

Lean Supply Chain: Take an Opportunity to do More with Less

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Abstract: The purpose of this paper is to demonstrate that the application of lean approach in supply chain can act and influence the improvement of performances of the overall supply chain, as well as of all its participants. Some of the benefits which can be achieved by applying lean tools, methods and techniques, with minimal required investment, in supply chain are: reduced wastes, reduced costs, improved quality, faster delivery, and consequently increased supply chain profitability. In this paper, the comparison of traditional and lean supply chain is done according to different derived characteristics. The identification of comparative characteristics is done by desk research in combination with conversational research. The paper can serve as a basis for transforming existing supply chain into a lean supply chain.

Keywords: lean supply chain; efficiency; lean approach; lean supply chain management; supply chain

1 INTRODUCTION

Application of lean approach provides improvement of the efficiency and effectiveness of participating companies in the supply chain (SC), as well as the overall supply chain. The lean approach is focused on eliminating wastes and better use of resources in performing business activities and processes. All unnecessary activities that do not contribute to the creation of value for products or services for customers need to be identified and eliminated. In practice, waste is often present in demand forecasting, procurement of materials and raw materials, inventory management, product manufacturing, product storage, preparation of deliveries, transportation, logistics services and return of products [1]. Therefore, it is necessary to eliminate wastes in all supply chain processes: plan, source, make, delivery and return of products [2]. Accordingly, it is important to educate, respect and involve all employees from operational workers in the production process to the highest levels of company and supply chain managers.

Manufacturing has evolved from the craft and mass non-lean production to more recent lean manufacturing. The field of supply chain management (SCM) has also evolved rapidly, along with these developments in manufacturing. Supply chain management can be defined as "the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole" [3]. One key characteristics of present-day business is the competition of supply chains. The success and failure of supply chains will be determined by the customers [4]. Today, the requirement for survival for most supply chains is providing the right product, in the right quantity and quality, at the right cost, at the right time to the right customer. Hence, to fulfil this requirement, some companies have transformed their supply chains by adopting and implementing concepts of lean supply chain (LSC).

This paper is organized into five sections. The next section elucidates the theoretical basis of lean approach. Section 3 provides a literature review regarding lean supply chain management (LSCM) and briefly discusses the tools,

techniques, procedures and practices of lean supply chain. Section 4 provides comparison of traditional and lean supply chains based on derived characteristics. Section 5, gives conclusions and proposes directions for further research.

2 LEAN APPROACH

The history of the emergence of the lean system is closely related to Japan and the Toyota Company, thought to be the creator of the lean manufacturing, also called the Toyota Production System (TPS) [5]. In the early 1980s, the Japanese automotive industry, led by Toyota, has taken lead in the global automotive industry by translating traditional production organization into lean manufacturing. The goals of TPS were to eliminate wastes and realize the processes based on actual customer demand. This required the education and development of all employees, the prospect of a supply chain driven by real customer demand, the creation of a self-learning organization, and the introduction and implementation of standardized processes. Toyota has thus been able to produce products with fewer defects, in shorter production processes, with fewer suppliers, with lower inventory levels and with less investment.

The term "lean" dates back to 1988 when John Krafcik published "The Triumph of Lean Production System" in the Sloan Management Review. Womack and Jones (1996) determine lean approach as a systematic analysis and elimination of redundant activities in work processes as well as sources of losses, with the aim of influencing quality, cost and time [6]. According to them, lean approach enables organizations to operate better with less and less resources i.e. less human resources, less equipment, less space and time. NIST (2000) defines lean as a "systematic approach to identifying and eliminating wastes through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection" [7]. Authors Shah and Ward (2007) explain lean as a management philosophy that is concerned with identification and elimination of wastes within and beyond organizations' product value chain [8]. Gupta, Sharma and Sunder (2016) determine lean as "an integrated multi-dimensional approach encompassing wide variety of

management practices based on philosophy of eliminating wastes through continuous improvement" [9]. Basic characteristics of lean concept proposed in [5] are: elimination of wastes, minimizing wastes, maximizing the quality of products or services, continuity and balance of material flow, pull principle of material flow management, directionality to meeting customer requirements, continuous staff training, flexibility of the process, strong partnership with suppliers, efficiency of technical and technological equipment, standardization of work, a culture of continuous improvement of processes and operations, etc.

Some authors differentiate the terms of "hard" and "soft" lean [10]. According to them, "hard lean" deals with the manufacturing process and techniques, methods and tools of production, with a focus on improving efficiency. "Soft lean" refers to an organization's value system, adaptability, employee participation and a focus on value for the consumer.

Therefore, the essence of lean is to reduce wastes, produce quality products and services in the right quantity, and deliver them at the right time at the lowest cost [11]. The seven types of wastes that enterprises need to deal with are: transportation, inventory, motion, waiting, over-processing, over-production and defects. Except for the above, as the eighth type of waste is recognized the lack of involvement and use of human resources (e.g. [12, 5]). Lean's basic principles are to eliminate 3M: Muda, Mura and Muri, which are Japanese terminology for wastes, unevenness and overburden, and get continuous process improvement by increasing productivity, reducing cost or both (e.g. [13, 14]).

3 LEAN SUPPLY CHAIN

Supply chain can be defined as "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer" [15]. Supply chain is a "global network used to deliver products and services from raw materials to end customers through an engineered flow of information, physical distribution and cash" [16]. Lean supply chain involves identifying all types of wastes in the overall supply chain and taking steps to eliminate them while minimizing delivery time [17, 18]. It should enable that flows and processes from the supplier, through the manufacturer, then the distributor, and to the end customers, proceed without waste [19, 20]. Participants in the lean supply chain must constantly make efforts to make various improvements and focus on eliminating wasteful or worthless activities along the chain [21] while meeting the real needs of customers. Successful implementation of lean approach in the supply chain requires the direct involvement and cooperation of focal company, and their key suppliers and key customers.

Lean principles and practices became popular in the 1990s, and their application in the context of the supply chain attracted more attention a few years later [22]. The implementation of the lean concept in the supply chain was initiated by Womack and Jones (1996) with the publication of the book "Lean Thinking" [6]. According to El-Tawy and

Gallear (2011) when lean thinking is adopted by all the main participants in the supply chain, it is a new way of thinking that is referred to as lean supply chain [23]. In 1996, Lamming defines lean supply chain as "an arrangement (which) should provide a flow of goods, services and technology from supplier to customer (with associated flows of information and other communications in both directions) without wastes" [24]. Therefore, the lean concept can be applied in the overall supply chain, starting with ordering materials from suppliers, through the production of products, their distribution and delivery of products to end customers, and the eventual return of products ([25-27]). Vitasek et al. (2005) define lean supply chain as "a set of organizations directly linked by upstream and downstream flows of products, services, information and funds that collaboratively work to reduce cost and waste by efficiently pulling what is needed to meet the needs of individual customers" [28]. However, it is noted that lean supply chain concepts are not yet sufficiently developed [29], and that there is a lack of generalization of the lean supply chain management framework [30].

Based on past experience, it has been observed that the application of lean supply chain management leads to continuous improvement of supply chain performance, regardless of supply chain activity ([20, 31-33]). Lean supply chain management promises "enhancing competitiveness by improving efficiency and increasing flexibility at all stages of the supply chain" [34]. The application of lean supply chain management enables wastes elimination, quality improvement, costs reduction and increase of supply chain flexibility ([35, 6]). However, it is difficult to implement LSCM because it requires the involvement and collaboration of multiple supply chain participants [36]. Vlachos (2015) emphasizes lack of top management involvement as one of the main obstacles to support LSCM implementation [37]. Jadhav et al. (2014) also said that the top of the supply chain should be managed by strong leaders in order to make a real lean change [38]. Accordingly, the actual engagement of top management plays major role in conducting and sustaining enhancement [39]. Otherwise, shortage of commitment can cause number of complications, such as limited resources, longer decision-making processes, and miscommunications [30]. Successful implementation of LSCM faces four significant challenges: (I) existing ways of commerce based on changing auction prices, (II) obstacles in establishing a shared value stream, (III) the involvement and concern of top managers, and (IV) the influence of external factors based on power [30]. Several authors have suggested the need for leadership restructuring and the establishment of supporting infrastructure ([40, 41]).

Lean supply chain management enables better results in the overall supply chain [30], reduce wastes in the supply chain, reduce inventory in SC, reduce business risk through joint ventures in R&D and technology, achieve the required product quality, increase knowledge through joint product design [42]. Authors Womack et al. (1990) noted that automotive manufacturers who have succeeded in collaborating with distributors based on lean philosophy have achieved greater profits over the product life cycle, increased

customer loyalty, benefits from customer knowledge for product development and improved sales forecasts [35]. Lean supply chain management is enabled by information and communication technologies [40]. It is recommended to start with lean approach in supply chain, and then consider introducing new information systems and technologies to support the supply chain process [43].

Up to this point, several examples of successful lean supply chains in manufacturing and service industries have been presented: automotive industry (e.g. [40, 20]), food supply chain (e.g. [37]), electronics (e.g. [25]), toys supply chain ([39]), agribusiness ([26, 30]), fashion ([44]), healthcare (e.g. [45]), etc. Minor applications have been noted in areas such as computer science, construction, design, engineering, government and the military [46].

3.1 LSCM Principles and Practices

Each supply chain is unique and complex. The right choice of LSCM practice depends on the context of each company and its supply chain [47]. The strategy of transition from the traditional supply chain model to the LSCM cannot be indiscriminately generalized, as different contextual factors are decisive for such a decision [48]. Great number of studies is connecting LSCM practices with lean concept principles [26, 29, 37]. Anand and Kodali (2008) [29] that were later updated by Jasti and Kodali (2015a) [49], suggest 8 methods for the application of LSCM, consisting of 82 practices, which are: information technology management; management of suppliers; eliminating wastes; just in time (JIT) manufacturing; customer relationship management; logistics management; senior managers' commitment; and continuous improvement. Perez et al. (2010) suggests such a structure of LSCM practices that considers seven different aspects that belong to one of five lean principles: value specification; value stream identification; value stream formation; value specification based on the demand of customers; aim for perfection [30]. The seven proposed aspects are: demand management; value definition; processes and products standardization; value chain efficiency; key process indicators; establishment of good relations with chain members; and cultural change. Blos et al. (2015) suggested a structure constructed of eight SCM operational dimensions, whose function is to make the supply chain less vulnerable to both in-house and foreign risks: (I) customer service, (II) inventory management, (III) flexibility, (IV) time to market, (V) finance, (VI) ordering cycle time, (vii) quality, and (VIII) market [50]. Tortorella et al. (2017) have empirically validated 4 bundles of 22 interconnected and internally consistent LSCM practices: customer-supplier relationships management, logistics management, elimination of wastes and continuous improvement and top management commitment [51].

When it comes to individual LSCM practices, most commonly used are Kanban and close relationship between customer, supplier and relevant stakeholders (e.g. [24, 25]). Kanban is usually related with JIT deliveries [52, 53], by which the real material is delivered at the expected time, to the place and the quantity in which it was requested [54]. In

addition, several studies point to the practice indicates a distribution centers that affects the cost of transportation and the realization of orders ([26, 55-57]). Further, the 5S is used as a tool of visual management based on the belief that the organization of work space is crucial to ensuring a smooth workflow. It is based on 5 Japanese words starting with the letter 's' which were later translated to equivalent English words: Seiri (Sort), Seiton (Set in Order), Seiso (Shine), Seiketsu (Standardise) and Shitsuke (Sustain). After identifying value from the customer's perspective, the next step is to identify the value stream for each product, by Value Stream Mapping (VSM) tool. There is a large number of other useful LSCM practices (e.g. Heijunka, Jidoka, six sigma, poka-yoke, work standardization, etc.).

4 COMPARISON OF TRADITIONAL AND LEAN SUPPLY CHAINS

Each supply chain consists of a large number of participant enterprises (e.g. suppliers, manufacturers, distributors, wholesale, retail). Supply chain participants are directly and indirectly involved in the processes and flows of products, services, information, money and knowledge, from end suppliers to end customers [58].

In a traditional supply chain, each participant seeks to maximize their own profit, regardless of the other supply chain participants. Thus, retail seeks to meet the demand of end customers and to maximize profits. Based on demand of end customers, procurement orders are sent to wholesale. Wholesale determines projected needs based on received orders from retailers, as well as forecasts of retail demand. Wholesale wants to maximize its own profits. It issues procurement orders to the manufacturer. The manufacturer is making a master production schedule based on received orders and demand forecasts. Furthermore, it additionally uses components and inventory data to plan production. He procures the necessary raw materials and supplies from the supplier. The manufacturer also wants to maximize its own profit. The supplier seeks to meet the needs of the manufacturer and to maximize profits. Therefore, in a traditional supply chain, each participant predicts demand based on received data from the immediate downstream participant. Thus, wholesale does not have insight into the demand of end customers, as well as other upstream participants in the supply chain. This behaviour of the participants in the supply chain usually results in an occurrence of bullwhip effect. This description of traditional supply chain was done based on [59].

Within the lean supply chain, all participants collaborate and strive to meet the real needs of end customers while maximizing the overall profitability of the supply chain. Supply chain profitability is the difference between the revenue generated from the sale of products to end customers and the total cost of the supply chain [60]. Participants in the lean supply chain pay special attention to eliminating all wastes in the chain and in that way reducing costs at the overall supply chain level.

The comparison of traditional and lean supply chain was done according to different characteristics (Tab. 1). The

following characteristics are derived for purpose of this comparison: the aim of participants in SC; cooperation in SC; time horizon of relationships between participants in SC; processes in SC; customers in SC; demand forecasting; suppliers in SC; selection of suppliers in SC; frequency of

product delivery; product quality control; human resources in SC; SC performance measurement; process improvements in SC; and participation in new product development. The results presented in a lot of works are used, such as [24, 61-64, 41, 65-68, 8, 59], etc.

Table 1 Comparison of traditional and lean supply chains

Characteristics	Traditional SC	Lean SC
The aim of participants in SC	Each SC participant strives to maximize own profit	All SC participants strive to maximize the profitability of the overall SC. Emphasis on eliminating all wastes in SC and reducing the cost of the overall supply chain.
Cooperation in SC	Communication of SC participants to achieve their own goals	Collaborative relationships between SC participants based on mutual trust, commitment and shared responsibility to achieve common goals.
Time horizon of relationships between participants in SC	Short term	Long term
Processes in SC	The processes aren't integrated nor standardized in SC. Key processes in SC are usually not determined.	Processes are built based on the actual customers' needs. The key SC processes are determined. The processes are standardized. Tendency is to apply fail-safe processes (jidoka). Visual control of the process in SC is used.
Customers in SC	Meeting the needs of immediate customers is being considered (first level customers).	Relationships with all customers are considered (all levels). Segmentation of customers is done. Higher forms of cooperation are achieved with key customers.
Demand forecasting	Each SC participant works to predict demand	End-customer demand is predicted and data is provided to all key participants in SC.
Suppliers in SC	Large number of suppliers. Mostly no supplier segmentation is done.	Small number of suppliers. Supplier segmentation is performed. Higher forms of cooperation are being pursued with key suppliers.
Selection of suppliers in SC	The criteria regarding the price of the product mostly are used	Multiple criteria are used (e.g. average delivery time, product quality, order quantity, ordering frequency, supplier's distance, level of willingness to cooperate, level of service, order status visibility, etc).
Frequency of product delivery	It is not a frequent product delivery	Very frequent product delivery
Product quality control	Mostly, it's not strict	Strict and standardized product quality control activities
Human resources in SC	Employees on low-level are not given sufficient attention	Continuous education, appreciation and involvement of all employees from operational workers in the production process to the highest levels of enterprise managers and supply chain.
SC performance measurement	Participating companies measure their own business performance	Performance measurement at SC level. Both financial and non-financial performance measures are used.
Process improvements in SC	SC participating companies improve owns processes	Creating a self-learning SC. Continuous improvement of the SC processes.
Participation in new product development	Only one SC participant participates in the development of a new product	More SC participants are participating in new product development

Within the lean supply chain, collaborative relationships are established between participants to maximize the profitability of the overall SC. Emphasis is on eliminating all wastes in SC and consequently on reducing the costs of the overall supply chain. The focal company considers all customers and all suppliers and performs segmentation to reveal key customers and key suppliers in lean supply chain. Further, the focal company tries to establish long-term higher forms of cooperation with key customers and key suppliers. Lean supply chain processes are designed based on customers' real demand, they are standardized, and key processes are identified that receive particular attention in terms of different advancements using lean management concepts, principles, methods, techniques and tools (e.g. Value Stream Mapping, Little's Law, Takt Time, 7 wastes, 3M, 5S, JIT (Just In Time), Poka-Yoke, jidoka, Single Minute Exchange of Die (SMED), Total Productive Maintenance (TPM), Overall Equipment Effectiveness (OEE)). Performance measurement is done at SC level by using Supply Chain Operations Reference (SCOR) model, Global Supply Chain Forum (GSCF) model, Balanced

scorecard (BSC) model, or some other model. More interested participants of SC are involved in new product development. All employees participate in the continuous improvement of the processes in lean SC lead by company and supply chain managers.

5 CONCLUSION

Application of the lean approach in supply chain can efficiently improve the performance of the supply chain, as well as all its participants. Some of the potential benefits of applying lean in supply chain are reduced wastes, reduced costs, improved quality, faster delivery and flexibility, improved efficiency, reduced production lead-time, reduced work-in-progress inventories, etc. Thus, the lean concept provides answers to the need to make supply chain processes more effective, efficient and adaptable, using extremely applicable sets of tools, methods and techniques. With minimal investment, it enables supply chain participants to maximize utilize of their resources, and thus reduce costs and increase supply chain profitability. Participants in the lean

supply chain should continually make various improvements with the focus on eliminating wasteful or worthless activities along the supply chain while meeting the real customer's requirements. Successful implementation of lean approach in the supply chain requires the direct involvement and cooperation of focal company, and their key suppliers and key customers.

In this paper, the comparison of traditional and lean supply chains is done according to different characteristics. The following characteristics derived and used: the aim of participants in SC; cooperation in SC; time horizon of relationships between participants in SC; processes in SC; customers in SC; demand forecasting; suppliers in SC; selection of suppliers in SC; frequency of product delivery; product quality control; human resources in supply chain; supply chain performance measurement; process improvements in supply chain; and participation in new product development. One of the main conclusions is that participants of lean supply chain collaborate on eliminating wastes and better use of resources in performing supply chain activities and processes while striving to meet the real needs of end customers.

Finally, the following scopes can be interesting for future research: (1) a comprehensive framework for implementation of lean approach in supply chain should be developed; (2) a practical guide for transforming existing supply chain into a lean supply chain can be suggested; (3) a more case studies of lean supply chain should be presented; etc.

Notice

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