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Rules of Implantation of Lean Six Sigma in Supply Chain to Reducing Lead-Time and Removing Waste in (SME´s)

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Abstract:

The study sought to explore the impact of the approved approach of application of Lean and Six Sigma, which focuses on improving quality and reducing lead-time, and removing waste in the supply chain. As this integration of both applications is suitable for small and medium-sized companies (SMEs), the manager of company X wishes to solve its problems in lead time and transportation costs. The paper used the application of Lean and Six Sigma within the DMAIC stages.(define, measure, analyse, improve, control) The study also aims to take advantage of the stages through careful application of them to achieve the best results of reducing lead time and removing waste.

Keywords: Lean Six Sigma, supply chain, analysis, Measure, DMAIC, control.

1- Introduction

Lean and Six Sigma are used to improve the quality, productivity, profitability, and market competitiveness of an organization. Lean focuses on reducing waste, while Six Sigma focuses on process improvement. Six Sigma aims to reduce process variation using problem-solving and statistical tools. The benefit of using Lean and Six Sigma independently is that they can each produce better results for the company. However, when these tools are applied together, they complement each other and provide improvements that are more significant. Lean and Six Sigma start to make these improvements by understanding the current state of affairs, and then they set achievement targets in order to create the future state for the operations of the whole organisation. Six Sigma are quality improvement projects, which use a specific framework known as: Define, Measure, Analyse, Improve and Control (DMAIC). Lean is a set of tools relating to value stream mapping techniques and strategies, which can help to improve the operations in a supply chain. In this paper, Company X is a medium-sized food manufacturing **public limited company;** which has implanted ISO 9001 in order to create a quality improvement culture. The company is seeking to develop its delivery performance by reducing delivery time and deviation from schedule in delivery and cutting transport costs. This paper will examine how delivery lead-time and transport costs can be reduced, by integrating Lean and Six Sigma in the supply chain measures. It will also study the effects of implementing Lean and Six Sigma in supply chain management.

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Company X adopted the international standard of quality management systems, known as ISO 9001, which is aimed at small and medium enterprises, implementing the procedures of ISO and making the changes necessary to achieve this quality standard and increase the profitability of the company. However, given the complexities of supply chain operations from the flow of raw materials to manufacturing and delivering the product to the right customer within time and cost constraints and waste reduction, this goal cannot be achieved by ISO 9001 only. Company X still has a number of problems relating to Delivery lead-time and transport costs. Hence, it needs to make use of Lean and Six Sigma in order to commence these developments. It also faces competition from other companies, which is forcing the company to seek quick and successful solutions.

The study showed that the combination of these tools into one application, for small and medium enterprises, was highly efficient and that it was also possible to identify the root causes of problems. It also gave the potential for measurement, analysis, improvement and control.

2-Lean and Six Sigma in the supply chain

The integration of Lean and Six Sigma will help company X to improve its business processes and find the right solutions to solve its problems in the supply chain process. According to Bendell (2006), the compatibility and integration of Six Sigma and Lean are limited when testing or looking for optimal joint solutions. Theoretically, it is believed to be a mutual exchange, but this only exists as a philosophical compatibility. A Lean supply chain tries to remove all sources of waste or damage in order to reduce delivery lead-time and transport cost. If priority is not accorded to Six Sigma, control problems appear, and attempts to control the process are uncertain. However, the approaches of both Six Sigma and Lean could be described as either subordinate (one controls the other) or integrative. To integrate both applications, that is Six Sigma and Lean, into the project requires an ISO 9001 certificate to avoid market pressures, to achieve the required standards and finally, to produce a comprehensive model.

The features common to Six Sigma and Lean in regard to the supply chain can be summarized as strategically attempting to:

- Integrate the people and systems approach.
- Include and participate
- Focus on results
- Integrate training.

According to Cudney and Kestle (2011), Lean and Six Sigma are powerful applications for improving quality, productivity, profitability and market competition for any company. Lean and Six Sigma can produce quick improvements in the supply chain process. Moreover, a reduction in lead-time and delivery costs can be realized by minimizing the variation in company production processes. Six Sigma methodology can

Be used in the problem solving and includes five elements: Define, Measure, Analyse, Improve and Control (DMAIC). Dora et al., (2012) note that the main principle of Six Sigma is to reduce the defect rate and control variations in processes. Unlike Six Sigma, which is a specifically problem-solving methodology, Lean focuses on reducing waste and improving process lead-time (Antonyet al.,2005) Six Sigma is a business improvement strategy used to develop business profitability processes, reduce waste and business operation costs. For this reason, joint integration of Lean and Six Sigma will produce good results as each application focuses on specific aspects of the improvement and development of company work processes.

3- Lead-time

As Nabhani and Shokri (2009) note, lead-time is one of the strategic factors for a supply chain, when a supply chain stretches from a supplier of raw materials to the factory and distributor to the delivery of the product to retailers. Processed foods require more attention in terms of timing and correct validity and quality under stringent health conditions. According to George (2003), there is one way to measure time to follow individual items due a process.

$$Lead\text{-}time = \frac{Amount\ of\ work\ in\ process}{Average\ completion\ Rate}$$

Improving lead-time will have a significant effect on improving the performance of the supply chain and will add value to the supply chain performance. In addition, the drop in the value of quality can affect the performance of the supply chain. As the competition between companies relies on the high quality of the product and service this will add value to suppliers by succeeding in reducing lead-time and lowering the cost of delivery Stainer (1997) .

4- DMAIC (Define – Measure – Analyse – Improve – Control)

DMAIC is a problem-solving methodology, following the phases of DMAIC. Integration of Lean and Six Sigma applications can be used step-by-step systemically in order to provide a better

opportunity to achieve results from both applications. For instance, as shown in Figure 1, Six Sigma defines the process whilst the Lean is concerned with the definition of customer demands. The next paragraph will explain more about the application of Lean and Six Sigma within the DMAIC stages.

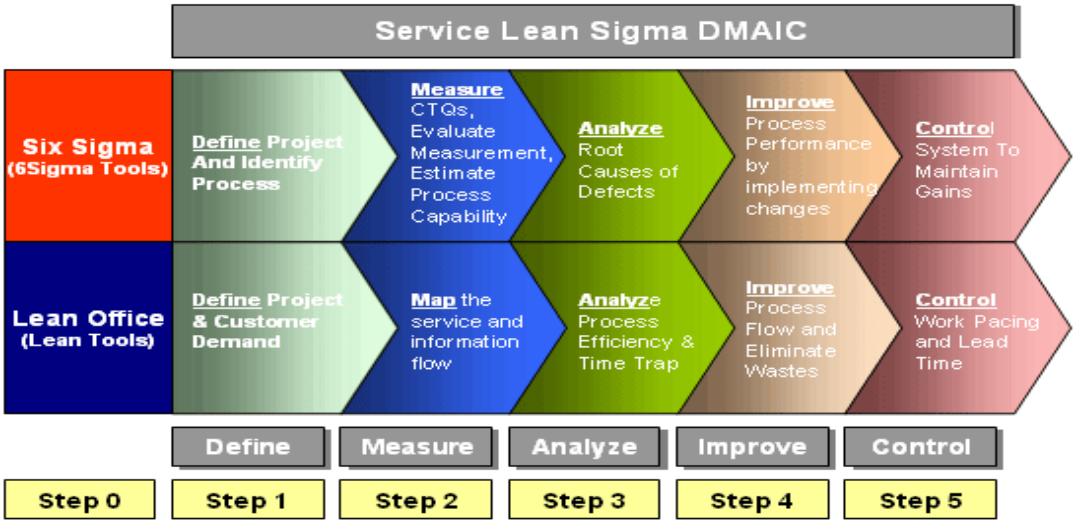

Figure 1: DMAIC Stages based on Yadavalli *(2020)*

4.1- Defining Stage

The team need to identify the causes of the problems, efforts should be focused on improved delivery lead-time, and transport costs. Moreover, within the supply chain for company X, the problem is particularly centered around delivering products from – to and the improvement needs to be made in this area. The team also needs to collect data and information in addition to the voice of the customer (VOC) to obtain more in-depth

Knowledge of the reasons underlying these problems. According to Rashmi (2011) they are four elements which should be considered to ensure success:

- Update trailer status
- Improve trailer dispatch plan
- Make good communication withen SC Parts
- Real time estimates

4.2- Measurement stage

The team will define more processes, as well as collecting VOC from the retailer and customer feedback, to define the current situation of company X (Lim, 2001). Defining the company's current processes requires carrying out the process plan (data collection plan, metrics and operational definitions). The company also needs to define the VOC by using focus groups; a customer needs

map (CNM) and a quality function development (QFD) diagram. These tools will provide clear information and help the team to measure the root causes of the problem.

4.3- Analysis stage

The team will analyse collected date using Pareto analysis and fishpond analysis. Nabhani and Shokri (2009) have shown that this stage is necessary to determine more possible reasons for delays in delivery time and the high cost of transportation. Table 1 includes the names of the targeted areas of delivery. Using an Excel spreadsheet and scoring areas that are related to the root of the problem on a scale of 1-10, as a result of this application the team will consider the highest scores as the root problems, excluding other causes, which did not record high scores below 200.

Table 1: Analysis of root problems (based on shokri 2009)

Delivery route	Route no.	Defect	Possible causes of problems					
			Loading Time	Process Loading	Different Distance	Long Distances	Number of Retailers	Traffic on Roads
Brighton	1	30	#		#		#	#
Worthing	2	6	#	#	#			#
Eastbourne	3	10	#		#			#
Bexhill	4	6	#	#				#
Horsham	5	5	#		#		#	
Portsmouth	6	11	#		#			#
Crawley	7	2	#					
Guildford	8	7	#	#	#	#		#
Southampton	9	3	#	#	#	#	#	#
Error dependency			800		450			412
Weight			9	3	9	1	1	9

This analysis will give the results of the reasons for the delay in the delivery of the products, as well as identifying the most important reasons for the high cost of transport which; are loading time, traffic on roads and different distances.

The team should also determine the cause of the problems by using an effect XY matrix. (Table 2) This method will help to determine the course of the results of Table (1), as Y output variables. As a result of brainstorming, the team will determine X input variables that is the possible causes of Y. Establishing this XY matrix will identify possible causes, by means of the scoring between X and Y and will produce very accurate results which can help to determine the exact cause of the problem.

Table 2: XY Matrix (based on shokri 2009)

Y OUTPUT VARIABLES	Loading time	Different distances	Traffic on roads	
Score (1-10)	9	3	7	
X INPUT VARIABLES				**Weighted score**
Loading plan	9	3	9	85
Route plan	9	9	9	140
Warehouse layout	9	7	3	145
Staff shortage	3	3	3	103
Number of shops on each order	9	9	9	100
Loading method	3	3	3	88
Warehouse space	9	3	3	70
Specific occasions	6	3	9	120

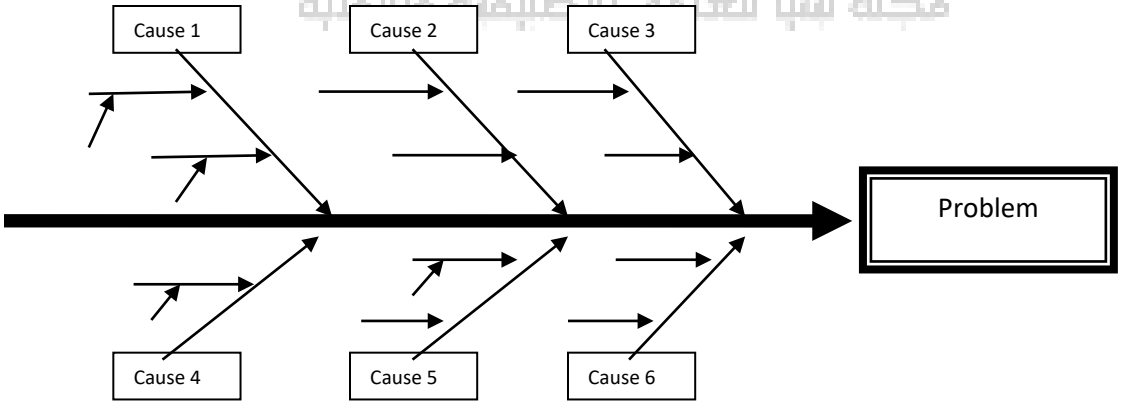

Fig. 3. Root causes of problem based on (Yadavalli *2020)*

4.4- Improvement stage.

It is necessary to define, measure, and analyse the effects of the problem, the figure (3) illustrates those gap activities in cause and effect diagram. These will clarify the root causes of lead-time and

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transport cost problem. Table 2 shows that the highest score relates to loading time, then traffic on different distances followed by different distances. However each of these causes has its own reasons which is, scored gradually from top to bottom as follows:

- Warehouse layout
- Route plan
- Specific occasions
- Staff shortage
- Number of shops in each order

Table 3:Problem causes and reasons

No.	Problem causes	Results of problem causes from XY Matrix
1	Loading time	• Warehouse layout • Special occasions • Staff shortage
2	Traffic on roads	• Route plan • Special occasions • Number of retailers on each order
3	Different distances	• Route plan • Number of retailers on each order

Table (3) shows the relationship between the causes of the problem and the reasons for those causes. To make improvements in its loading time the company should re-organise its warehouse to make loading the products easier to avoid creating problemds with lead-times. On special occasions the company needs to know about changes in customer demands by means of communication through the supply chain. Moreover, company X needs to manage its staff better and employ more staff to reduce loading times. With regard to traffic on the roads, the company should choose roads with less traffic and obtain information from its retailers about road traffic and also allow sufficient time to deliver cargo and ensure the arrival of the delivery on time. Finally, with regard to different distances, the retailers should be divided and be placed on routes which are close geographically to ensure best delivery timing and reduce the cost of transportation.

4.5- Control plan

Following the improvement recommendations, the team are ready to make improvements and to draw up a control checklist to review procedures to ensure implementation of the recommendations. They should also use statistical process control and visual workplaces which are of assistance in monitoring performance and measuring the results.

5- Discussions

This paper discussed the supply chain processes for company X, an SME, which is involved in the manufacturing, storing and delivering of ready meals and sandwiches. Although company X has been certified by ISO 9001 and has a quality improvement culture, it still has problems in delivery lead-time and increased transport costs.

The integration of lean six sigma will help to gain better results, whereas each application concerned with improvement of specific aria. The study included DMAIC Stages (Define – Measure – Analyze – Improve – Control).

- Define- During this stage four main elements were identified; which considered as important element to improve .

- Measure- In this stage has add more details to measure the roots of problems .

- Analyze- By using analysis tools (pareto analysis and fishpond analysis) this stage could show reasons of delay of delivery time and increase the cost of transportation.

As resolute the team could determinate four main points need to improve as showed in table (3). This stage need monitoring and measuring by the team to insure better result, and correct any deviations.

6-Conclusion

In conclusion, the study has shown the Integration of Lean and Six Sigma applications in a work programme will help the company, which aims to benefit and achieve high efficiency with consideration to the supply chain. The applications of Lean and Six Sigma have proven their potential to define root causes of these problems. In addition, through the application of tools of Lean and Six Sigma DMAIC has made it possible to define measure, analyse, improve, and control. These tools enabled the company team to apply several methods of Six Sigma to find accurate reasons for the root causes. Studies have shown that Lean and Six Sigma applications are designed to address the

problems of SMEs, as this programme requires a working group with good knowledge, which is able to obtain sources of information and the right data to enable the team to identify the most important root causes.

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