

Critical Performance Measures for Optimizing Hospital Supply Chain Systems

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ABSTRACT

As per the current scenario in India, the frequency of patients is increasing day by day and thus reducing the facilities available for each patients in terms of safety & satisfaction of patients. This phenomenon is indirectly affecting the quality of hospital. Concurrent improvement in quality & efficiency leads to make customer demands more expensive. In India the doctor to patient ratio is very poor, approximately it is one doctor for 1700 patients. When it comes to the cost of treatment, it is very high that is not affordable for an average earning person. The requirement for better and affordable medical facilities is at high peak in India. In order to do so, Identifying prioritizing which can be studied and if integrated can lead to an efficient running of hospitals is our need. To make this changes a deep study of supply chain management is needed which will result in improving hospital's efficiency, reduction of cost and improvement in hospital's performance. This paper reviews identification of supply chain management by studying current literature review available on supply chain management. Objective of this paper is to provide a conceptual framework considering the supply chain efficiency parameters with various attributes and hospital supply chain components

I. INTRODUCTION

Between Supplier and till end customer there are many activities. If the emphasis is on a particular operation, it is called process. If the emphasis is on value addition, it is called value chain. If the emphasis is on movement (material, information, money) then it is called supply chain. SCM (supply chain management) is planning, implementation and controlling the operation of supply chain efficiently and with an eye on reducing operating cost. SCM term coined by Keith Oliver from consultancy firm Booz Allen Hamilton in 1982.

SCM is not only preferred in industrial sector but also it can be implemented in service sectors like hotels, banks, colleges and Healthcare sector. This paper focuses on the Supply Chain Management of hospitals. In order to be assured of successful SCM adaption, performance measurement is very important. Performance measure is a tool, monitors the efficiency and effectiveness of operation being carried out in hospital. There are limited no. of studies which explored the hospital SC performance measurement as a whole. This paper proposes conceptual hierarchical framework for prioritizing performance measures. Proposed framework consider the SC efficiency, dimensions as criteria and hospital SC operation as alternative to monitor the performance.

II. Objective

The healthcare sector is one of the fastest growing areas of the economy of most developed countries. In today's challenging business environment the organizations have started to realize that their success is highly dependent on their capacity to design and manage their supply chain management system in order to reap maximum benefits and to sustain competitive advantage in a fast-moving global world. Like other business organizations, increasing levels of competition, patient service alternatives, joint ventures, quality initiatives and emphasis on continuous improvement evidences dramatic changes in the operation of healthcare organizations.

Performance measurement provides the basis for an organization to assess how well it is progressing towards its predetermined objectives, helps to identify areas of strengths and weaknesses, and decides on future initiatives, with the goal of improving organizational performance. In order to make an organization effective, the performance measurement outcomes must be able to make the transition from measurement to management.

Efficiency of supply chain flow is considered as a crucial parameter for better operating of hospital. The efficiency of the supply chain is widely dependent on some performance measures such as cost, time, reliability, productivity, safety, quality, flexibility. The objective of this study is to provide a brief overview on performance measurement of hospital supply chain. More precisely, the purpose of this study is to:

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

III. Overview Of Litreature On Hospital Supply Chain Performance Measurement

The following literature review portrait the current status of healthcare sector relative to barrier and practices for implementation of SCM principles

A. Performance measurement system for healthcare processes

Authors- Shankar purbey; Kampan, Mukherjee, Chandan bhar.

A brief review of the existing performance measurement framework has been discussed. The proposed framework broadly categorize performance measurement parameter in three categories namely -Efficiency, Effectiveness, Flexibility. The Framework will help to organization to know their performance and also help in benchmarking the organization. The paper provides a brief review of the existing performance measurement frameworks. On the basis of review, performance measurement system criteria are identified and accordingly a framework has been proposed for measuring performance in healthcare processes.

B. Performance measures for healthcare system

Authors- David r. Nerenz, Nancy Neil.

This paper describes some of the key design consideration that go along with successful performance measurement systems and highlight some specific example of particularly successfully and innovative measurement systems. This systems allowed comparisons from hospital to hospital, from unit to unit within hospitals, and within the same hospitals over time. Having an explicit, objective measurement system allowed to make significant breakthrough in the understanding of the relationship between sanitary conditions and hospital morbidity and morbidity.

C. Supply chain management practices for improving patient-oriented care, Supply Chain Management.

Authors- Meijboom, B., Schmidt-Bakx, S., and Westert

This paper identified four major problem categories in the healthcare organizations: Communication, patient safety, waiting times, and integration. The findings are based on literature concerning country comparisons of patient experiences. The authors argue that the most important problems and the weakest links occur between providers; therefore supply chain management can be used effectively to minimize problems. A number of issues, such that availability of medical records of individual patients and information on provider performance, need to be considered and improved.

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 process, 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 less explored the potential of hospital supply chain as internal chain. Hence paper projected to consider the hospital supply chain with an approach of proposing a framework for performance measure of supply chain. In this paper 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 to consider the construct of supply chain efficiency with hospital supply chain operation to design a framework.

IV. Hospital Supply Chain Operations

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 (Dobrzykowski et al 2009). For achieving the satisfaction of patients(costumers), both medical treatment (services from medical professionals) and supporting operations (pharmaceuticals and medical supplies) are equally important (parnaby et al 2009 & Singh, 2008.) 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 that is medical care and supporting operation, which are given below:

A. Medical Treatment Operations

Medical Treatment Operations facilitates medical overhaul to patients. Main resources for this operations 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 (Bhattacharyjee et al, 2014 & Kujala, 2006 & Rahimnia et al 2010) are as follows

- a) Admittance: - Most initial activities, various stages are there in this activity for patients to be care and treated. Stages such as registration, triage and Inpatient admission.
- b) Patient Examination:- In order to be treated properly and to get cured as early as possible, Patient's examination is done by nurses and examination
- c) Treatment dealing: post examination, mode of treatment is decided. Treatment can be short span/long term depending on nature of patient's disease.
- d) Quality of care: This domain focuses on clinical content of care provided for defined groups of patients.
- e) Discharge/Transfer: Preferably the last stage at any hospital. This is done in either cases, when patient is treated & cured or when patient's critically is not in reach of particular hospital expertise.

B. Supporting/Allied operations

Supporting operation adds values to medical treatment processes. In order to examine, treat and cure patient, clinical materials such as pharmaceutical, medical supplies, & medical equipment are required. This processes normally occurred in two major units: Medical Supporting units(Singh 2008, swine hart et al, 2005 & Narayana et al,2014 & Mustafa et al, 2009) such as radiology, laboratory and pharmacy : and non-medical supporting unit (kumar et al, 2005,2008 & singh 2008) such as porting service for patient, supply and demand management, sterilized services. The supporting processes involve the following processes:

- a) Supply & demand management: - This include procurement of medical materials from various suppliers or supporting unit when needed.
- b) Synthesis: - This includes the preparation of medical treatment materials for clinical operations.
- c) Movement: - This include transfer of materials of patient to the point of care or where the materials or patients are required to be treated.
- d) Stock and 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 the management in the hospital to avoid wait or delay.
- e) Hygiene maintenance: - This includes necessary practices for preventive measures of hygiene to maintain clean surrounding around the patient for good health as well as preventing from diseases.
- f) Data record management: - This includes the storage and management of patient related data.

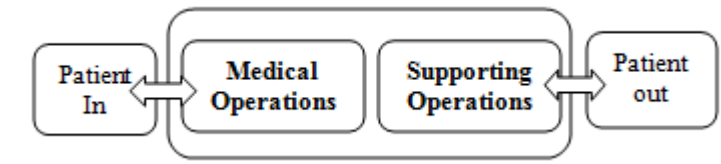


Fig. 1. Hospital Supply Chain Operation.

V. SUPPLY CHAIN MANAGEMENT PERFORMANCE AND EFFICIENCY

Supply chain management is currently regarded as having an important impact on reducing costs as having an important impact on reducing costs and improving performance in healthcare organization. (Bilas Christos, Manthou Vicky, Stefanou Constantinos, 2014). Hence, hospital supply chain performance measurement must ensure the involvement of supply chain efficiency in medical treatment and supporting operations. 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. Hospitals need to maintain an efficient of drugs and medical supplies in order to meet emergency demand, but this policy, although necessary, may raise costs. Last but not least, shortcomings of healthcare supply chain have severe impact on human health. Supply chain efficiency works on five dimensions. They are:

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

1. Cost

A. Medical Treatment Operations

1. *Cost of inspection* – More specialized functions include fire, hygiene, radiation, medical devices and medicines, and some countries include infection control and blood transfusions. Cost of inspection address the minimal requirements for a health care organization to operate and care for patients; they do not usually address clinical process or hospital performance.
2. *Cost of resources* - Cost of capital refers to money or credit used to invest in or grow a business, which can come from variety of sources (that includes training of people, investment in infrastructure and equipment, labour cost, etc.).
3. *Cost Of Care* - the money hospital spend on the resources needed to care for patients for example if hospital has to perform CT Scan of a patient, cost of care will includes the cost related to CT scan machine and its operator cost.
4. *Operating cost* - It includes cost of medical operations, surgical instruments, human resource, cost of outsourced services, etc.

B. Supporting/Allied operations

1. *Cost of issue order and cost of supplies* - When hospital orders medical goods there is a cost associated with the process. The cost is made of two component fixed cost and variable cost. Fixed cost remains the same for any order that is placed by any hospital. Variable cost can be significant and includes the cost of preparing a purchase requisition.
2. *Inventory days of supply* - It is an efficiency ratio that measures the average number of days the hospital holds its inventory before selling it. It includes the cost associated in maintenance and carrying of inventory.
3. *Value of buffer stock* - Buffer stock, or buffer inventory, is that which is kept on-hand in excess of forecast demand, maintaining buffer stock is prudent to minimize stock-outs and ensure consistent supply to customers. And cost associated with maintaining the inventory.
4. *Revenue per physician* - It includes cost associated with the wages of physicians. It also includes the cost of expert physicians appointed on hourly basic or for a particular case.

2. Time

A. Medical Treatment Operations

1. *Waiting Time of patients* - Patient waiting time is an important indicator of quality of services offered by hospitals. The amount of time a patient waits to be seen by clinical staff.
2. *Time to admit* – it is the time elapsed between actual entries in the hospital to the admittance in hospital.
3. *Response time to unplanned issue* - It is the average time elapsed from admission of patient till the first response is produced during the situations of unplanned issues.
4. *Time of discharge* - It is the time elapsed from discharge at doctor level to discharge at administrative level which includes documentations.
5. *Patient Turnaround time* - It is the time required to get a job done and deliver the output, once the patient is admitted in hospital according to the patient request. Turnaround time is the amount of time. Elapsed from the time of admission to the time of completion of operation on patient.

B. Supporting/Allied operations

1. *Order lead time* - It is the time required to meet a customer request or demand. Lead-time is basically the time gap between the order placed by the hospital and the time when the hospital get the final delivery.
2. *Order processing time* - It refers to time involved in pre & post approval from authority in command, shipment, inspection and transportation.
3. *Order fulfillment time* - It is a continuous measurement defined as the amount of time from customer authorization of a sales order to the customer receipt of products.
4. *Patient Turnaround time* - It is the time required to get a job done and deliver the output, once the patient is admitted in hospital according to the patient request. Turnaround time is the amount of time elapsed from the time of admission to the time of completion of operation on patient.

3. Reliability

A. Medical Treatment Operations

1. *Accuracy of results* - As the medical treatment is very intricate process the test results must be very accurate to find the actual cause of the diseases.
2. *Accuracy of medical treatment* - The way of medical treatment directly affect the health of patients so it must be accurate in terms of several operations and decisions of doctor.
3. *Accuracy of discharge process* - The patient should be observed & validate carefully that he/she is perfectly healthy or not.

B. Supporting/Allied operations

1. *Lead time variability* - The lead time of any operation or function in medical treatment should not be increased and for that all the necessary equipment and medicines etc. should be available.
2. *Fill rate* - The fill rate is the fraction of treatment need that is met through immediate stock availability, without backorders.
3. *Percentage of rush orders* - The hospital should be reliable in critical conditions when the percentage of admissions of patients increases i.e. pre planning must be proper of the management.
4. *Accuracy of orders* - The patients need and demand must be fulfilled in short time with greater accuracy of providing it to the specific patient among the large number of patients whose need is to be fulfilled.
5. *Stock out a point of use* - The management of maintaining the stuff required for medical treatment before getting it stock out.
6. *Stock accuracy* - Various steps to be taken like forecasting to derive the demand and fulfilling it in advance.
7. *Pick & Pack Accuracy* - It is a method of optimization of routes and proper storage, and providing service with greater accuracy and reducing errors.
8. *On time delivery*: Delivery should on time with lower percentage of delay.
9. *Response time to urgent request* - The management of hospital must be reliable to withstand in emergency conditions regarding treatment.

4. Productivity

A. Medical Treatment Operations

1. *Productivity of Testing Labs* - It includes getting the sample from point of drawing to the lab and getting the sample tested on time in lab.
2. *Productivity of tools* - It can be stated as for how many operations and how much a tool can perfume efficiently (i.e. error free).
3. *Productivity of Doctors as well as staff* - It can be defined as the rate by which doctor treats the patients satisfactorily in prescribed or minimum period of time on the other hand, productivity of staff can be stated as how staff (nurses) is working under doctors lead efficiently.
4. *Bed turnover* - Average length of time that elapses between the discharge of one patient and the admission of next patient to the same bed short turnover intervals have been linked to an increased productivity

B. Supporting/Allied operations

1. *Authentication of medical suppliers* - The validation of the supplier should be done so as to verify whether the supplier follows proper composition & Rules or not.
2. *Handling of clinical materials* - The management of maintaining the stuff required for medical treatment.
3. *Availability of pharmaceutical materials* - The medicines should be available enough to supply to patients.

5. Quality

A. Medical Treatment Operations

1. *Pattern of treatment* - The sequence of various treatment should be proper depending on the disease and the health of the patient.
2. *Quality of clinical investigation and care* - The patient should be transferred to the respective department depending upon the cause and proper test should be performed to determine the root of cause.

3. Satisfaction - At the end of the treatment the patient should be satisfied in terms of various parameters like service, cost & quality of treatment.

B. Supporting/Allied operations

1. *Hospital Structure* - The hospital should be efficient for admitting large no. of patients with varying disease also it should be equipped with modern techniques and technology available in the market for treatment.
2. *Organization process* - The flow process of organization right from the admitting the patient to the discharge would be in favor of patient i.e. the patient or its family should not suffer from various problems.
3. *Cleanliness* - Hygiene is an important parameter for providing better environment for patient's health.
4. *Utilization of resources* - Resources available with the hospital management should be utilized in effective manner in order to reduce the loss.

6. Flexibility

A. Medical Treatment Operations

1. *Professional flexibility*: Professional flexibility can be measured by type of different (department like orthopedic, pediatric etc.) cases treated by doctors and time or cost or both spent for consulting specialized doctors not available in the hospital.
2. *New Service flexibility*: Number of new services that can be launched by the hospital may be one indicator of new service flexibility.

B. Supporting/Allied operations

1. *Instrumental* - Instrument flexibility can be measured by time saved by particular instrument in conducting test as well as number of tests conducted by a particular Instrument.
2. *Volume Flexibility* - It is defined as maximum number of patients that can be treated in each department per day and average number of patients treated in each department per day.
3. *Expansion Flexibility* - The hospital may consider number and variety of expansions that can be accommodated without incurring high cost or large changes in performance outcomes.

7. Safety

A. Medical Treatment Operations

1. *Technical quality of care*: Calibration of various medical equipment's should be done before performing test for better results.
2. *Communication/Information*: The Communication between the administration and medical team should be proper in order to address patient in better way.
3. *Caring/compassion*: The Behavior of the staff should be proper towards the patient and they should be efficient to take care of them.

B. Supporting/Allied operations

1. *Authentication of medical suppliers* - The validation of the supplier should be done so as to verify whether the supplier follows proper composition & Rules or not.
2. *Handling of clinical materials* - The management of maintaining the stuff required for medical treatment.
3. *Availability of pharmaceutical materials* - The medicines should be available enough to supply to patients.

VI. CONCEPTUAL FRAMEWORK FOR HOSPITAL SUPPLY CHAIN PERFORMANCE MEASUREMENT

This section presents the conceptual framework for measuring hospital supply chain performance measurement. As discussed earlier, conceptual and presented based on brief overview of available literature pertaining to healthcare supply chain management, more precisely hospital supply chain. The need of hospital supply chain management is studied. The constructs for supply chain is considered, which are; cost, time, reliability, productivity, flexibility, safety, quality as discussed earlier. In order, to gauge the performance more accurately, various performance measures were identified from literature and characterized as per their characteristics under

these constructs of supply chain efficiency. The various performance measures are as shown in (table 1.) Performance measure 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 the 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 consist of areas where these criteria and sub-criteria would affect, and they are the component of hospital supply chain management (medical treatment operation and supporting/allied operation).

The proposed framework is composed of following elements; Overall Goal: - Hospital Supply Chain Performance.

Criteria: - Medical Treatment Operations, Supporting/Allied Operations (Components of hospital supply chain management).

Sub-criteria: - total 62 performance measures grouped under components and categorized based on their nature. Alternatives: - Supply Chain Constructs (Cost, Time, Reliability, Productivity, Flexibility, and Quality & Safety).

Table .1. Categorized Performance Measures

Sr. no.	Components Of Hospital Supply Chain Management		
	Performance Criteria	Medical Treatment Operations	Supporting/Allied Operations
1.	Cost	1. Cost of inspection 2. Cost of capital resources 3. Cost of care 4. Operating cost	1. Cost of issue orders 2. Total cost of supplies 3. Inventory days of supply 4. Value of buffer stock 5. Revenue per physician
2.	Time	1. Time to admit 2. Patient waiting time 3. Response time to unplanned issue 4. Time to discharge 5. Patient turnaround time	1. Sourcing response time 2. Order lead time 3. Order processing time 4. Order fulfillment cycle time 5. Production/preparation time 6. Cycle time 7. Transportation time
3.	Reliability	1. Assessability 2. Accuracy of results 3. Accuracy of medical treatment 4. Accuracy of discharge process	1. Lead time variability 2. Fill rate 3. Percentage of rush orders 4. Accuracy of orders 5. Stock out at a point of use 6. Stock accuracy 7. Pick and pack accuracy 8. On time delivery 9. Response time to urgent request
4.	Productivity	1. Availability of tools 2. Productivity of	1. Inventory turnover 2. Availability of tools and equipment

Sr. no.	Components Of Hospital Supply Chain Management		
	Performance Criteria	Medical Treatment Operations	Supporting/Allied Operations
		testing labs 3.Productivity of doctors 4.Productivity of support staff (nurses) 5.Response utilization 6.A bed turnover	3.Staff productivity 4.Availability of porters
5.	Quality	1.Pattern of treatment 2.Quality of clinical investigations and care 3.Satisfaction	1.Hospital Structure 2.Organization process 3.Cleanlines 4.Utilization of recourses
6.	Flexibility	1.Professional flexibility 2.New service flexibility	1.Instrumental flexibility 2.Volume flexibility 3.Expansion flexibility
7.	Safety	1.Technical quality of care 2.Communication/ Information 3.Caring/compassion	1.Authentication of medical suppliers 2.Handling of clinical materials 3.Availability of pharmaceutical materials

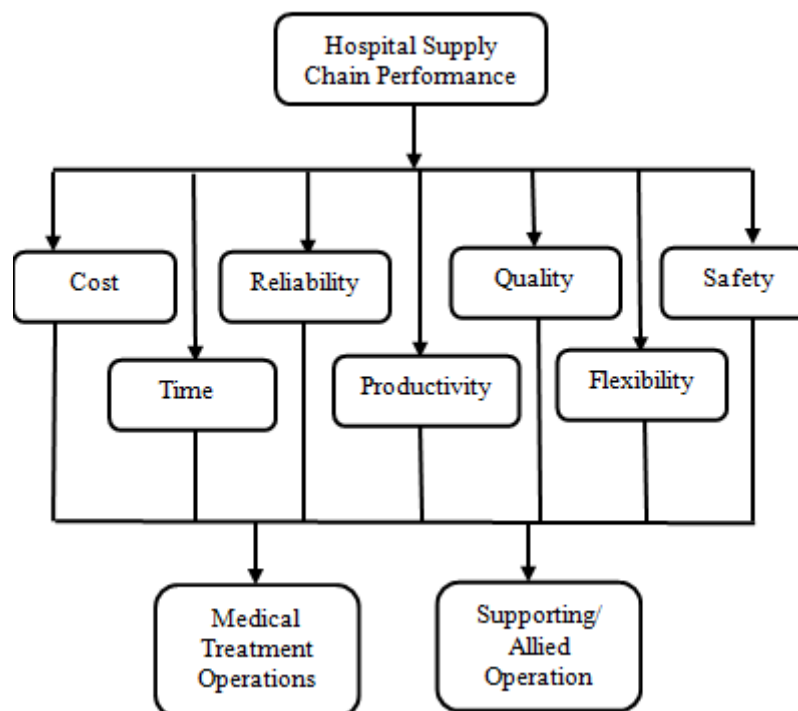


Fig. 2. Hierarchical Representation of the Framework for Assessing Hospital Supply Chain Performance

VII. CONCLUSION

The ultimate objective of the study is to identify critical performance measures used to assess the performance to hospital supply chain management. In order, to undertake this study, brief overview of literature is done and it is evident from it, that very rare studies are being conducted in the field of supply chain performance measurement in the healthcare sector of India especially for hospital 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. A framework is suggested comprising of goal as overall supply chain performance, with criteria supply chain efficiency constructs i.e., Cost, Time, Reliability, Productivity, Safety, Quality & Flexibility with almost 62 sub-criteria's or performance measures categorized under them collectively. Whereas these performance constructs and sub criteria will be prioritized on components of hospital supply chain management i.e., Medical Treatment Operations & Supporting/ Allied Operations. The paper presented here, proposes conceptual framework for accessing hospital supply chain performance. However, the study will follow with prioritization and ranking of critical performance measures for hospital supply chain

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