



Supply Chain Management in Healthcare: A Literature Review

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Abstract. Supply chain management becomes more important in the developing world in order to provide a material flow with an optimum cost and time generally. Many sectors focus on supply chain management optimization and qualifications to construct a better network of suppliers for their end consumers. Especially in healthcare sector, not only for pharmaceutical products but also for hospital materials, supply chain management gets importance for service quality and patient satisfaction. Thus, there are many studies about supply chain management in healthcare to emphasize its importance. In this study, it is aimed to put forward a literature review of supply chain management in healthcare in order to give a perspective by expressing the important cases and researches which are parallel to the latest studies. Furthermore, this literature review will assess a perspective in order to understand how to manage a complex supply chain in healthcare sector by investigating studies in the literature.

Keywords: Supply chain management · Pharmaceutical companies · Distribution · Healthcare sector

1 Introduction

Supply chain management (SCM) can be defined as a set of companies which transfers the product to the end user via suppliers, product assemblers, merchandisers and transportation companies which are the parts of a supply chain [1]. Another definition of a supply chain can be extended as the flow of goods, services and information starting from raw materials and going finally to the end user [2]. The importance of Supply Chain Management continues to grow and to be introduced in the literature [3]. Supply chain, especially in multi-vendor supply chains, which can be globally or locally, may be difficult in terms of evaluation of performance as it is hard to define performance measurement criteria in a supply chain [4]. Furthermore, supply chain management provides an energy between local and global companies to integrate the process excellence of management and to manage the interaction between all members of a supply chain [5].

In healthcare sector, supply chain management also gains importance because of logistics, pharmaceutical products and patient satisfaction to improve service quality compared to other sectors. Furthermore, the change in healthcare sector has been very

rapid during the last years. Many healthcare organizations are aware of the importance of applying a better technique and method in order to adopt their supply chain management strategies in spite of the fact that the methods and techniques pose problems in terms of industrial settings [6]. Improving healthcare quality in a public or private sector depends directly on its supply chain management efficiency.

In this study, it is aimed to investigate the studies in the literature about supply chain management in healthcare between the years 2000 and 2018. The study includes four main parts: an introduction part to give a perspective and brief introduction about supply chain management in healthcare, a literature review part for examining the topics and methods in supply chain management in healthcare, an analysis part in order to classify the studies by their topics, years and methods and finally a conclusion and discussion part to debate the results of the study.

2 Literature Review

Kumar, Ozdamar and Zhang (2008) have investigated a cost reduction technique about the medical suppliers from a case study in Singapore. Furthermore, they have concluded that some applications of just-in-time (JIT), reengineering, outsourcing reductions may be cost-efficient even if information technologies (IT) implementations start from a high initial cost because of the deficiency of experts. Information technologies at the initial stage of identifying suppliers can be beneficial in terms of cost reduction [7]. Another study explained by Meijboom, Schmidt-Bakx and Westert (2011) emphasized the organizational lacks affecting the cure of patients and taking the inputs from multiple healthcare suppliers in order to solve by the practices of Supply Chain Management. Also, they provided a literature survey including industrial processes in healthcare. They have mainly focused on the lead time of suppliers, integration and suitable IT practices [8].

Another study by Kumar, Swanson and Tran (2009) focused on the radio frequency identification devices (RFID) which enable healthcare supply chains more effective and reductive in terms of costs and the current RFID systems in healthcare supply chain are too costly to apply even if there are some applications of RFID systems to be installed a cost-efficient way [9]. On the other hand, Attaran (2012) has expressed the important achievement factors and the latest challenges in implementing RFID systems within healthcare supply chain management and the positive and negative sides to apply RFID systems in supply chains have been identified in terms of cost and processes [10]. Uthayakumar and Priyan (2013) have proposed an inventory model for the distribution which combines the pharmaceutical and hospital supply chains. The model they proposed has taken into consideration the lead time, time and space availability, customer service levels and by the aid of this model, they determined an optimal proposition for lead time and available lot size by illustrating a numerical example [11]. Settanni, Harrington and Srai (2017) have evaluated Pharmaceutical Supply Chains in terms of production and delivery models. Also, they have categorized the modellings and concluded that the definitions of Pharmaceutical Supply Chains are extremely based on production centralized definitions and have deficiencies to reflect patient consumptions [12].

Aronsson, Abrahamsson and Spens (2011) have analyzed healthcare supply chains in terms of agility and lean manufacturing. They tried to understand how the process of healthcare supply chains can be agile and lean by establishing a supply chain orientation and what is needed for by applying an empirical analysis by the aid of agile and lean philosophies in supply chain management in healthcare in order to develop the effectiveness of healthcare supply chains [13]. Shah, Goldstein, Unger and Henry (2008) aimed to investigate the work design by its improvement for a supply chain management in healthcare in order to better transfer a better patient treatment service quality given that the patient care services cannot be easily predictable and there are many private and public companies which are independent. These companies are generally collaborated and in a rhythm in terms of supply chain process. They have taken four organizations, that are independents, for defining their different supply chain processes in healthcare industry and for understanding their supply chain mechanisms [14].

Sinha and Kohnke (2009) identified the lack between increasing demand and current high-quality supply in healthcare industry, effectiveness of cost and time which is a problem in developing and developed countries. They have proposed a framework consisting of 3A, which are affordability, awareness and access to inform healthcare supply chain managers and in order to integrate the continuous improvement as a definition of quality and technological improvements [15].

Cook et al. (2001) took into consideration of service industry if the supply chain management is as affective as in the manufacturing industry or not. They showed improvement of the quality, reduction of costs and lead times which are results of a high performed supply chain at the healthcare area [16]. Another study explains the increase at a pharmaceutical supply chain efficiency. In this paper, Australian e-commerce project provides an information system integration to health care sector and gets improved levels of data as a result [17]. Chandra and Kachhal (2004) served a supply chain model that contains e-commerce integration. They also showed different methods such as optimization and simulation for inventory and purchasing policies [18]. Another e-commerce study is done by Kim (2004), which includes statistical results to find out effects of B2B e-commerce in health care sector. He conducted a survey and evaluated results to show internet-based integration improves supply chain management in health care sector [19].

McKone-Sweet et al. (2005) studied supply chain management implementation to healthcare sector. They found out some constraints such as education, team operations for procurement, all actors in the chain, lack of leadership, uncertain incentives, data collection and evaluation. The main problem is both leaders' and managers' supply chain knowledge in practice which directly effects supply chain performance [20]. Kim made a practical study at a hospital, which shows nearly 30% of decrease in inventory levels by improving its supply chain management system. This improvement includes purchasing operations and inventory policies of pharmaceuticals. A transparent system was designed to optimize inventory levels at every step of the supply chain. By this system, demand forecasting is more accurate and ordering process is linked with the online system. Decrease in inventory resulted with decrease in costs [21]. Langabeer (2005) mentioned about the difficulties of supply chain management in health care. He analyzed the current situation of management systems and seek for the reasons of

technology usage scarcity. He gives advices for future studies to adopt new technologies to improve health care supply chain [22].

Zheng et al. (2006) studied at a different area: e-adoption of healthcare supply chain. They drew a framework in the light of English National Health Service that considers health, business and supply in terms of every organization to use e-commerce [23]. A common supply chain model is given by Baltacioglu et al. (2007), for service sector. Capacity, demand, customer and supplier relationship, service and order operations management are main elements of the chain and included in the proposed model. This model is applicable for also healthcare sector [2]. Kitsiou et al. (2007) studied healthcare supply chain to analyze its information system to define every element such as entities, data and information flows, processes etc. They also suggest new technological alternatives to improve health care supply chain management system while adding value [24].

Sousa et al. (2011) built a dynamic programming for optimizing the global supply chain problem of a pharmaceutical company as a case study. The aim of the study was to maximize net present value of the company by considering costs of distribution and production which are located in different places and tax rates. Also, they have built this model by dividing into two problem which are primary and secondary subproblems [25]. Rahimnia and Moghadasian (2010) examined the leagility of supply chain managements in healthcare sector, especially in hospitals. They have conducted a case study to evaluate the perspective of leagility in hospitals on behalf of a professional supplier since the situation of current system requires an agile and lean system for hospitals in terms of delivery systems [26]. Walker et al. (2008) studied the important factors of green supply chain management and initiatives in the private and public sector such as external and internal barriers to implement the environmental concepts. They have also studied a private healthcare company, as a case study, in order to understand how the legislations, affect the suppliers of a hospital and concluded that hospitals generally choose local providers to contribute to the local economy [27].

Bhakoo and Choi (2013) investigated the implementation and reaction of IOS in hospitals by considering different parts of a supply chain including distributors, manufacturers and healthcare sector. They concluded that the implementation of IOS is very complex and the reaction of internal pressures can be different in healthcare supply chains [28]. Kwon et al. (2016) discussed the importance of supply chain management in healthcare sector in terms of costs of patients compared to the rate of readmission. They also investigated the three main strategic areas in order to increase the profit of suppliers and to improve supply chain process and concluded that the quality of healthcare service quality depends on the supply chain surplus [29].

Kogan et al. (2014) studied the collaboration between healthcare supply chain members and analyzed how the effects can change the relationships of providers in healthcare sector. Also, they concluded that the uncertain demand and operational costs may block the consolidation of providers and even if they consolidate each other, the net profit of medical providers may not change [30]. Ishii et al. (2017) explained that the integration of supply chain in healthcare sector can provide a cost reduction and improve healthcare quality by examining three healthcare departments with the aid of experts in supply chain. They concluded that a more effective supply chain

management in hospitals can mostly give a healthier academic life for those who work in hospitals [31].

Imran et al. (2018) tried to build a multiperiod model of pharmaceutical supply chain by assuming that the amount of medicines coming from providers is not certain. On the other hand, time, quality and cost, called as business triad, are the three objectives of the model and they supported their model by a numerical example by concluding that the required satisfaction has a different combination of these three objectives [32]. Syahrir et al. (2015) have prepared a report to make a survey and analyze the topics of supply chain management in healthcare and disaster by taking into considerations inventory-control management, service quality, operations research topics in healthcare and information technologies [33]. Zepeda et al. (2016) studied on the logistics services and uncertain demand for hospitals, which are two main factors considering the effects of internal institutional regulations on inventory costs by the data of the State of California. They concluded that logistics services have strong effects in local systems' infrastructures if they are weak [34]. Also, Rossetti (2011) examined the factors affecting pharmaceutical supply chain management and logistic evolution in healthcare sector have been investigated in detail based on industry dynamics [35].

Moons et al. (2019) conducted a literature review to evaluate the hospitals' supply chain logistics performances by the latest studies done in this area [36]. Dobrzykowski et al. (2014) also studied a literature review to list operations and supply chain management in healthcare sector studies between the years 1982 and 2011, which are used a structured analysis [37]. A different literature review study conducted by Narayana et al. (2014) gives important aspects on managerial researches and insights about pharmaceutical supply chain concept by a content analysis which focuses on performance improvement in supply chain of hospitals [38]. Chen et al. (2013) used an empirical test to evaluate hospitals' supply chain performance. They used a research model by taking into consideration the performance factors of hospitals in terms of IT integration of hospitals and suppliers, the base of trust and the flow of knowledge and also, the effects of these factors are very important for the supply chain performance in a hospital as they are interrelated factors [39]. Another literature study conducted by Bishara (2006) mentioned the crucial factors of pharmaceutical supply chain management by a literature survey in the light of the definition "cold supply chain" [40].

Bagchi et al. (2014) studied the supply competency effects on foreign direct investments by using Boolean-based logical analysis by considering the environment of supply, infrastructure, and capacity. They advised strategic planners to what to focus on in order to attract the foreign direct investors and eased the decision-making process in this global competitive environment [41]. Kelle et al. (2012) proposed a multi-item inventory model for a hospital in terms of pharmaceutical supply chain by considering three main strategies which are operational, tactical and strategical. They conducted their case study in an individual care unit for the inventory management at a local warehouse by evaluating service levels, ordering systems and optimal allocations [42]. As a different study of inventory control systems in hospital conducted by Stecca et al. (2016), they tried to understand the optimization of inventory by focusing on the central of pharmacy and the optimization of inventory costs of logistics of pharmaceutical products with the aid of mixed integer linear programming level by level [43].

3 Analysis

In the analysis section, the 43 articles which have been reviewed are classified according to their years, their usage of operations research techniques or modellings

Figure 1 shows the article number of supply chain management in healthcare according to their years. In the Fig. 1, it has been seen that the article number has an intention to increase between years 2000 and 2006. Furthermore, the number of articles fluctuates in other years.

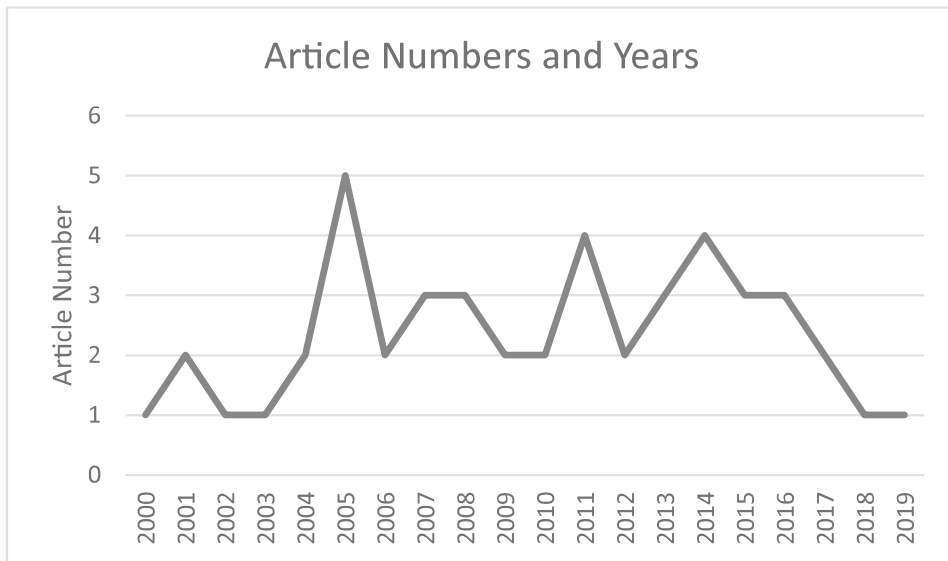


Fig. 1. The number of articles according to the years

Figure 2 shows that the number of articles according to the existence of mathematical modelling in the articles reviewed.

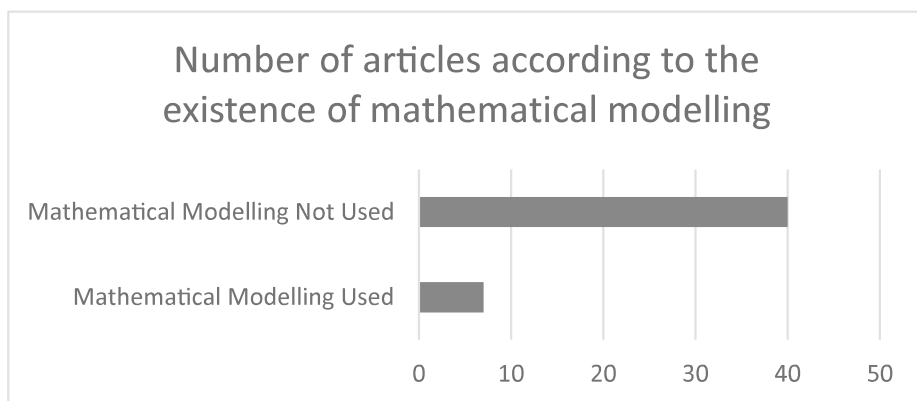


Fig. 2. The number of articles according to existence of mathematical modelling

The articles in which any mathematical modelling is not used have a high percentage compared to the articles that mathematical modelling is used.

On the other hand, there are two types in healthcare supply chain management articles, which are pharmaceutical SCM and hospital SCM specifically. Figure 3 shows the rates of reviewed articles in terms of pharmaceutical SCM and Hospital SCM. It has been seen that Hospital Supply Chain management articles have a bigger percentage than Pharmaceutical SCM.

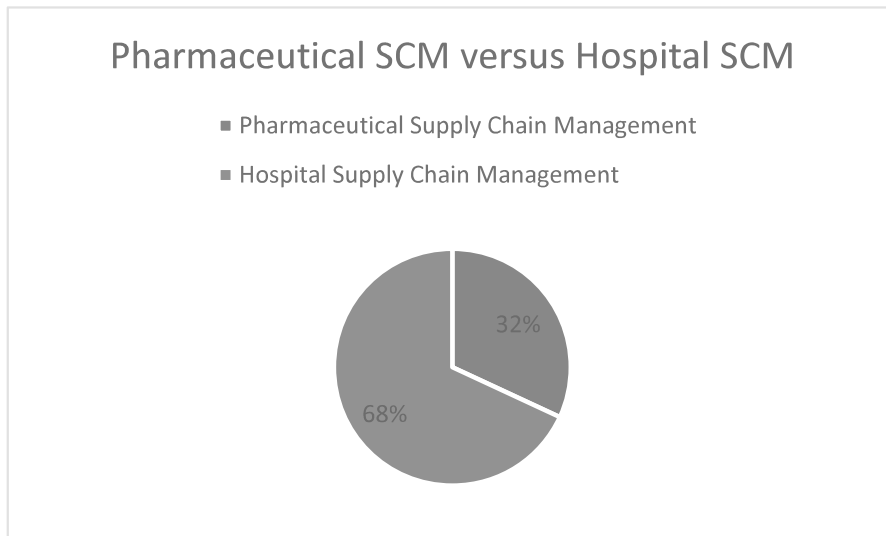


Fig. 3. The Pharmaceutical SCM and Hospital SCM article percentages in the reviewed articles

4 Conclusion

Understanding the structure of supply chain management for healthcare industry is not an easy topic and its value increases nowadays. There are many studies in the literature that supply chain management in healthcare industry in which this study examined 43 articles about pharmaceutical and hospital supply chain management. Firstly, the big gap about articles in the literature is that mathematical modelling in the literature. Nearly 15% of the papers examined have not any mathematical modelling for supply chain management. Models might help inventory, cost and other operation factors' optimization in terms of operations research.

Another classification can be considered as the supply chain focus area: evaluation of pharmaceutical or hospital SCM. Pharmaceutical SCM articles are less than hospitals' studies. Medicine sector is as important as the hospital operations so that the ratio of the studies about pharmaceutical SCM and hospital SCM might increase to improve the efficiency and reduce the costs of health care supply chain. Last but not least there are not many studies about industry 4.0 applications in health care systems attached to supply chain management evaluation in order to adapt the latest challenges of industry 4.0.

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