

Logistics and Supply Chain Management Quality Improvement of Supply Chain Process Through Vendor Managed Inventory: A QFD Approach

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ABSTRACT

Most of the time quality in healthcare is perceived as efficiency of services offered to the patients or end users. But at the same time quality is a main component of the efficiency of the process involved in the healthcare system. Quality Function Deployment (QFD) approach helps in translating the need of the process or customer to the implementation design QFD is applied to assess the importance and viability of VMI (Vendor managed inventory) for supply chain process. Main purpose of this paper is to suggest a quality improvement tool for supply chain process in a healthcare organization. One of the objective of the paper is to construct house of quality considering all the management's expectation against technical parameters.

A QFD approach is applied to assess the importance of Vendor Managed Inventory (VMI) in supply chain process improvement. With application of QFD, house of quality matrix is constructed and helps in selection of most viable indicator which removes the ambiguity among indicator's selection. A questionnaire survey is used as research instrument to find out ratings of the indicators. The sample size used is 30 and ratings are find on the basis of survey. As a conclusion VMI proves to be a vital player in quality improvement of supply chain process. For all the expected indicators VMI plays a vital role to bridge the gap. So with QFD approach, VMI is efficient tool to improve the process quality and in turn improves the overall satisfaction of end user from process.

Keywords: QFD (Quality Function Deployment), VMI (Vendor Managed Inventory), Healthcare Sector, Supply Chain Process, Process Improvement

INTRODUCTION

Indian healthcare industry has grown at a comparable pace with other service industries. Healthcare industry is a service industry with some distinct features than other industries like manufacturing and retail (Paryani, Masoudi, & Cudney, 2010). Indian healthcare industry is opportunistic in terms of revenue. A study report of Pricewatercooper says "Healthcare is one of India's largest sector, in terms of revenue and employment, and the sector is expanding rapidly. Today the total value of the sector is more than \$34 billion. This translates to \$34 per capita, or roughly 6 per cent of GDP. "By 2012, India's healthcare sector is projected to grow to nearly \$40 billion" (PricewaterhouseCoopers, 2007). It also has competitive advantage over its competitors across the world in terms of cost and quality of services. With opportunities and competitive advantage of healthcare industry, quality is one of the main concern. Quality is a main aspect of any product or services. In healthcare industry quality relates to the quality of services provided to patients or

end user, efficiency of the processes, safe and efficient products or services to customers. Healthcare industry is been differentiated in terms of quality of service only as most of the healthcare setups and hospitals provides the same clinical services (Camgoz-Akda, Tarım, Lonial, & Yatkın, 2016). The purpose of the paper is to apply a quality tool known as Quality Function Deployment (QFD) in supply chain process so as to increase the overall performance and efficiency of the process. QFD is been developed by Yoji Akao in 1966 in Japan. This approach helps in translating the need of the process or customer to the implementation design. It is first implemented in Mitsubishi heavy industries to improve the quality of manufacturing process. After its first implementation, it was then used in a food industry in 1987. This approach helps in measuring the quality of the existing services or product and also measures the expectation of the customer or end users from that product or service which helps in improving the current process and meeting the expected requirement of customers. With current researches it is shown that QFD is majorly used in prioritizing the

products and their characteristics. However healthcare industry lacks the application of QFD. In present paper application of QFD on VMI (Vendor Managed Inventory) is described in context of supply chain process of healthcare organization.

Supply chain management is a process that gains its importance nowadays and plays important role in assuring quality to end user. Supply chain management is the integration of all the activities and decision to deliver right product at time and right place (Prasad, Subbaiah, & Rao, Supply chain design through QFD-based optimization, 2014). Role of supply chain management became prominent in 1990's and since then it became an important part of any industry (Prasad et al., 2016).

Current Inventory System

Organization of this study is a group of eye care chain having several branches in pan-India. Organization is working on traditional method of supply chain in which requirement generates from end user and processed based on the current inventory and sales of the product. This system creates stock outs and shortage of stock frequently as system is managed manually. Inventory comprises of three major categories of the organization:

Pharmacy – All drugs prescribed and sold to patients.

OT consumables- All consumables to be used in surgeries.

Optical- Frames, glasses and lenses to be prescribed and sold to patients.

Major problem with the existing system is to forecast inventory which can lead to inconvenience to customer indirectly (Disney & Towill, 2003). However major part of healthcare is working on this system of supply chain.

Vendor Managed Inventory

Vendor managed inventory is a tool that helps in streamlining the supply chain process and brings all stakeholders at one place. Vendor managed inventory is majorly impacted by three stakeholders, i.e. purchasers, healthcare providers and producers (Toba, Tomasini, & Yang, 2008). VMI has necessity to invest considerable resources and effort in achieving collaboration with their suppliers and cost-effectiveness becomes an issue which leads to supply base rationalization and a segmented approach (Bhattacharya, Mukhopadhyay, & Giri, 2015).

Major challenge is to improve the quality of supply chain's process and to provide the quality healthcare services to the patients at the end of the day. In traditional supply chain, each player is responsible for his/her own inventory control which can cause ambiguity about exact inventory holding for organization (Disney & Towill, 2003). VMI can provide instant benefits to buyer or customer and in long run benefit to suppliers said (Kauremaa, Holmstrom, & Smaros, 2009). With the globalization of supply chain, many goods and services are effected by several factors (Treville, Shapiro, & Hameri, 2004). This paper will discuss about improvement of quality of supply chain process through vendor managed inventory and QFD will help in bringing the requirement of process and available resources on single platform. As VMI has been a mathematical modeling and empirical research subject, this will help in the study to measure the indicators.

Flow of paper starts with first phase which discuss the management's expectation from VMI programme. Details are mentioned below:

- Minimum inventory holding cost – This is measure of cost of inventory in organization. It is divided in three cost, i.e. cost of capital, cost of handling and storage and cost of risk (Durlinger & Paul, 2012). Requirement of management is to reduce the cost.
- Minimum number of head counts in supply chain department – It is total cost involved in manpower of supply chain and management want to reduce the manpower cost.
- Maximum order filling rate – Order fill rate is the percentage of fulfilling customer's requirement of any material or service (Lu, Song, & Yao, 2003). This is important indicator of performance of supply chain.
- Minimum stock outs – This is indicated total number of items that reaches zero in number due to which customer's requirement was not fulfilled.
- Minimum turnaround time of the product/services – Turnaround time is total time taken to reach the material to end user from the generation of requirement.
- Minimum number of suppliers – Total number of supplier which serves the organization.
- Minimum liability of the suppliers – Total credit dues on the organizations of all the suppliers and vendors.

- Brand/product standardization – Total number of similar products available in the product formulary in the organization.
- Operational efficiency improvement – Operation efficiency of manpower and all the related people with the process.
- Overall process improvement – Complete process improvement of supply chain with improvement in the above indicators.

All these constructs has been decided based on the requirement and expectations of the management.

Then next step is to identify the voice of existing process which helps in describing the current challenges of the process. Further the constructs of VMI are formulated that helps in meeting the expectations of management through process improvement.

Once the voice of process and voice of management's expectation has been determined, then house of quality is been constructed based on the ratings of survey. The survey is done with all stakeholders of the study (Management, supply chain department, patients and end users). The purpose of the study is to find out the most suitable construct among all the selected constructs and to improve overall quality of the supply chain process.

LITERATURE REVIEW

Most of the time quality in healthcare is perceived as efficiency of services offered to the patients or end users. But at the same time quality is a main component of the efficiency of the process involved in the healthcare system. A report says that measuring and assessing the quality is important because it indicates the current performance and lead to the improvement measures (Morris & Bailey, 2014).

There are various tools that helps in measuring the quality of a service or a process. QFD is alike tool that act as a catalyst to translate voice of requirement to appropriate technical stages (Chan & Wu, 2002). It is a tool that helps in designing a product or service based on customer's requirement involving all the stakeholders (Einspruch, 1996). QFD has been developed by Yoji Akao in 1966 in Japan. This approach helps in translating the need of process or customer to the implementation design. It is first implemented in Mitsubishi heavy industries to improve the quality of manufacturing process. After its first implementation, it was then used in a food industry in 1987.

QFD is TQM's (Total Quality Management) part and is based on a tool which is a matrix known as House of Quality. It is a graphical representation which shows what's (customer's requirement) and How's (technical requirements to meet what's) (Chan, Chan, & Chan, 2002).

Literature Concerning Vendor Managed Inventory in Healthcare

In introduction part it has been discussed that vendor managed inventory is considered as a process improvement tool of supply chain. Toba et al. (2008) said in their research that major numbers of hospitals are still using old system of supply chain management and healthcare industry is slow to adapt the new techniques. One of the widely adapted tool or technique is VMI. Wal-Mart and Procter and Gamble had successfully adapted and implemented the VMI tool which further implemented by several industries and companies like GlaxoSmithKline, Electrolux Italia, Boeing and Alcoa and Nestle and Tesco (Sari, 2007). Retail and manufacturing industry had adapted the VMI concept in early 90's but since then the concept has not been widely accepted in India and very less accepted by Indian healthcare industry. VMI is a collaborative initiative where all stakeholders are equally involve in managing the inventory where in traditional method every player has its own responsibility of managing the inventory (Turhan & Vayvay, 2012). Major benefits of VMI are considered as demand visibility and transparency in process of supply chain (Pohlen & Goldsby, 2003). This research will help in gaining the insight of VMI integrated with QFD to improve overall performance of supply chain.

Application of QFD in Supply Chain of Healthcare

The benefits of QFD are well known in various industries but healthcare industry is still in process of utilizing the benefits of the tool. This tool provides complete picture of customer's requirement and involves the collective efforts of more than one department (Maewall & Dumas, 2012). It is well applied in lowering the cost of services and improves competitive presence of organization in market. Various researches has been done on QFD integration with other quality tools, such as integration of QFD with SERVQL, integration of QFD with six sigma, lean quality etc. (Camgoz-Akdag, Tarım, Lonial, & Yatkin, 2013). But study with integration of QFD with VMI which is a tool of

supply chain and helps in improving overall performance of SCM has not been done yet. So this study also shows application of QFD with VMI tool on performance improvement of supply chain process of the organization.

What's and How's

This relates with customer's requirement and expectations. It helps in achieving the goal of organization and also strengthen organization to improve the weak attributes (Chan, Chan, & Chan, 2002). Table 1 represents the listed expectation of management and attributes of VMI that will fulfill what's and expectation.

Table 1: Management's Expectation and Technical Parameters

Management's Expectation (What's)	VMI to fulfill management's expectation (How's)
Minimum inventory holding cost	Shifting the inventory from customer to supplier
Minimum number of head counts in supply chain department	Shifting of operational and clerical jobs to suppliers through real data access.
Maximum order filling rate	Planning of stock position through real time data.
Minimum number of stock out	Access of real time inventory data to the supplier to maintain stock outs.
Minimum turnaround time of product/services	Maintaining required stock at supplier's place
Minimum number of supplier	Contract management with suppliers.
Minimum liability of the suppliers	Minimization of the suppliers and contract management.
Brand/ product standardization	Clinical management's brainstorming and approval.
Improving operational efficiency	Reduced number of manpower and work hours
Overall process improvement	Minimizing stock outs/TAT/supplier/liability maximizing the OFR

What 1 – Total inventory cost which includes inventory of pharmacy, optical, OT and other related items should be minimum to organization.

How 1 – This can be done by sifting the inventory management responsibility to supplier by providing them real time data accessibility. This data can help them to monitor the level of stock and managing the optimal inventory level at the same time.

What 2 – Supply chain department should have minimum number of head counts which further reduces the cost to organization.

How 2 – All the clerical and operation jobs performed by supply chain department's manpower need to be reduced by more automation of work and shifting the inventory management to supplier.

What 3 – Rate of fulfilling the customer's or end user's requirement should be maximum in order to achieve maximum patient satisfaction.

How 3 – This is one of the important requirement of management and this can be achieve by planning and forecasting of stock position. Proving the stock or inventory position either through organization or through real time data can help to do the same.

What 4 – One of the important performance indicator of supply chain department is minimum number of stock outs, i.e. zero stock level of any item of inventory.

How 4 – By accessing the real time data for warehouse and each departments, supplier can maintain the stock and prevent the position of stock out.

What 5- Turn around time is the time taken in completing the requirement from the time of its generation. This should be minimum to have efficient system.

How 5 – This can be managed in two phases, one to have optimal stock level in organization by supplier and other have optimal stock level at vendor's place.

What 6 – Minimum number of suppliers leads to streamlined process and standardized quality products to be supplied to organization.

How 6 – Contract management is the way to manage suppliers. Contracts can be done for several condition like price, delivery, services and quality.

What 7 – Financial burden can be reduced in two ways to the organization, one through minimum inventory cost and other through minimum liability of suppliers to the organization to have minimum liability of suppliers is necessary.

How 7 – This can be easily done by having sorting of number of suppliers into the required ones and by contract management. As through contract management suppliers will be abide by terms and conditions of contracts.

What 8 – Healthcare setups had number of similar products for end users, this creates hassle to the process. Various number of products need to be reduced to require one only for better inventory management.

How 8 – Through brand/product standardization it can be done. Management authority after brainstorming decided for the product and brand to be used in organization for every category.

What 9 – Operational efficiency refers to achieving maximum process accuracy and having maximum results of output.

How 9 – When manpower of supply chain will be free from clerical jobs, they can be used in other efficient tasks and overall efficiency of the department will be improved.

What 10 – Supply chain process is having series of steps that in turn increases the overall time of deliverables and reduces the efficiency of process.

How 10 – With improvement of all indicators like TAT, OFR, Accuracy, minimum number of stock outs etc., it will be improved as well.

QFD MATRIX AND PROCESS

QFD matrix is an important matrix that helps in assembles the requirement/expectation of customer and technical parameters to fulfill the requirement in a graphical representation.

This matrix is a two phased matrix in which columns show what's and How's. Competitive analysis in the matrix also helps in competitor's strength and weakness. Roof of the matrix shows correlation between expectations and parameters that represents strong, medium and weak relationship on the scale of 1–9.

Step 1: Customer's Requirement – Voice of Customer

This step represents the voice of management. Management's expectation are enlisted in this step which is based on questionnaire survey. Total number of 10 parameter are enlisted based on survey of 30 person of organization which are directly or indirectly involved in

management. Some of them are operation managers of the organization and other are part of management team of organization.

Supply chain process improvement	Minimum inventory holding cost
	Minimum number of head counts in supply chain department
	Maximum order filling rate
	Minimum number of stock out
	Minimum turnaround time of product/services
	Minimum number of supplier
	Minimum liability of the suppliers
	Brand/ product standardization
	Improving operational efficiency
	Overall process improvement

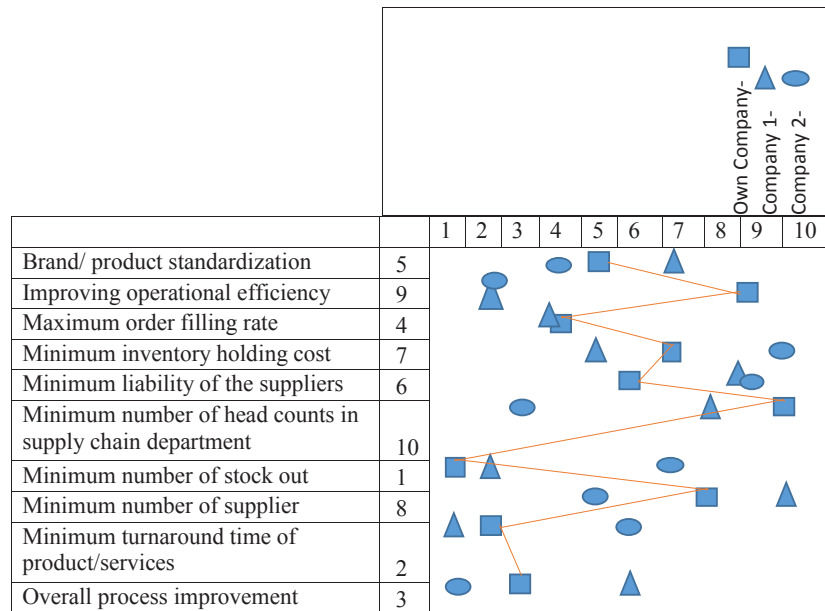
Step 2: Customer's Importance Rating

In this step, indicators are rated as per their importance. These ratings are based on survey of the organization in which average rating of the sample is taken. 1 being most important and 10 being least.

Supply chain process improvement	Minimum inventory holding cost	5
	Minimum number of head counts in supply chain department	9
	Maximum order filling rate	4
	Minimum number of stock out	7
	Minimum turnaround time of product/services	6
	Minimum number of supplier	10
	Minimum liability of the suppliers	1
	Brand/ product standardization	8
	Improving operational efficiency	2
	Overall process improvement	3

Step 3: Customer's Rating for Competitor

Competitor analysis helps in providing picture of competitor's strength and weakness, which helps organization to work on its weaknesses. This is done on the basis of questionnaire survey.



Step 4: Technical Parameters – Voice of Process

ranking of the parameters and competitor analysis. This completely provides a glance of construction of house of quality.

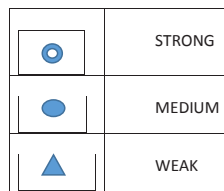
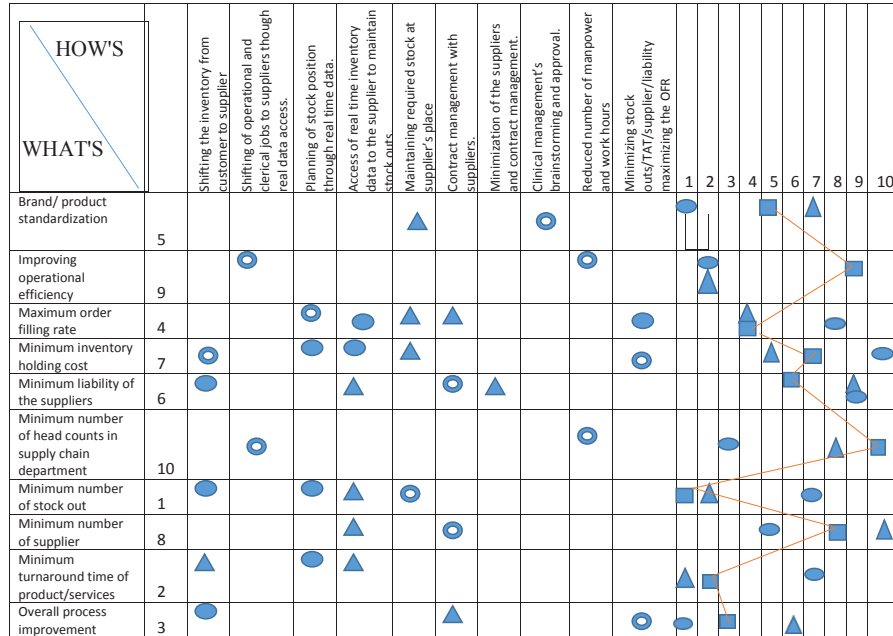
This table shows compiled analysis and ranking of management’s expectation, technical parameters,

HOW'S	WHAT'S	HOW'S									
		Shifting the inventory from customer to supplier	Shifting of operational and clerical jobs to suppliers through real data access.	Planning of stock position through real time data.	Access of real time inventory data to the supplier to maintain stock-outs.	Maintaining required stock at supplier's place	Contract management with suppliers.	Minimization of the suppliers and contract management.	Clinical management's brainstorming and approval.	Reduced number of manpower and work hours	Minimizing stock outs/TAT/supplier/liability maximizing the OFR
		1	2	3	4	5	6	7	8	9	10
Brand/ product standardization	5										
Improving operational efficiency	9										
Maximum order filling rate	4										
Minimum inventory holding cost	7										
Minimum liability of the suppliers	6										
Minimum number of head counts in supply chain department	10										
Minimum number of stock out	1										
Minimum number of supplier	8										
Minimum turnaround time of product/services	2										
Overall process improvement	3										

Step 5: Relationship Matrix

with competitor analysis. Strong, weak and medium relationship are shown in the matrix.

This matrix shows correlation between the indicators of management's expectation and technical parameters



Step 6: Difficulty of Process

This step represents difficulty of technical understanding complexity of the process and its parameters in the matrix which helps in parameters.

How's \ What's	Shifting the inventory from customer to supplier	Shifting of operational and clerical jobs to suppliers through real data access.	Planning of stock position through real time data.	Access of real time inventory data to the supplier to maintain stock outs.	Maintaining required stock at supplier's place	Contract management with suppliers.	Minimization of the suppliers and contract management.	Clinical management's brainstorming and approval.	Reduced number of manpower and work hours	Minimizing stock outs/TAT/supplier/liability maximizing the OFR
Minimum inventory holding cost										
Minimum number of head counts in supply chain department										

How's	Shifting the inventory from customer to supplier	Shifting of operational and clerical jobs to suppliers through real data access.	Planning of stock position through real time data.	Access of real time inventory data to the supplier to maintain stock outs.	Maintaining required stock at supplier's place	Contract management with suppliers.	Minimization of the suppliers and contract management.	Clinical management's brainstorming and approval.	Reduced number of manpower and work hours	Minimizing stock outs/TAT/supplier/liability maximizing the OFR
What's										
Maximum order filling rate										
Minimum number of stock out										
Minimum turnaround time of product/services										
Minimum number of supplier										
Minimum liability of the suppliers										
Brand/ product standardization										
Improving operational efficiency										
Overall process improvement										
Process Difficulty Rating -	9	1	2	4	10	7	6	3	5	8

Step 7: Technical Analysis

This step represents complete analysis for house of matrix, an importance rating. Roof of house represents the importance of each parameters against each technical analysis. Importance rating is done on the basis of analysis of each requirement against each technical parameter that represents the importance, partial importance and no importance in the box of roof.

If the box is blank that represents the non-importance of that requirement against technical parameter, if it's in the middle it represents partial importance and it's in the box against the requirement, it is having complete importance.

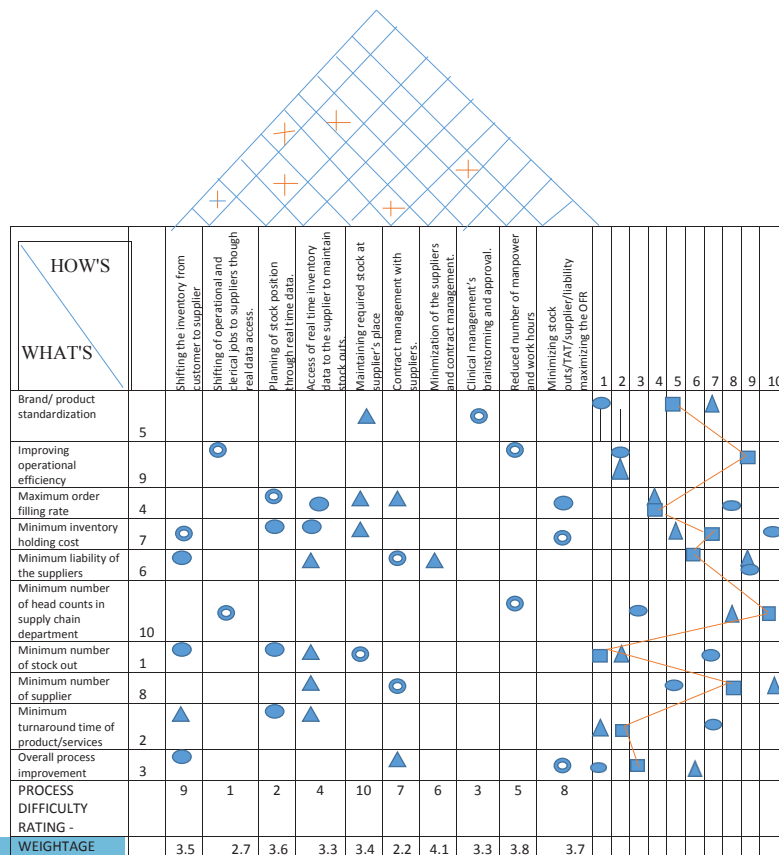
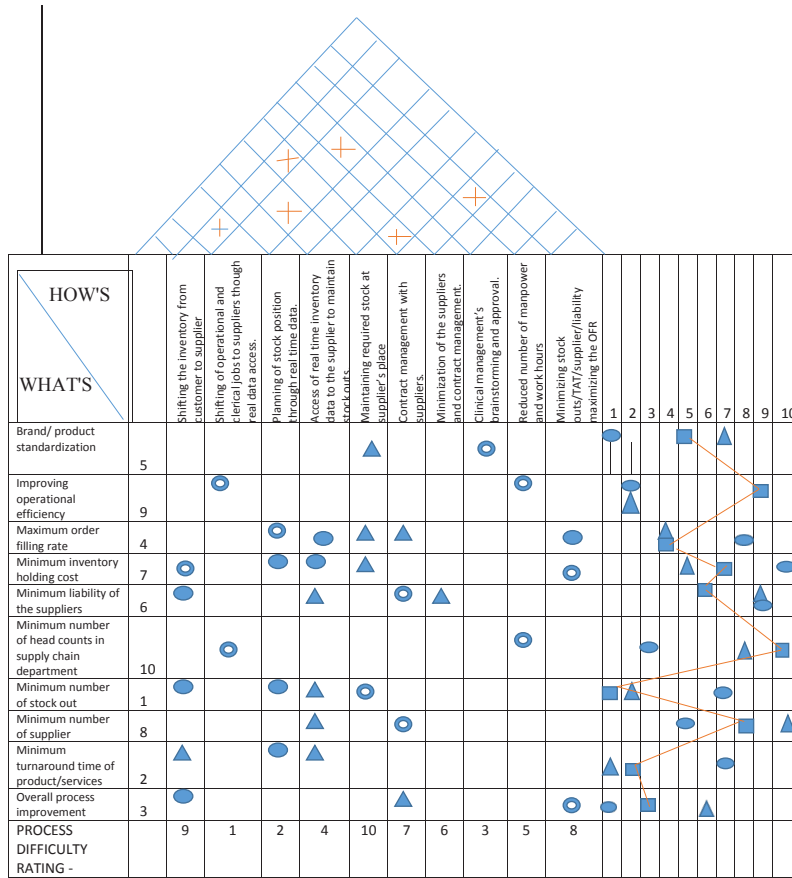
STEP 8: House of Quality

This step is complete representation of house of quality in which competitor analysis, ranking, its weightage is

shown. This the main objective of the study to construct this house of quality and helps in understanding all the parameters and expectation of management and end users.

DISCUSSION

With the integration of VMI with QFD, we can efficiently increase the supply chain process efficiency. Although various researched has been conducted previously on different vertical by using QFD. But none has touched the healthcare industry or hospital industry in the reference. Current research is done on the parameters and variables that are important in a healthcare setup and helps in improving the overall efficiency of supply chain in a healthcare organization. From above study “number of stock out” is the key area of concern for the management. This study highlights the important variables that effects the supply chain process and with a scientific technique its efficiency increases to a great extent.



CONCLUSION

This paper helps in finding the most important expectation of management and the important technical parameter that fulfills the expectation of management. All steps mentioned in the paper concluded that most important expectation of management is to minimize number of stock outs and all the parameters are ranked accordingly. Weighted average are also mentioned. In the last step complete house of quality is constructed with all the expected parameters and technical parameters. It also shows competitive analysis which helps to understand the strength and opportunities from the market. At the same time all weakness of own organization also highlighted which helps in understanding and working.

Overall objective of the study is to improve overall efficiency of the process and improve process is done with the construction of house of quality and helps in meeting and fulfilling management's expectation with application of supply chain tool "Vendor Managed Inventory".

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