Proceedings of the International Conference on Applied Mechanical Engineering Research (IC-AMER2019)
NIT Warangal, India – May 02-05, 2019
Paper No. XXX (The number assigned when the papaer is accepted)

Conceptual framework for performance measurement of hospital supply chain management

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Abstract: -As being developing nation, there is ever increasing need of providing healthcare services with utmost safety standards and affordable cost. In such as competitive environment, supply chain management has proven its impact on reducing cost and enhancing performance of services sectors also. As a result of which, evaluating performance of healthcare supply chain especially hospital supply chain will yield competitive benefits and facilitate continuous improvement of system. Hence, the main objective of the paper is to identify the practices of supply chain performance measurement in healthcare sector specifically for hospital supply chain. Paper aims to identify the critical supply chain performance measures for hospital supply chain operations and also focuses to present a conceptual framework for hospital supply chain performance measurement. Existing studies are reviewed to identify the present efforts in analyzing the importance of supply chain performance measurement system (SCPMS) in healthcare sector. Study also focuses on difficulties and pitfalls required to be removed for efficient SCPMS. Research articles, case studies, government report studied along with interaction with experts in the field and personnel from hospital administration. The result shows that, healthcare supply chain management is very long yet very complex in structure. In this chain, hospital has become most important part and has its integral supply chain as suggested in this study. Findings shows that, hospital supply chain has two major components i.e., medical treatment operation (MTO) and supporting/ allied operation (SO). Performance analysis of hospital supply chain impacts hospital's efficiency, reduction in cost of treatment and improvement in overall performance. Study also identified various performance attributes and measures critically associated with hospital. Also, study suggested a framework to analyze the performance of hospital supply chain management. The study is conducted in one of the private rural hospital attached with medical college located in central India. Findings are limited to existing hospital under study, which can be explored and generalized by analyzing the hospital supply chain performance measurement practices in other government aided rural hospital and other corporate multi-specialty healthcare service providers. The study is first of novel in nature, which considers the intricate aspects of hospital supply chain performance. Took support of existing literature review and validated by interacting with hospital personnel.

***Keywords*:** Supply chain management, supply chain performance measurement, performance measurement system, healthcare supply chain, hospital supply chain, performance measures

1. Introduction

The philosophy of supply chain management has been adopted to supervise various operation/ activities over longer period of time. In order to be assured of successful supply chain management adoption, performance measurement is very important. Performance measurement is a tool to monitor the efficiency and effectiveness of operation being carried out [1,2]. Supply chain performance measurement must consider whole supply chain perspective. It can be done by considering business operation carried out in particular supply chain. Performance measurement of supply chain must be done to enhance the effectiveness and efficiency of supply chain as a whole [3]. Few work present the development of performance measurement framework in hospital, whereas they lack in considering hospital supply chain aspect [4,5]. While other studies focuses on the measurement and improvement of particular business operation in hospital supply chain [6,7]. There are very limited number of studies which explored the hospital supply chain performance measurement as a whole [8,9]. This paper proposes a conceptual hierarchical framework for prioritizing performance measures. Proposed framework considers the supply chain efficiency dimensions as criteria and hospital supply chain operation as alternatives to monitor the performance.

The rest of the paper is presented in 6 sections; section 2 covers an overview of work done on hospital supply chain performance measurement, section 3 elaborates the various operations/ activities/ processes of hospital supply chain, section 4 presents performance measurement criteria for hospital supply chain and associated sub-criteria. Proposed conceptual framework and prioritization of performance measures will be presented in section 5, section 6 concludes the study followed by section 7 of reference.

2. OBJECTIVE OF STUDY

Hospital supply chain is constantly going though challenges and opportunities resulting due to ever dynamic operation conditions which consist of expectations of service quality of healthcare at affordable cost. Concurrent improvement in quality and efficiency leads to make customer demands more expensive. Measuring the performance can enable the healthcare professionals to assess the improvement in activities towards attainment of strategic goals and objective of the hospital. Adoption of appropriate performance measures/ metrics plays most important role in highlighting the efficiency of healthcare supply chain performance measurement. The selection of these performance measures widely considers the benefits of hospitals, clinicians and customers (patients). These will help in raising the service value of healthcare supply chain management/. During literature review related to supply chain performance measurement of hospital supply chain, we came across various measures such as healthcare services, communication, patient safety, waiting times, and integration, which affect the supply chain management. Whereas, cost and time are the most important criteria of today's hospital supply chain. Along with this, reliability of utilized healthcare services and productivity of medical treatment processes is also an vital criteria for today's hospital supply chain. Together, if we consider the aspects of cost, time, reliability and productivity of supply chain, they becomes the construct of supply chain efficiency. Therefore, improving overall supply chain efficiency with high level of service quality is major context for enhancing hospital supply chain performance. Besides this, in order to recognize the processes of hospital supply chain for successful management of supply chain, therefore must look at both operation of hospital supply chain i.e medical treatment operation and supporting/ allied operations. The sole objective of this study is to provide and an brief overview on performance measurement of hospital supply chain. More precisely, the purpose of this study is to;

i. To identify the performance measures for constructs under supply chain efficiency for hospital supply chain.
ii. To proposed a conceptual hierarchical performance measurement framework for hospital supply chain considering supply chain efficiency drivers and hospital supply chain operations.

3. OVERVIEW OF LITERATURE ON SUPPLY CHAIN PERFORMANCE MEASRUEMENT IN HOSPITALS

3.1 Brief Overview of Performance Measurement System

Performance measurement facilitates guidance, and improvement action in various conditions depending on the contextual utility and application(Elg et al, 2013). Further, the concept of performance measurement system is predominantly applied in public reporting, provider incentive programs and also in quality improvement programs (Berenson et al, 2013). Performance measurement system are conceptualized in various ways such as "organizational performance assessment system", outcome based management system" etc. Several definition were introduced in the literature by various authors exhibiting its application areas in an attempt to resolve this complexity of performance measurement system.

3.2 Performance Measurement System for Healthcare Supply chain Management

Globally, there is an intense complexity in healthcare systems. Owing to which, healthcare service providers are challenged to provide efficient services at affordable cost. Hence, healthcare performance measurement becomes very important, especially considering the overall activities of the hospital supply chain management. It becomes important to recognize the supply chain management components in hospital, which can be considered for continuous improvement leading to improved service quality and safety. Elements of supply chain management for hospital consist of medical treatment unit, supporting units and hospital storage treated as internal supply chain(Supeekit et al, 2015), whereas, externally chain includes vendors, manufacturers and distributors etc. The prime concentration of healthcare supply chain

management relies on its performance assessment. The ultimate aspect for healthcare supply chain is safety and satisfaction of the patient.

Healthcare supply chain is very complex yet unexplored. There are multiple reasons for healthcare supply chain management to be immature which can be less management involvement, redundancy in clinical processes, etc. Also, cost has major impact in healthcare supply chain (Kumar et al, 2008). Constraint of time plays vital role while considering the safety of the patient. It has been evident that, there is very fewer studies explored the potential of hospital supply chain an internal chain. Hence, paper projected to consider the hospital supply chain with an approach of proposing a framework for performance measurement of supply chain. Here, we would be considering the subsets of internal supply chain such as medical treatment operation and supporting/allied operations. Success of any supply chain lies in improving its efficiency (Supeekit et al, 2015). Therefore, we suggest considering the construct of supply chain efficiency with hospital supply chain operation to design a framework

4. HOSPITAL SUPPLY CHAIN OPERATION

Hospital supply chain in this study is shown in figure 1. It is one of the most complex supply chains. End user of hospital supply chain is patients who seek diagnosis and pursue the treatment [10]. For achieving the satisfaction of patients (customers), both medical treatment (services from medical professionals) and supporting operations (pharmaceutical and medical supplies) are equally important [11, 12]. In order to improve the efficiency of hospital supply chain performance for successful management of the supply chain, it is important to explore various activities under major hospital supply chain operation i.e. medical care and supporting operations, which are as given below;

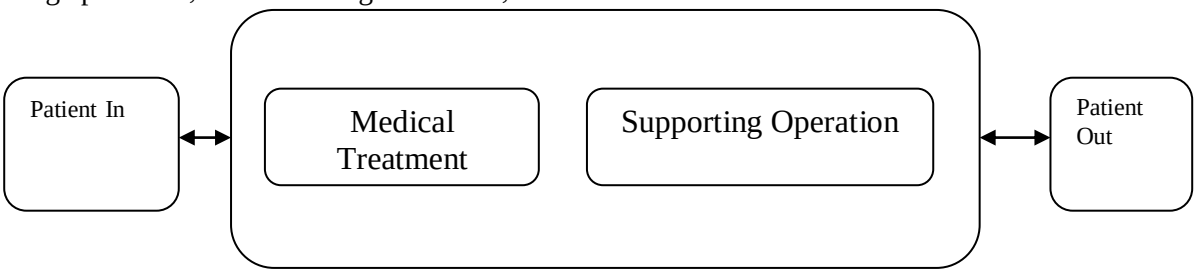

Figure 1: -Hospital Supply chain

4.1 Medical Treatment Operations

Medical treatment operations facilitate medical overhaul to patients (customers). Main resources for this operation are doctors, nurses; whereas medical tools and equipment are integral part while treating to patients. There are various places where medical treatments are done such as Surgery, Neurology and Pediatrics etc. Medical treatment activities as cited in literature [13-15] are as follows;

i. *Admittance*: - Most initial activity, various stages are there is this activity for patients to be cared and treated. Stages such as registration, triage, and inpatient admission.
ii. *Patient Examination*: - In order to be treated properly and to get cured as early as possible, patient's examination is done by nurses and doctors.
iii. *Treatment Delivery*: - Post examination, mode and pattern of treatment is decided. Treatment can be of short span/ long term depending on the nature of patient's disease.
iv. *Discharge/Transfer*: -Preferably the last stage at any hospital. This is done in either cases, when patient is treated and cured or when patient's criticality is not in reach of particular hospital expertise

4.2 Supporting/ Allied Operations

Supporting operation adds value to medical treatment processes. In order to examine, treat and cure patient, facilities such as clinical material and medical equipment are required. The said activities has majorly observed in following sections: medical assisted units [12, 17-19] such as radiology, laboratory and pharmacy; as well non-medical assisted units [1, 7, 12] such as porting service for patient, supply & demand management, and sterilization services. Following sub-processes are the part of supporting/ allied operations.

i. *Supply & Demand Management*: - This includes procurement of medical resources from various suppliers or supporting units when needed.
ii. *Synthesis*: - This includes the preparation of medical treatment materials for clinical operations

iii. *Movement:* - This includes transfer of materials or patient to the point of care or where the materials or patients are required to be treated.
iv. *Stock & Capacity Management*: - This include the processes to ensure the availability of medical materials while keeping the cost lowest possible and also it ensures the resource management in the hospital to avoid wait/ delays.

5. HOSPITAL SUPPLY CHAIN OPERATION

Performance measurement is a process which provides strategic decision making for improvements in firm/ organization. In order to observe improvement in a supply chain, the initiatives for performance measurement must be supply chain centric so as to enhance supply chain efficiency [3, 20, 21]. Hence, hospital supply chain performance measurement must ensure the involvement of supply chain efficiency in medical treatment and supporting operation. Studies revealed that, [22, 23] patient safety primarily be the most important concern to ensure best possible service to patient. In order to ensure patient safety, the supply chain performance measurement system for the hospital supply chain should consider the supply chain efficiency constructs as the criteria with various sub-criteria contribution to overall supply chain performance for hospital. Furthermore, the performance measurement system must possess a unambiguous justification of criteria and a relationship model between criteria, sub-criteria and alternative on which performance of supply chain is to be evaluated [20, 24]. This section would explore the hospital supply chain performance criteria including supply chain efficiency criteria.

5.1 Supply Chain Efficiency

Supply chain efficiency takes into consideration of multiple performance criteria linked to supply chain operations with integration of supply chain partners [8, 27]. The most important criteria which are considered while thinking of supply chain efficiency include cost & time [26, 27], whereas with respect to supply chain context reliability received lot of attention. In addition, so as to measure the efficient use of resources, productivity has also gained lot of importance [27, 39]. Also, Quality, flexibility & utmost important safety now playing vital role in making healthcare services more affordable and adaptable [27, 39, 40] Therefore, supply chain efficiency with seven dimensions for this study is as follows;

i. *Cost:* - Managing Cost effectively and efficiently
ii. *Time:* - Managing Time of all operations with high responsiveness
iii. *Reliability:* - Ensuring the accuracy of the treatment processes and its sustainability.
iv. *Productivity:* - Ensuring optimum utilization of resources available to carry out medical treatment processes
v. *Quality:* - Ensuring the quality of services and satisfaction of patients
vi. *Flexibility:* - Ensuring the adaptability of hospital as well as future expansion of hospital.
vii. *Safety*: - It includes the overall safety of patient throughout the treatment.

6. CONCEPTUAL FRAMEWORK FOR HOSPITAL SUPPLY CHAIN PERFORMANCE MEASUREMENT

This section presents the conceptual framework for measuring hospital supply chain performance measurement. As discusses earlier, framework is conceptual and presented based on brief overview of available literature pertaining to healthcare supply chain management, more precisely hospital supply chain. The need of the hospital supply chain management is studied. Four constructs for supply chain efficiency is considered, which are; cost, time, reliability and productivity as discusses earlier. In order, to gauge the performance more accurately, various performance measures were identified from literature and categorized as per their characteristics under these constructs of supply chain efficiency. The various performance measures are as shown in table 1. Performance measures identified from literature review list in the table probably may not be all are equally relevant and critical to assess the hospital supply chain performance. Hence, the purpose of this study is to present a framework to prioritize them and rank as per their level of contribution towards supply chain performance in hospital supply chain.

The framework also consists of areas where these criteria and sub-criteria would affect, and they are the component of hospital supply chain management (Medical Treatment Operation & Supporting/ Allied Operation). The proposed framework is composed of following elements;

Overall Goal: - Hospital Supply Chain Performance

Criteria: - Supply Chain Efficiency Constructs (Cost, Time, Reliability, Productivity & Safety)

Sub-criteria: - Total 50 performance measures categorized under hospital supply chain components.
Alternatives: - Medical Treatment Operations, Supporting/ Allied Operation (Components of Hospital Supply Chain Management)

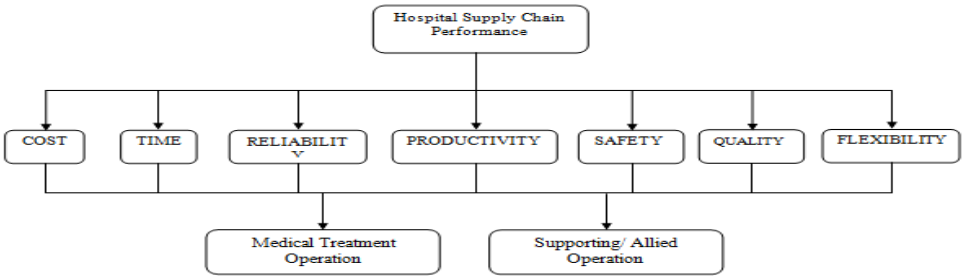

Fig. 2. Hierarchical Representation of the Framework for assessing hospital supply chain performance

Table. 1. Categorized Performance Measures

Sr. No.	Components Of Hospital Supply Chain Management		
	Performance Criteria	***Medical Treatment Operations***	***Supporting/Allied Operations***
1.	Cost	Cost of inspection, Cost of capital resources, Cost of care, Operating cost	Cost of issue orders, Total cost of supplies, Inventory days of supply, Value of buffer stock, Revenue per physician
2.	Time	Time to admit, Patient waiting time, Response time to unplanned issue, Time to discharge, Patient turnaround time	Sourcing response time, Order lead time, Order processing time, Order fulfillment cycle time, Production/preparation time, Cycle time, Transportation time
3.	Reliability	Accessibility, Accuracy of results, Accuracy of medical treatment, Accuracy of discharge process	Lead time variability, Fill rate, Percentage of rush orders, Accuracy of orders, Stock out at a point of use, Stock accuracy, Pick and pack accuracy, On time delivery, Response time to urgent request
4.	Productivity	Availability of tools, Productivity of testing labs, Productivity of doctors, Productivity of support staff (nurses), Response utilization, A bed turnover	Inventory turnover, Availability of tools and equipment, Staff productivity Availability of porters
5.	Quality	Pattern of treatment, Quality of clinical investigations and care, Satisfaction	Hospital Structure, Organization process, Cleanliness Utilization of recourses
6.	Flexibility	Professional flexibility, New service flexibility	Instrumental flexibility, Volume flexibility, Expansion flexibility
7.	Safety	Technical quality of care, Communication/Information, Caring/compassion	Authentication of medical suppliers, Handling of clinical materials, Availability of pharmaceutical materials

7. CONCLUSION

The ultimate objective of the study is to identify and prioritize critical performance measures used to assess the performance of hospital supply chain management. In order, to undertake this study, brief overview of literature is done and it is evident from it, that, very scare studies are being conducted in the field of supply chain performance measurement in the healthcare sector of India especially for hospital supply chain. Study identified that there are two parts of healthcare supply chain management; internal chain (hospital supply chain) and external chain (consist of vendors, manufactures and distributors of medical supply supplies (pharmaceuticals and devices)). Focus of this study is concentrated on hospital supply chain management. Performance of hospital is governed by the performance of its supply chain components with reference to supply chain efficiency metrics. In order assess hospital supply chain performance, a framework is suggested, comprising of goal as overall supply chain performance, with criteria supply chain efficiency constructs i.e. Cost, Time, Reliability, Productivity & Quality, Flexibility & Safety and having 50 sub-criteria or performance measures categorized under them, which are identified from existing literature review. The supply chain efficiency parameters identified and associated sub-criteria are required to be pair wise compared in order to assess their importance level as well their contribution towards hospital supply chain components i.e., Medical Treatment Operation(MTO) and Supporting/ Allied Operations(SO). The Paper presented here, proposes conceptual hierarchical framework for assessing hospital supply chain performance. However, the study will continue with prioritization and ranking of critical performance measures for hospital supply chain

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