Application of Lean Six Sigma Principles to Food Distribution SMEs

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Abstract. Across the world service industry organisations including SMEs have been facing unprecedented challenges in delivering best quality products at low costs and fast delivery speeds. Lean and Six Sigma are increasingly used as practical methodologies to improve delivery and quality and to reduce operational costs, to thereby enhance business competitiveness. This study aims to investigate the implementation of Lean Six Sigma by means of an empirical case study in food distribution SMEs in Saudi Arabia. Suitable statistical tools have been applied in each phase of the DMAIC cycle. The case study indicated that a combination of the strengths of each approach could bring about considerable performance improvements in SMEs.

Keywords: Lean, Six Sigma, Lean Six Sigma, SMEs, Food distribution.

1 INTRODUCTION

For service industry businesses to succeed and prosper, it is essential for them to stay ahead of the competition and to respond to market changes rapidly. Nowadays SMEs face even greater challenges because they have to compete in the global economy. SMEs have been forced to respond more quickly in this new economic climate and to become more flexible operationally, tactically and strategically. The ever-increasing competitions in the current challenging business environment have meant that companies have to enhance their supply chain performance. This has resulted in supply chain management becoming a significant way for companies to achieve a competitive advantage. Food distribution firms provide the link between food manufacturers and end consumers. Important activities of a food distribution firm include procurement, inventory, warehousing, order processing, and customer service (Nabhani and Shokri, 2009).

During the second half of the Twentieth Century, Lean and Six Sigma were the two most important structured process improvement methodologies. They each evolved separately; Lean concentrates on process speed and eliminating waste, and Six Sigma, like its forerunner TQM, aims to eliminate process variation which leads to defects. When the two methodologies are combined the results will be superior to the outcomes that would result from either one alone. The integrated approach is superior to earlier ones because it integrates the process elements and the human elements of process improvement. Lean concentrates on improving process speed and removing waste, while Six Sigma concentrates on eliminating the process variation which results in defects. ‘Lean Six Sigma’ combines Lean and Six Sigma to offer the best of both systems.

The subject of this case study is a food distribution SME. The company faces many problems and difficulties in the process of delivering food, two of the most prominent being delays in the delivery of orders and low levels of quality, leading to customer dissatisfaction with the service provided. Customers have made negative observations and complaints, suggesting the potential for financial losses due to loss of customers. Prior to starting this Lean Six Sigma project to improve the quality of service at the company, the total cost of late deliveries was calculated, to justify the running of the project. This paper will address these issues, aiming to investigate the implementation of Lean Six Sigma by integrating some of its principles by means of a case study in food distribution SMEs.

2 THE NEED TO INTEGRATE LEAN AND SIX SIGMA

Lean six sigma is a methodology which strives to achieve maximum shareholder value by rapidly improving customer satisfaction, quality, and process speed and flexibility as well as reducing cost and increasing bottom-line savings (George, 2002; Shamou and Arunachalam, 2009; Snee, 2010). Lean strategies play a significant part in eliminating waste and non-value-added activities throughout the organisations, while Six Sigma statistical tools and techniques allow an organisation to reach a higher standard of process performance and capability (Antony, 2011; Kumar et al., 2006). In spite of Lean and Six Sigma having developed separately, several articles advocate an amalgamated approach (Pepper and Spedding, 2010). Most of the current literature implies Lean and Six Sigma are the optimal combination for process improvement (George, 2002; Arnheiter et al, 2005; Shamou and Arunachalam, 2009; Antony, 2011; Zhang et al, 2012; Salah et al., 2011; Snee, 2010). Snee (2010) writes that Lean and Six Sigma are clearly based on two different perspectives. Lean is based on the wish to raise the product flow velocity by eliminating all non-value-added activities while Six Sigma has its roots in the desire to guarantee final product quality by concentrating on very high conformance levels. It is important for the supporters of one system to learn from the supporters of the other. As has been mentioned previously, when companies implement either Lean management or Six Sigma on its own, they may reach a point of diminishing returns.

Six Sigma and Lean go hand in hand and complement each other. If Lean and Six Sigma are integrated it results in a combination of the Lean philosophy of waste elimination with the Six Sigma mentality of constant perfection (Lee and Choi, 2006). Similarly Pepper and Spedding (2010) argue that the fusion of Lean and Six Sigma is potentially an extremely powerful tool. If Lean's cultural elements and Six Sigma's data driven investigations are combined, the result could be an indisputable and ongoing approach to implementing organisational changes and improving processes. The results obtained when the two methodologies are brought together are superior to the results obtained from one method alone. When Lean and Six Sigma are integrated this results in greater flexibility in problem solving and offers two possible approaches, Kaizen and DMAIC, to use when tackling problems, according to the kind of problem or project involved (Shamou and Arunachalam, 2009). Furthermore Lean Six Sigma has been useful in SME organisations as Zhang et al. (2012) have pointed out. Nevertheless there is still room for more research in this area so as to develop the theoretical background of the implementation of Lean Six Sigma in SMEs.

Lean and Six Sigma are two well-known strategies for business process improvement which can offer striking improvements in cost, quality and time by concentrating on process performance (Kumar et al., 2006; Taylor, 2009). By raising levels of customer satisfaction rapidly, Lean Six Sigma maximises shareholder value (Nabhani and Shokri, 2009). Arthur (2007) believes that quality, cost and on-time delivery are the most important drivers of customer satisfaction. When the two tools are used in combination, it is highly likely that all three objectives will be achieved.

3 IMPLEMENTING THE LEAN SIX SIGMA METHODOLOGY

The organisation of the case study has been based on the proposals by George and George (2003) and George et al (2005). The small project team consists of four members and the scope of the case study is to achieve a reduction in the number of complaints about the delivery process and quality of goods. Suitable statistical tools have been applied in a synergistic and integrated application of Lean Six Sigma methodology to use customer requirements as a means of pinpointing defects and their causes, then to apply the best solution to enhance the delivery process. Table 1 shows the tools and technologies which have been applied in the study in each phase of Lean Six Sigma within the DMAIC cycle framework.

Table 1: Tools and technologies which have been applied

DMAIC	Tools
Define	Project charter, Interviews, SIPOC Diagram, Data Collection, Pareto Chart.
Measure	Data Collection, Brainstorming Strategy, Histogram, Process Map, Process Capability Calculation, Sigma Level Calculation, VSM analysis calculation, VOC Identification.
Analyse	Fishbone Diagram, Cause & Effect Matrix, Pareto chart, Brainstorming Strategy, Quality function deployment method.
Improve	Brainstorming Strategy, VSM Analysis Calculation, Process Map, Implementation Plan.
Control	Data Collection, Process Capability Calculation, Sigma Level Calculation

The implementation of this project began with the 'define' stage, where a project charter was established. Definitions were established of prerequisites such as the goals of project, its scope and the resources required, providing a basis on which the subsequent stages could proceed. According to George and George (2003), the basic principle of Lean Six Sigma is that a defect is anything that makes a customer dissatisfied, such as poor quality, high cost and long lead times. The first step in dealing with these problems is to take a process view of how the firm meets customer requirements. The tool for building a high-level map of such a process is a SIPOC diagram (Figure 1), including suppliers, inputs, processes, outputs and customers.

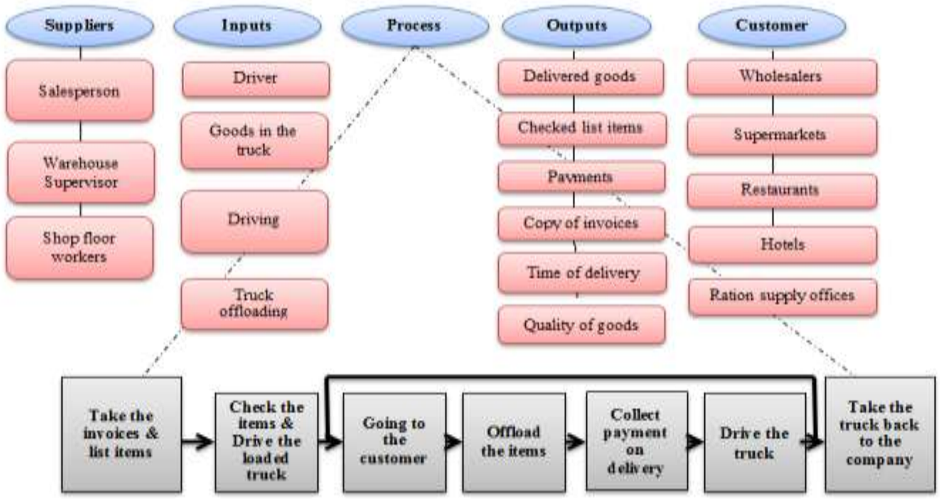

Figure 1: SIPOC diagram

A sample of customers was asked about their satisfaction with the service provided by the company and the main problems that they had faced or noted when their orders were fulfilled. The problems related to delivery were incorrect billing, late delivery, supply of a reduced quantity, substandard items delivered, and incorrect products or quantities delivered. A Pareto chart (Figure 2) shows that 50 percent of all complaints related to delivery were about late delivery, meaning that this was the problem having the greatest impact.

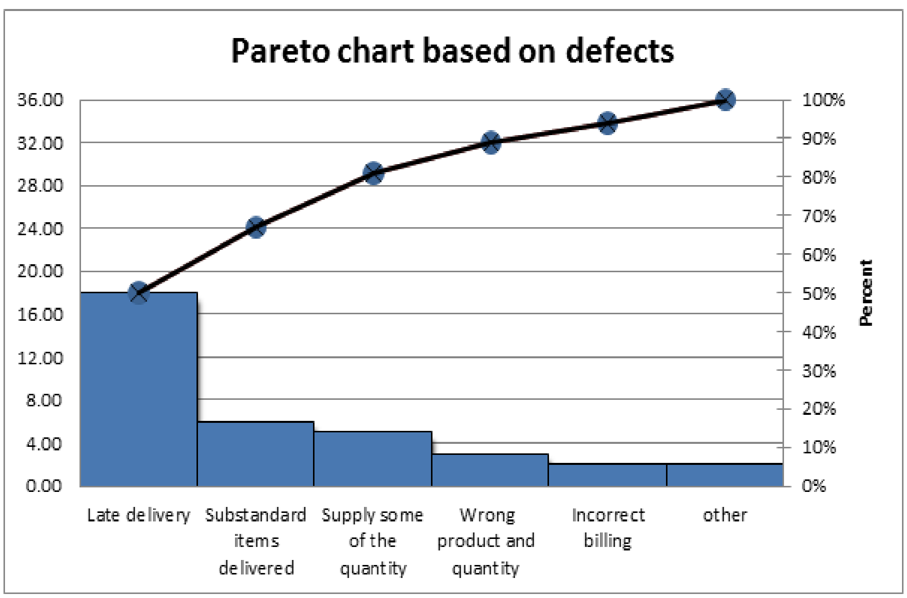

Figure 2: Pareto chart based on defects

A Pareto chart based on costs was used for deeper analysis. Costs were determined on the basis of two main considerations: the average cost of the possibility of losing a customer and the calculated cost per defect in the service provided. Looking at the curve chart used to calculate the cost based on the above considerations, it can be seen that both give almost the same result, i.e. that late delivery and substandard items delivered were respectively the most costly problems, so the next step was to concentrate on late delivery to identify its causes and potential solutions.

At the measuring stage, the current process was mapped and measured. ‘Late delivery to the shops’ was used as the critical-to-quality variable (CTQ-Y), with the defect being late delivery. Since cycle time was identified as CTQ, a data collection plan was developed. Key measures and sources of data must be identified for proper data collection to take place.

The customer complaint database indicated that delivery-related variables were the lateness by sales office, time spent loading, lateness by customer, number of shops and traffic problems. Figure 3 shows that, ‘lateness by sales office’ was the variable appearing most often in the customer complaint database. It was necessary to verify this further. The main objective was to reduce as far as possible the number of causes of this defect.

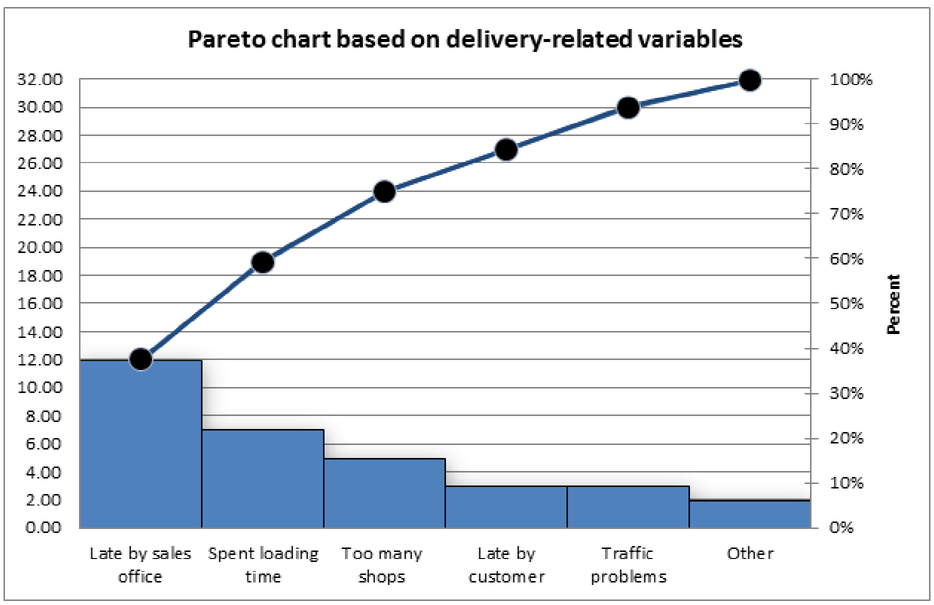

Figure 3: Pareto chart based on delivery-related variables

A value stream map (VSM) analysis was carried out to verify the result of the Pareto analysis. A current-state VSM was drawn, allowing the one non-value-added step that should be removed to be identified. Next, a future-state VSM was drawn by removing from the process any non-value-added step, then identifying any potential for reducing the cycle time in each of the other steps.

Looking at the average time data in all steps of the current-state and future-state value stream maps, it was noted that there were two key gaps between the ideal and existing amount of time spent, on billing of sales and on loading the items.

The causes were seen to be the same as those of the Pareto chart, indicating that lateness by the sales office was the most important cause of the defect. The root causes of the problem of late delivery can be identified by using the fishbone diagram shown in Figure 4.

The association/effect scores for each of the variables were entered after brainstorming and a fishbone diagram was drawn up. Possible sources (Xs) were chosen for further analysis with a cause and effect XY matrix, using the CTQ-Y variables, so that the possible sources of the three elements could be identified and the number of potential causes narrowed down.

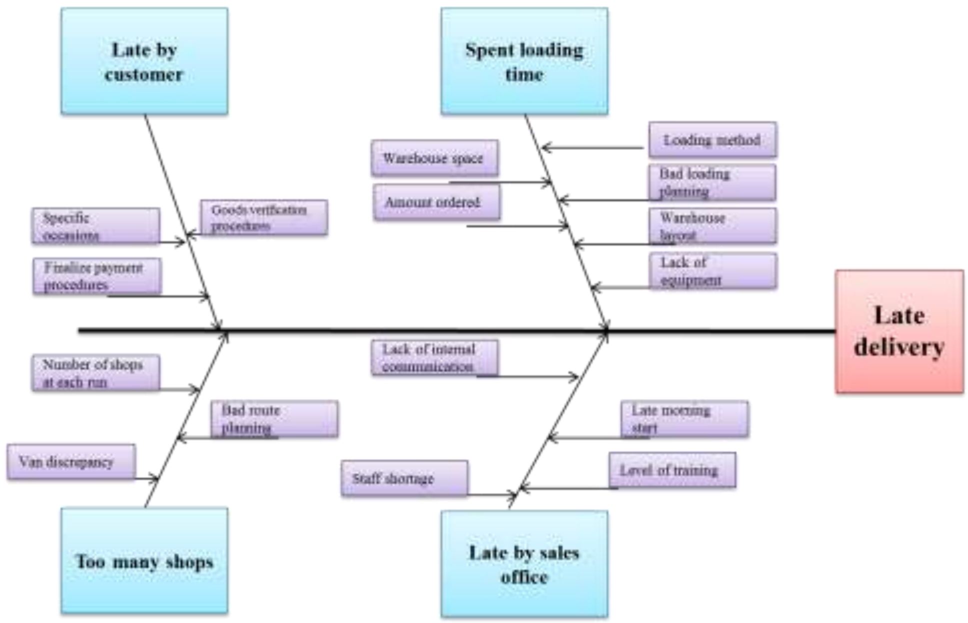

Figure 4: Fishbone diagram

The four causes with the highest scores, i.e. those having the most impacts on lateness by the sales office, were chosen as the key sources of the defect, to be given further considerations, so that suitable solutions could be implemented during the improvement and implementation stages. These four sources, identified as potential causes of the three variables which had already been chosen as the CTQ-Ys for delivery time, were: Bad loading planning; Loading method; Late morning start; and Lack of equipment.

Based on the results of the analysis phase and after determining clearly the reasons for the delay, the team members categorized the solution as comprising two key stages: changing daily hours of work and improving operations management. It had already been suggested that delivery time could potentially be reduced by changing the daily hours of work, improving the loading method and loading planning, and using trolleys to carry the items in order to help deliver the services in the right quality and quantity at the right time.

4 RESULTS

By using the above method, we were successful in reducing the cycle time required to deliver orders to customers during working hours, which helped to reduce delays in delivery and increase customer satisfaction significantly, thus reducing the likelihood of losing customers due to dissatisfaction. The results of the data analysis indicate that changes in hours of work, loading plan and loading method brought down the number of defects by 95% from 10.5 to 0.5 per week, resulting in a considerable improvement in the Sigma level from 1.7 to 3.55. Although the direct focus of the project was the causes of deliver delays, it contributed indirectly to raising the quality of goods delivered and reducing the number of customer complaints about delivery of substandard goods, as the new trolleys helped significantly in reducing the risk of dropping items and damaging them while they were being taken to the trucks.

Table 2: results of implementation Lean Six Sigma

	Before improvement	**After improvement**
Defect/week	10.5	0.5
Sigma level	1.7	3.55

5 CONCLUSION

There are a range of operational difficulties which affect food distribution SMEs in Saudi Arabia. Lean Six Sigma can be used to great effect to reduce or eliminate the associated defects. The case study indicates that a combination of the strengths of each approach (the speed of Lean and the consistency of Six Sigma) could bring about considerable performance improvements. A synergy of Six Sigma and Lean has provided an effective methodology which has helped to improve food distribution in an SME by reducing costs, improving the cycle time and reducing quality defects, thus increasing customer satisfaction. These significant improvements demonstrate the effectiveness of the Lean Six Sigma approach. In view of the success of this methodology in this specific case, it is likely that it can also be usefully implemented in SMEs in other service industries.

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