Emerald Journal of Manufacturing Technology Management

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Journal:	*Journal of Manufacturing Technology Management*
Manuscript ID:	JMTM-12-2012-0114.R3
Manuscript Type:	Article
Keywords:	Six Sigma, Logistics management, Small and Medium Sized Enterprises, Supply chain management, Food Service, Quality management

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Abstract

Purpose – The purpose of the paper is to investigate the implementation of the Six Sigma methodology as a systematic business strategy and quality initiative to improve the critical logistical measures within small-to-medium sized food distributers.

Design/methodology/approach –The first stage was the conducting of structured questionnaires to verify the applicability in terms of capability, resources and culture in the targeted industry. The second stage was the implementation of two industrial case studies to investigate the impacts of Six Sigma on logistical measures.

Finding – It was found that Six Sigma is applicable and beneficial in small – to – medium sized food distributers. It was also found that required training, personal characteristics of managers, size of the organisation, education level and workplace of the employees are the most effective elements to adopt Six Sigma for these organisations.

Research limitations/implications – Cultural factors including high level of secrecy in information exchange, ambiguity and lack of knowledge, sampling population and requirement of ISO9000 were found as key issues in implications of this research programme.

Practical implications – Six Sigma programme can be used as a problem solving practice, a performance measurement tool and a business strategy in small food distributers through more simplified approach to improve the ultimate food supply chain.

Originality/value – This research article studies the application of Six Sigma in food logistics SME sector by having integrated research approach, and also provides a practical scientific and rigorous quality and profitability improvement methodology for smaller food distribution organisations with limited resources.

Keywords: Six Sigma, Logistics, food distribution, SME, supply chain management, food service

Article Classification: Research Paper

1- Introduction

As the food industry becomes increasingly global and expands to meet the demands of a growing world population, so does the increasing need for competitiveness within and between food supply chains with growing consumer driven value (Zokaei and Hines, 2007). The global food supply chains and logistics network of today are particularly fragile and complex and may be easily subject to risk of poor quality, higher cost, and increased lead time due to complex network of different entities (Dani and Deep, 2010). With globalisation and expansion, consolidation also often follows and as a result, the small-players within the food sector, that characteristically deal with logistics and distribution, face increasing competition and will need to continually improve to survive. This is exacerbated by the fact

that like many other sectors, the food sector is dominated by a large proportion of the market being supplied through a large number of small to medium sized enterprises (SMEs), defined for the purposes of this study using the UK definition as any organisation with less than 250 employees (European Commission, 2003 and Department of Trade and Industry DTI, 2005 cited in Kumar et al., 2009). It is vital then that SMEs are able to distinguish themselves from their competitors through aspiration for quality, customisation and continuous improvement. However, this remains a challenge since many SMEs run on very tight margins, with low staff resources and see quality and performance management as a luxury rather than necessity. This made less research interest in this area and especially related to the food distribution SME sector. The motivation behind this research study is thus to examine how SMEs in the food distribution sector might be able to adopt an appropriate quality and business improvement initiative throughout its integrated functions of purchasing, transportation and storage which extends to assuring effective customer service, total cost efficiency, competitive advantage and ultimately enhanced organisational performance (Mentzer et al., 2008).

Specifically, the key purpose of this research is to evaluate the capability, key success factors and benefits of the use of Six Sigma in food distribution SMEs. Distribution is part of the logistics and there are number of logistics measures and objectives (Wilding and Jurialdo, 2004; Nabhani and Shokri, 2009) in the literature that could be directly referred to the distribution. The Six Sigma programme was selected as the systematic quality initiative to be studied for this purpose since it is recognised as a standard for improving customer satisfaction and profitability (Burton, 2006) and is also promoted in the literature as an accessible and workable quality management approach compared to other initiatives such as Lean and ISO9000 within SMEs (Antony et al, 2005). This comparison between Six Sigma with lean and ISO9000 was selected for this article, since lean and ISO9000 are the most common quality related practices in SMEs due to their simplicity and minimum cost (Antony et al, 2005). It means that SMEs with limited time, budget and employee resources would rather to use quality improvement initiatives with less required capital investment and easier to understand and apply. However, there is a lack of evidence of the application of Six Sigma, particularly within food distribution and logistics SMEs so this research study aims to fill this knowledge gap by evaluating the organisational capability of food distribution SMEs to implement Six Sigma, to assess the key success factors of its implementation and to justify the use of Six Sigma over other quality management frameworks. In so doing, the paper also

identifies the most critical logistical pinch-points in food distribution SMEs and reviews the practical benefits of using Six Sigma in food distribution SMEs.

2- Background Literature

The growing interest of Six Sigma as an ever-increasing integration of quality and business strategy is acknowledged by researchers (Griggs and Walls, 2007; McAdam and Lafferty, 2004) in that the competitive nature of supply chains demands quality and perfection in both production and service. The increase of the scope of the Six Sigma literature is reflected in studies covering service sectors (Delgado et al, 2010; McAdam and Hazlett, 2010), business functions and SMEs (McAdam and Hazlett, 2010). Six Sigma is recognised as a means of managing global competitiveness to pursue continuous improvement (Kumar et al., 2008) and is described by Johannsen and Leist (2009) both as a top-down strategic improvement programme and as a set of quality tools or techniques. It is also described as a business excellence strategy (Antony et al., 2007) and as being a customer-driven (Nakhaie and Neves, 2009; De-Koning and De-Mast, 2006), a project-driven (Assarlan et al, 2012; Kwak and Anbari, 2006) or a business-driven (Savolainen and Haikonen, 2007) methodology, which focusses on decision-making based on quantitative data (De-Koning and De-Mast, 2006) and statistical and non-statistical tools (Manville et al, 2012), to lead towards improving the organisation's product, process and service (Savolainen and Haikonen, 2007), financial performance (Nakhaie and Neves, 2009) or general business strategy (Savolainen and Haikonen, 2007). This significant relationship between a customer – focused practice with supply chain capability and financial improvement was acknowledged by research studies (Lado et al, 2011).

The statistical basis of Six Sigma is defined by convention as ensuring less than 3.4 DPMO (defect per million opportunities) or a success rate of 99.99997 percent (isixsigma, 2009), where the term sigma is used to represent the variation around the process average. Six Sigma thus focuses on variation and defect reduction (Kumar et al., 2009; Kumar et al., 2008; Burton, 2006; Anderson et al., 2006; Naslund, 2008; McAdam and Lafferty, 2004; Raisinghani et al., 2005; Biolos, 2003; Haikonen, 2004), but is also cited in the literature as contributing to process improvement (McAdam and Lafferty, 2004; Lee-Mortimer, 2006; Anbari and Kwak, 2004; Haikonen et al., 2004; Buck and Tolentino, 2006), customer satisfaction (Thomas and Barton, 2006;Kumar et al., 2008; Behara et al., 1995; Anbari and Kwak, 2004), cultural change (Raisinghani et al, 2005), quality improvement (Wessel and

Burcher, 2004) and financial enhancement (Thomas and Barton, 2006; Kumar et al., 2008; Anbari and Kwak, 2004). The Six Sigma methodology can also reduce the complexity of other supply chain performance measurement systems such as Supply Chain Operation Reference (SCOR) Model, which was recommended by the literature (Barber, 2008). As a top-down approach (Klefsjo et al, 2001) and its acquisition and transformation perspectives (McAdam and Hazlett, 2010), business transformation may be required to promote Six Sigma (Al-Mishari and Suliman, 2008) and the approach is also heavily dependent on the collation and availability of factual and disciplined benchmarking and performance measurement information, training and education, top management commitment and leadership (Suresh et al, 2012; Kumar et al, 2011; and Hilton and Sohal, 2012) but the rewards are as developed learning capabilities within managers and employees (Manville et al, 2012), increased customer satisfaction, reduced operation cost, increased revenue and improved processes (Kumar et al., 2008; Andersson et al., 2006; Miguel and Anderieta, 2009; Antony and Desai, 2009; Kumar et al, 2006; Antony et al, 2005; Thomas, 2006) although it is recognised as being potentially time consuming and complex (Chakrabarty and Chuan, 2009; Bendell, 2006) and the cost of training and infrastructure can create limitations (Antony, 2006). It was indicated that effective application of Six Sigma can help firms choose their competitive positioning such as focusing on internal efficiencies or differentiation strategies (Malik and Blumenfled, 2012).

Within SMEs, limitations to apply Six Sigma may be particularly acute but aside from work by Kumar et al. (2009), Antony (2008), Kumar and Antony (2008) and Kumar et al (2011) who identified that the prime objectives of SMEs were quality, cost and profitability and that these could be improved through the application of a Six Sigma programme, there has been little other empirical work done. It has been suggested through an implementation framework that Six Sigma is highly applicable in any SME without any need for intensive training and team building (Kaushik et al, 2012; Kumar et al, 2011, Thomas and Barton, 2006; Nabhnai and Shokri, 2009) and there are some examples of case studies using Six Sigma to improve the food supply chain (Thomas and Barton, 2006, Nguyen et al, 2004; Trinekens and Zuurbier, 2008) where it is mooted that Six Sigma can change food safety and quality culture from “End-of-Line” inspection to a new “quality assured process”, where both quality and safety of the food is improved through process improvement (Trinekens and Zuurbier, 2008).

It is important, however, to justify the application of Six Sigma in comparison with Lean and ISO9000 as two most common quality practices in SMEs to improve logistical or supply chain measures. The notion of 'Lean' was introduced primarily as a waste and cost reduction tool, which strives for competitiveness and value-adding (Naslund, 2008 And Thomas, 2009) internally and in global SC context (Mollenkropf et al, 2010). Lean principles are in close relationship with other quality initiatives since they have been incorporated as a target – setting quality based scheme in some food supply chains (Hines et al, 2006). Indeed, both Lean and Six Sigma were introduced as a repackaging of the Total Quality Management (TQM) philosophy (Naslund, 2008). Both share very similar key success factors (KSFs), but the key difference is the systematic breakthrough methodology of Six Sigma, which results in both financial enhancement and process improvement (Naslund, 2008, Kumar et al, 2006 and Thomas, 2009). In fact, Six Sigma aims for discovering and immediate systematic break though projects, whilst Lean is about taking the fast and smooth continuous incremental improvement (Assarlind et al, 2012).

Conversely, ISO9000 is a quality management system containing a series of quality assurance standards that have been developed by the International Organisation for Standardisation in Geneva, Switzerland (Pina and Selles, 2008) and was introduced by an organisation to promote the importance of quality as a fundamental business management strategy. ISO9000 was also established as a series of International Standards that identify the minimum activities that a company must have in place in order to control quality (Han et al, 2007; Kumar and Antony, 2008). The major criticism against ISO9000 is its inability to guarantee quality as a commercial advantage (Pina and Selles, 2008, and Kumar and Antony, 2008) and as the result of an empirical analysis between Six Sigma, Lean and ISO9000 for different manufacturing SMEs, Six Sigma was introduced as the most appropriate tool to improve the supply chain measures (Kumar and Antony, 2008). This article can be seen as an extension of Kumar's and Antony's work in 2008 as a more tailored approach and for food distribution SMEs in order to investigate its application and practical benefits. The practical benefits of the Six Sigma methodology of DMAIC (Define, Measure, Analysis, Improve, Control) to the logistics and distribution operation as the most common problem solving methodology of Six Sigma (Nakhai and Neves, 2009) and also an appropriate methodology to achieve highest level of process capability (Tannock et al, 2007) will also be considered as the part of justification to implement Six Sigma.

3- Research Background and methodology

In the food supply chain, food distribution is a crucial part of the overall logistical operations for products that may have a very short shelf life and require fast moving supply channels. Minimising 'defects' and minimising waste is thus a crucial element in this part of the chain and it is recognised as one of the most important processes within a food supply chain, since it can directly affect the whole supply chain's performance in terms of quality, cost, flexibility, dependability and speed (Ahmad et al, 2005). In the light of this, it is important to know whether the application and use of Six Sigma in a food distribution SME can help improve performance in this particular sector.

Food distribution businesses are highly involved in both logistics functions and dimensions at both a strategic and operational level in an intensive supply chain where key business strategy priorities typically include customer service, inventory management, operation cost and maintaining product quality. Within such businesses there are usually three different service functions: ordering processes, warehousing processes and delivery processes. Against this, organisations need to provide the best possible service with high quality to distinguish the business as a fully customised organisation. According to Cuthbertson and Piotrowicz (2008), from a study of food logistics Balanced Score Cards (BSC), the key logistical measures of such businesses can be classified as either process or functional based. It was suggested by them that most of these measures have customer or organisational perspective, which could be approached by Six Sigma methodology. But, there was no specific indication of how and for which measures this could be happening. The key research question of this research is to investigate whether the Six Sigma is applicable and beneficial for food distribution SMEs to fill the existing knowledge gap of implementing Six Sigma in food distribution SMEs in a practical and effective manner. Therefore, the objectives of this research article are presented as:

(i) To investigate the organisational capability of food distribution SMEs to implement Six Sigma;

(ii) To investigate the senior management commitment and/or employee resistance to change driven by Six Sigma;

(iii) To justify the application of the Six Sigma methodology against other quality management initiatives;

(iv) To identify the most strategic logistical pinch-points in food distribution SMEs to be focused by Six sigma in order to have the highest financial impact; and,

(v) To examine the practical benefits of using Six Sigma in a food distribution SME

A research study indicated that majority of the logistics research throughout recent years has primarily been in logical positivist and interpretive areas, which acknowledge the rising in both quantitative and qualitative research approaches in logistics (Craighead et al, 2007). Therefore, it was decided to use both approaches for this research study as required. To achieve the first four of these objectives, a series of respective questionnaires were distributed across different samples of SMEs. A single questionnaire was used for some objectives, whilst objective (ii) was broken down into two separate questionnaires – one for senior management and one for employees. Although it may have been more conventional to seek responses from less number of companies across all quantitative study, the rationale for taking such an approach was the notorious difficulty of getting SMEs to engage in research and also limited number of food distribution SMEs in UK food market. The approach taken reduced the response burden on participants and led to a much larger overall sample of responses being useable.

Table 1 summarises the sampling strategy for each of the first four research objectives. The sampling strategy for the first, third and fourth questionnaires was the snowball sampling, in which researchers identified first food distribution SME and then recognised the list of other food distribution SMEs or food related organisations (for third and fourth questionnaires) through making more relationship with the first food distribution SME (which was then used as the case study Company) and some more first few targeted Companies. The rationale behind selecting this strategy was to having difficulty to identify food distribution SMEs without connection. The sampling strategy for the second questionnaire was purposive sampling in which researchers tried to use managers and employees for two different questionnaires with two different objectives; the respondents within each sample population were selected randomly based on availability. The rationale behind this sampling strategy for questionnaire two was profound differences of two sections of the questionnaire in terms of objectives and research question and also intensive work loads for both managers and employees in these types of organisations. The sample size of questionnaires is different due to availability of data in that specific period of time and it increased over time by identifying more food distribution SMEs. The data set for last two questionnaires were all food related SMEs including manufacturers and all food distribution SMEs which have already been accessed during first two questionnaires, as it was believed that the result of those two

questionnaires would also be applicable for food distribution SMEs, while the number of respondents would also increase.

Table 1

The questionnaires were used to deal with first four research objectives were essentially quantitative, requiring respondents to rank and prioritise answers across LIKERT scales. The responses were thus able to be compiled across all samples and another analysis performed in addition to more descriptive analyses. The analysis, which is described in more detail below, enabled authors to see whether any key trends, associations or typologies existed in relation to the use of Six Sigma.

The constructs of the first questionnaire were selected based on focusing on some important common resource capability elements to practice systematic programmes such as Six Sigma. However, the size of organisation is an important variable factor in which smaller companies may have limited sources. The constructs for top management commitment and employee resistance to change of the second questionnaire were selected as key defining factors for them. For instance, some distinguishing variables of level of willingness, concern and involvement for top management commitment, and level of willingness, concern and knowledge for employee resistance to change were asked within questionnaire to assess the possibility of cultural barriers linked to these two critical human resource success factors of implementing Six Sigma in this sector. The motivation behind selecting those three quality initiatives in questionnaire three was the similarity between them in terms of practice and culture; TQM has not specifically been evaluated due to its vague nature (Fotopolous and Psomas, 2009). This means that TQM as a philosophy with different definitions and therefore lack of transparency would not present a clear identification for a quantitative approach of data collection. This questionnaire actually and in practice has been conducted after fourth questionnaire; the presented business objectives had been selected as the result of data gathering of fourth questionnaire and also literature review (Shepherd and Gunter, 2006; and Gunasekaran and Ngai, 2003).

The constructs of questionnaire 4 were selected as the result of extensive literature review on articles that focussed on supply chain and logistics measurement frameworks (Shepherd and Gunter, 2006; and Gunasekaran and Ngai, 2003).

The fifth research objective is of a more qualitative nature and thus required a more qualitative analytical approach and so two case studies were used. Both case studies were conducted in the same company at different points in time and after the implementation of the above questionnaires.

As such there is only one case study Company but two separate case analyses were conducted and so the results were presented as two case studies. The motivation behind selecting these two specific case studies was the response to the result of questionnaire four in which time and quality related metrics were selected as key project selection criteria for this type of businesses. The "lead time" measure as an important time-related metric had already been taken in consideration by publishing a research article to reflect this case study. Therefore, it was decided to select two quality related case studies for this publication. The first case study was about quality of products, which referred to the returned products as defect. The second case study was about quality of service to meet customer satisfaction in order processing as one of the key service processes in this type of organisations. However, there are still many other constructs that can be selected depending on strategic project selection criteria, which is critical for any Six Sigma application to have as effective result as possible.

The purpose of these case studies were broadly to verify the practical benefits of the Six Sigma methodology of DMAIC on logistical performance in a local, TQM culturally-transformed and ISO9000 certified food distribution SME. The company with 50 employees, is based in North East of England and is involved in storing and supplying raw material (chilled, frozen and dry) and packaging to food outlets throughout the north of England. The activities in the company involve taking and processing orders, loading goods and delivering them to the customers on the same day. The key objective of the company is to be differentiated from its competitors in quality of service.

The scope of these two case studies is presented in Table 2 to demonstrate the title of the case study, targeted CTQ, defect, methodology of the case studies and tools and techniques used. The purpose of conducting these case studies was to reflect the fifth research objective, which was "to reveal the practical impact of the DMAIC methodology of Six Sigma as a problem solving methodology to improve service quality for a food distribution SME". The first case study was carried out to look at the issue of reducing the number of quality related product

rejects through adopting the DMAIC methodology and improving the customer service for this business and as such looked more at operations, whereas the second case study was focused more on administration tasks and looked at how customer satisfaction level were improved through the order taking process and by adopting the DMAIC methodology and reducing the number of mistakes.

The Analytical Hierarchy Process (AHP), which was presented as one of the applied tools is a quantitative method that can support managers in a broad range of decisions and complex problems including supplier selection and prioritisation of solutions (Gaudenzi and Borghesi, 2006). This AHP tool was used in the case studies of this research to prioritise and identify the most optimum solutions or improvement strategy to deal with the problems. In fact, it is used to support any decision making process, in which different potential factors are quantitatively compared with each other within a matrix structure in order to select the best option.

Table 2

4-Result and Discussion

4-1- Questionnaire Analysis

The result of first questionnaire with 32% response rate suggested that 80% of respondents had already implemented some sort of problem solving or process improvement projects in their organisation, although none of the respondents had any knowledge of Six Sigma. The analysis for different quality improvement-related practices for these organisations revealed three size-based groups: those with fewer than 10 employees, those with between 11 and 50 employees and those with between 51 and 250 employees. There was no respondent with more than 250 employees for this questionnaire, although few of them have been targeted. The results of first questionnaire indicated in table 3 that organisations with between 51 and 250 employees had a greater ability to start Six Sigma projects in terms of organisational resources. This result revealed that 100% of respondents with between 51 and 250 employees had already applied principle organisational requirements to implement Six Sigma. Information sharing for many of the respondents was happening through customer complaint databases or face-to-face visits, whilst the bigger organisations used more extensive ways of information gathering. The distribution of how respondents implemented different organisational practices is described in table 3. The results suggest that record

keeping, complaint data base and taking a problem solving approach were the more common practices in the sector and they also suggest a positive correlation between the size of the organisation and their implementation of different organisational practices typical of Six Sigma project implementation.

Table 3

Questionnaires two was conducted to study two of the most important key success factors of implementing Six Sigma in food distribution SMEs. The first analysis of questionnaire two was carried out to highlight the top management commitment through studying the level of senior management willingness for quality improvement, senior management concerns with customer satisfaction and senior management involvement in problem solving project based on educational level of 98 managers from different levels in 70 food distribution SMEs using a LIKERT scale ranking system of scores from 1 to 10. Using the average scores allocated by respondents, the results presented in table 4 show high level of commitment within senior management as this element is the most important success factor of implementing Six Sigma. It also presented that the key differentiating issue that formed grouped responses around a manager's commitment for the potential implementation of Six Sigma as a quality improvement practice was that of education level of the manager. However, as the results also show, although they form statistically distinct groups, the impact of education level is not particularly strong since the average score for the three groups is across a relatively small range. However, the results are interesting from a training and development perspective and in particular show that better educated managers are more likely to be strategic in their work, being more open to change and improvement and being less involved in operational problem solving.

Table 4

Two further analyses of questionnaire two were also attempted, the first to examine the impact of the location of a businesses on a manager's commitment, the second to examine the impact of business size on a manager's commitment. The result provided statistically no significant differences, confirming the consistent level of commitment within senior managers of the food distribution SMEs. It also indicated that personal characteristics of the

manager were likely to be more important than anything to do with the physical characteristics of the SME.

The further analysis of the second questionnaire to reflect the employee resistance again showed that the level of education was important in determining any employee resistance to change but also showed that the nature of their employment (either in operations or in administration) had an impact. As Tables 5 and 6 present, the better educated administration-based employees were most open to change and prioritised issues such as customer satisfaction and quality improvement. The key contributing element of this difference was indicated as a lower level of understanding for technical tools and performance measurement amongst lower educated employees who were also employed in shop-floor operations and highlights the important role of basic training for these employees prior to implementing Six Sigma in order to increase the level of understanding and reduce the chance of resistance.

Table 5

Table 6

Questionnaire three was carried out to investigate the impact of different quality improvement practices on some business objectives depending upon the type of business. The results found that whilst no individual food distribution company had implemented Six Sigma throughout its entire operations, the logistics or distribution department of few food manufacturers had. The presented result for manufacturers in table 7 represents all departments including logistics and transport department.

Having conducted the 10 points "Likert Scoring" analysis, table 7 represents the mean score (from 1 as the lowest to 10 as highest) and variation (Std) of impact of implemented practices to some business improvement objectives of food related businesses. The result of descriptive analysis presented in table 7 suggests that 103 respondents (163 usable samples) have been using one or more than one of those improvement practices, and the rest have not been practicing any of them. The sample size of respondents for each practice(s) has been presented in table 7. It has also suggested that most of the food distributors and wholesalers have been implementing Lean, ISO9000 or both but it was found that the highest average score of impact on business objectives (9.64) was for few food retailers, which implemented all three quality improvement practices. It was also found that companies that have implemented Six Sigma with or without any other quality improvement practices had higher

scoring value of impact on business objectives than those companies that have been implementing lean, ISO9000 or both together. This justifies the strength of Six Sigma on business improvement in the food industry in comparison with lean as a waste reduction tool and ISO9000 as a commercial standardisation certificate.

Table 7

The result of questionnaire four with a 23% response rate recommended that time and quality related measures (lead time, process cycle time, and service quality) can be selected as the most important logistical key performance indicators (KPIs) with respect to project selection criteria for food distribution SMEs. Lead time with the average score of 8.9, and process cycle time and service quality with the average score of 8.2 in "Likert Scoring" style were selected as the highest scored metrics. This means that any Six Sigma project is better to focus on identifying the customer requirements and potential defects related to lead time, process cycle time and service quality measures to ensure a strategic approach to project selection with highest customisation and financial impact. It is important to note that the selected measures of any of these KPIs need to be quantitative in order to be approached by a systematic methodology of the Six Sigma.

4-2- Case Study Results

To examine the practical benefits of Six Sigma and through application of DMAIC methodology of Six Sigma, the first case study reviewed 76 different manufactured quality related customer complaints and returned goods (defect), which was documented within the period of 5 months through traceability documentation. Having had the first stage of review, only 69 complaints were valid, as the rest had no reliable source. This represents a 0.03% defect percentage of 286,812 sold items for that period of time and a 4.97 sigma value. The Pareto analysis indicated that 55% of the source of the defect was related to fresh poultry, vegetable and chilled Pizza Cheese (Figure 1). The defect percentage might be appeared low, but the dramatic financial impact of even this small percentage due to potential loss of valuable customers made the management team to focus on this measure.

The monitoring chart of Figure 2 indicates that the number of quality related complaints increased with no usual or random reason up to higher limit during weeks 8 and 9. This was closely investigated through the database and traceability procedure to identify if there was

any non-random cause of this event during supply or storage processes. The high number of customer complaints related to manufactured quality of supplied fresh poultry and Cheese was found as the major source of the excessive number of customer complaints for those two weeks.

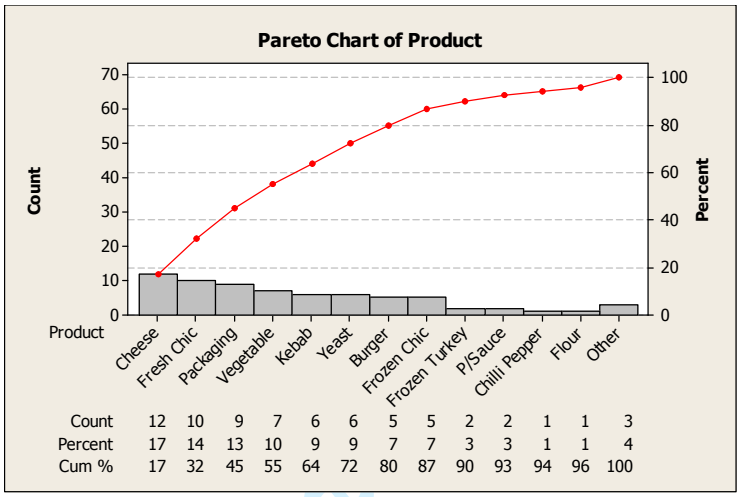

Figure 1- Pareto analysis to select the most important sources of the defect

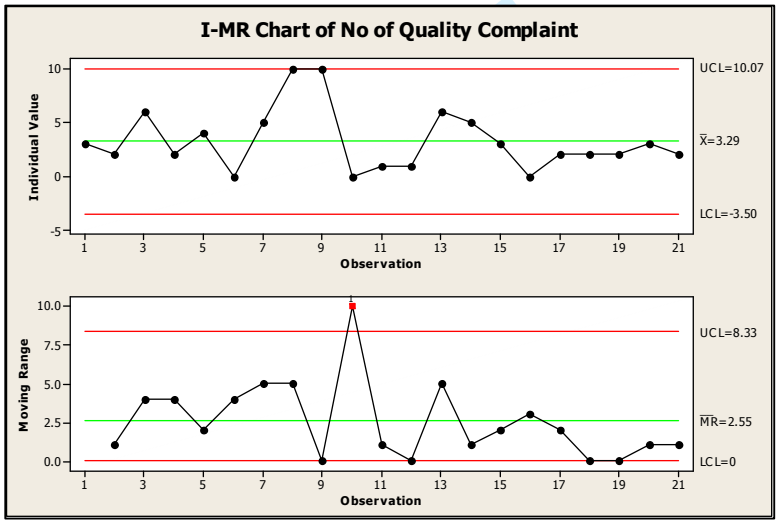

Figure 2- Monitoring chart for the number of quality related returned goods in a time term

The further analysis of the possible sources of the defect within "analysis" stage of the DMAIC methodology indicated that irregularity of the product failure and also the supplier's failure to meet the standard of the product were the most severe key sources of the defect, which needed more attention. The result of analysis stage was obtained through "root causes

and effect analysis", which happened collaboratively and with the help of the manufacturers. This analysis helped to identify the most critical input variables (causes) for the output variable (irregularity and failure in supplier's performance to deliver poor quality fresh poultry and pizza cheese) through a systematic data-driven brainstorming analysis. This type of analysis is used to quantify the importance of output variables (defects) and also relationship between each variable and sources of them (input variables). Then, the sum of multiplied scores of importance of variables and relationship scores would be calculated to identify the most important causes of the defect. It was suggested that "high variability in moisture, fat and protein level of the Fresh Cheese due to continuing changes in mix percentage" and "Failure of the accurate gas flush sealing of the packaging of fresh poultry" could be indicated as key sources of this 55% quality related product rejects. These sources of the defect were communicated with manufacturers of fresh poultry and Pizza cheese and their action was closely monitored.

The most optimum selected improvement strategies, which were obtained through extensive brainstorming and a prioritising technique (AHP) were applied for 12 weeks period in the supplying manufacturers as the pilot scheme to minimise the causes of the defects. AHP technique that was trained to supplying manufacturers during case study allowed them to quantify the brainstormed potential solutions and identify the most optimum solution to deal with high variability of moisture for cheese and Gas flush sealing problem for the fresh chicken. The new data were collected for 3 months and the final result of the number of quality related product rejects reduced to 0.01% and 5.13 sigma value. This difference was important in financial term as the result of reducing the chance of reverse logistics and valuable customer loss, and increasing consumer safety. This can also promote the role of a food distribution SME to improve the performance of the supplier within food SC.

The second case study was carried out to review the customer complaints related to the "order taking" process as one of the most important processes in logistics operations. In an initial analysis, it was highlighted that more than 60% of service – related customer complaints were referred to the "uploading wrong items on the sales order by telesales team" and so this measure was selected as the defect. A sample of 13150 raised sales orders over 19 weeks was used, which represents an average 692 sales orders per week. The defect rate (wrong sales orders) was average 16 per week, which financially and strategically was significant in terms of potential loss of the valuable customers and reverse distance logistics.

This represents the defect percentage of 2.31% and sigma value of 3.49. The target value was set by the management team to halve the amount of defects and increase the sigma value to more than 4.

The result of "root cause and effect analysis" in analysis stage through systematic and data driven calculation indicated that "human error due to lack of concentration and overload work" and also "Confusion over number of different choices of selection for one specific item" were selected as the key root causes of the defect and output variables. This was generated through a thorough and rigorous relationship analysis of some variables influencing the defect (mistakes in order processing) in order to identify the most important root causes of those variables. In fact, the most important root causes of above mentioned output variables which consequently would have dominant effect on causing the order mistakes have been selected as "lack of concentration" and other human related issues in telesales team.

Having analysed the root causes of the defect and also brainstormed potential solutions, the most optimum solutions were selected through AHP. Downloading the "order review software" and also "designing on-line ordering system" were implemented in a pilot scheme as the two most optimum solutions to minimise the sources of the defect.

Therefore and as the result of these changes, the total number of defects (wrong sales orders) was reported as 2 out of average 733 raised sales orders per week; this represented significant improvement through reducing the defect rate to % 0.27 and increasing sigma value to 4.28.
The result of both case studies indicated dramatic impact of using a systematic and reliable DMAIC methodology on customer service value and satisfaction level for this food distribution SME. The significance of this methodology in this practice was simplicity of tools and techniques with minimum required training and simple team building, although the methodology is rigorous, data driven and systematic. The estimated financial benefits of the first and second case studies was reported by business owner of this organisation as £100,000 and £12,000 per year as the result of minimising the Cost of Poor Quality (COPQ) such as potential customer loss, rework, refund and scrap rate. The implementation has gained the full buy – in by the management and has also been under monitoring process continuously to ensure about process capability and also effectiveness of the improvement strategies.

5- Conclusion

The research gap in Six Sigma application in food service SMEs and lack of attention in research studies in relation to integrating Six Sigma with food supply chain and logistics have been highlighted by this study. It was concluded that despite of lack of attention in literature, any food distribution SME with high value in customisation has capability to meet required key success factors and to be enabled to potentially implement Six Sigma in order to improve their logistical measures. It was also concluded that Six Sigma is more reliable methodology to improve the business performance of the food distribution SMEs in comparison with Lean and ISO9000 as two most used tools and techniques in the sector.

Senior management support and employee resistance to change are however two important key success factors to be examined and although no significant difference was found between managers of food distribution SMEs in terms of organisational characteristics such as size of the company and top leader's cultural background, more extensive training for required technical tools is an important factor to improve employee commitment for change in these organsiations. More in-depth inter-face analysis to assess the role of management commitment to quality on employee resistance to change could be carried out as future study. There are various single logistical measures in a small food distributor that could be targeted by this methodology in order to improve the process performance of this type of industry systematically and in more sustainable manner. The project selection for these measures was suggested to be focused on time and quality related logistical measures.

It is also concluded that key purposes and value of Six Sigma in food distribution SMEs include reducing defects and continuously improving the financial performance of the organisations. The practical benefits of the Six Sigma methodology is not limited to the organisation itself, as it was reported in both case studies that the supply base was also benefited through implementing the Six Sigma methodology in a food distribution SME. Practical benefits of Six Sigma for food distribution SMEs could also be significant in terms of preventing from losing the valuable customers who might potentially be critical in financial terms. There are some potential limiting factors for this type of business, however, which can influence the application of Six Sigma such as: information secrecy, limited data and some uncertainty in project selection, which can have an impact on the success of Six Sigma implementation in food distribution SMEs.

A most valuable management implication of this research is however to recognise the quality journey in food supply chain and logistics, and the importance of how real quality improvements seem to be made. Promoting cultural transformation towards TQM and apply ISO9000 first before advancing to Six Sigma application appears to be a valuable lesson. This approach also has substantial valuable influence on management roles, through the application of a systematic, sustainable and achievable problem solving methodology with financial and customisation benefits.

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Appendices

Appendix A)

Questionnaire 1 - Resource Capability Questionnaire

RESPONSE ALTERNATIVE: 1=Strongly Disagree/Very Bad / Very low
2 = Disagree/Bad/Low
3 =Neither Agree/ Good/High nor Disagree/Bad/Low,
4 =Agree/ Good/ High
5 = Strongly Agree/Very Good / Very high

Please underline or thick as appropriate

SECTION A

1. What is the Size of your organisation?

1. 10 or less than 10 employees 2. Between 11 and 50 employees 3. Between 51 and 250 employees 4. More than 250 employees

2. Which of the following describe your business?

1. Manufacturer
2. Distributor
3. Distributor, business to business (B->B)
4. Distributor, Business to consumer (B->c)
5. Third party logistic provider

3. What is the position you hold in your company?

1. Quality manager
2. Warehouse manager
3. Director
4. Operations manager
5. Store manager
6.Others

4 .Is your company certified by ISO 9000?
Yes / No

SECTION B

5. Are you aware of a management tool called six sigma?
Yes / No

6. To what extend are you aware of the six sigma?

1. Very high
2. High
3. Neither High nor Low
4. Low
5. Very low

7. Are you aware of the quality initiative tool called Kaizen / Continues improvement?
Yes / No

8. Have you ever used six sigma in your company?
Yes / No

9. If yes, how do you agree with the benefit of six sigma after it's used in your company?
1. Strongly Disagree
2. Disagree
3. Neither nor Disagree
4. Agree
5. Strongly agree

10. Have you ever carried out a project in your company that has a purpose of eradicating defect and improve quality?
Yes / No

11. How do you rate the implementation frequency of above project in your company?

1 Very low
2 Low
3 Neither Low nor High
4 High
5 Very High

12. To what extend do you know of kaizen?

1 Very bad
2 bad
3 Neither good nor bad
4 Good
5 Very good

13. Have you used kaizen / continues improvement in your company?
Yes / No

14. Do you know of Total Quality Management (TQM)?
Yes / No

15. Are you aware of a management tool called JUST IN TIME (JIT)?
Yes / No

16. To what extend do you know of the JIT?
1. Very Bad
2. Bad
3. Neither good nor bad
4. Good
5. Very Good

17. Have you ever used any quality initiative tool in your company to increase profits by eliminating variability, defects and waste that undermine customer loyalty?
Yes / No

18. If yes, how do you rate the implementation frequency of this type of project in your company?

1. Very Low
2. Low
3. Neither high nor low
4. High
5. Very High

19. Have you carried out a project in your company which aimed at eliminating waste by producing right amount of parts at the right place at the right time to make sure that inventories are maintain at the lowest level or eliminated entirely?
Yes / No

20. How do you rate the implementation frequency of this type of project in your company?

1. Very Low
2. Low
3. Neither high nor low
4. High
5. Very High

21. Have you carried out a project that has an approach that motivates, supports, and enables quality management in all activities of the organization, focusing on the needs and expectations of internal and external customers which involve the entire work force?
Yes / No

22. How do you rate the implementation frequency of this type of project in your company?

1. Very Low
2. Low
3. Neither high nor low
4. High
5. Very High

23. Have you ever carried out a project in your company that seeks to continuously affect incremental changes for the better, involving everybody within the organization from the workers to managements?
Yes / No

24. How do you rate the implementation frequency of this type of project in your company?

1. Very Low
2. Low
3. Neither high nor low
4. High
5. Very High

SECTION C

25. Do you currently use any excessive information sharing tool such as ERP, MRP, EDI, EPOS, SAP, or other Internet integrated information exchange soft wares?
Yes / No

Please, specify:

26. Do you have any specific record keeping procedure for all your data?
Yes / No

27. How often are the complaints from your customers?

1. Very Low
2. Low
3. Neither high nor low
4. High
5. Very High

28. How do you rate your responsiveness to your customers?

1. Very Low
2. Low
3. Neither high nor low
4. High
5. Very High

29. Do you keep records or data base of your customer complaints?
Yes / No

30. Do you have any customer enquiry line or team?
Yes / No

31. Do you currently have any quality management team or department in your organisation?
Yes / No

32. Do you measure your company's performance?
Yes / No

If yes, what is the method?

33. Have you ever had implemented any problem solving project?
Yes / No

If yes, please specify some exemplars:

Appendix B)

Questionnaire 2 - Key Success Factor Questionnaire – Analysing the top management commitment and staff resistance to change as two critical human resource factor of success in Six Sigma and any quality improvement Projects in Food Distribution SMEs

Section A – Top Management Commitment:

This questionnaire has been conducted partially to identify key management commitment factors towards any quality improvement practice.

1. Your role in the organisation:

A) Managing Director	B) Member of board of directors	C) Line Manager
D) Warehouse Manager	E) Purchasing Manager	F) Sales Manager
G) Office Manager	H) Marketing Manager	I) Transport Manager
J) Other, Please Specify		

2. The years of management experience :

A) More than 10 years	B) Between 3 to 10 years	C) Less than 3 years

3. Your latest level of education:

A) Post Graduate Degree
B) Undergraduate Degree
C) A-Level
D) GCSE or O-Level
E) Less than GCSE or O-Level

F) Others (Please, specify)

4. Location of your organisation (County):

5. Size of your Organisation:

A) Less than 10 employees
B) Between 10 and 50 employees
C) Between 51 and 250 employees
D) More than 250 employees

Please, specify the level of willingness, concern and involvement in correspondence to your position, roles and responsibilities, and practice by scoring in front of each variable (from 1 as the lowest to 10 as the highest):

No	Willingness for Quality Improvement	Score
6	Your Willingness to learn more	
7	Your Willingness to Information exchange with competitors	
8	Your Willingness for staff training	
9	Your Willingness to have ISO9000	
10	Your Willingness to implement further quality practices	
11	Your Willingness to have quality improvement team	
	Concerned with Customer Satisfaction	**Score**
12	Your Concerns with rejected products and Customer Complaints	
13	Your Concerns with Quality assurance rather than Inspection	
14	Your Concerns with gross profit	
15	Your Concerns with customer satisfaction	
16	Your Concerns with efficiency in service	
	Involvement in Problem Solving	**Score**
17	Your Involvement in Strategic Decision Making	
18	Your Involvement in Operational Decision Making	
19	Your Involvement in Collecting Word of Mouth from Customer	
20	Your Involvement in Problem Solving projects and practices	

Section B – Staff Resistance to Change:

This questionnaire has been conducted partially to identify key management commitment factors towards any quality improvement practice.

1. Your role in the organisation:

A) Warehouse Assistant B) Driver C) Office Clerk and Administrator

2. The years of management experience :

B) More than 10 years B) Between 3 to 10 years C) Less than 3 years

3. Your latest level of education:

A) Undergraduate Degree
B) A-Level

C) GCSE or O-Level
D) Less than GCSE or O-Level
E) Others (Please, specify)

Please, specify the level of willingness, concern and knowledge in correspondence to your position, roles and responsibilities, and practice by scoring in front of each variable (from 1 as the lowest to 10 as the highest):

No	Willingness for Quality Improvement	Score
4	Your willingness to work in project team	
5	Your willingness to initiate a quality problem	
6	Your willingness to learn about quality improvement practices	
7	Your willingness to work in a new environment and with new people	
8	Your willingness to initiate	
	Concerned with Customer Satisfaction	
9	Employee concern about customer's enquiry	**Score**
10	Employee concerns about number of defects and mistakes	
11	Employee concerns about inefficiency in operation	
12	Employee concern about job loss due to comments	
13	Employee concerns about unforeseen challenges	
	Knowledge of Technical tools and process	**Score**
14	Your knowledge about your work, duties and responsibilities	
15	Your knowledge about the processes and operations in the organisation	
16	Your knowledge about any performance measurement tool	
17	Your knowledge about data collection tools and techniques	
18	Your knowledge about Statistical tools and techniques	

Appendix C)

Questionnaire 3 - Benefits of Six Sigma, Lean and ISO9000 as three common quality improvement practices on business objectives in food sector

Title:
Name (Optional):
E-Mail Address:
Company Name (Optional):

1. What is the Size of your organisation?

1. 10 or less than 10 employees 2. Between 11 and 50 employees
3. Between 51 and 250 employees 4. More than 250 employees

2. Which of the following describe your business?

1. Manufacturer
2. Distributor
3. Wholesaler
4. Cash & Carry
5. Retailer
6. Supermarket
7. Caterer
8. Others

3. What is the position you hold in your company?

1. Quality manager
2. Warehouse manager
3. Director
4. Operations manager
5. Store manager
6. Others

4. What type of quality initiative have you been implementing in your organisation (please, tick as many as appropriate)?
1. Six Sigma
2. Lean
3. ISO 9000
4. Others, please specify

5. How important was the impact of these measures (if applicable) to the business objectives of your organisation? Please, give score to each quality initiative as appropriate

	Score
Significantly Important	9-10
Important	7- 8
Neutral	5- 6
Less Important	3- 4
Not Important	0-2

practiced quality initiative	Scrap reduction	Cycle Time Reduction	Delivery Time Reduction	Cost Reduction	Increase in Productivity	Increased Sales	Improved Profitability
ISO							
Lean							
Six Sigma							

Appendix D)

Questionnaire 4 – Selecting the critical logistical measures for project selection

Title:
Name (Optional):
E-Mail Address:

Company Name (Optional):

1. What is the Size of your organisation?

1.10 or less than 10 employees 2. Between 11 and 50 employees
3. Between 51 and 250 employees 4. More than 250 employees

2. Which of the following describe your business?

1. Manufacturer
2. Distributor
3. Wholesaler
4. Cash & Carry
5. Retailer
6. Supermarket
7. Caterer
8. Others

3. What is the position you hold in your company?

1. Quality manager
2. Warehouse manager
3. Director
4. Operations manager
5. Store manager
6. Others

Please, give score to following questions in the scale of 0-10 as instructed below:

	Score
Significantly Important	9-10
Important	7- 8
Neutral	5- 6
Less Important	3- 4
Not Important	0-2

4. How important are these factors to set your strategic objectives in the company?

	Score
profit	
quality	
cost	
flexibility	
Market share	
innovation	
others	

5. How important are these measures for winning customer loyalty in your organisation?

	Score
Product quality	
Product reliability	
Fast Delivery	
On-time delivery	
Wide product range	
Competitive price	
Others(please, specify)	

6. How important are these operational measures to improve the logistics performance in your organisation?

	Score
Improving Supplier Performance	
Customer Satisfaction In order Processing	
Food Safety	
Process Quality (Hygiene and Storage...)	
Response to Customer Complaint	
On-Time Delivery	
Stock Control in Goods In	
Customer waiting time on the phone	
Transport Cost	
Inventory Cost	
Storage Cost	
Driver Efficiency	
Defect Free Goods	
Defect Free Delivery	
Shop Floor Scheduling	

7. How important is the impact of implementing any quality improvement practice on these measures?

	Score
Reduction in scrap rate	
Reduction in cycle time	
Reduction in delivery time	
Reduction of cost	
Increase in productivity	
Increased sales	
Increased profitability	
Improving the quality of food	
Improving the hygiene & food safety	

Table 1- Sampling strategy for Research Objectives (i) to (iv)

Research Objective	Questionnaire objective	Sample Size
(i) Assessing organisational capability	Assessing the organisational resources to implement Six Sigma for each group (Questionnaire 1)	70 food distribution SMEs
(iia) Assessing the top management support	Assessing the level of top management willingness, concern and involvement in quality improvement based on education level, location and size of business (Questionnaire 2a)	98 managers of 70 food distribution SMEs
(iib) Assessing the employee resistance to change	Assessing the level of employee willingness, concern and understanding in quality improvement based on education level and workplace (Questionnaire 2b)	158 employees of 70 food distribution SMEs
(iii) Justification of implementing Six Sigma	Actual benefits of Six Sigma, Lean and ISO9000 (Questionnaire 3)	180 food related SMEs
(iv) Identifying the most critical logistical measures	Selecting the critical metrics for project selection (Questionnaire 4)	140 food related SMEs

Table 2- Scope of the Case Study research methodology

No	**Title of the case study**	**Methodology used**	**Defect**	**Targeted CTQ**	**Tools/techniques**
1	Reducing the number of "quality related returned goods" in a food Distribution SME (Case Study 1)	DMAIC	Number of returned goods	Reducing the COPQ (Cost of Poor Quality)	Pareto Chart, Process Map, Cause and Effect matrix, Monitoring Chart, Analytical Hierarchy process (AHP)
2	Improving customer satisfaction in an order taking process of a food distribution SME (Reducing the defects in order processing) (Case Study 2)	DMAIC	Wrong orders	Order processing	Pareto Chart, Process Map, Process Sigma level, cause and effect matrix , AHP

Table 3 - Percentage of implementation of different quality-related practices for three different size groups

Organisational Practice	Percentage of implementing respondents			
	Between 51 and 250 employees	Between 11 and 50 employees	10 or less employees	Average
Excessive Information Sharing	100%	45%	20%	55%
Record Keeping	100%	72%	50%	74%
Complaint Database	100%	100%	35%	78%
Quality Management Team	100%	33%	22%	52%
Problem Solving Project	100%	90%	50%	80%
Average	100%	68%	35%	67%

Table 4- The impact of three different education group in top management commitment for food distribution SMEs

Top Management commitment factors	Education Level		
	Higher Education (std)	A-Level (std)	Lower than A-Level (std)
Willingness for quality improvement	8.64 (1.008)	7.61 (0.916)	6.83 (0.786)
Concerned with customer satisfaction	8.57 (1.016)	8.50 (0.921)	8.06 (0.936)
Involvement in problem solving	8.04 (1.008)	8.17 (1.043)	8.22 (1.14)
Average	8.42	8.09	7.70

Table 5 - The impact of three different educational background on employee resistance to change in food distribution SMEs

"Employee Resistance to Change" factors	Education Level of employees		
	Higher Education (std)	A-Level (std)	Lower than A-Level (std)
Willingness for quality improvement	8.9 (0.87)	8.17 (1.03)	7.46 (1.1)
Concerned with customer satisfaction	8.22 (1.21)	7.7 (1.4)	7.5 (1.2)
Understanding of technical tools and process	7.28 (1.1)	4.5 (6.8)	4.8 (1.6)
Average	8.13	6.8	6.6

Table 6- The impact of two different work places on employee resistance to change in food distribution SMEs

"Employee Resistance to Change" factors	Workplace of the employees	
	Office (std)	Shop floor (Warehouse, delivery) (std)
Willingness for quality improvement	8.3 (1.1)	7.8 (1.16)
Concerned with customer satisfaction	7.9 (1.39)	7.6 (1.2)
Understanding of technical tools and process	7.3 (1.9)	5.09 (1.6)
Average	7.72	6.83

Table 7- The impact of practiced quality improvement initiative on business objectives considering the type of business

practiced quality initiative	Type of Business and sample size	Scrap reduction (Std)	Cycle Time Reduction (Std)	Delivery Time Reduction (Std)	Cost Reduction (Std)	Increase in Productivity (Std)	Increased Sales (Std)	Improved Profitability (Std)	Average
ISO	Manufacturer (12), Wholesaler (6), Distributor (8), Cash and carry (3), Retailer(9)	7.4 (.69)	5 (1.22)	5 (1.26)	4 (1)	6.9 (.87)	8.66 (.86)	9 (.75)	5.8 (.95)
Lean	Wholesaler (12), Distributor (26), Cash and carry (3)	7.75 (.5)	9 (.0)	8.33 (.57)	7.5 (.57)	7 (1)	3.75 (.95)	6.25 (1.25)	7.08 (.69)
Six Sigma	Manufacturer (3), Retailer (2)	9.5 (.7)	9.5 (.7)	8 (.0)	9.5 (.7)	7.5 (.7)	10 (.0)	10 (.0)	9.14 (.4)
ISO & Lean	Wholesaler (6), Distributor (7), Cash and carry(1)	7.75 (.95)	8 (.0)	7.33 (1.5)	7 (1.1)	6.33 (.58)	6.66 (1.15)	8 (.81)	7.30 (.87)
ISO & Six Sigma	Manufacturer (2)	9.66 (.57)	9 (1)	8 (1.4)	9 (1.4)	7.5 (.7)	9 (1)	9.66 (.57)	8.83 (.95)
ISO, Lean & Six Sigma	Retailer (3)	9.83 (N/A)	9.68 (N/A)	9 (N/A)	10 (N/A)	9 (N/A)	10 (N/A)	10 (N/A)	9.64 (N/A)
Average		7.6 (1.07)	7.46 (.59)	6.94 (.95)	6.4 (.96)	7 (.94)	7.72 (.79)	8.54 (.68)	7.40 .77

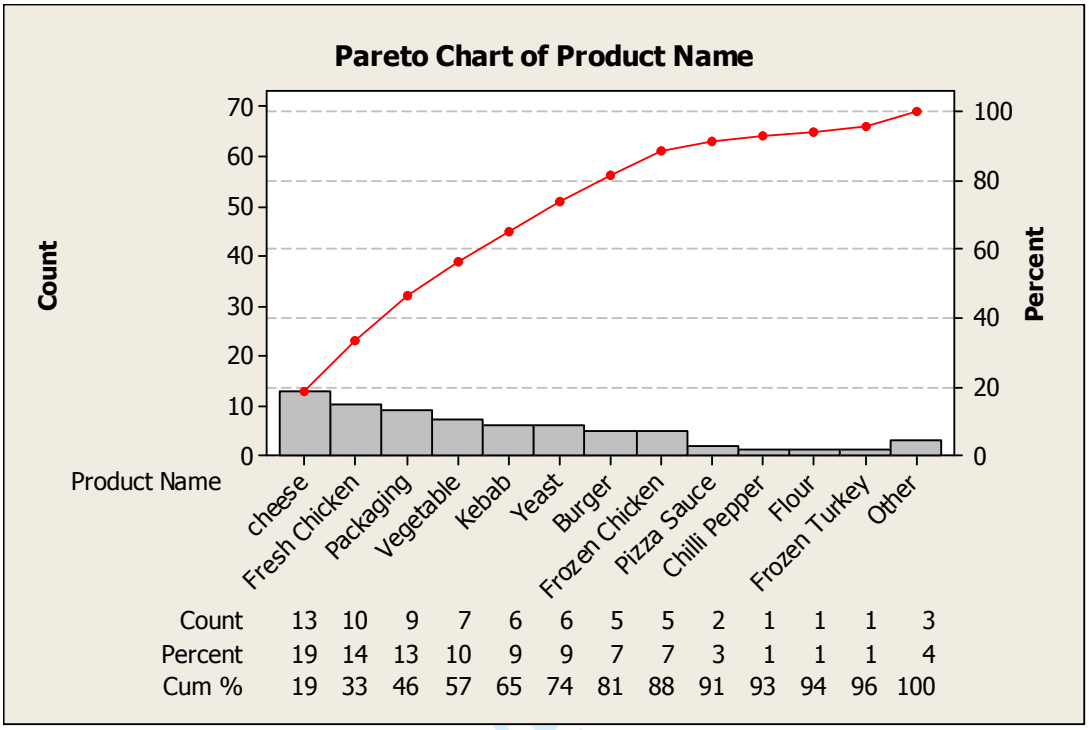

Figure 1- Pareto analysis to select the most important sources of the defect

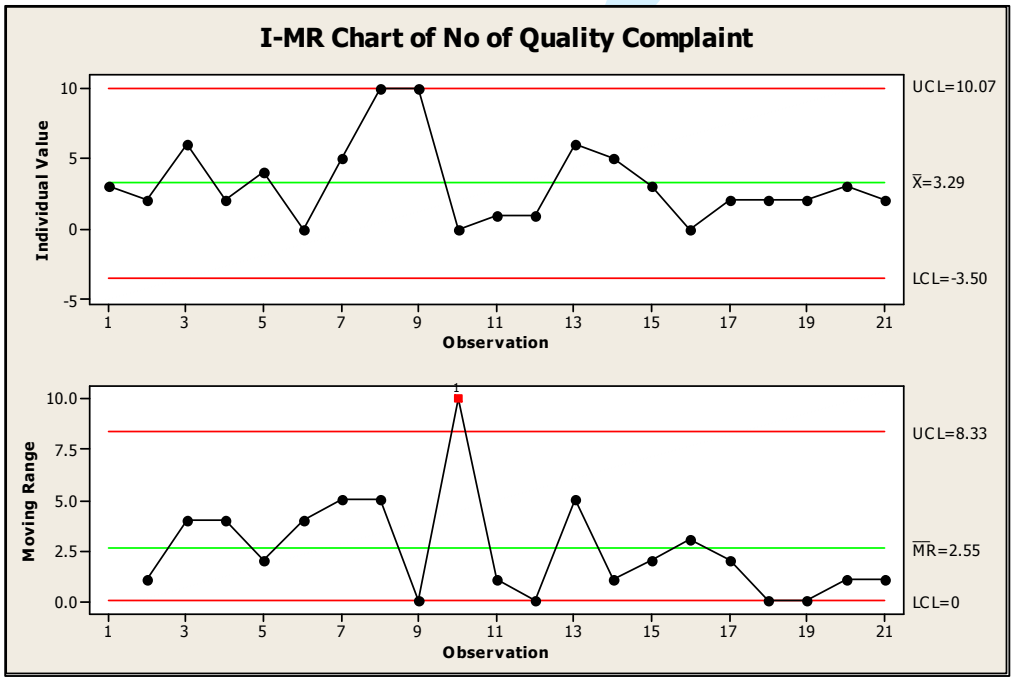

Figure 2- Monitoring chart for the number of quality related returned goods in a time term

Dear reviewer,

The third review provided has identified some more useful input into our paper and provided very accurate comments. As a consequence, we are delighted to see the comments of the reviewer as an acceptance of the paper and we have made final required changes to the paper. The following sections refer to each specific review point in turn, explaining where and how we have amended the paper. We think the paper is now a much stronger piece and we hope it deals with the reviewer's comments in a satisfactory manner at this point.

There is a track change on page 6. And see the reviewer's comment about a typo on Page 12.

The track change in page 6 has now been accepted.

Paper looks fine now. However a typo is noticed in Page 12, Line 43/44. The likert scoring system should be from 1 to 10.

The authors have now changed the Likert score from "0-10" to "1-10".