Prioritizing Lean Supply Chain Management Initiatives in Healthcare Service Operations: A Fuzzy-AHP Approach

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Abstract – The main purpose of this study is to propose a holistic approach for prioritizing lean SCM initiatives in healthcare service operations, based on relative weights of various initiatives on a range of performance measures for better understanding of what motivations and supporting factors influence the selection of LSCM initiative/strategy. Twenty-four LSCM initiatives were identified, using a comprehensive literature review. Q-sort method was initially used to categorize those initiatives into four categories: (a) Continuous process improvement; (b) Enterprise alignment/integration; (c) Waste elimination; and (d) Flow management/JIT. Fuzzy AHP was used to prioritize the four categories based on its relative weight of importance on three different performance dimensions. The result shows that continuous improvement is a dominating LSCM initiative in increasing operational and financial performance while enterprise alignment/integration is a dominating initiative in enhancing organizational images and operational performance.

Keywords – Lean supply chain, Healthcare, Fuzzy-AHP.

I. INTRODUCTION

In healthcare sector, various competitive priorities exist, which influence overall performance across many functional areas of hospital operations. Those priorities include patient satisfaction, operating room utilization, overtime requirements, and staff morale. From a performance perspective, these priorities are closely related to performance measures of healthcare operations. With increasing practices of supply chains due to various factors including globalization and economic trends [1-2], decreasing resources and increasing demand on healthcare services [3], healthcare service providers are adopting supply chain practices for achieving benefits of supply chain management, in particular improving quality of service and value at lower costs of operations.

With increasing supply chain practices in healthcare operations, it is recognized that healthcare service providers need to redesign, improve and implement appropriate logistics activities (eg. purchasing, material and capacity planning, scheduling, warehousing, etc). The need for effective and efficient logistics and real-time information flows has led many service providers to embark on various improvement initiatives, in particular improving a range of performance measures involved in healthcare practices.

Although there is considerable research on overall supply chain practices and improvements in general, improving healthcare performance through prioritizing lean supply chain management initiatives and them for further assessment is still lacking. Therefore, the main focus of this study is to investigate lean supply chain management in healthcare service operations from both theoretical and practical perspectives, using an industry case. Thus, the key objectives are to:

(i) Identify various LSCM initiatives using a comprehensive literature review on healthcare service operations;
(ii) Identify performance measures in implementing LSCM strategy in healthcare service operations;
(iii) Determine relative weight of importance of LSCM initiatives/strategies on different performance measures.

II. LITERATURE REVIEW

In recent times, there are significant changes in healthcare industry and the field of supply chain management [4-8]. The impact of supply chain management in healthcare operations is evident from increasing pressure on maintaining efficient and effective logistics and information flows for better outcomes in hospital operation [9]. It is evident from various research activities that effective supply chain management has contributed positively for improving organizational performance, customer service level [10-12]. At the same time, the importance of effective SCM is stressed by various other researchers [13-15]. Overall, close connection between effective SCM and improvements in healthcare operations has led to many research investigations in recent times, emphasizing on current healthcare service operations, challenges and issues, and performance improvement using various improvement methods including lean approach to healthcare.

Healthcare Service Operations

Healthcare service operations are very broad in functional perspectives and involve many stakeholders across both macro and micro level. In line with the scope of this study, current practices covered in this context are confined mainly to lean healthcare supply chain, emphasizing processes, current practices and their issues,
performance measures and improvement methods in various healthcare settings. A number of research projects [4, 16, 17-18] have identified key healthcare processes, associated logistics and supply chain in broader hospital settings.

It is important to note that, in hospitals, healthcare logistics and supply chain activities cover not just supporting services and processes/functions such as purchasing and inventory control directly linked with warehouse and pharmacy operations but also healthcare services operations such as patient care units, operating rooms, housekeeping unit, engineering and maintenance unit, IT outsourcing unit, and catering unit. It is noted that logistics in healthcare is poorly understood and accounts for a sizeable portion of a hospital’s operating budget [18, 20].

Challenges and Issues
Healthcare providers are facing with many challenges and constraints in providing efficient customer response (ECR) to its patients [21]. Supply chain management in healthcare service operations involves key processes, stakeholders and various components (materials, operations, activities, resources and information). Among many issues, shortage of qualified medical staff, and unavailability of on-time for various activities/operations are major challenges. Furthermore, lack of best practices of healthcare service operations and the supply chain management of its resources equally contribute to its inefficiencies [22]. Hence, main challenges in the healthcare service operations include [13-14, 23-27]:

(i) Lack of capacities (resources) for meeting increasing patients’ demand;
(ii) Decreasing levels of traditionally maintained on-site storage of medical supplies;
(iii) Increasing cost on logistics activities as a proportion of overall hospital operating budget;
(iv) Potential waste of storage and inventory as a result of overstocking; and

Similarly, various other issues have been identified, including the lack of organizational competencies to execute business strategy of lower supply cost [20], cost-effective and timely healthcare meeting growing demand [23], and the lack of good logistics management for reducing healthcare operating cost [17].

In recent times, a number of research activities [28-29] have reported research findings on performance measurement using fuzzy-based approaches. In similar research, proposed a fuzzy-based performance evaluation method for lean supply chain implementation [30]. It is important to note that supply chains need to engage in continuous improvement and eliminating non-value added activities for achieving effective and efficient customer service levels [30]. This could be defined as a “lean supply chain management”. Various methods suggested for improving supply chain performance have been focused on many aspects of supply chain, including supply chain agility for improving responsiveness to customer demands and various tools and techniques such as TQM, JIT and BPR for improving performance and gain competitive advantage.

Among many improvement philosophies and techniques adopted in improving supply chain performance, lean philosophy is recognized as one of the popular methods many have been adopting in order to remain competitive in the increasingly global market [30]. The core thrust of a lean supply chain is to create a streamlined, highly efficient system that produces finished products at the pace customers demand with little or no waste [25]. Similarly, there has been some research on performance in healthcare service operations, aiming to improve overall healthcare logistics, cost reduction [20], and system improvement using various strategies, techniques and tools [13, 15-16].

In spite of large number of research activities on broader supply chain performance and lean supply chain practices, the concept of lean supply chain in healthcare and its performance evaluation is still underdeveloped for a variety of reasons including (i) a lack of healthcare industry-specific research; and (b) deficiencies in performance evaluation methods [30]. Although there is extensive work on identifying various performance measures, improvement methods such as lean, six sigma, JIT and BPR in supply chain practices, associated mainly with manufacturing, there is lack of systematic approach to prioritise measure and metrics. In addressing some of the issues identified, Arif-Uz-Zaman et al. [30] propose a lean supply chain performance evaluation method, based on fuzzy approach for identifying overall supply chain performance under lean strategy. Although these research activities have addressed broader research question of performance evaluation in supply chain under lean improvement strategy, there is still lack of research on prioritizing different performance measures across supply chain, in particular in healthcare practices. This paper proposes a Fuzzy AHP approach to prioritizing LSCM on different performance measures in healthcare service operations, based on a comprehensive literature review and assessment of various categories from industry experts.

III. METHODOLOGY

The research methodology consists of two stages. The first stage focuses on identifying LSCM initiatives and performance measures in implementing LSCM in healthcare service operations. This stage involves (i) identification of items from a comprehensive literature review and categorizing those items using Q-sort method, and (ii) validation of LSCM and performance measures constructs, based on data collected through an interview process. Six Sigma experts (Section Chiefs, Nurse Specialists, and Ward Service Staffs) were interviewed and asked to assign each LSCM initiative and performance measure into one of four and three different constructs. In the second stage, nine experts (lean consultants, medical doctors, section chief, and academia)
were interviewed. Interview data were analysed through an integrated Chang's extent analysis using Fuzzy-AHP, to establish the relative weight of importance of LSCM constructs on three performance dimensions.

IV. RESEARCH FINDINGS

Construct validity analysis using Q-Sort method
After three round of interviewing with six experts, the result of Q-Sort analysis (with an acceptable level of Cohen Kappa Coefficient) shows that fourteen performance measures could be grouped into three constructs, which are: (i) operational performance (0.8712); (ii) financial benefits (0.8644); and (iii) organizational images (0.8916). In addition, the result also shows that twenty-four LSCM initiatives could be grouped into four constructs. These are: (i) Continuous process improvement (0.8023), (ii) Enterprise alignment/integration (0.7411), (iii) Waste elimination (0.7325), and (iv) Flow management/JIT (0.7164) respectively.

Criterion validity analysis using Fuzzy-AHP
After validating the constructs of LSCM initiatives through Q-Sort method, analytical hierarchy structure was established to determine the relative weight of important among LSCM constructs based on a different performance constructs. Within each performance and LSCM constructs, this study also identifies the prominent performance measures and LSCM initiative. A panel of nine experts was selected based on their experiences. All experts were interviewed personally in order to evaluate LSCM constructs across three performance constructs using Fuzzy-AHP technique. It is important to argue that the number of experts should be large enough to assure multiple perspectives, and small enough to make the research manageable.

As shown in Figure 1, among three constructs of performance measures in implementing LSCM in healthcare, operational performance (relative weight = 0.514) is the prominent category followed by financial benefits (relative weight = 0.455) and organizational images (relative weight = 0.003) respectively. Within the operational performance, inventory turn-over, space utilization, and length of stay show the dominant measures with an equal relative weight of 0.157. For the financial benefit, profitability (relative weight = 0.189) and operating cost (relative weight = 0.168) was considered as a dominant measure while market growth (relative weight = 0.032) and market share (relative weight = 0.009) was the least important. Finally, for the organizational images, assurance (relative weight = 0.016) was the dominant measure while eminence (relative weight = 0.002) is the least. These results confirm the importance of prioritizing various performance measures in implementing LSCM, given a wide range of relative weights within each category, but with one category (operational performance) contributing more than 50% of total weight. Of all measures, profitability in financial category has the highest relative weight, suggesting strong financial focus of organizations, even in the current supply chain practices. Figure 2 exhibits the relative weight of important among four LSCM constructs across three performance constructs. The result shows that in order to achieve the operational performance, continuous process improvement (relative weight = 0.142) and enterprise alignment/integration (relative weight = 0.140) is the prominent practice while flow management/JIT (relative weight = 0.115) indicates the least important. To improve the financial performance, continuous process improvement (relative weight = 0.158) is the prominent practice. Finally, to enhance the organizational images, enterprise alignment/integration (relative weight = 0.012) and flow management/JIT (relative weight = 0.011) is the prominent practice. These results reveal that continuous process improvement is the prominent LSCM practice in enhancing two out of three performance categories (operational and financial benefits). It implies that the main operations are customer and service provider interface focused. Therefore, more efforts in improving operation processes, more performance outcomes be achieved. In addition, it is important to note that enterprise alignment/integration was put in a top two prominent LSCM practice on operational performance and organizational images. This confirms the concept of LSCM that focuses on removing non-value added activities and promoting the level of both internal and external integration.

V. CONCLUSIONS AND IMPLICATIONS

The paper identified twenty four LSCM initiatives using a comprehensive literature review and categorized them into four groups using Q-sort method. Based on a set of data collected through interviews, the four categories were prioritized using Fuzzy-AHP approach, which resulted in relative weights of various performance measures of each category. The results show that continuous process improvement is a dominant LSCM construct that contributes to increasing operational and financial performance while enterprise alignment/integration is a dominant initiative in enhancing organizational images and operational performance. Overall, operational performance is a significant category of LSCM implementation while continuous process improvement contributes the most for both operational performance and financial benefits. Implications of these results to the healthcare service operations are that LSCM need to be selected through careful analysis of individual performance measures, based on the desired levels and relative weight of each measure.

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REFERENCES


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**Figure 1:** Prioritizing of Performance Dimensions (Categories) using Fuzzy-AHP (Relative weight)

**Figure 2:** Prioritizing of LSCM initiative/strategy using Fuzzy-AHP (Relative weight)