its optimal performance and one technology has many applications.

5. Conclusion and future work

This paper examines and analyzes the different kinds of technologies and their applications available to support procurement activities to achieve procurement optimization based on a survey of evidence-based literature. Firstly, the results show that among the different technologies and tools identified, most are web-based applications that procurers combine in the process of carrying out procurement activities; and that the interoperability of systems remains a challenge in using these technologies in the procurement. Based on finding, it can be concluded that using industry 4.0 technology in procurement process, there is yet no single system or application that can support the execution of all the functions in the procurement process, and that the issue of interoperability of systems, particularly in cloud environments and e-market platforms remains a challenge in the use of industry 4.0 technologies to procurement activities. Secondly, in addition to the use of technologies, there are some other factors needed to be considered in achieving procurement optimization. Adoption of necessary technological capabilities and best practices, supplier and customer capabilities are among them. Industries use different kinds of software and ERP systems. Therefore, the applicability of the technologies will depend on the ability to integrate with them. Some industries are more technology-driven and some are not. It can be identified that there is a relationship between different kinds of industries and technologies.

Based on the discussion, it is evident that industry 4.0 can be applied in the entire supply chain and different areas in procurement in achieving optimization. Therefore, there exists an opportunity for future researches to concentrate on these results and a model can be developed in the future which acts as a roadmap to procurement optimization incorporating industry 4.0 technologies and best practices as future research. Furthermore, when considering the present Sri Lankan context, there exist research opportunities for practical analysis of the theoretical aspect highlighted in this paper by applying it to the selected industry.

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