Journal of Alexandria University for Administrative Sciences ©
Volume 57 – No. 1 – January 2020

The Effect of Lean Supply Chain Practice on Supply Chain Performance in Egypt Manufacturing Industry[1]

Hanaa Mohamed Mahmoud[2]

Prof. Dr. Ashraf Adel Labib[3] **Dr. Aisha Tarek Noour [4]**

Arab Academy for Science, Technology & Maritime Transport

ABSTRACT

The general objective of this paper is to determine the impact of lean practice on supply chain (SC) performance in Egypt manufacturing industry, an empirical framework was proposed for lean supply chain (LSC) practices to encompass the five processes (plan, source, make, deliver, return) of the supply chain operations reference "SCOR model" which constitute the main processes of supply chain management (SCM). This study adopted a quantitative explanatory research design to test empirically the extent of applying lean practice in manufacturing sector in Egypt market throughout the SCOR model five processes, and to investigate the impact of applying LSC practices on the total SC performance (cost, time, quality, and flexibility). A survey questionnaire was distributed to managers from 30 manufacturing companies from different industries implementing lean practice in their operations, only 66 validated questionnaires were obtained. The results revealed. First, the identification and empirical validation of lean practice implementation degree across SCM which provides means to focus on the most popular and elementary LSC practices among different manufacturing industry sectors in Egypt. Second, the effect of LSC practices on the total SC performance, although not all aspects matter to the same extent and effect. As, the practices of

[1] Received in 14/10/2019, accepeted in 26/11/2019.

[2] Researcher. (Email:Hanaaabdou@hotmail.com)

[3] Professor of Business Administration Dean, College of Management and Technology. (Dr.a.labib@aast.edu)

[4] Assistant Professor at Marketing and international Business. (aishenoour@aast.edu)

value stream analysis or value stream mapping (VSA or VSM), lean shop floor (LSF), customer relationship management (CRM), and information technology (IT) management have a significant positive effect on the total SC performance. While supplier relationship management (SRM) and just in time (JIT) practices have an insignificant effect on the total supply chain performance.

Keywords: Lean production, Lean supply chain management, Supply chain performance, Supply chain management practices.

1- Introduction

In the era of globalization, many organizations are seeking ways to hit competitive advantage over their peer competitors. Shifting from company orientation to supply chain orientation is a necessary manner for an organization's survival (Vonderembse et al., 2006). In 2000, SCM was defined by Council of Logistics Management, as a systematic coordination and tactics over traditional business functions within a particular firm and across businesses within the supply chain for the pursuit of boosting long-term performance for individual firms and the supply chain as a whole. Thus, SCM is one of the most substantial approaches for organizations to boost performance (Ou et al., 2010). Lean implementation in the supply chain is adopted to compete with superiority and achieve the required competitive advantage (Ugochukwu, 2012; Taylor, 2006; Womack & Jones, 1994). It is considered an underlying support of the SCM (Agus & Hajinoor, 2012). Also, it is an evolving concept and increasingly has fast popularity as SCM approach (Hines et al., 2004). Despite its concept was originated in an automotive manufacturing industry, it has been extended beyond shop floor operations to embrace the entire supply chain (Ugochukwu, 2012). In this regard, lean management is adopted as an integrated SCM strategy to enhance SCs effectiveness and reduce the cost and delivery time (Nimeh et al., 2018).

There are a researchers' attempts to depict LSC performance measurement that implies the impact of LSC techniques and tools over the SC performance by using Supply Chain Operations Reference (SCOR) model, this is to measure SC performance (supply chain leanness) at process level (plan, source, make, deliver, return) (Arif-Uz-Zaman & Ahsan, 2014), the authors used standard metrics established by (Shepherd & Günter, 2006) to measure the performance of each process based on the four performance attributes (cost, time, quality, flexibility) and provided optimal metrics for LSCs with applying performance management practices that produce best-in-class performance. (Shepherd & Günter 2006) were not the only researchers that have proposed a taxonomy for SC performance measures along with SCOR model processes, also there were many attempts from other researchers to provide SC performance measures on a process-based classifications e.g. (Gunasekaran et al., 2001; Gunasekaran et al., 2004; Chae, 2009) these classifications were provided by the authors with different performance attributes and different considerations.

Due to the investigation gap, there are neither systemic nor comprehensive definitions for lean practices that encompass SCM (Nimeh et al., 2018; Arif-Uz-Zaman & Ahsan, 2014; Ruiz-Benítez et al., 2018; Azevedoa et al., 2012; Ugochukwu, 2012; Wee & Wu, 2009; Herzog & Tonchia, 2014 ; Khanchanapong et al., 2014; Green et al., 2014; Tortorella et al., 2017). Therefore, there is a lack of consensus on what constitutes LSC practices, and it is still greatly under-studied. Besides the lack of consensus in defining SC performance measurement systems and their respective measures (Gunasekaran et al., 2004; Neely, 2005; Chan & Qi, 2003; Chan, 2003; Chae, 2009; Bhagwat & Sharma, 2007; Gunasekaran & Kobu, 2007; Chia et al., 2009; Kocaoğlu et al., 2013; Delipinar & Kocaoglu, 2016; Theeranuphattana & Tang, 2008; Leończuk, 2016), the literatures about LSC practices are scarce and only suggest a positive association between lean supply chain management (LSCM) and SC performance e.g. (Wee & Wu, 2009; Perez et al., 2010; Jasti & Kodali, 2015). The empirical validations are little and have not given the attention they deserve by the researchers and held in many different countries other than Egypt (Tortorella et al., 2017; Nimeh et al., 2018).

Thus, based on these arguments, the research question can be formulated as: What is the degree of implementation of LSC practices in Egypt manufacturing systems and their contribution to enhancing the total SC performance?. In this context, this research has three main objectives. Firstly, to investigate the extent to which LSC practices have been adopted by manufacturing organizations in Egypt. Secondly, to test empirically the impact of LSC practices on the total supply chain performance (cost, time, quality, flexibility) although not all practices matter to the same extent and effect. Thirdly, to propose an empirical framework for LSC practices that can be considered closely pertained to supply chain management in Egypt manufacturing industry.

This research is considered a fruitful study to provide academic value and practical value. Firstly, it provides academic value to understand the lean practice approach that encompasses SCM, and more knowledge about SC performance measurement systems. The study body of information can be used by scholars and researchers who may be interested in conducting researches in both domains LSC practices and SC performance. Secondly, it provides practical value to assist practitioners in Egypt to know the extent to which LSC practices are affecting SC performance in their manufacturing fields. As it shows practical significance to the manufacturers and distributors in the supply chain and this will support the improvement of costing and non-costing strategies. The firms' SCM professionals will benefit from the findings of this study to identify opportunities derived from implementing a lean practice approach that enhances the acquisition of capabilities that could result in a competitive advantage.

2- Literature Review

2-1 Lean Supply Chain Practice

2-1-1 Lean overview

IMVP researcher "John Krafcik" came with the name of lean production after conducting comparing study for Japanese production techniques which were highlighted based on mass-production systems that were commonly used by the auto industry in North American and European. Toyota Motor Company was the early implementer for these unique Japanese techniques that were coined as the "Toyota Production System (TPS)" (Womack et al., 1990).

The National Institute of Science and Technology (NIST/MEP, 1998) defined lean according to (Buzby et al., 2002) as "system approach for identification and waste(non-value added activities) elimination through by continuous improvement by following the product at the pull of the customer in pursuit of perfection". In other words, with fewer resources, more customer value can be created (Daud & Zailani, 2011). Lean is an approach to attain with less effort, cost reduction achievement, quality, and efficiency-boosting (Sezen & Erdogan, 2009).

Since value-added activities (VA) and non-value added activities (NVA) terms were derived mainly from TPS, The VA activities can be defined as the activities that the customers are willing to pay for tangible goods and intangible functions, The NVA encompasses eight kinds of wastes, Anything that interfere the smoothness of production flow is defined as "Waste" (Wee & Wu, 2009). (Wickramasinghe & Wickramasinghe, 2017) have identified all kinds of wastes that do not add value from the customer's perspective to the final product or service include waiting times waste, overproduction, unnecessary materials movement, over-processing, over inventory, defects, underutilization of people staff and facilities, environmental waste and the biggest one is being overproduction (Liker, 2004).

Successful adoption of lean production practices has created a streamlined and high-quality system that results in producing products and services with high productivity levels, cost reduction, short lead times, and a high level of volume flexibility, which substantially improves organizations' performance (Shah & Ward, 2003). Also, lean production (just in time "JIT" and total quality control "TQC") enables reliability in order cycle, inventory reduction, and process control (Prajogo et al., 2016). Whilst, (Shah & Ganji, 2017) indicated that not all lean production tools have the same impact on quality, speed, dependability, and flexibility.

Many organizations in different sectors over the world have adopted lean production concept in purpose of increased organizational performance (Narayanamurthy & Gurumurthy, 2016; Panwar et al., 2015; Taj & Morosan, 2011; Wickramasinghe & Wickramasinghe, 2017; Chavez et al., 2013; Harris & Cassidy, 2014). Thus, lean concept is known to increase manufacturing effectiveness (Womack & Jones, 2003). It has been evolved over the last decades after showing an amazing impact on manufacturing organizations. Therefore, its principles started to be applied in service organizations and public sectors and showed fabulous positive impact on such organizations and sectors (Arlbjørn et al., 2011; Piercy & Rich, 2009; Kundu et al., 2011; Suárez-Barraza & Ramis-Pujol, 2010; Hwang et al., 2014). Nowadays it can be considered that becoming lean is the world's concern.

2-1-2 Transition to Lean Supply Chain Management

The supply chain paradigm, which came first, emphasizes on activities that are bringing any sub-assemblies and raw materials into manufacturing operation and eventually delivers the products smoothly and economically to the end customer, LSC paradigm emphasizes on values and wastes that may occur all across the supply chain (Behrouzi & Wong, 2011a, b). According to (Marodin et al., 2017; Moyano-Fuentes et al., 2019) LSC is defined as a group of organizations directly connected by upstream and downstream streamlines of products, services, information, and funds that cooperatively work to reduce wastes and cost by pulling what is required to meet customers' needs in an efficient manner.

Applying lean principles, tools and techniques allow lean organizations to perform better than non-lean organizations and additionally, the cooperation of all key players (e.g. suppliers, manufacturers, and customers) is essential in order to perform more effectively, accordingly, lean philosophy can be expanded over the whole supply chain to consider all those players of the supply chain (Behrouzi & Wong, 2011; Arif-Uz-Zaman & Ahsan, 2014). And its concept has been applied beyond the boundary of the organization's workstation to include all supply chains across multiple organizations (Hines et al., 2004). Hence, applying LSC enables the organizations to benefit more from the lean journey, enhancing better value to the customers by more efficient and quick responding to the customers' needs (Srinivasan, 2004; Behrouzi & Wong, 2011 a, b). It allows the streamline of goods, services, and technology flow from suppliers to ultimate customers without waste (Marodin et al., 2017; Wee & Wu, 2009).

In this research, the LSC practices bundle is inspired by the models established by (Shah & Ward, 2007; Arif-Uz-Zaman & Ahsan, 2014). (Shah & Ward, 2007) set definitions for lean production practices bundles that are extended beyond shop floor operations, the authors outlined three constructs for lean production practices (supplier-related, customer-related,and internally related) to encompassing SCM as figure 2-1 this model is widely used in literature by (Marodin & Saurin, 2013; Marodin et al., 2017) and validated empirically in Brazilian Small and Medium Enterprises (SMEs) (Filho et al., 2016).

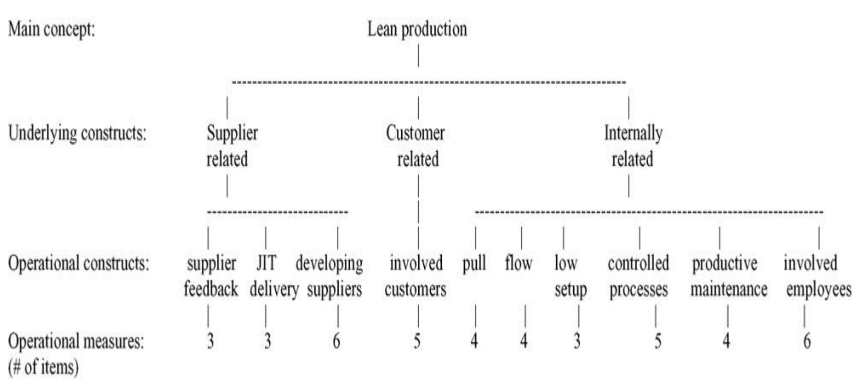


Figure 2-1: Lean production bundles for (Shah & Ward, 2007)

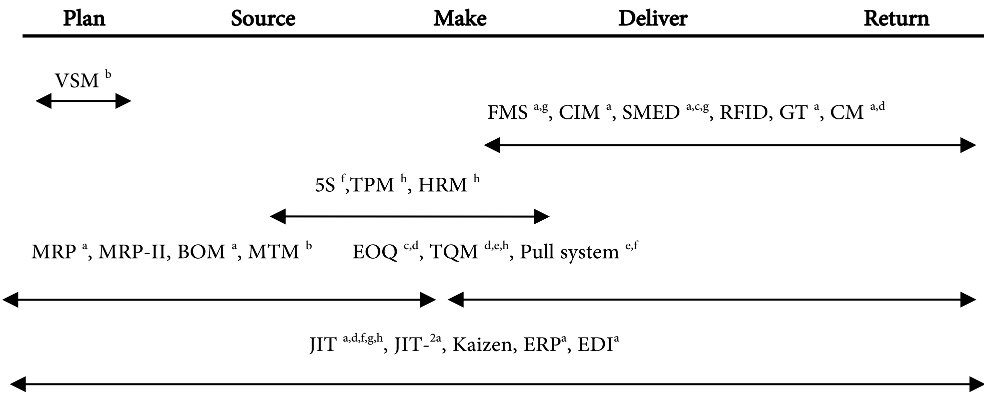
Also, (Arif-Uz-Zaman & Ahsan, 2014) proposed a model in literature review depicting different LSC tools over SCOR model processes "plan, source, make, deliver, return". As shown in figure 2-2. SCOR (Supply Chain Operations Reference) model is a supply chain performance measurement system developed by supply chain research council in 1997 and defined as "systematic approach for identifying, evaluating and monitoring supply chain performance" (Shepherd & Gu¨nter, 2006; Arif-Uz-Zaman & Ahsan, 2014). This model is used as a strategic planning technique used in identifying, measuring, reorganizing, improving SC processes, and controlling the SC processes (Dissanayake & Cross, 2018). The SCOR provides a hierarchical definition for the SCs processes and activities and classified into six essential processes: plan, source, make, delivery, return, and enable, in addition, it defines for each process the best standards and practices and SC KPIs (RÍO et al., 2019). Enable process was added in SCOR model version 11 but it was no longer process categorizations, but at the same level of detail as plan, source, make, deliver and return processes.

In this sense, the proposed LSC practices of this study; SRM practice for source process, LSF as internally related practice for make process, and CRM practice for delivery and return processes. In addition to practices that were adopted across the whole processes of SCM, those LSC practices were theoretically depicted in figure 2-2 by (Arif-Uz-Zaman & Ahsan, 2014):

- VSA or VSM as a lean practice that is widely used in the plan process as a planning tool (Kuhlang et al., 2011; Wee & Wu, 2009; Ruiz-Benítez et al., 2018).
- Extending JIT along with the five processes and not only limited to JIT delivery by suppliers (Arif-Uz-Zaman & Ahsan, 2014; Nimeh et al., 2017; Green et al., 2014).
- Applying IT management along with the five processes (Gunasekaran et al. 2001; Arif-Uz-Zaman & Ahsan, 2014 ; So & Sun, 2010; Ruiz-Benítez et al., 2018; Jasti & Kodali, 2015).

Thereby, the proposed LSC practices of this paper cover the five processes of SCOR model (plan, source, make, deliver, and return) for proving the point of how well lean practices can be deployed beyond shop floor boundaries. Those practices are in sequence as followings:
- Value stream analysis (VSA or VSM) as planning related practice.
- SRM as supplier-related practice.
- Lean shop floor (LSF) as internally related practice.

- CRM as customer-related practice.
- Just in time (JIT) as an integrated supply chain practice.
- Information technology (IT) management as an integrated supply chain practice.



Notes: VSM, value stream mapping; MRP, material requirement planning; BOM, bill of material; MTM, method time measurement; FMS, flexible manufacturing planning; CIM, computer integrated manufacturing; SMED, single minute exchange of die; RFID, radio frequency integrated device; GT, group technology; CM, cellular manufacturing; TQM, total quality management; JIT, just in time; JIT-2, supplier-customer relationship; MRP-II, manufacturing resource planning; EDI, electronic data interchange; EOQ, economic order quantity; TPM, total productive maintenance; HRM, human resource management.

Figure 2-2: Effects of different lean supply chain tools and techniques over SCOR model by (Arif-Uz-Zaman & Ahsan, 2014)

2-1-2-1 Value Stream Analysis or Value Stream Mapping

(Ugochukwu, 2012) considered VSA as one of the lean practices that are being applied in the process of transforming a supply chain to a lean supply chain, the author indicated that VSA is a basic ground for waste elimination, and also proposed VSM as a technique for adopting VSA. Similarly, (Tortorella et al., 2017) considered VSA or VSM as one of the continuous improvement and waste elimination bundles. According to (Ruiz-Benítez et al., 2018), VSM involves a depiction of the materials and information flows from supplier to customer. Value stream encompasses all the activities (both VA and NVA) that is essential to fetch the output of product or service from the original notion through the manufacturing and/or development processes to the payment receipt, it is a tool used to map a productive process or an entire supply chain network, It maps not only material flows but also the information flows that process and control production (Muñoz-Villamizar et al., 2019). VSM is used as a planning tool to acquire an entire overview of the organization's value streams status, by setting planned flow-oriented value streams for the target-status, based on the analysis of the current status (Kuhlang et al., 2011). Also, VSM is a tool for identifying the activity lead time status in the supply chains (Wee & Wu, 2009). In other words, it connects all processes from raw material to final consumer smoothly which results in higher quality, shorter lead time, and lower cost (Rother & Shook, 1999).

VSM or VSA is considered as planning practice (Wee & Wu, 2009; Kuhlang et al., 2011; Arif-Uz-Zaman & Ahsan, 2014) can be adopted in this study framework to be alighted with plan process in SCOR model.

2-1-2-2 Supplier Relationship Management

Helper, (1991) argued that long-term and mutual trust relationships between the suppliers and customers is crucial to compete globally, the author's study indicated that Japanese automakers (particularly Toyota) depended on a loyal and skilled supplier base to have a competitive advantage. (Keller et al., 1991) indicated that supplier support is a critical factor for successful lean production implementation. And, the organizations' activities can't be achieved perfectly without supplier integration involvement (Jasti & Kodali, 2015). Therefore, suppliers should be included in the value stream (Muchri, 2017). (Shah & Ward, 2007; Marodin et al., 2017) proposed lean supplier-related practices in a multi-dimensional measure of lean production which includes some constructs (supplier feedback about their performance, JIT delivery by suppliers, and develop suppliers to be more involved in the production process of the focal firm). SRM is defined as the organization's ability to establish, manage, and maintain with its suppliers reliable long-term partnership. This relationship can include partnerships and joint ventures at the operational level (Li & Lin, 2006; Parveen & Rao, 2009; Azevedo et al., 2012). Also, (Kim, 2013) considered SRM as organizational practice for the purpose of generating mutual benefits between the buying firm and its suppliers by disseminating and applying operational, financial, and strategic knowledge. Establishing long-term relationships with key suppliers can capture the benefits of building learning routines and ensures both parties' sets of capabilities that are aligned and stay useful for future joint projects (Echtelt et al., 2006; Nimeh et al., 2018). Supplier relationship refers to the extent of interaction with the supplier to direct quality regards and guarantee just-in-time delivery through taking into consideration the suppliers number, long-term relationships, and involving the suppliers in the design of the product and in the process of development and by giving feedback on suppliers' performance (Iranmanesh, et al., 2019). This paper proposed SRM as one of the most important LSC practice which also could be aligned with the source process in SCOR model.

2-1-2-3 Lean Shop Floor as Internally Related Practice

LSF practice achieves a positive operational effect on the organization's internal operations by reducing the variability and wastes in the manufacturing process (Shah & Ward, 2003). There is a positive relationship between applying LSF practice and the improvement of overall operational performance (Demeter & Matyusz, 2011; Shah & Ward, 2003; Kull et al., 2014; Marin-Garcia & Bonavia, 2015; Wickramasinghe & Wickramasinghe, 2017). (Shah & Ward, 2007) established LSF practice tools as internally related practice that was adopted empirically to test its association with operational performance (Filho et al., 2016). Also, it was empirically investigated as a shop floor practice to find out its effect on inventory and quality (Marodin et al., 2017). LSF includes the tools of pull, continuous flow, set up time reduction, total productive/preventive maintenance, statistical process control, and employee involvement (Shah & Ward, 2007). These tools are commonly proposed by many other authors (Fullerton & Wempe, 2009; Herzog & Tonchia, 2014; Marin-Garcia & Bonavia, 2015; Wickramasinghe & Wickramasinghe, 2017; Garza-Reyes et al., 2015; Bhasin, 2012; Zhang et al., 2016; Ruiz-Benítez et al., 2018; Azevedoa et al., 2012; Marodin et al., 2017; Arif-Uz-Zaman & Ahsan, 2014). This study proposes LSF practice in its framework as one of the most important LSC practices that could be aligned with "make process" in SCOR model.

2-1-2-4 Customer Relationship Management

According to (Grant & Schlesinger, 1995) better service for the customers in terms of both cost and warranties besides the help of a flexible manufacturing system can mainly be provided by building a long-term relationship with the customers and performing analysis on various customers' needs. Also, (Shah & ward, 2007) indicated customer involvement as one measure for lean production construct which focuses on the organization's customers and their needs. (Khanchanapong et al., 2014; Iranmanesh et al., 2019) showed how early customers' involvement in the process of product development allows the improvement of product development in a way that meets the needs of the customers and leads to cost reduction. CRM includes customer involvement by frequently and timely exchange of information with customers about (e.g. inventory levels, demand, production schedules, current and future product offerings) (Marodin et al., 2017; Iranmanesh et al., 2019).

According to (Azevedoa et al., 2012) CRM is defined as existence of substantial relationships with customers to share information, the authors argued that SC processes should be aligned with the customer's needs obtain a successful relationship with the customer that would result in maintaining SC operations reliability, while boosting quality and customer satisfaction. Various paradigms and activities were discussed by (Boulding et al., 2005; Nimeh et al., 2018; Iranmanesh et al., 2019) in order to constitute customer relationship including building long-term relations with customers, boosting customer contacts, initiatives of integrated problem-solving, response effectively to customer complaints, and improving customer satisfaction.

It was argued by (Abdallah, et al., 2014; Wasti & Jeffrey, 2016) customer relationship enhances customer loyalty, boosts the sharing of knowledge and expertise, develops the process of the problem-solving, boosts the responsiveness given to the customers, develops customer needs understanding, differentiates the products by improving the capacity, and develops the organization's market share. (Jasti & Kodali, 2015) indicated that 26.67% of the frameworks have proposed customer relationship that exhibited superior outcomes in LSCM activities adoption. In this regard, this study proposes CRM in its framework as one of the most important LSC practice which also could be aligned with deliver and return processes in SCOR model.

2-1-2-5 Just In Time

JIT was adopted in the Toyota Production System which was considered as the foundation of the lean approach (Arif-Uz-Zaman & Ahsan, 2014). Its system implies that the organization should produce the right product at the right time (Womack & Jones, 2005). Hence, it is a basis for achieving low work in progress, unit cost reduction, more profit, higher quality, and lower inventory, since JIT denotes pull system adoption that also results in lower inventory and shorter lead times (Wan, 2006). (Shah & Ganji, 2017) showed with empirical evidence the significant positive impact of JIT on speed, quality, dependability, and cost. Implementing JIT upstream from the suppliers includes small quantities of frequent deliveries from the tier suppliers to the production line (Ruiz-Benítez et al., 2018). Despite it is originally used inside the plant in the production process, JIT practice has been extended across the supply chain as an integrated SC strategy combining the elements of JIT-production, JIT-purchasing, JIT-selling, and JIT-information (Green, et al., 2014; Nimeh et al., 2018; Philip et al., 2019). JIT emphasizes on waste elimination across all processes (Green, et al., 2019). In this study, JIT is considered to be adopted not only in the production system but also showing its adoption along with suppliers (purchasing) and customers (selling) to embrace its effect across SCOR model processes.

2-1-2-6 Information Technology Management

The successful present complex supply chain relies substantially on how well the information flows over the supply chain activities. The use of information technology is needed to control the flow of information across the supply chain activities (Tan, et al., 2002). In the contemporary scenario, the organizations must operate as a part of multi-organizations, multi-system networks, and they cannot be considered as independent entities (Lambert & Cooper, 2000). Therefore, multi-company network integration is very much important (Norek & Pohlen, 2001). Hence, the utilization of information technology is a basic requirement to control and maintain those multi-networks also to improve the effectiveness of the supply chain (White & Pearson, 2001).

(Powell et al., 2013) combined methodologies in which ERP-based was proposed as a lean implementation process and its adoption is considered as an enabler for lean implementation in the organization. (Ward & Zhou, 2006) indicated that the companies may benefit from the adopted practice of information technology integration such as enterprise resource planning (ERP) systems in order to have experienced success in reducing lead time through applying lean/JIT practices since the balance achieved between adopting lean/JIT and IT integration would affect lead-time performance improvement. LSC tools related to IT management practice can be proposed and adopted across SCOR model processes which are: enterprise requirement planning

"ERP", material requirement planning "MRP", group technology "GT", computer-integrated manufacturing (CIM), electronic data interchange "EDI", radio frequency integrated device "RFID" (Arif-Uz-Zaman & Ahsan, 2014; Ruiz-Benítez et al., 2018). (Gunasekaran, et al., 2001) indicated that MRP and ERP are widely improving the effectiveness of scheduling technique, this subsequently improves SC performance, group technology "GT" and computer-integrated manufacturing (CIM) improve SC flexibility to enhance customer service and satisfaction, and E-commerce and electronic data interchange (EDI) can be used to eliminate non-value adding activities in the customer order path.

Wastes in SCM are emerged by incorrect material flow, funds flow, and information flow in the system, the effectiveness and the transparency of this information flow across supply chain can be achieved by implementing IT management practice, round 57% of the frameworks have proposed IT management practice as a key element to hit excellence in LSCM (Jasti & Kodali, 2015). Therefore, this research study proposes IT management as one of the most important LSC practices that should be considered in this paper framework.

2-2 Supply Chain Performance

SC performance is defined as the ability of the whole supply chain to satisfy the needs of the end-customer, pertained to ensuring product availability, delivery at the right time in the right way, and ensuring suitable levels of inventory (Leonczuk, 2016). Its performance measure is "a set of metrics which helps in quantifying the efficiency and/or effectiveness of an action." (Mishra et al., 2018). There are many different frameworks and categorizations for SC performance, a different frameworks for SC performance measurement systems were proposed such as the process identification in the SCOR model ;(Shepherd & Günter, 2006) classified SC performance based on SCOR model processes (planning and product design "plan", supplier "source", production "make", delivery "deliver", customer "return") with their respective performance measures in terms of cost, time, quality, and flexibility, innovation. Similarly, (Arif-Uz-Zaman & Ahsan, 2014) proposed a framework for SC performance metrics based on the theoretical framework established by (Shepherd & Günter, 2006; Gunasekaran et al., 2001) that classified the SC performance based on SCOR model processes. Also, the balanced scorecard was introduced by (Kaplan & Norton, 1992) as another framework for the SC performance measurement system. (Bhagwat & Sharma, 2007; Afonso & Cabrita,

2015) proposed classification for SC performance according to the balanced Scorecard perspectives “financial perspective, customer perspective, internal business perspective, and innovation and learning perspective” with their respective measures. Other categorizations for the SC performance were established by (Elrod et al. 2013; Arif-Uz-Zaman & Ahsan 2014; Bozarth & Handfield 2007), the authors categorized the SC performance measures in terms of (time, cost, flexibility, and quality). (Behrouzi & Wong, 2011) identified the SC performance in terms of (quality, cost, delivery, and reliability) to identify lean SC performance in an automotive industry. Also, (Nimeh, et al., 2018) defined SC performance in terms of efficiency and flexibility measures.

According to (Behrouzi & Wong, 2011), SC performance measures should be selected based on:

1. Alignment with supply chain strategies and company goals.
2. Balanced between supplier-related, manufacturer-related and customer-related measures.
3. Considering both financial and non-financial measures.

Therefore, all the metrics in this study were selected based on three aspects:

1. The most common metrics used in recent researches about measuring the impact of lean practice as supply chain strategy on the performance in terms of cost, time, quality, flexibility (Behrouzi & Wong, 2011; Nawanir et al., 2012; Khanchanapong et al., 2014; Arif-Uz-Zaman & Ahsan, 2014; Shah & Ganji, 2017; Chavez et al., 2013) which are the four attributes that are commonly implied to measure lean performance in supply chain.
2. Process-based approaches (Balfaqih, 2016), since we have taken in this research the taxonomy of (Shepherd & Gunter, 2006) which mainly provided a classification of supply chain metrics depends on the five main processes of SCOR model in terms of plan, source, make, deliver, and return. Therefore, the study provided a balanced approach in assessing SC performance between supplier-related, manufacturer-related, and customer-related measures.
2. Differentiating between cost measures as financial measures and non-cost measures as non-financial measures in terms of time, quality, and flexibility. It is essential to differentiate between those both aspects of performance since an exclusive dependence on cost indicators can result in misleading of SC performance

depiction (Chen & Paulraj, 2004). Cost measures that involve all the costs pertained to supply chain operations (Leonczuk, 2016). And adding non- cost measures in terms of time and quality indicate supply chain ability to deliver a higher performance level of customer service, whilst flexibility provides the ability to cope with rapid changes in demand or supply (Shepherd & Günter, 2006). Being flexible refers to making the products/services available to meet customers' individual demands (Gunasekaran, et al., 2001).

2-3 Lean Practice and Supply Chain Performance

There are many researchers have discussed the relationship between lean practice and performance (e.g. operational performance and organizational performance, economic performance), these studies tested different lean practices influences on different performance dimensions, as there are an impact of lean practices on cost performance and non-cost performance (Chavez et al., 2013; Chavez et al., 2015; Taj & Morosan, 2011; Rahman et al., 2010; Harris & Cassidy, 2014; Koumanakos, 2008; Balakrishnan et al., 1996; Filho et al., 2016; Sharma et al., 2015; Shah & Ganji, 2017). In the transition to LSC performance, there are many authors discussed the impact of LSC practices on SC performance (Arif-Uz-Zaman & Ahsan, 2014; Tortorella et al., 2017; Nimeh et al., 2018; Abdallah et al., 2014). (Arif-Uz-Zaman & Ahsan, 2014) have analyzed a case study of "Motion Pant Co." before and after lean implementation, the authors indicated that the performance for LSC in comparison to non-LSC were showed significantly better in both cost and time than quality and flexibility. Thus, lean performance evaluation for the supply chain of this company showed more effective performance in cost and time competitive strategy. (Tortorella et al., 2017) combined 22 LSCM practices into four LSCM bundles in terms of customer SRM (CSRM), logistics management (LOM), elimination of waste and continuous improvement (EWCI), and top management commitment (TMC) and considering the contextual variables in assessing LSCM practices degree, in addition, the authors revealed the substantial contribution of LSCM practices implementation on SC performance, although not all aspects matter to the same extent and effect. (Nimeh et al., 2018) concluded that all of LSCM practices in terms of JIT, flow of information, customer relationship, supplier relationship, and waste reduction, have a significant positive impact on SC performance. (Abdallah et al., 2014) indicated the various effects of each practice of the

SCM practices (internal integration, information sharing, postponement, supplier integration, and customer integration) on SC efficiency performance and SC effectiveness performance.

3- Methodology

3-1 Research Hypothesis

H1: VSA or VSM has a positive impact on the total SC performance.
H2: SRM has a positive impact on the total SC performance.
H3: LSF has a positive impact on the total SC performance.
H4: CRM has a positive impact on the total SC performance.
H5: JIT has a positive impact on the total SC performance.
H6: IT management has a positive impact on the total SC performance.

3-2 Research Conceptual Framework

From the above section, the research model is depicted as the following framework figure 3-1 indicating LSC practices (independent variables) and total SC performance (dependent variable).

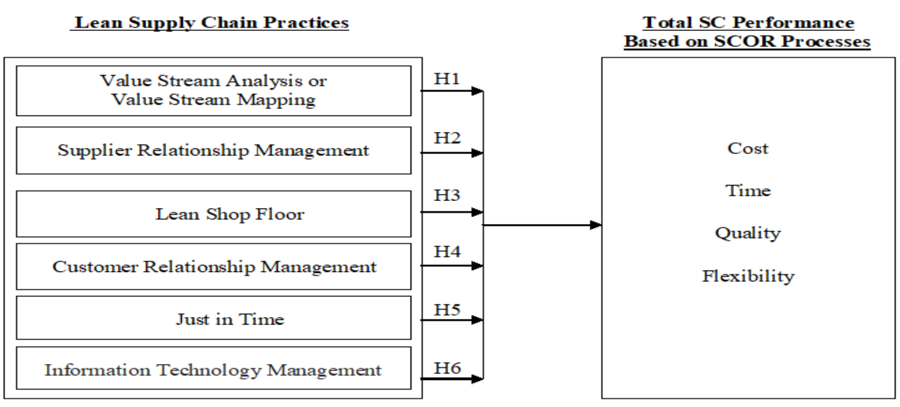


Figure 3-1: The research conceptual framework

3-3 Sampling and data collection

Data was collected by using on-line survey questionnaires that were self – administered by the researcher via online communications, 30 specified Egyptian manufacturing organizations from different manufacturing industry sectors were selected as target population that have been adopting both lean practice and SCM, those organizations were listed as the most popular organizations in this strategy as advised from our professional relatives in Egypt industrial modernisation center, from which the sample size of 80 managers (Chef Executive Officer- CEO, operations manager, supply chain manager, plant manager, lean manufacturing consultant, logistics manager, purchasing manager, others) was selected so that it is considered a convenience sampling (non-random) as a non-random choice strategy is commonly used by many authors in lean manufacturing (LM) research studies in which the search for the organizations are already known to the researchers (Boyle et al., 2011; Netland & Ferdows, 2014; Tortorella, et al., 2016). For example, (Shah & Ward 2007) have drawn a sample when they administered a survey on LM from the events of courses and training since the respondents needed to have experience in the topic. The questionnaires were distributed to 80 managers, only 66 valid respondents were obtained (Chef Executive Officers-CEOs with 3.1%, operations managers with 13.8%, supply chain managers with 26%, plant managers with 3.1%, lean manufacturing consultants with 36.9%, logistics managers with 9.2 %, purchasing managers with 0%, others with 7.7%), a response rate of 82.5 % which is superior. According to (Mugenda & Mugenda, 1999; Muchiri, 2017) a response rate of 50% is appropriate for reporting and analysis, 60% rate is considered a good rate, and over the rate of 70% is superior.

3-4 Questionnaire development

The questionnaire includes close-ended questions and follows five point likert scales method, it consists of three parts: The first part indicates varied demographics as table (3-1); position title, company years of LM implementation, and industry sector, which aims to prove and validate certain assumptions. This part was adopted from the questionnaires of authors (Green et al., 2014; Tortorella et al., 2017; Muchiri, 2017; Ghosh, 2012; Marodin et al., 2016).

Table 3-1: Demographic information

S	Demographic information	
1	Position title	Supply Chain Manager.
		Lean Manufacturing Consultant.
		Operations Manager.
		Supply Chain Manager.
		Plant manager.
		Logistics manager.
		Purchasing Manager.

		Others.
2	Years of LM implementation	under 5 years.
		5 - 15 years.
		Over 15 years.
3	Industry sector	Consumer goods.
		Textiles and mill products.
		Automotive.
		Food & Beverage.
		Furniture & fixtures products.
		Steel.
		Electronic& other electrical equipment.
		Stone, clay, glass& concrete products.
		Chemical & allied products.
		Others.

The second part indicates the level of LSC practices implementation degree in Egypt manufacturing organizations as table 3-2; this part was adopted from (Shah & Ward, 2007; Herzog & Tonchia, 2014; Marodin et al., 2017; Muchiri, 2017; Green et al., 2014; Jasti & Kodali, 2015; Ruiz-Benítez et al., 2018). It consists of six practices.

Table 3-2: Lean Supply Chain practices constructs

S	LSC practices	Constructs	References
1	Value stream analysis or value stream mapping as planning related practice.	Process mapping	(Herzog & Tonchia, 2014)
		Waste evidence	
		Cost reduction	
2	SRM as supplier related practice.	longer-termrelationship with suppliers	(Marodin et al., 2017; Shah & Ward, 2007; Ruiz-Benítez et al., 2018)
		Supplier involvement.	(Shah & Ward, 2007; Muchiri, 2017)
		Supplier feedback on their performance	(Shah & Ward, 2007)
3	Lean shop floor as internally related practice.	Pull system	(Shah & Ward, 2007)
		Continuous flow	
		Set up time reduction	
		Statistical Process control	
		Employee involvement	
		Total productive/preventive maintenance (TPM)”	

4	CRM as customer related practice.	Customer relationship	(Marodin, et al., 2017)
		Customer involvement	(Shah & Ward, 2007)
5	Just in time as an integrated supply chain practice.	JIT deliveries by suppliers "JIT-purchasing strategy"	(Shah & Ward, 2007; Green, et al., 2014)
		JIT in manufacturing "JIT-production strategy"	(Green, et al., 2014)
		JIT deliveries to customers "JIT-selling strategy"	(Green, et al., 2014)
6	Information technology management as an integrated supply chain practice.	EDI to communicate between departments	(Jasti & Kodali, 2015)
		Enterprise resource planning system "ERP"	
		Information technology employed at customer base.	
		Effective and transparency information flow throughout supply chain	
		Bar coding and scanner in logistics systems	
		Electronic commerce"E-commerce"	

Finally, the third part indicates the impact of LSC practice on total SC performance. performance measures were selected to evaluate SC performance based on the fact that these measures are the most common measures used in the majority of researches and recent in dates e.g. (Chavez et al., 2013; Taj & Morosan, 2011; Nawanir et al., 2016; Arif-Uz-Zaman & Ahsan, 2014; Ruiz-Benítez et al., 2018; Filho et al., 2016; Sharma et al., 2015; Shah & Ganji, 2017; Prajogo et al., 2016; Khanchanapong et al., 2014; Azfar et al., 2014; Dora et al., 2016; Kumar et al., 2015; Afonso & Cabrita, 2015; Droge et al., 2004, Jacobs et al., 2007; Machuca et al., 2011; Rosenzweig et al., 2003; Folinas et al., 2014 ; Sangwa & Sangwan, 2018; Arif-Uz-Zaman & Ahsan, 2014; Behrouzi &Wong, 2011; Chavez et al., 2015). From which, the measures were classified into four different performance attributes (cost, time, quality, flexibility), those attributes are highly common in these researches that have discussed lean practice and performance topics. Then, the selected measures for cost, time, quality, and flexibility attributes were categorized into the five main processes of the SCOR model (plan, source, make, deliver, and return) based on a theoretical framework established by (Shepherd & Gu¨nter, 2006). Therefore, this study included all SC performance measures to encompass the whole SCOR model processes that constitute SC processes based on the performance attributes that are commonly used to assess lean practice on performance. This can be indicated as the following table 3-3:

Table 3-3: Selected Supply Chain performance measures to assess Lean Supply Chain practice

SCOR model Processes	Performance attributes	Performance Measures	References
Plan	Cost	Sales	(Arif-Uz-Zaman & Ahsan, 2014; Chavez et al., 2015)
		Return on investment ratio	(Chavez et al., 2015; Afonso & Cabritab, 2015; Nawanir et al., 2016)
		Value added productivity	(Ruiz-Benítez et al., 2018; Chavez et al., 2015)
		Production efficiency	(Arif-Uz-Zaman & Ahsan, 2014; Khanchanapong et al., 2014)
Plan	Time	Planning cycle time	(Machuca et al., 2011)
		Cash to cash cycle time	(Azfar al., 2014)
	Quality	Accuracy of forecasting techniques	(Arif-Uz-Zaman & Ahsan, 2014)
		Perfect order fulfillment	(Behrouzi & Wong, 2011)
	Flexibility	Mix flexibility	(Behrouzi & Wong, 2011)
		New product flexibility	(Behrouzi & Wong, 2011)
Source	Cost	Cost for materials purchasing	(Bhasin, 2012; Ruiz-Benítez et al., 2018)
		Supplier cost-saving initiatives	(Arif-Uz-Zaman & Ahsan, 2014)
	Time	Purchase order cycle time	(Arif-Uz-Zaman & Ahsan, 2014)
Source	Quality	Supplier rejection rate	(Behrouzi & Wong, 2011)
		The extent of mutual assistance with supplier leading in problem-solving efforts.	(Arif-Uz-Zaman & Ahsan, 2014)
	Flexibility	Procurement flexibility	(Machuca et al., 2011)

Continued table 3-3: Selected Supply Chain performance measures to assess Lean Supply Chain practice

SCOR model Processes	Performance attributes	Performance Measures	References
Make	Cost	Production cost	(Ruiz-Benítez et al., 2018)
		Capacity utilization as incoming stock level, work-in-progress, scrap level, finished goods in transit.	(Ruiz-Benítez et al., 2018)
		Inventory cost.	(Pakdil & Leonard, 2014; Machuca et al., 2011)
		Inventory turnover.	(Machuca et al., 2011; Dora et al., 2016)
	Time	Manufacturing lead time	(Khanchanapong et al., 2014)
	Quality	Defect rates of production.	(Sangwa & Sangwan, 2018)
	Flexibility	Easily change the production volume of a manufacturing process.	(Khanchanapong et al., 2014)
Deliver	Cost	Total logistics costs.	(Arif-Uz-Zaman & Ahsan, 2014; Sellitto et al., 2015)
		Transport costs.	(Ruiz-Benítez et al., 2018)
	Time	Delivery lead time	(Khanchanapong et al., 2014)
	Quality	Number of on-time deliveries	(Bhasin, 2012; Dora et al., 2016)
	Flexibility	Delivery flexibility	(Bhasin, 2012; Sangwa & Sangwan, 2018)
Return	Cost	Warranty/ returns processing costs.	(Kumar et al., 2015; Behrouzi &Wong, 2011)
	Time	Customer query time.	(Folinas et al., 2014)
	Quality	Customer satisfaction.	(Ruiz-Benítez et al., 2018)
		Improving product quality perceived by customers.	(Ruiz-Benítez et al., 2018; (Arif-Uz-Zaman & Ahsan, 2014)

	Flexibility	Flexibility of service systems to meet particular customer needs.	(Shepherd & Günter, 2006)

4- Research Findings and analysis

4-1 Reliability Test

Reliability analysis was conducted for determining the Cronbach's alpha values for each component to measure the indicators' internal consistency for a construct (Hair et al., 1998). It is a very important step to test the questionnaire before using it for data collection (Cooper & Schindler, 2014). As shown in table 4-1 all Cronbach's alpha values showing a high internal consistency among LSC practices measures and SC performance measures, as the values are greater than 0.7 except for IT management practice measures as (Sekran, 2003) stated that Cronbach’s Alpha between 0.5 and 0.7 is acceptable for social science.

Table 4-1: Reliability Test

Sub/Variable(s)	No. of Items	Cronbach’s Alpha
VSA or VSM	3	0.903
Supplier relationship management	3	0.797
LSF	6	0.930
Customer relationship management	2	0.886
JIT	3	0.872
IT management	6	0.647
Cost	13	0.898
Time	8	0.874
Quality	8	0.872
Flexibility	6	0.883

4-2 Data Analysis Techniques

In statistical modeling, IBM SPSS software version 23 was used in data analysis; a descriptive analysis was conducted as an indication for LSC practices implementation degree in Egypt manufacturing sector. Also, regression analysis is used as a statistical process measuring the relationship significance between the variables. In other words, it is used to determine the impact of LSC practices implemented on total SC performance, identifying R square value and the adjusted R square value to measure the variance among the research variables (Stephanie, 2018), indicating the Beta coefficient as the higher the absolute value of the beta coefficient, the stronger the effect (Stephanie, 2018).

4-2-1 Descriptive statistics to evaluate Lean Supply Chain practices implementation degree in Egypt manufacturing industry

As indicated in table 4-2 the majority of respondents' ratings regarding LSC practices implementation degree for the six practices presented in this research. CRM is the highest adopted practice with a large extent (mean=4.015). Then respectively, SRM is adopted between moderate and large extent (mean=3.6767), JIT is adopted with moderate extent (mean= 3.4141), LSF is adopted with moderate extent (mean= 3.383), VSA or VSM is adopted with moderate extent (mean= 3.26) and IT management is adopted with the lowest degree of implementation with moderate extent (mean= 2.972).

4-2-2 Impact of Lean Supply Chain practices implementation on total Supply Chain performance

A multiple regression analysis was applied to indicate the significant relationship between LSC practices and the total SC performance, the results showed that the general adoption of LSC practice explains 39 % of the variance in total SC performance (adjusted R square = 0.39), and there is a positive significant association between LSC practice and total SC performance. Despite the practices of SRM and JIT have an insignificant impact on SC performance, with correlation (P) and beta (β) values respectively (P=.061, β=.095) and (P= 0.419, β= 0.028).

Thus, H2 and H5 are rejected. The rest of LSC practices (VSA/VSM, LSF, CRM, IT management) have a significant positive contribution to the total SC performance although not all aspects matter to the same extent and effect, as the highest β, stronger the effect as follows:

- The relationship between VSA or VSM practice and total SC performance is significantly positive (P= 0.002, β=.118), Thus, H1 is accepted.
- The relationship between LSF practice and total SC performance is significantly positive (P= 0.001, β=.116), Thus, H3 is accepted.
- The relationship between CRM practice and total SC performance is significantly positive (P= 0.034, β=0.122), Thus, H4 is accepted.
- The relationship between IT management practice and total SC performance is significantly positive (P= 0.017, β=0.137), Thus, H6 is accepted.

Table4-2: The extent of Lean Supply Chain practices implementation

Sub/ Variable (s)	Measure	Very small extent	Small extent	Moderate extent	Large extent	Very large extent	M	Result
VSA or VSM							3.26	Moderate extent
Process mapping	(F)	2	25	8	29	2	3.061	
	%	3.0	37.9	12.1	43.9	3.0		
Waste evidence	(F)	3	21	11	0	31	3.530	
	%	4.5	31.8	16.7	0	47.0		
Cost reduction	(F)	4	17	10	31	4	3.212	
	%	6.1	25.8	15.2	47.0	6.1		
Supplier relationship management							3.676	Between Moderate and Large extent
Long term relationship with suppliers	(F)	0	4	19	32	11	3.758	
	%	0	6.1	28.8	48.5	16.7		
Suppliers involvement	(F)	0	4	20	30	12	3.758	
	%	0	6.1	30.3	45.5	18.2		
Suppliers feedback	(F)	0	10	19	30	7	3.515	
	%		15.2	28.8	45.5	10.6		
LSF							3.383	Moderate extent
Pull system	(F)	1	13	19	19	14	3.485	
	%	1.5	19.7	28.8	28.8	21.2		

Continued table 4-2: The extent of Lean Supply Chain practices implementation

Sub/ Variable (s)	Measure	Very small extent	Small extent	Moderate extent	Large extent	Very large extent	M	Result
Continuous flow	(F)	2	5	25	22	12	3.561	
	%	3.0	7.6	37.9	33.3	18.2		
Set up time reduction	(F)	4	15	25	14	8	3.106	
	%	6.1	22.7	37.9	21.2	12.1		
	(F)	1	13	19	19	14		

Statistical Process control	%	1.5	19.7	28.8	28.8	21.2	3.485	
Employee involvement	(F)	2	5	25	22	12	3.561	
	%	3.0	7.6	37.9	33.3	18.2		
Total productive/ preventive maintenance	(F)	4	15	25	14	8	3.106	
	%	6.1	22.7	37.9	21.2	12.1		
Customer relationship management							4.015	Large extent
Customer relationship	(F)	2	3	13	19	29	4.061	
	%	3.0	4.5	19.7	28.8	43.9		
Customer involvement	(F)	1	5	11	27	22	3.970	
	%	1.5	7.6	16.7	40.9	33.3		
JIT							3.414	Moderate extent
JIT-purchasing	(F)	6	5	14	21	20	3.667	
	%	9.1	7.6	21.2	31.8	30.3		
JIT-production	(F)	7	6	10	20	23	3.697	
	%	10.6	9.1	15.2	30.3	34.8		
JIT-selling	(F)	13	16	14	12	11	2.879	
	%	19.7	24.2	21.2	18.2	16.7		
IT management							2.972	Moderate extent
Electronic data interchange "EDI"	(F)	8	16	16	15	11	3.076	
	%	12.1	24.2	24.2	22.7	16.7		
Enterprise resource planning system "ERP"	(F)	6	13	21	10	16	3.258	
	%	9.1	19.7	31.8	15.2	24.2		
Information technology employed at customer base.	(F)	8	17	23	12	6	2.864	
	%	12.1	25.8	34.8	18.2	9.1		
Effective and transparency information flow throughout supply chain	(F)	9	17	18	16	6	2.894	
	%	13.6	25.8	27.3	24.2	9.1		
	(F)	14	10	9	21	12		

Bar coding & scanner	%	21.2	15.2	13.6	31.8	18.2	3.106	

Continued table 4-2: The extent of Lean Supply Chain practices implementation

Sub/ Variable (s)	Measure	Very small extent	Small extent	Moderate extent	Large extent	Very large extent	M	Result
Electronic commerce "E-commerce"	(F)	19	16	10	12	9	2.636	
	%	28.8	24.2	15.2	18.2	13.6		

* (F) = frequency, (M) = Mean.

5- Discussions and conclusions

In this research, majority of respondents are from lean manufacturing consultants and supply chain managers, this enriched respondents' answers to be more professional, 51.5 % of the respondents are from companies experienced with LM implementation for less than 5 years which means that lean practice in Egypt is newly emerged strategy, this results corroborated to previous researches (Muchiri, 2017). As, Lean adoption in emerging countries is up to this time superficial and less implemented than developed countries (Panizzolo et al., 2012; Tortorella et al., 2017).

Applying LSC practice formulated into six practices and adopted across the SCOR model processes with various degrees of implementation, the results indicated that the average implementation degree of LSC practices in Egypt manufacturing industry is at a moderate level of adoption which means that LSC practices are not considered in its full maturity stage; CRM practice showed the highest implementation degree (to a large extent of implementation, mean= 4.015) which means that the companies in Egypt are still focusing on sales volumes as traditional concept to improve the competitiveness, SRM practice has been adopted between large and moderate extent of implementation (mean=3.676), and it placed the second concern from practitioners believing that the quality of their produced product depends mainly on the quality of their raw materials purchased from their suppliers, JIT practice has been adopted to a moderate extent of implementation (mean=3.414), as JIT production is the highest degree of implementation in relative to JIT purchasing and JIT selling as traditional concept due to lack of control from the companies to purchase from their supplier in the right quantity at the right time, and in the right place in addition to the lack of control to sell their product to the customer by applying JIT selling strategy because of the instability of demand and supply in Egypt market. Implementing LSF as internally related practice with a moderate extent of implementation (mean=3.383), whereas the employees maybe not well trained enough to deal with LM in the production system and there is a lack of commitment from the top managers to implement LM to a large extent. The practice of VSA or VSM has been adopted to a moderate level of implementation (mean=3.260) which means that there is a moderate implementation degree of the planning techniques in Egypt manufacturing industry in order to achieve continuous improvement and waste elimination throughout the supply chain. IT management practice showed the lowest implementation degree with a moderate extent of implementation (mean=2.972), this is due to the poor infrastructure in Egypt and the poor culture of people to deal with the electronic systems.

In addition, the results indicated applying an integral LSC practice has a significant positive contribution to the total SC performance although not all aspects matter to the same extent and effect, this result is in line with (Nimeh et al., 2018; Tortorella et al., 2017). As IT management practice has a significant positive impact on total SC performance, this result corroborated to previous studies e.g. (So & Sun, 2010) in which they indicated that IT management improves the performance of cost and quality. In this study, it showed the highest positive impact (β= 0.137), explaining that IT management is essential pillar for enhancing the SC performance and achieves excellence in LSCM and any slight improvement in IT management would have an effect on SC performance, then respectively CRM practice (β= 0.122), VSA/VSM practice (β= 0.118), and LSF practice has the lowest positive impact (β= 0.116) because this practice focuses mainly on attaining excellence on operational performance related to the manufacturing activities more than focusing on SC performance related to SC activities. only two practices of SRM and JIT showed insignificant relationships with the total SC performance, as SRM has an insignificant impact on the total SC performance, this result is inconsistent with the results of previous studies (Nimeh et al., 2018; Lee et al., 2007; Tortorella et al., 2017). And it may be associated with factors in Egypt market like the foreign currency fluctuations and the imposed limitations on the imports may impede and erode the efforts of establishing SRM practice to be significantly influential on SC performance in terms of cost, time, quality and flexibility. Also, JIT has an insignificant impact on the total SC performance, this result is in line with the evidence that JIT/lean may not improve all performance dimensions. Examples of such papers are: (Flynn et al., 1995; Dean & Snell, 1996; Ketokivi & Schroeder 2004; Swink et al., 2005). Also, (Green et al., 2014) indicated that T-JIT (JIT-manufacturing, JIT-purchasing, JIT-selling, and JIT-information) is not significantly associated with organizational performance directly but its effect on organizational performance is indirect through supply chain competency since The T-JIT strategy is an effective strategy for improving supply chain competency. The result of this study that showed the insignificant relationship between JIT and the total SC performance is due to the fact that in the absence of stable demand and supply market like Egypt market, maintaining a lower level of inventory is not being significantly influential on the SC performance dimensions in terms of cost, time, quality and flexibility.

6- Research implications

The contributions of this research highlighted two implications; theoretical implications and practical Implications.

6-1 Theoretical Implications

- This study shows unique and important findings that contribute to the body of knowledge about LSC practices and SC performance.

- This research provides empirically validated a set of LSC practices and SC performance measures and investigating the associations between these proposed practices and measures since the empirical validations to show the positive association between LSCM and SC performance have not given the attention that they deserve by the researchers. Therefore, these research measurements could be useful for conducting further empirical researches in this field with different research settings.

- This research provides a bundle of LSC practices along with SCOR model processes and validates these practices empirically to investigate the transition from a primordial LM practice to LSC practice, it was conducted for the first time in the researches related to Egypt manufacturing sector.

- This research provides distinguished empirical evidence for a set of SC performance measures that are used to assess LSC performance in terms of cost, time, quality, and flexibility in a way that embraces all

SCM processes which might assist other researchers to use these measures in each specific area in SCM. As there was a previous research has suggested SC performance measures to assess LSC performance with these performance attributes and process categorization but with different methodology and objectives (Arif-Uz-Zaman & Ahsan, 2014). Also, other researches proposed measures to assess LSC performance but with emphasizing narrowly on a specific industry sector (Behrouzi & Wong, 2011).

6-2 Practical Implications

This research provides some lessons for practitioners. Firstly, the study proposes an empirical framework for LSC practices that can be considered closely pertained to SCM in Egypt manufacturing industry as it has provided evidence tested empirically in Egypt manufacturing industry scenario about the implementation level of each of the proposed LSC practices and their associations with SC performance attributes and processes (plan, source, make, deliver, and return) which constitute SCOR model processes and pertained to SCM processes, manufacturing companies' managers could compare that with the pace of their LSCM implementation. Hence, they could judge which LSC practice needs more attention at a given phase of their initiative. Accordingly, they can uniform the new strategy and investment decisions in light of increasing global competition. Secondly, based on extensive reviewing for literatures and empirically tested researches about SC performance measurement systems and LSC performance, set of SC performance indicators were proposed along with the five SCOR model processes that might be considered as substantial KPIs can be taken in to account in evaluating the effective lean implementation across SCM. Since, performance measures were introduced beyond shop floor operational measures to include planning measures, sourcing measures, customer service measures, and after-sales service measures. (Wisner et al., 2008) argued that performance indicators enhance SCM in which effectively links supply chain partners to achieve optimal performance in meeting end-customer needs and provide feedback regarding customers' needs and the supply chain's capabilities. In this regard, this research could assist in setting suitable SC performance measurement system that helps lean organizations to attain the outcomes of applying lean practice because, in the light of setting proper performance measures along with supply chain, lean practice outcomes would be reflected clearly in the firm's performance measurement system.

7- Research limitations

- The majority of respondents are from multinational organizations more than local organizations.
- The survey questionnaire was lengthy to cover the whole research points, which has taken an hour from respondents to complete.
- The sample size is small because: a) lean practice and SC performance are sensitive and critical topics, therefore this study targeted professional managers who are a few in number, b) we have faced reluctance from many managers to cooperate with this research because they considered asking about strategy and performance are confidential topics, cannot be disclosed.
- The research generalizes the Egyptian manufacturing sector without investigating the differences in the impact between the different types of manufacturing organizations.

8- Directions for Future Research

- This study suggests conducting this investigation in Egypt service field and the public sector.
- It is recommended to conduct this investigation comprising local organizations in particular by using different methodologies.
- This study suggests an investigation for future researches regarding the barriers and challenges for achieving successful LSC implementation especially when they are concerned with lean practice implementation in emerging countries.
- Regarding the research objective which is mainly concerned with unveiling the positive association between LSC practices and total SC performance, we have selected a specific set of LSC practices and SC performance measures based on the main framework of the SCOR model processes. However, further investigation can be performed to select different frameworks for LSC practices selection and different supply chain performance measurement systems (e.g. balanced scorecard).

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ملخص البحث باللغة العربية

الهدف العام من هذا البحث هو تحديد تأثير ممارسة نظام الإنتاج الرشيق (تقليل الفاقد) على أداء سلسلة الإمداد فى قطاع التصنيع فى مصر، حيث تم اقتراح إطار تجريبي لممارسات سلسلة الإمداد الرشيقة لتشمل العمليات الخمس (الخطة، التوريد، الصنع، التوصيل، الإرجاع) لنموذج مرجع عمليات سلسة الإمداد SCOR الذي يمثل العمليات الرئيسية لإدارة سلسلة الإمداد. تبنت هذه الدراسة تصميمًا بحثيًا تفسيريًا كميًا لإختبار بشكل تجريبى مدى تطبيق ممارسة الإنتاج الرشيق في قطاع التصنيع. في مصر خلال الخمس عمليات التى تمثل نموذج ال SCOR وللتحقق من تأثير تطبيق ممارسات سلسة الإمداد الرشيقة على الأداء الكلى لسلسة الإمداد (التكلفة والوقت والجودة والمرونة). تم توزيع إستبيان إستقصائي على مديرون من عدد ثلاثون شركة تصنيع فى مختلف الصناعات ، تقوم هذه الشركات بتطبيق ممارسات الإنتاج الرشيق في عملياتها ، و تم الحصول على ستة و ستون رد كإستبيانات صالحة للدراسة. أظهرت النتائج أولاً، تحديد والتحقق التجريبى من درجة تطبيق ممارسات الإنتاج الرشيق عبر إدارة سلسة الإمداد للتركيز على ممارسات سلسة الإمداد الرشيقة الأكثر شيوعاً والأولى بين قطاعات التصنيع المختلفة في مصر. ثانيًا، تأثير ممارسات سلسة الإمداد الرشيقة على الأداء الكلى لسلسة الإمداد، على الرغم من أن جميع الجوانب لا تهم بنفس القدر والأثر. نظراً لأن ممارسات تحليل تدفق القيمة أو تعيين تدفق القيمة (VSA **أو** VSM)، و تقليل الفاقد فى التصنيع الداخلى (LSF)، وإدارة علاقات العملاء (CRM)، وإدارة تكنولوجيا المعلومات (IT)لهم تأثير إيجابي على الأداء الكلى لسلسلة الإمداد في حين أن كلاً من إدارة علاقات الموردين (SRM) و نظام الإنتاج فى الوقت المحدد (JIT) ليس لديهم أى تأثير.

الكلمات المفتاحية: الإنتاج الرشيق، إدارة سلسلة الإمداد الرشيق، أداء سلسلة الإمداد، ممارسات إدارة سلسلة الإمداد.

Suggested Citation according to APA Style

Mahmoud, H.; Labib, A. and Noour, A. (2020). The Effect of Lean Supply Chain Practice on Supply Chain Performance in Egypt Manufacturing Industry. *Journal of Alexandria University for Administrative Sciences*, Faculty of Commerce – Alexandria University 57(1), 261 – 304.

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JAS.AU@alexu.edu.eg

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