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Reducing the Delivery Lead Time in a Food Distribution SME through the implementation of DMAIC methodology

Abstract

Purpose - DMAIC (Define, Measure, Analyse, Improve, Control) Methodology of Six Sigma is a systematic data driven approach to reduce the defect and improve the quality in any type of business. The purpose of this paper is to present the findings from the application of DMAIC methodology in a food service "Small to Medium Sized Enterprise" (SME) in a lean environment to reduce the waste in this field.

Design/methodology/approach - A simplified version of DMAIC was adopted through the application of appropriate statistical tools in order to focus on customer's requirements to identify the defect, the cause of the defect and improve the delivery process by implementing the optimum solution.

Findings - The result suggested that modification in layout utilization reduced the number of causes of defect by 40% resulting in jumping from 1.44 Sigma level to 2.09 Sigma level which is substantial improvement in SME.

Research limitations /implication – Simplicity of DMAIC is important to enabling any SME to identify the problem and minimize its cause through a systematic approach.

Practical implications – Integrating of Supply Chain objectives with any quality initiatives such as lean and Six Sigma has a substantial effect on achieving to the targets.

Originality / Value - This paper represents a potential area in which DMAIC methodology along side the Lean Management can promote Supply Chain Management objectives for a food distribution SME.

Key Words – Food Distribution, Lean Management, Six Sigma, Supply Chain Management

Paper Type – Research Paper

1-Introduction

The application of any quality initiative in a service business requires the understanding and definition of service, quality perception and customer perception for quality. The latter is very controversial and one of the most difficult challenges faced by researchers. Service is defined as an activity or series of activities that are more or less intangible. Service is an elusive and abstract construct that is difficult to define or measure (Rose, et al, 1997). This fact has also been earlier supported that in relation to service processes, it is particularly necessary to consider customer satisfaction explicitly, because these requirements may be less obvious (Wood, 1994).

Quality in a food service industry is "Functional quality in perception" which means how the customer receives the quality that meets his or her expectations. This is a real problem as the quality in food service industry is unlikely to be perceived; whilst in manufacturing industries the quality is clear. Intangibility of service leads to difficulties in order to assess the received quality. There are some highlighted problems associated with identifying the customer expectations, designing services to meet customer requirements and assessing the performance of service by customer (Beardsell, et al, 1999).

Research programs through analytical approaches will potentially impact on meeting customer expectations. Implementing any research program for food service

organizations will result in quality improvement (Rodgers, 2005). Focus on customers and the increased stress of the systematic measuring of quality are two important propositions on success in quality improvement for a service company (Edvardson, 1998).

This paper intends to verify this argument by presenting insights from the adopting of DMAIC (Define, Measure, Analyze, Improve, and Control) methodology of Six Sigma and Lean practice in a food distribution SME. It has been acknowledged that many food industry SMEs are not aware of Six Sigma or they do not have the necessary financial resources for investigating the methodology (Antony, 2005). The study is part of a larger ongoing research program which aims to develop a simpler, cheaper and versatile methodology for reducing waste in SMEs through the application of six-sigma.

2-Supply Chain Management

There have been numerous statements from different expertise associated with the definition of Supply Chain Management (SCM). SCM is defined as a system whose constituent parts include suppliers, production facilities, distribution services and customers linked together via the feed forward flow of materials and the feedback flow of information (Gunasekaran, et al, 2001). SCM encompasses every effort involved in providing and delivering a final product from the supplier's supplier to the customer's customer where as warehousing, order management, distribution across all channels and delivery to the customers are among these efforts (Lummus, et al, 2001).

SCM includes the management of information systems, purchasing, customer service, sourcing, transportation, production scheduling, order processing, inventory management, warehousing and marketing. SCM is a strategic management tool used to enhance overall customer satisfaction that is intended to improve a firm's competitiveness and profitability (Lummus, et al, 2001). As such effective (SCM) has been acknowledged to be one of the most important aspect for business success including the food distribution businesses.

A food distribution firm heavily involves in procurement, order processing, customer service, inventory and warehousing. Implementing SCM practices to improve the operations in a food distribution SME is not as easy as in bigger counterparts as there may be lots of complexities and difficulties in analyzing the operational objectives (Figure 1). Implementation of SCM in SMEs differs with large enterprises due to differences in structure, knowledge, resources and technology (Vaaland, et al, 2007).
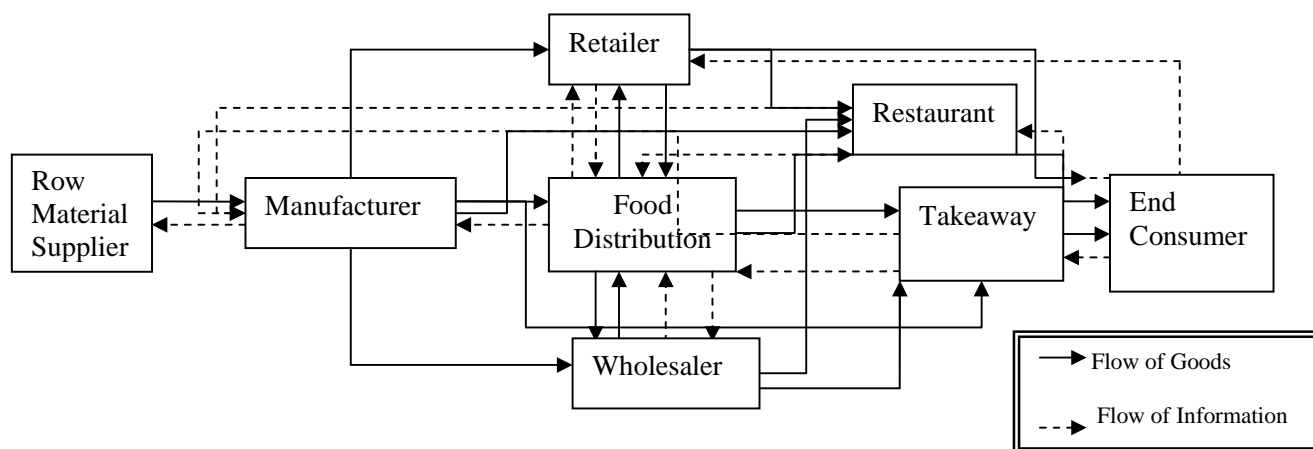
Figure 1 – Complexity of Food Supply Chain

The integration of any quality initiative with the SCM can ease the potential or actual difficulties associated with Supply Chain (SC) practices, measurement and models via using the systematic approach of these quality initiatives and embedding them with SC objectives and practices. SC quality management programs should include quality management practices with special attention paid to operational items (Lin, et al, 2004).

Customer satisfaction is one of the key objectives in SC and achieving to that level to satisfy the customer specifically in a food distribution SME is the matter of whether the customer is satisfied or delighted. Integrated SC with quality initiatives such as Six Sigma will facilitate to approach to the customer satisfaction in SC. According to the study, the company's integrated SC is better able to meet the quality expectations of the end customer, since quality management practices are implemented in coordination across the Supply Chain.(Sila, et al, 2006)

There are different practices in SC in order to be analyzed and improved as the operational items. The SC practices as approaches applied in managing integration and coordination of Supply, demand and relationships in order to satisfy customers in effective and profitable manners. Lead time management is one of the key practices of downstream SC in this case (Wong, et al, 2005).

The intention of this paper was to adopt "Lead Time in delivery performance" of a food distribution SME and minimize it through a simple systematic approach to reduce the chance of endangering the customer satisfaction and profitability of the company.

3-Lead Time

Waste reduction has been a common strategy in lean management for reducing the non-value adding stages in a process and increasing its efficiency. Whilst this approach has been applied extensively in manufacturing, it has also been effectively applied to the service sector The key problem in analysing the waste is that there is no clear overview on its size, since it is never registered by management team unless it is searched for. It has been suggested that time is the most critical performance dimension for the logistics

and distribution processes (Lamming, 1996). In fact, reducing the lead time in a distribution business not only can have tremendous results in improving operational management and reducing the cost of poor quality, but it can also have a substantial effect on customer satisfaction in delivery performance.

A competitive company must have both high quality goods and provide a high quality service by adding value to the chain. By reducing lead time and achieving faster delivery, the company's competitiveness will be enhanced (Arnheiter, et al, 2005). Within a Supply Chain context, delivery speed and reliability have become key requirements for competitive differentiation and increased profitability and these two factors will be used to measure the performance of the SC (Chan, 2002). It has been indicated that lead time, delivery time and on time delivery are all important SCM measures as their measurement will have dramatic impact on quality of SCM (Tummala, et al, 2006).

Lead time in a food distribution SME is a lean measure that could be associated with either waiting time for the loading bureaucracy, warehouse operation and delivery route conditions. Lead time minimization is a quantitative measure in which focusing on it through systematic data driven approach will potentially improve the performance of a food distribution SME. Delivery process is one of the key processes in a food distribution SME which is critical in terms of customer satisfaction.

4-Performance Measurement

Performance measurement is a key element in SC in order to improve its performance regardless of the type of the business. Performance Measurement is a process of data gathering, information exchange, measurement and analysis of the data to establish the Key Performance Indicators (KPIs). Developing specific work plans to transform the strategic plans in SC in to a tactical plan that will help achieve the departmental goals (Parr, et al, 2004). This is directly referred to having a systematic performance measurement policy to understand where the company or department is and where and how it wants to get to where it is going.

There have been different ways of measuring the performance including benchmarking and interview. It has been argued that a systematic performance measurement approach will help for better decision making through the identification of threats and opportunities (see for example F T S.Chan et al (2003) , P Samaranayake (2005))

The element of "Time" is an important resource in modern business environment in terms of customer satisfaction (Chan, et al, 2003). Hence, in order to understand the SC operation, it is necessary to measure the activity time. It has earlier been stated that the emphasis is on performance measures dealing with suppliers, delivery performance, customer service, inventory, logistics costs and customer satisfaction in a SC (Gunasekaran, et al, 2001).

In terms of the food service, the practicality of measuring the performance of a food service through systematic approaches to consider their service product in the customer's term to minimize the risk of customer dissatisfaction as the moment of truth (Johns, et al, 1998).

Therefore, the adoption of a continuing, simple, reliable and rigours performance measurement system linked to the business strategy is a key factor for successfully measuring the performance of delivery lead time in a food distribution SME.

5-Six Sigma and Lean

Six Sigma is a project, data and technology driven quality management tool and acts as a business improvement strategy in order to improve the business competitiveness through reducing the defects and improving customer – oriented quality. In fact, Six Sigma has two different dimensions including the business and technical approach in which the technical aspect as a systematic tool facilitates the company to improve the business profitability and this allows the company to set the continuous systematic strategy. It has been defined as:

"a disciplined method of using rigorous data gathering and statistical analysis to pinpoint sources of errors and ways of eliminating them". (Klefsjo, et al, 2001).

In a modern version of Six Sigma, quality along with service, availability, delivery fulfillment and marketing should be considered. It is important when attempting to integrate Six Sigma into SC.

Six Sigma is a process focused program and aims to improve the process through systematic methodology. SCM is also focused on processes within SC. It has been argued that the integration of Six Sigma with other comprehensive quality standards is practical and could provide the best outcomes. (Raisinghani, et al, 2005).

This has later been supported through the daily Six Sigma work in Samsung that Six Sigma and SCM would be two pillars of business improvement at Samsung. He also emphasized that nature of SCM and Six Sigma is the same where as process redesign or improvement is involved in both (Yang, et al, 2007).

Six Sigma has a collaborative interaction with SC as Balanced Score Card is a top requirement for both to define the customer requirements and both focus on process based business improvement. Benefits of Six Sigma in SC are including the project discipline, sustaining results, human resource development and quantitative strength (Yang, et al, 2007). So that it could be a good idea to use Six Sigma in SC projects in order to improve the SC metrics.

In respect to the Six Sigma implementation in service processes, the idea of using the tool in service processes such as transportation and distribution. He also indicated that reducing the lead time and providing faster delivery as two customer value goals are considered when selecting a Six Sigma project (Antony, 2006). This supports the idea of using Six Sigma methodology to reduce delivery lead time for a food distribution SME.

However it has been argued that the Six Sigma methodology may not always be successful in a food service SME. (McAdam et al, 2004). A simplified version of Six Sigma methodology along side its conceptual principles is suggested for this type of

business. It has been recommended that deeper understanding of the concept and undertaking the most cost – effective approach of methodology in terms of training and tools must be a primary focus in a service SME (Thomas, et al, 2006). The idea of using simplified Six Sigma where appropriate such as in a food service SME through basic training, simple tools and laser focusing in projects and methodology stages ha been unanimously supported by the academics. (Arthur, 2004, Antony, 2005, Mortimor, 2006)

Lean Six Sigma for the services is a better approach as business improvement methodology in reducing the lead time. It maximizes the shareholder value by achieving the fastest rate of improvement in customer satisfaction. Figure 2 illustrates the benefits of lean Six Sigma.

The role of lean in SC through two lean characteristics of eliminating the waste and striving for perfection has been earlier emphasized (Cox, 1999). These two characteristics can also be considered as Six Sigma features. In other hand using simplified lean Six Sigma can promote eliminating the weaknesses of each concept especially when is applied in a food service SME.

Hence, this is acknowledged that using simplified version of Six Sigma methodology and in-house training embedded to a lean practice will be applicable and appropriate for a food distribution SME to manoeuvre in SC objectives such as reducing delivery lead time.

Figure 2 – Lean Six Sigma, Lean and ix Sigma (Source: E D. Arnheiter, 2005) (14)
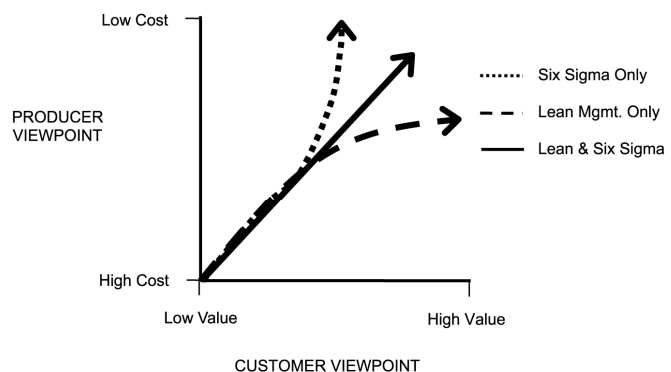
6-DMAIC

Applying a step-by-step process based road map is a key success factor in implementing any Six Sigma project regardless of the size or type of the business. Initially, it has stated that the major contribution of a process based methodology is to provide a simple and robust mathematical model to calculate a performance index of a performance measure in a SC network to deal with both tangible and intangible performance measures (Chan, et al, 2003).

DMAIC (Define, Measure, Analyze, Improve, Control) methodology is the most common structured problem solving road map in Six Sigma which guides the improvement process through laser focusing and helps detect the root causes of the failure in any process. Table I represents the characteristics of each stage in DMAIC.

Six Sigma Steps	Key Processes
Define	Define the requirements and expectations of the customer
	Define the project boundaries
	Define the process by mapping the business flow
Measure	Measure the process to satisfy customer's needs
	Develop a data collection plan
	Collect and compare data to determine issues and shortfalls
Analyse	Analyze the causes of defects and sources of variation
	Determine the variations in the process
	Prioritize opportunities for future improvement
Improve	Improve the process to eliminate variations
	Develop creative alternatives and implement enhanced plan
Control	Control process variations to meet customer requirements
	Develop a strategy to monitor and control the improved process
	Implement the improvements of systems and structures

Table I- Key Steps of Six Sigma, Y H Kwak, et al (2006) (31)

DMAIC could be one of the best methodologies to be applied for process improvement in a food distribution SME, while it is flexible in terms of utilizing tools and techniques. Accordingly, the simple tools in each stage of methodology which are easy to use and do not need the high level of training are the most appropriate tools that can be adopted for a service process in any SME such as food distribution where the training facilities and resources are limited. It has been confirmed that some simple tools could be used in a service SME and they are not limited for any specific stage of DMAIC (Antony, 2006).

The following case study is on a UK based food distribution company and is part of an ongoing research program which has been conducted and demonstrates a review of the application of DMAIC methodology in delivery process to reduce lead time.

7-Background

The company in this case study was a food distribution SME in the north east of England with a £ 5.5m turnover This company's activities included: receiving and processing the orders, invoicing, storage, loading and delivering products to the food outlets. The company's products were distinguished in chilled, frozen and dry. The latter accounted for nearly 60% of the products.
During this study, the warehouse has been relocated to a new and bigger depot.

The company experienced problems with its delivery process. It received numerous different complaints from dissatisfied customers which accounted for a potential annual £ 100,000 customer loss.

In an attempt to reduce the number of complaints, the company decided to employ the DMAIC methodology.

The quality manager who acted as project manager for this study had a fare amount of knowledge, experience and skill in Six Sigma concepts tools and techniques and also project management comparable with Green Belt to start the project. The quality manager selected a very small team and trained them in team working, data collection and data analyses as a generic approach.

8-Methodology

The project structure has been organised by assigning different people in different jobs. The scope of the project was to reduce the number of complaints in the delivery process. The first step in this stage was to conduct a SIPOC diagram in order to identify the real and potential internal or external customers, their requirements for the delivery process as well as inputs and outputs of the process. SIPOC is a high level process map that includes the suppliers, inputs, process, output and customers as illustrated in Figure 3. Quality is judged based on the output of a process and is improved by analysing inputs and process variables

Suppliers	Inputs	**Process**	Outputs	Customers	Requirements
• Shop Floor Employees	• Loaded Van		• Delivered Goods	• Takeaways	• Right Product
• Warehouse Manager	• Goods in the Van		• Finalized paper work	• Restaurants	• Right time
	• Driving		• Payments	• Wholesalers	• Right quality
	• Van offloading		• Signed, marked and checked copy of invoices	• Office Employees	• Right quantity
	• Driver		• Time of delivery	• Credit Department	• Right payment
			• Quality of goods		• Meet the company Rules

Take the Invoices & Paper work from office → Drive off the Depot → Get to the shop → Offload the items → Finalize paper work and payment → Drive off the property → Take the Van back to the home
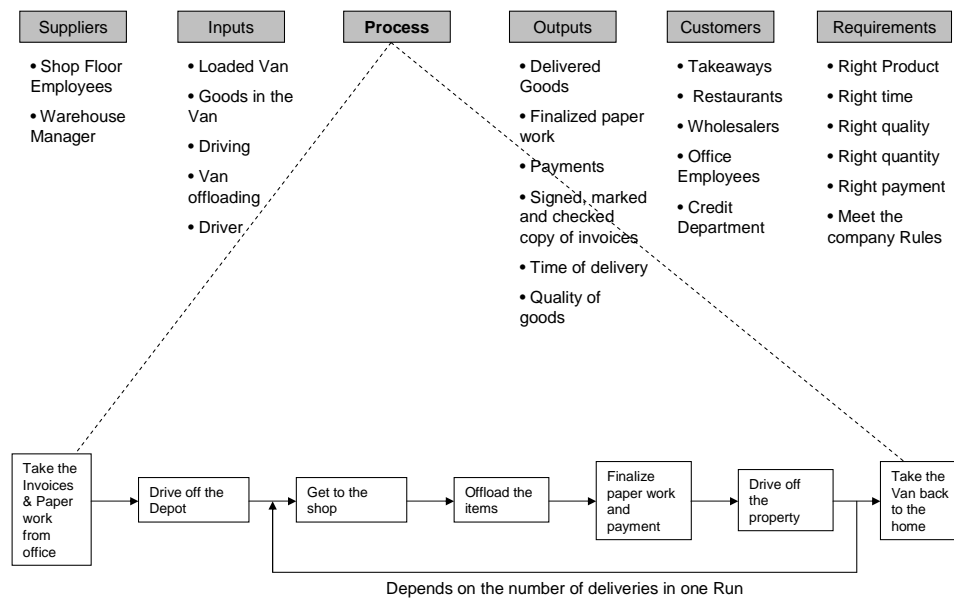
Depends on the number of deliveries in one Run

Figure 3 – SIPOC Diagram of Delivery Process

The team consisted of telesales and customer service team members who collected the customer's statements in order to identify the Voice of the Customer (VOC). VOC is an assessing process to service or product quality. VOC provides information that demonstrates to SC stakeholders how better product and service quality management can improve the performance of the whole chain (Mowat, et al, 2001). The failure to understand the words coming from the customer leads to the failure in whole program, particularly in a food business where the customer's perception in quality is ambiguous. The Balanced Score Card has been produced to categorize the customer's vision.

The complaint database was then analyzed using Pareto Chart in order to identify the most important delivery related problems. Figure 4 indicates that 50% of total delivery related complaints for a period of four months was associated with the Late Delivery. Therefore, the team confirmed that Late Delivery is the most important problem in delivery process.
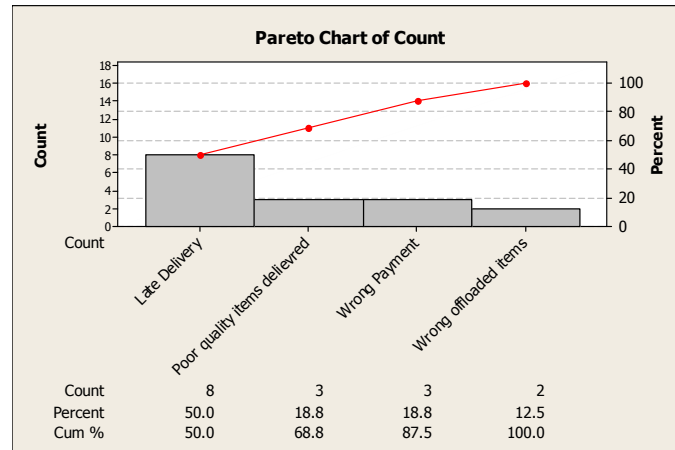
Figure 4 – Pareto Chart to select the focused problem

In the measuring stage, the existing process was mapped and measured. The late delivery to the shops was nominated as the Critical to Quality variable (CTQ-Y). Therefore, the defect was the late delivery. The data collection involved the identification of the key measures and the sources to collect the data. Driver delivery sheets, productivity data base and error data base in which the mistakes or complaints in each process were entered were the key sources of the data in this stage. The data was collected on a weekly base. The tools used in this stage included the Pareto Chart, Histogram and Process Sigma Level. The data for the number of total runs for each route were collected for a period of four weeks and the number of late deliveries for each route (Delivery time > average + 10%) was calculated.

The error database which had been produced through the customer complaint database was analysed to work out the key variables influencing the late delivery in different runs.. (Figure 5)
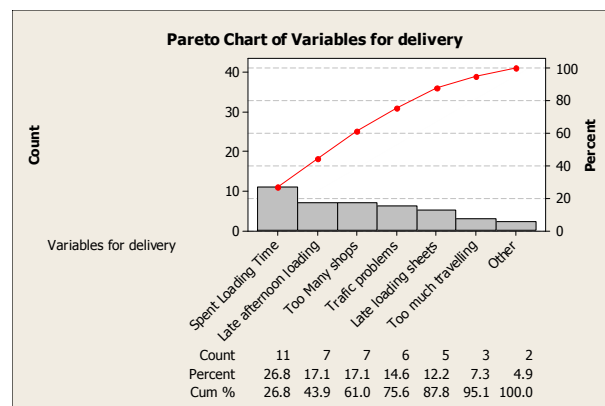

Figure 5 – Pareto Chart on the variables

Figure 5 illustrates that the variable "spent loading time in the warehouse" has the highest level of variables referring to the customer complaint database. This was required to be verified in further steps. The team decided to reduce as much as possible the number of causes for the defects.

In the Analyse stage the team calculated the gap between the actual data and the target value for each 11 specific route.

The scatter plot in Figure 6 indicates that the gap for almost all of the routes is quite the same apart from one route. Therefore, this eliminates the possibility of the effect of any specific route as the uncontrolled variables in reducing the defect, since the complaints are all scattered within different routes and are not limited to that specific route.

$$y = -0.0318x + 3.9182$$
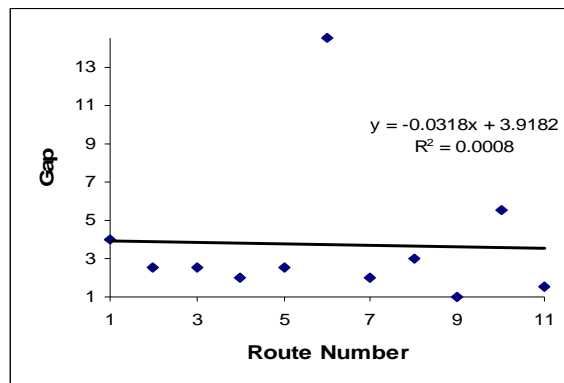$$R^2 = 0.0008$$

Figure 6- Scatter Plot on effect of run on the defect

The error dependency analysis as an Excel based calculation was carried out to verify the result of the Pareto analysis (figure 5) through brainstorming in this stage. The error dependency score (table 2) was calculated by designing a table in Excel Spreadsheet. This contained the routes as rows, the possible sources of the defects as columns and the number of defects for each route as another column. The Sum of the total number of relations of each enabling possible source was calculated and multiplied by the total number of defects for each related route to deliver the dependency score. Then, each source was weighed relying on the dependency score. The three major causes with a score of more than 400 were weighed as 9. The weight of three indicates the scores between 200 and 400 and the weight of one represents the scores less than 200. The result was the same as the result of Pareto Chart (Figure 5) indicating the spent loading time as the most important cause of the defect.

Delivery Route	Route No	Defect	Possible Sources						
			Late Loading Sheet	Late afternoon Loading	Loading Time	Too Much Distance	Too much Travelling	Too many Shops	Traffic Problems
Billingham	1	8		*	*			*	*
Bishop Aukland	2	5	*	*	*		*	*	
Darlington	3	5		*	*			*	*
Distance	4	4	*		*	*	*		*
Hartlepool	5	5		*	*			*	*
Middlesbrough	6	29	*	*	*			*	*
Northallerton	7	4			*		*		
Peterlee	8	6			*				
Redcar	9	2	*	*	*			*	
Stockton	10	11	*	*	*			*	
Sunderland	11	3			*	*			*
Error Dependancy (Sum of Defect* Total)			255	455	902	88	39	455	324
Weight			3	9	9	1	1	9	3

Table II – Error dependency table with the scores and weights

The possible sources (Xs) with the weight of 9 which had already been introduced by the figure 5 and table 3 were selected to be further analyzed through Cause & Effect XY Matrix (Figure 7) as the variables (CTQ-Y) to identify the possible sources of these three elements reflecting the idea of narrowing the causes.

Output Variables (Y's)	Late afternoon Loading	Spent Loading Time	Too Many Shops at route	
Importance Score (1 - 10)	6	9	3	
Input/Process Variables (X's)	Table of Association Scores (X's to Y's)			Weighted Score
Bad Loading Planning	9	3	0	81
Bad Route Planning	3	3	9	72
Warehouse Layout	9	9	1	138
Staff Shortage	9	9	3	144
Late Morning Start	9	0	3	63
Number of Shops at each Run	1	9	9	114
Loading Method	9	9	3	144
Van Discrepancy	3	3	9	72
Late Depot leaving	0	0	3	9
Lack of Internal Communication	9	9	3	144
Warehouse Space	3	9	0	99
Goods In Delivery Distraction	9	9	0	135
Tonnage of Orders	3	9	3	108
Specific Occasions	9	9	9	162

Figure 7- Cause & Effect XY Matrix

As it is shown in figure 7, the list of potential causes for the three major variables has been generated to indicate the most critical causes of the variables.

The variables and their potential causes (Xs) have been entered in the Cause & Effect XY Matrix. The importance score for each variable quantifies how important the variable is to the customer. The association/Effect scores for each X for the variables have been entered after brainstorming in which the most associated x with the variable gets scored as 9 and then 3, 1 and with no relationship scored 0. The six most weighted score causes (Xs) which have been directly affecting the "Late Spent Loading Time" have been selected as the key sources for the defect to be focused in further stages. These six sources could be the potential causes for the three variables which have already been selected as the CTQ-Y for the delivery time. However, the selective causes must be more focused to introduce the appropriate solutions in improvement and implementation stage. These six key causes included:

Poor Warehouse Layout
Staff Shortage
Poor Picking & Loading method
Lack of internal communication
Goods in Delivery distraction
Failure in Specific Days

Having identified the root causes of the problem, possible solutions were brainstormed with the Telesales team, management team and external customers to generate the best possible solutions. It was decided that the solutions must be focused on internal solutions such as

sending the van earlier, which was directly affected by the loading procedure. Focusing on other areas required complicated flow of information and strong customer development which was not practical at the time.

The affinity diagram was conducted to categorize the solutions and was analyzed to prioritize the solutions. The categories in this stage were the "Layout Utilization", "Resource allocation", "Operation management" and "Route Scheduling".

Following intensive brainstorming with the warehouse manager, drivers, and management team for the different categories of the solutions, the "layout utilization" was selected as the best category to be focused, since it involved less risk and more consistency which it was associated with.

Therefore, the layout utilization not only is the most valuable solution to reduce the causes of the defect in this stage, but it is a requirement for applying other bunch of solutions. We can understand that how the layout utilization is important for the implementation stage of DMAIC in this specific project. It is also clear that shifting the operation to the new depot with its resources and space will require an appropriate layout utilization to transfer this value down the line. There fore, this solution will either directly or indirectly have great impact on the efficiency in the delivery process and reducing the CTQ-Y (Late delivery time). It had already been suggested that improving the loading process and layout utilization will potentially reduce the delivery time and has been prioritized as the solution since the other solutions were either dependent to this or were not practical due to difficulties in resources, budget and complexity. Figure 8 represents the category of layout utilization containing the list of possible solutions.

> **Layout Utilization**
> -Picking area for fast going items (A1)
> - Racking system for dry goods (A2)
> - Two doors operation (A3)
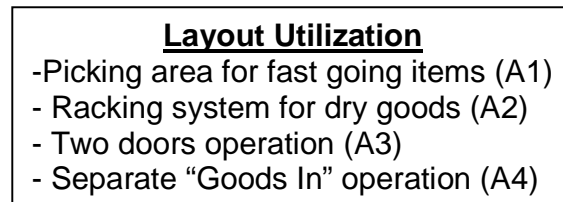> - Separate "Goods In" operation (A4)

Figure 8- Category of Layout Utilization and its containing as the best solution category

Then, analytical Hierarch process matrix has been set where the number in the I_{th} row and J_{th} column gives the relative importance of O_i as compared with O_j. The 1-9 scale has been used to indicate the importance comparison of two solutions as shown in figure 9.

Figure 9 – AHP on selecting the most optimum solution

As figure 9 indicates, after analyzing the relationship between solutions through brainstorming and prioritization, the "Picking area for fast going items near the loading bay (A1) had the highest value in the "W" matrix and is the most optimum solution to minimize the travelling time and consequently spent loading time as the root cause of the problem.

9-Implementation:

The implementation plan was carried out in two different stages. The first was process redesign in which the picking area for the fast going items was designed. This led to second stage which was "Early leaving of the vans" as the "Poka - Yoke" or mistake proofing to minimize the chance of late delivery. Therefore, the whole implementation is the "Process Management" for the delivery process which has happened through "Process Re-design" in previous process (Loading). The optimum solution was discussed with the relevant people and it was decided to implement it in the new depot as figure 10 shows. .
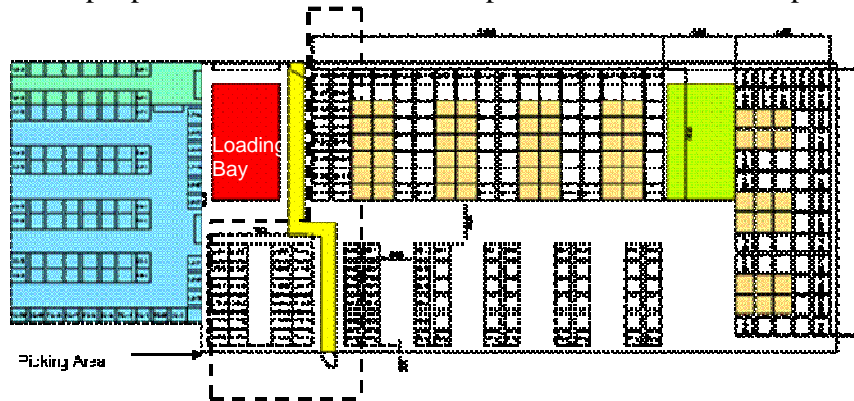

Figure 10- Design of Picking area in the warehouse

Prior to implementing the "Picking Area" in the new depot, the team decided to collect the data by observing the loading time spent for each loading/route for the period of five weeks in the existing depot.

Then the data from another source called the loading time data base containing the quantity of deliveries in each run, the total weight, the number of staff loading the vans and the total time spent to load the van was collected for a period of five weeks in order to calculate the average loading time. Then the runs with the loading time more than average plus 10% tolerance were summed to identify where the company is with regards to this matter.

The number of defects was 168 loading/route out of 321 opportunities (Total loading/route) in five weeks time representing the 34 defects/week and 1.44 Sigma level. A loading index value was also been calculated as shown below:

$$L_i = T / Q * W * E$$

Where the "T" is the average spent loading time for all routes, "Q" is the quantity of deliveries in each route, "W" is the tonnage of each route and "E" is the number of employees involved in loading the van indicating that the less the Li, the better

performance. Li for the existing process and layout was calculated as 1.97. Minimising this index value was the target of the team. The Q, W and E values are not changing in big ranges among different routes and therefore they will not be determining value. T value would be the determining value for this index.

There was not a great deal of cost to allocate the picking area, since the management team decided to facilitate the new depot and buy the racking system. The total cost for the dry goods racking which half of that has been used for the picking area was £ 6,000. In fact, the biggest cost contribution of this project was £6,000. The picking area has been designed near the loading bay where the vans are loaded in order to shorten the distance between the fast going items and the van and consequently the travelling time as a Muda in lean thinking. This implementation has been piloted for five weeks to collect the new data and verify it.

The picking area has been planned and drawn near the loading bay and the staff have been trained to apply the "Trolley Picking" practice in which each staff takes one loading sheet which contains the required items and within a very short space the staff collect the items in dry and

Frozen picking area and leave the trolleys in the waiting area near the loading bay to be checked (Figure 11 and 12).

Picking area for dry goods

Figure 11 – Specific designed Picking area for the fast going items (Palletised & Racked)

Waiting area near the picking area and loading bay

Figure 12 – Picking area near the loading bay and the waiting area for the trolley

10-Results and Discussion:

There are different variety of tools and technologies within the different stages of DMAIC methodology and their application depends on the process, resources and the people in the team. Table III indicates the tools and technologies that have been adopted during this study in each stage of DMAIC.

Stage	Tools & Technologies
Define	Balance Score Card, Project Charter, SIPOC Diagram, Interview, Data Collection, Pareto Chart, Affinity Diagram
Measure	Data Collection, Brainstorming, Histogram, Process Map, Process Sigma Calculation
Analyse	X-Y Cause & Effect Analysis, FMEA Analysis, Scatter Plot, Pareto Chart, Brainstorming
Improve	Brainstorming, Affinity Diagram, Analytical Hierarch Process(AHP), Process Map, Implementation Plan
Control	Monitoring Chart, Process Sigma Calculation, Data Collection

Table III – The applied Tools & Technologies of DMAIC in this study

Having implemented the five weeks pilot scheme in adopting the "Picking Area" near the loading bay, the data collected in the period of five weeks showed the number of defects to be 80 loading / route out of 287 opportunities representing the 20 defects/ week and 2.09 Sigma level. The average loading index value was also calculated as 1.13. The calculation determines that the number of defects was reduced from 34 to 20 per week. The Sigma level jumped from 1.44 to 2.09 which in such a process is a huge jump and the Li index was also reduced from 1.97 to 1.13 indicating that the spent loading time was reduced through implementing the "Picking Area".

The verification analysis for the spent loading time before and after implementing "Picking Area" was carried out through "Paired t – Test" in 95% CI indicating the t-value as 0.041 which is less than 0.05.

This will reject the H_0 and confirms that there is a difference between two sets of data. There fore, the "Picking Area" will be a verified solution to reduce the spent loading time as a key root cause of the delivery lead time.

Having implemented this strategy, the number of customer complaints associated with the late delivery has been reduced by 60% resulted in 30% reduction in total number of delivery related customer complaints and reflecting nearly £ 30,000 potential benefits for the company which is substantial figure for a SME with £5.5m yearly turnover. Table IV represents the actual benefits of this case study to the industry.

	Before Improvement	After Improvement
Defect/Week	34	20
Loading Index Value	1.13	1.97
Sigma Level	1.44	2.09
Financial Benefit/Anum	-£100,000	£30,000

Table IV – Actual benefits of the program to the industry

These results have been discussed within the different teams and it has been supported by the top management team, warehouse manager's and the shop floor staff's statement as an effective solution to reduce the spent loading time.

Management commitment and involvement in this project was clearly obvious due to the transparency in communication and management briefing by the project manager and discussing the potential benefits of the project in the whole operation and profitability within the company by the top management team. It was decided by the company to implement this solution as a business strategy to reduce the defect and improve the customer satisfaction.

It has been identified that simplified systematic and data driven analysis of the problems through laser focusing on the key complaints in a food distribution SME can have dramatic impact on the total number of customer complaints, since the number of data is low and the quality perception is totally customer driven. It has also been a good internal response and improved job satisfaction with the shop floor employees, since there was a better flow of goods through a lean based streaming of the picking and loading practices which resulted in an easier job for the staff. There fore, the SC operation has been improved through a lean and Six Sigma DMAIC practice followed by reducing the lead time and improving the internal flow of goods in the warehouse.

The responsible team has established the procedure and assigned different individuals to regularly monitor the data addressing the spent loading time and the number of delivery related complaints reflecting the effectiveness of the business strategy on the whole objective of Supply Chain Management. The control charts have no means in this process as the company is in the service industry and there is no variable on means. In fact, the extreme side of the normal distribution process are the targets of the projects to satisfy the customer. There fore, the control chart has been replaced by the monitoring chart and the recorded data with regular analysis to ensure that the operation is under control.

11-Conclusion:

DMAIC methodology and the Six Sigma concept along side the lean practises will be the beneficial approaches to reduce or eliminate defects in a food distribution SME, if they are simplified and laser focused through using the simple tools and identifying the most critical issue in each process. Using DMAIC with integration from lean thinking has proven to be a successful practice in improving Supply Chain objectives in a food distribution SME through reducing the lead time as lean waste and a quality defect to improve customer satisfaction. The root cause of the defect was identified in loading process in which a modification in layout utilization (Designing "Picking Area" near the loading bay for the fast going item) as a process redesign resulted in reducing the travelling time and spent loading time and consequently delivery lead time as the defect in next process. This addressed a dramatic effect on improving customer satisfaction for the business.

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