International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 03, 2020
ISSN: 1475-7192

The Influence of Lean Six-Sigma Tools in Reducing the Cost of Quality and Fulfilling of Competitive Advantage of Firms

[1]Dr. Rasha Jasim Ahmed Ebraheem Alobaidy

Abstract---*Nowadays, firms are seeking to improve their value at the market in line with increasing their revenues. Firms employ several strategies to achieve this goal. Lean Six Sigma (LSS) is a new trend in quality management practices. The aim of this article is to investigate the contribution of LLS in reducing the cost of quality and fulfilling of competitive advantage of firm. To achieve this aim the researcher used the qualitative and quantitative methods, employing the questionnaire survey tool. The study sample consisted of 98 participants. Data was analyzed using Statistical Package for the Social Sciences (SPSS).Books, papers of journals and several papers of conferences were revised. The analysis of literature shows that LLS is considered as significant strategy for improving the efficiency of firms' processes and customer satisfaction. It also indicates that LLS assists organization in improving the quality of their services or products in parallel with reducing their expenses, which is reflected in fostering firms' competitive advantage.*

Keywords---*lean, Six Sigma (SS), Lean Six Sigma (LSS), Quality, Cost of Quality, and Competitive Advantage.*

I. Introduction

Lean Six Sigma (LSS) appeared in the environment of manufacturing business, in purpose of mitigating waste, reducing lead-time, improving the consumption of material, improving quality and flexibility and maintaining the precision and accuracy on a high level. While the most critical factor of LLS is the customer satisfaction [1]. Lean Six Sigma is a combination of Sis Sigma (SS) and Lean Manufacturing approaches. Six Sigma has formulated from continued improvement and scientific management theories. Six Sigma has evolved from finest elements of several former initiatives of quality. SS was adopted as a firm need for tactical and strategic process in order to produce optimal outcome, improve firm processes, improve employee skills and change the firm culture. Nowadays, SS is adopted by many firms in various industries around the world [2]. While Lean notion has generated after Second World War in Japan. It was manifested due the failure of grant the massive investment needed to build facilities as the ones in the USA. Toyota was the first firm that introduce Lean in order to mitigate waste in their operations [3]

Various researchers have investigated this topic from several aspects. Some researchers have developed model in order to implement LLS in firms in various filed such as Thomas, Barton, & Chuke- Okafor, (2009) and Antony, Hilton, & Sohal, (2009). While others have conducted an empirical review for a large number of studies related to the LLS concept, for example Shafer & Moeller, (2012). In addition, many researchers have investigated the influence of LLS implementation on many factors such as firm's performance, quality, process efficiency and

[1]***Affiliation: Lecturer Dr. / College of Islamic Sciences / Department of Islamic Banking and Finance / University of Iraq***
E-mail: rasha_9484@yahoo.com

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

customer satisfaction (Verver, Does, & Heuvel, 2006; Does, Koning, & Bisgaard, 2008; Lee, Cheng-Ting, & Gwo-Ji, 2013). However, there is a rareness in investigating the influence of LLS implementation on cost of quality and competitive advantage in a single study. This study. Thus, this study was developed to conduct a theoretical review to investigate the influence if LLS on reducing the cost of quality and fulfilling the competitive advantage of firms.

II. Problem Statement

In recent decades, it is highly recommended for firms to monitor their effectiveness in the market.A precious observation for the efficiency of internal process and an immediate adjustment to the trends of the market is a part of daily tasks for successful firms[1]. These firms arealways looking for new strategies to develop their operation processes and fostering their competitive advantage.Many methodologies and ongoing improvement management programs are instituted, such as total productive maintenance, total quality management and six sigma and Lean[4].

Quality is not only about manufacturing things with zero defects. It is about providing service or manufacturing a product in order to meet the needs of every single customer[5]. Firms often face the problem of provide the intended quality for their customer because of flaws in their process. In the context of achieving the intended quality, firms usually suffer from the high rate of expenses. Firms count quality as a priority because of their impact on their revenue and competitive advantage in the market.

Nowadays, firms have utilized Lean Six Sigma as a management approach in order to drive their innovating practices or its daily processes[5]. They arelooking for improve the efficiencyof their processes and quality of their services or products. Many researchers have investigated the influence of LLS on firms from several aspects. They have detected the impact of LLS on the quality of services and products, firm performance, process efficiency and customer satisfaction. Based on the research knowledge, there is a rareness in investigating the influence of LLS on the cost of quality and competitive advantage of firm in a single study. This study will be conducted to answer the following question "what is the influence of LLS toolsin Reducing the Cost of Quality and Fulfilling of Competitive Advantageof Firm?"

III. Research Significance

Lean Six Sigma concept has been investigated form several aspects. The purpose of this research is to investigate the influence of LLS implementation in reducing the cost of quality and fulfilling the competitive advantage of firms. Former researches have studied the impact of LLS on single factor such as quality, process efficiency and so on. Based on the researcher knowledge, there is no research that investigates the impact of LLS on the cost of quality and the competitive advantage for firms. This study will full this gap. In addition, this study can be considered as a reference for future researches related to this topic. Moreover, this research may be counted as a reference for firms who concern in adopting LLS in order to investigate its significance.

IV. Research Methodology

To achieve the aim of this study, the researcher will conduct an extensive analysis for secondary data whereby revising related papers of journals, books and papers of conferences.

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

V. Literature Review

Six Sigma definition

Six Sigma is considered as a smarter mode to administrate a business or a department. It lay customer first and utilizes data and facts in order to drive better solution [6]. Six Sigma (SS) has been defined by several researchers. Each definition draws up its characteristic from the perspective of the researcher. From the business perspective SS can be defined as the process that assist firms to essentially focus on breakthrough and continuous improvements in all business tasks in order to boost customer satisfaction [7]. While from the statistical perspective, SS (σ) is a metric of measurement process that reflects the amount of variation through a data which is normally distributed [2].After an extensive review for literature,Schroeder, Linderman, Liedtke, & Choo, (2008)providea precise base definition which characterize Six Sigma's theoretical aspects. They describe SS as " an organized, parallel-meso structure to reduce variation in organizational process by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives" (Schroeder, Linderman, Liedtke, & Choo, 2008: 540).Based on this definition, SS runs as a parallel structure devoted to improving the firm and it combines macro-firm strategy and meso and micro tactics (Sinha & Van de Ven, 2005; Barney, 2002a). SS offers a hierarchical structure in which champions (leaders) initiate, upholding, and revise key projects for improvement. Then Black Belts deployed as a project leaders to monitor Green Belts in solving problems efforts (Barney, 2002b; Sinha & Van de Ven, 2005). Black Belts are improvement specialists who are trained in SS structured method for four weeks with hands-on experience in upgrading one or more processes whereas Green Belts are individuals who receive two weeks of training. The selection of SS projects (project hoppers) follows a formal mechanism developed by the firm. Project hoppers include senior management who is responsible for the decision rights in order to initiate a project. In addition, leaders perform a core role in the execution of SS projects. Senior executive Champions act several function for SS projects, encompassing: facilitate project selection, Identify project charters definition, choose Black Belts and other resources for the project, remove obstruction to complete the project, and pursue progress revising or tollgate revising in cooperate with Black Belts [8][9].

Six Sigma is implemented to make every single area of an organization better able to fit the changing needs of markets, customers and technologies with benefits for customers, shareholders and employee. It is employed to play a role in improving customer satisfaction, reducing defects and reducing cycle time. Hence, dramatic savings of cost to businesses, capturing new markets, building a reputation for superior performing services and products will be achieved [6]. The Six Sigma uses two methodologies. The statistical aim of Six Sigma is compressing process on target and mitigating process variation. A process of Six Sigma should bring closer to zero defects whereby 3.4 defects per million chance for defect to take place [10].

Six Sigma Methods

The methodology of Six Sigma uses tools of standard quality like cause-effect, FMEA and statistical process control (Breyfogle III, 1999; Hoerl, 1998; Ishikawa, 1985; Kume, 1985, 1995). The utilization of SS tools varies upon many factors. DMAIC and DMADV are the most popular among these tools.

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

DMAIC Method

The Six Sigma algorithm for problem solving encompasses five phases named the DMAIC cycle. The DMAIC cycle consist of defining, measuring, analyzing, improving and controlling phases(Bergman & Klefsjo, 2003; Magnusson, Kroslid, & Bergman, 2003). It should be mentioned that this approach is also implemented in Lean process and LSS.Some researchers suggest the pre-define phase as an independent phase in the model of DMAIC but the majority of LSS professionals combine activities of predefine phase into define phase. Figure 1 demonstrates the phases of DMAIC model and the tools utilized in each one.

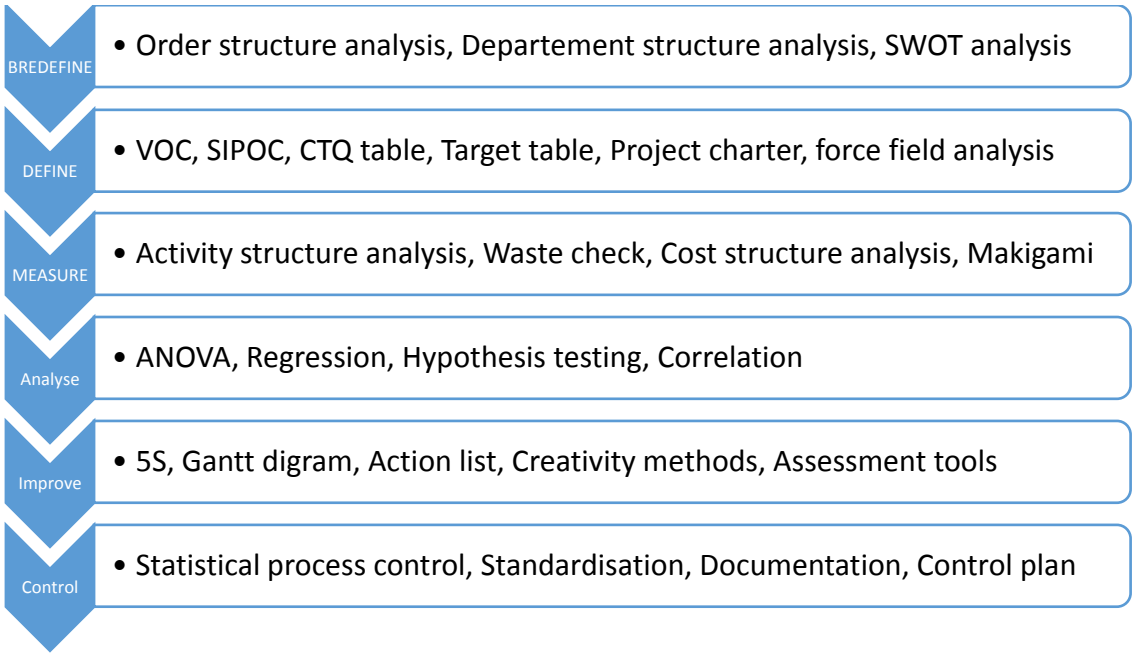

Figure 1: The phases and tools for DMAIC (A.M.T. successfactory and Uckert Sigma Consulting , 2015; George, 2003 as cited by Rakusa, 2016).

Before LSS project officially onsets, the predefine phase takes place. Through this phase, the prioritization or selection of the processes, which should be improved, is occurred. The prerequisite for selection the process is to have a deep understanding for the structure of the department, services and responsibilities supplied by the department and to make a cost structure analysis. In this phase, also a benchmark can be made to the competitiveness of the department to take a closer look to the prices, products and services that are offered by competitors[11].

Through the define phase, the requirements and expectations of the customers are specified. In addition, the boundaries of the project are determined, and goals and responsibilities are selected. At the end of this phase, the mission of the project is clarified. In the measure phase, data collection plan is developed whereby quantify and document the current situation. The aim of this phase is to determine the shortfalls and issues of the measured process and set hypotheses regard the root causes. Theses hypotheses, variation sources and defects causes are analyzed through the analysis phase. Moreover, the improvement opportunities, which are discovered, are prioritized. Through the improve phase. The process is enhanced to remove variations and establish creative

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

alternatives. Through control phase, variations are controlled to meet the requirements of customers and strategies are manifested to monitor and control the improvement of the process. Add up, a sustainable solution for the process is established to fulfill ongoing stability [12].

DMADV Method

The second methodology that is conducted in SS is DMADV. In contrary of DMAIC, the DMADV method is employed to innovate and invent for new or modified services, processes and products[13]. DMADV method includes defining, measuring, analyzing, designing and verifying phases[5].

In the define phase of DMADV, project leaders defined needs and wants that believe to be counted most paramount to customers. Needs and wants are defined by customer feedback, historical information and other sources of information. As the DMAIC, the data is collected and specifications are recorded according to the defined metrics in the measure phase. In this phase, all the processes, which are required to efficiently manufacture the services or products, are assigned metrics for the evaluation. In the analyze phase, the outcomes of the manufacturing process is tested in order to create an improvement baseline. Leaders identify areas of processes that need improvements regarding manufacturing process or quality of a finished services or product. Then in the design phase, customers' needs and wants are compared to the outcomes of internal tests and any additional adjustments required are done.Before, the final services or products are released; customers test the improved processes. In the verify phase, while the services or products are being releasing and the feedback of customers are provided, the processes may be modified[14].

Lean Manufacturing Theory

Lean system endeavored to produce services and products of higher quality in the least time and at the lowest cost through eliminating wastes (Liker, 1996; Dennis, 2007). In this context, wastes is considered as "anything other than the minimum amount of equipment, materials, parts, space and time which are absolutely essential to add value to the product" (Russell & Taylor, 2000: 720). Wastes may take the following forms: transport, motion, over processing, waiting, defects and overproduction [15].Pavnaskar, Gershenson, & Jambekar, (2003) stated that the benefits of Lean are clear in factories around the world. Firms report cycle time reduction, work in progress (WIP) reduction, product quality improvement, net income improvement, on-time deliverables improvement, cost mitigation, and utilization of labor improvement. They also mentioned that implementing lean method leads to reduction in inventories, faster return on investment of inventory, higher level of manufacturing, boosting in flexibility, improved the utilization of spaces, mitigation in investment of tool, a better usage of machinery stronger job focus and better enhancement for the skills. Application of Lean are grounded on the optimal involvement of people through means of techniques and tools like Single-Minute-Exchange-of-Die (SMED), 5S and total productive maintenance (TPM) and Kanban [16]. Teamwork and complete employee involvement are key needs for efficient application of Lean (Shah & Ward, 2007; Fullerton & Wempe, 2009).

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

Lean Manufacturing Tools

Through Lean manufacturing, firms can eliminate the waste by implementing several tools like cellular manufacturing, just-in-time production, continuous improvement and production smoothing.

Cellular Manufacturing

The aimof cellular manufacturing is increasing the products mix with least waste. A cell includes workstations and equipment, which are set in an order to keep a smooth flow of components and materials during the process.In addition, it implies workers who are trained and qualified. Cell tool assists in support the one-piece flow in which each product proceed through the process as a one unit at a time wanting a sudden interruption according to the customer requirements. In the context of the demand where is a high variety of products and a faster delivery rates, cell tools can offer the flexibility required through gathering similar products into groups that can move over the same machine in the same order[17].

Just-In-Time Production

The notion of just-in-time production is removing the source of waste through manufacturing the right segment at the right time and the right place. It enables firms to adapt sudden changes in the demand of customers through manufacturing the right product in the right amount and at the right time[18].

Contentious Improvement (Kaizen)

Kaizen is a systematic method to progressive, organized and continuous improvement. This improvement can be achieved in several aspects for example, defective parts reduction and inventory reduction. 5s is considered as one of the paramount tools of continuous improvement. It captures waste and then works to remove it [18]. Kaizen tools assist firms to uncover its capabilities and potential strengths [17].

Production Smoothing

Production smoothing tool assist to proceed to a higher level of control for a specified process to reduce its waste. It operates in order to maintain the manufacturing level steady as possible from day to day[19]. It also mitigate the cost of production whereby smooth production schedule through efficient production of the right amount of parts and efficient use of work force [17].

Lean Six Sigma

The integration of Six Sigma and Lean principles makes it much capable to fulfill effective improvement whereby overcome the flows of both. This methodology called Lean Six Sigma (LSS), which is defined as a business methodology and strategy that boost the performance of process, and improve satisfaction of customers, leadership and results of bottom-line through improving costs, quality and speed [20]. The integration of LSS actions into the management approach leads to change in organization culture at all levels, with more stress on the top management level. They should commit their energy, time and resources of the firm to support the initiative. The statistical tools of LSS are combination of both Six Sigma tools and Lean tools. The impact of the implementation of LSS to a

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

business can be quantified using several inductors. Customer satisfaction index, customer winning rate, customer penetration rate, supply chain flexibility, reduction of lead-time and quality across the board are metrics, which use by Six Sigma. Total cost for each process is also an indicator for LSS, which represent a metric of performance for Lean[5].

Lean Six Sigma Criteria

Four key factors were identified as the basis of LSS according to George, Rowlands, & Kastle, (2004)**.** Thesefactors are satisfaction of customer demand through delivering quality and speed, improvement of processes through increasing flow in line with mitigating defects and variation, investing human resources to boosting cross-functionalteamwork, and making decision grounded on facts and data.

Satisfaction of Customer Demand

Customer is always the paramount focal point for LSS. Customer focus stemmed from both lean and six sigma. SS considers customer as a source for identifying the process aspects that are significant to quality [21]. While in lean approach, customers are participate in the supply chain through pulling the product, which increase the speed of the process[22]. In LSS, quality and speed are combined in order to achieve control and delivery requirements of the processaccording to customer needs [23].

Improvement of Process

LLS have combined the methodologies of SS and Lean in a way to complement each other. The lean approach is implemented to gain a steady flow through the customer participation in the supply chain and boost the performance and speed of the process [24]. Then SS is implemented to mitigate variations within the process, remove as defects as possible through the operation of the process and control the process according to the targeted upper and lower specification limits [25].

Human Resources

Commitment and training of workforce related to LSS tools are fundamental for efficient implantation of LSS. In addition, significant resources, cost and knowledge are needed [26]. It should be noted that LSS utilizes the same hierarchical structure as the methodology of SS.

Factual Decision-Making

Facts and data are important factors in the decision-making process of a firm. SS provides information regards the quality of the process and it employed to establish an improvement by implementing its tools. Zu, Fredendall, & Douglas, (2008)found that the systematic collection of date in a firm allowsthe responsible authorities to define the significant issues. Linderman, Schroeder, Zaheer, & Choo, (2003) mentioned that date should be reliable and grounded on objective measurements to ensure that process is run as targeted and make decisions through improving process.

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

Lean Six Sigma Implantation Plan

A proper well-constructed implementation plan layout the selection process of project and the way the initiative will be progressed [20]. There are several roadmaps which can be adopted according to the firm's needs. One of the appropriate and efficient approach was developed by Snee, (2010) in which the main elements of implementaion plane has been identified. theses elemts are shown in figure 2.

Figure 2: The main elements for the implementation plan of LSS according to Snee, (2010).

Cost of Quality

Firms set quality as the most important value for customer satisfaction and count it as a significant factor for fulfilling competiveness. In a process of improving quality, the cost related to achieving the intended quality is a considered as a critical factor since the aim of ongoing improvement programs is to meet customer needs with least production cost[27]. The cost of quality (COQ) is defined as the total cost incurred through the phases of quality management system (Design, implementation, operation and maintenance), the cost of resources allocated to ongoing improvement, the cost of product, system and services inabilities and all other cost and non-add value activities needed to achieve the intended quality of service or product[28]. Vaxevanidis & Petropoulos, (2008)has provided a more precious definition for COQ as "the sum of conformance and non-conformance cost" (p: 74). The cost of conformance has identified as the prevention of poor quality cost and appraisal cost where the non-conformance cost is the cost of poor quality and is implied the cost of external and internal failures [29].

Firms concern to the cost of quality since it counts as a meaningful measure for the effectiveness of the ongoing improvement cycle [30]. Cost of quality serves as a tool for earning the commitment of senior management. COQ also considers as a tool for capturing areas that need improvement. Cost of quality perform as a mean for preparing a case to establish a total initiative for quality management and provides an estimation for the potential benefits which will be earned through the quality improvement[31].

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

Competitive Advantage

Firms are challenged because of evolution of customer expectation, advancement of technology, and short life cycles for product. Invention acts a vital role for obtaining competitive advantages[32]. According to Barney J. , (2000) a firm has a competative advantage when it implements a strategy for value creating which is not being implemented by any potential or current competitors at the same time. Morover, a firm has a sustaniable competative advantage when the benifities of its value creating strategy cannot be duplicated by other firms.

The Realtion Between Quality and Competitive Advantage

The Realtion Between Quality and Competitive Advantage have been investigated by researchers and there is a consensus on the positive impact of quality on competitive advantage. Table 1 shows some of these researches.

Table 1: Some of Previous Researches That Investigate the Relation between Quality and Competitive Advantage.

Researchers	**Variables**	**Relation**
KROL, Wright, & Heiens, (1999)	Product quality and relative market shares	Positive relatioship
Das, Handfield, Calantone, & Ghosh, (2000)	Quality, customer satisfaction and competative advantage	High quality investements are crucial for customer satisfaction in moderate to high condistion of competition
Lee & Choi, (2006)	(Process innovation, quality) (quality, corporate competitivness)	Positive relationship
Lakhal, (2009)	Quality and competative advantege	Positive relatioship
Drohomeretsk, Gouvea da Costa, de Lima, & Garbuio, (2013)	Quality and most significant competitive priorities for firms	The most significant priority

The Contribution of Lean Six-Sigma Techniques and Tools in Reducing the Cost of Qualityand Fulfilling of Competitive Advantage

As mentioned above, one of the main objective of Lean Six Sigma is to improve the quality of a process within the least cost. The implementation of LSS has clearly shown a signifcant variation on the efficency of the targated process. Unefficient waiting time through the lifecycle of a process is considered a parmount problem especially for firms that provide services. Firms which implement LSS have gained a meaningful acheivement regarding this problem. LSS haseliminated the unsufficent waiting time of life cycle. Verver, Does, & Heuvel, (2006)have investigated the impact of LSS implementation in reducing the lifecycle time for a maintenance process at the Red

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

Cross Hospital. LLS have significantly decreased the number of maintenance persons and have led to a financial saving of €200,000. In additionDoes, Koning, & Bisgaard, (2008) have detected that LSS has dropped the waiting time through an information request process from 21.5 to 12.3 days and dropped the number of IR from 5.5 to 2.6. According toDoes, Koning, & Bisgaard, (2008) the annual savings of the project was €260,000. Moreover, firms that employed LLS to improve their customer satisfaction have confirmed the meaningful impact of LLS. Amway company at Taiwan has employed DMAIC toolto solve problems of customer unsatisfaction. Most of its customers groused that credit vouchers were not afforded imdeiately at the corners of service center and the vouchers' data were not correct. The project has improved the customer satisfaction and the finicial revenue was NT$ 1,200,000(Lee, Cheng-Ting, & Gwo-Ji, 2013). LLS confirm its significance not only in the servicing industries but it also improves the innovation one. Arizona State University has employed 5S and DMAIC tools to optimize the desensitized solar cells fabrication. 5S has booted the efficiency of all project. DMAIC wasused to eliminate defects of the critical titanium dioxide deposition process. Both tools have reduced the fabrication time by 54% and all critical defects to the extent have been eliminated. Add up the production of good cells has arisen from 17% to 90% [33].Prieto-avalos, Navarro-gonzález, González-angeles, & Medina-león, (2014) have investigated the influence of using DMAIC and VSM tools in manifacturing field. Both tools are employed to improve the effeciencyof all processes of production AC capacitors in AC CAPS area. The results of the project showed that the proceses were improved and the DPMO (Defects-Per-Million-Opportunities) was equaled to 3.4.

The efficient implementation of SS tools should foster the competitive advantage of the firm business [34]. Through the combination of DMAIC tools and TRIZ method, Wang & Chen, (2010) have indicated the efficiency of LLS in fostering the competitive advantage for banks with financial savings equal to US$828,000 through improving the running of savings account, reducing the cycle time of call centers, redesigning and improving of IT process related to remittance operation. LLS can help firms to respond effectively and quickly to the deviances inherent within hypercompetitive and rapidly changing environment [35]. Manville, Greatbanks, Krishnasamy, & Parker, (2012) have confirmed this result through emlpoying LSS in highly changeability firms that affected by political, social and technological factors through eliminating waste, maximize process speed and simplify the way in which firm performs its business.

VI. Data analysis

This section presents the findings of the study that aims to the Influence of Lean Six-Sigma Tools in Reducing the Cost of Quality and Fulfilling of Competitive Advantage of Firms. A cross sectional survey was utilized to obtain results by distributing it on a sample of (98) participants. Thus, the statistical package for the social sciences (SPSS) will be utilized to analyze the collected data in tabular and graphical form in order to perform an illustrative analysis. This section will give an explanation of the questionnaire outcomes obtained after collecting and analyzing the response. In this study, the mixed method is considered to specifically utilize the strength points of both quantitative and qualitative approaches.

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

Reliability analysis

The researcher has distributed the questionnaire on sample of study (98 respondents) and computes extents questionnaire reliability by calculation of internal consistency using Cronbach' alpha values, The Cronbach' alpha value for the total alpha values of " Influence of Lean Six-Sigma Tools in Reducing the Cost of Quality and Fulfilling of Competitive Advantage of Firms" reached (.780), this indicates to accept reliability.

Demographic profile of participants

The percentage and frequency were computed for each demographic variable to explore the participant's profile. The total number of participants in this study was 98 participants, belonging to various position, age, level of Education, gender, and experience years, which gain the study responses about research objectives and questions.

Table 1. Distribution of the sample according to gender

Independent Variable	Category	Frequency	Percent %
Gender	Male	93	94.9
	Female	5	5.1
	Total	**98**	**100.0**
Level of Education	Diploma	4	4.1
	Bachelor	3	3.1
	Master	16	16.3
	Doctorate	75	76.5
	Total	**98**	**100.0**
Age	Less than 30	12	12.2
	30-35	9	9.2
	36-40	59	60.2
	40-45	14	14.3
	More than 45	4	4.1
	Total	**98**	**100.0**
Position	Manager	31	31.6
	Head of department	23	23.5
	Employee	44	44.9
	Total	**98**	**100.0**
Experience	Less than 5	62	63.3
	5-10 years	18	18.4
	11-15 years	3	3.1
	More than 15	15	15.3
	Total	**98**	**100.0**

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

According to gender category, the high percentage of participant was male with total 94.9%, while the female participants represented only 5.1%. See figure no 1.

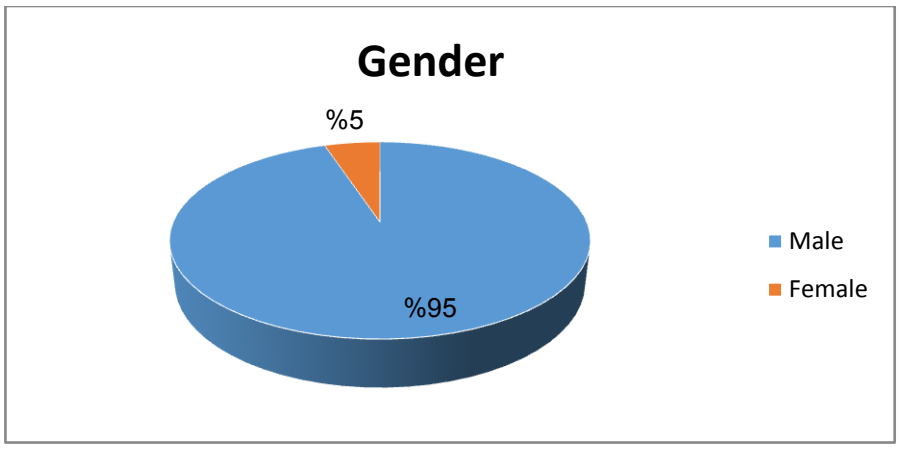

Figure 1: Demographic profile: gender

Table 1 presents the profile of the respondents in terms of experience, here are 62 respondents, 63.3%; they have less than 5 years' experience. Another 18 respondents, 18.4% whose experience between 5 to 10 years, with the remaining 3.1 % of respondents has between 11 to 15 years.

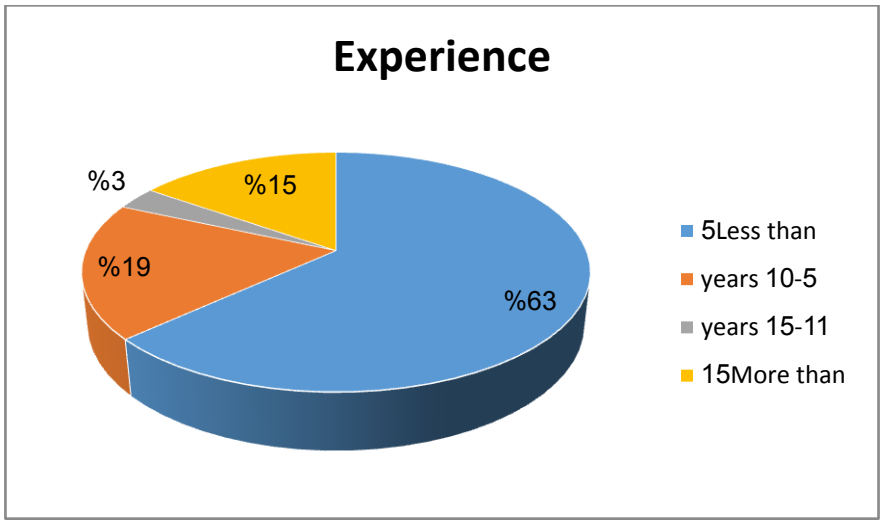

Figure 2. Experience responses

Table 1 shows the education level, it is worth pointing out that most of the respondents hold doctorate level degree at a percentage 76.5%. However, the lowest categories (bachelor's degree) by frequency (3) percentage 3.1 %.

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

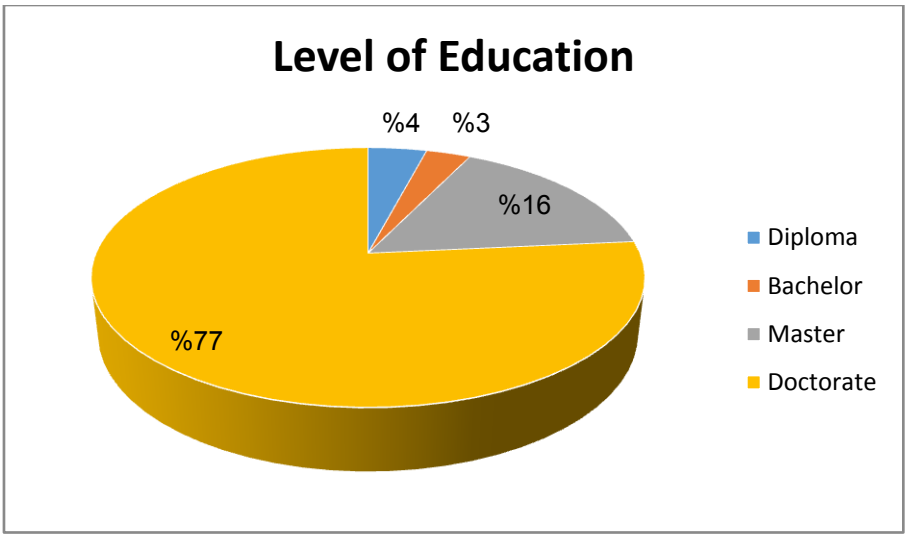

Figure 3. Education level of respondents

According to position category, it is worth pointing out that most of the participants are employee at a percentage of 44.9%. Following with 31.6% of the respondents are manager. However, the lowest categories (Head of department) percentage 23.5 %. See figure no 4.

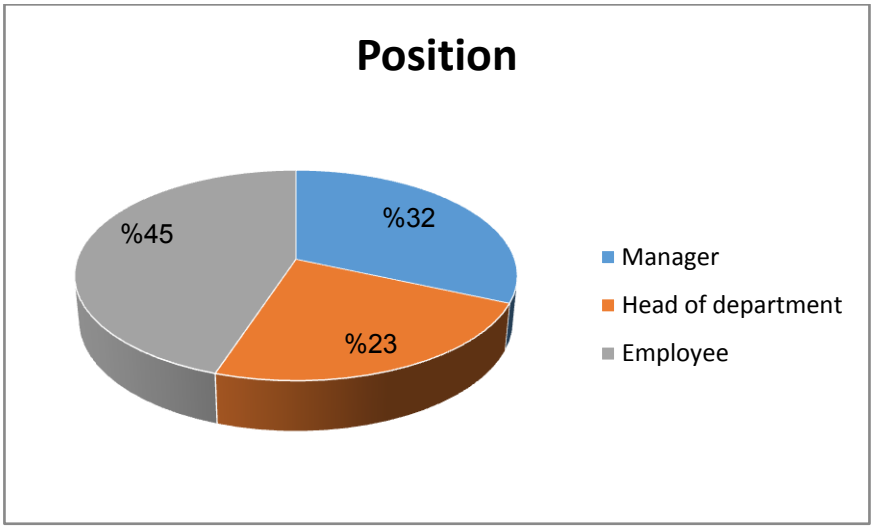

Figure 4. Position of respondents

Furthermore, the table no. (1) shows that the majority of participant age was within between 36-40 years, and 40-45 years totaling of 60.2%, 14.3% respectively of the study participants. While the age participants more than 45 years represents only 4.1%. As shown in figure below.

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

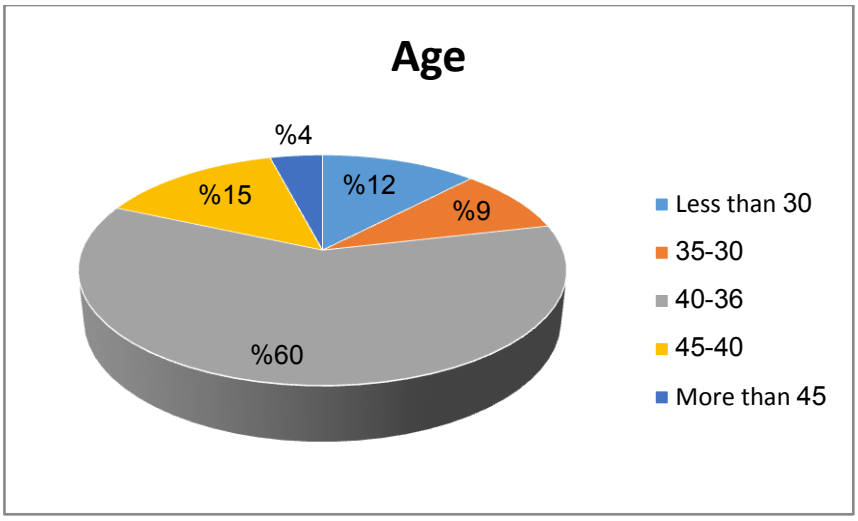

Figure 5. Demographic profile: age

Means and standard deviation

Means and standard deviation for "Lean Six-Sigma" items and total means of them, tables 2 shows that.

No.	Item	Agreement					Mean	S.D	Rank
		Strongly agree	Agree	Do not know	Disagree	Strongly disagree			
1	Reducing administrative errors	1.0	6.1	15.3	29.6	48.0	4.17	.974	1
2	Reducing daily work costs	4.1	7.1	14.3	23.5	51.0	4.10	1.144	2
3	Organizing daily workloads for employees	5.1	8.2	9.2	26.5	51.0	4.10	1.180	2
4	Overcoming obstacles that reduce performance levels	3.1	8.2	17.3	21.4	50.0	4.07	1.133	4
5	Accuracy and prompt delivery of instructions to employees	6.1	9.2	21.4	29.6	33.7	3.76	1.193	5
Total means							4.04	.862	

Table 2. Means and standard deviation for "Lean Six-Sigma" items and total means of them (n= 98)

Shown in the table 2 that the arithmetic means of paragraphs "Lean Six-Sigma" ranging from (3.76-4.17), the highest means reached (4.17) out of (5) for item (1) " Reducing administrative errors", then for items (2), (3) " Reducing daily work costs", " Organizing daily workloads for employees" (means 4.10). And the lowest means was (3.76) for items (5)" Accuracy and prompt delivery of instructions to employees", the total mean for "" Lean Six-Sigma" reached mean (4.04) and standard deviation (0.862).

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

- Cost of Quality

Table 3. Means and standard deviation for "Cost of Quality" items and total means of them (n= 98)

No.	Item	Agreement					Mean	S.D	Rank
		Strongly agree	Agree	Do not know	Disagree	Strongly disagree			
1	The company is keen to ensure that the quality of the products conforms to the specifications and standards	13.3	10.2	14.3	21.4	40.8	3.66	1.436	3
2	The company bears the costs of testing and inspection during production operations.	15.3	14.3	10.2	44.9	15.3	3.31	1.319	5
3	The company incurs the costs of injury to workers and its compensation.	9.2	23.5	19.4	31.6	16.3	3.22	1.240	7
4	The company shall bear the cost of controlling the quality of services provided to customers.	13.3	13.3	20.4	42.9	10.2	3.23	1.208	6
5	The company's management is aware of the importance of the costs of preparing and implementing quality-related training programs.	8.2	8.2	14.3	43.9	25.5	3.70	1.177	2
6	The company's management continuously checks the costs of planning the quality system.	4.1	8.2	13.3	40.8	33.7	3.92	1.081	1
7	The senior management of the company determines the costs of the final inspection of the products before undertaking the supply process.	3.1	16.3	24.5	30.6	25.5	3.59	1.129	4
Total means							3.52	0.671	

Shown in the table 3 that the arithmetic means of paragraphs " Cost of Quality" ranging from (3.22-3.92), the highest means reached (3.92) out of (5) for item (6)" The company's management continuously checks the costs of planning the quality system ", then for item (5) " The company's management is aware of the importance of the costs

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

of preparing and implementing quality-related training programs " (means 3.70). And the lowest means was (3.22) for item (3)" The company incurs the costs of injury to workers and its compensation ". The total mean for "Cost of Quality" reached mean (3.52) and standard deviation (0.671).

- Competitive Advantage of Firms

Table 4. Means and standard deviation for “Competitive Advantage of Firms" items and total means of them (n=

No.	Item	Agreement					Mean	S.D	Rank
		Strongly agree	Agree	Do not know	Disagree	Strongly disagree			
1	The company is keen on creativity and innovation in its products and innovation promotional methods at low cost.	7.1	3.1	15.3	38.8	35.7	3.93	1.133	5
2	The company's management seeks to reduce production costs to achieve a competitive advantage compared to competitors' products.	13.3	24.5	14.3	32.7	15.3	3.12	1.310	7
3	The company's management focuses on adopting a clear and reliable quality strategy.	-	6.1	12.2	44.9	36.7	4.12	0.853	3
4	The company works to reduce the percentage of defects in its products compared to competitors.	6.1	2.0	10.2	35.7	45.9	4.13	1.090	2
5	The company has the ability to rapidly respond to changes in product designs.	3.1	4.1	8.2	34.7	50.0	4.24	0.985	1
6	The company's management can develop its new products quickly.	7.1	11.2	26.5	32.7	22.4	3.52	1.169	6
7	The delivery times of the products in the company are very reliable.	2.0	6.1	14.3	50.0	27.6	3.95	0.924	4
Total means							3.86	0.570	

98)

Shown in the table 4 that the arithmetic means of paragraphs " Competitive Advantage of Firms " ranging from (3.12-4.24), and most notably the highest means reached (4.24) out of (5) for item (5)" The company has the ability

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

to rapidly respond to changes in product designs ", then for item (4) " The company works to reduce the percentage of defects in its products compared to competitors " (means 4.13). Moreover, the lowest means was (3.12) for items (2) "The Company's management seeks to reduce production costs to achieve a competitive advantage compared to competitors' products ". The total mean for "Competitive Advantage of Firms "reached mean (3.86) and standard deviation (0.570).

Answer questions

Main question:what is the influence of LLS tools in Reducing the Cost of Quality and Fulfilling of Competitive Advantage of Firm?

To answer this question, and to detect the effect of LLS tools on Reducing the Cost of Quality and Fulfilling of Competitive Advantage of Firm, the (Linear Regression) analysis was used (see Table 5).

Table 5. Result of the (Linear Regressions) analysis of LLS tools on the Cost of Quality (n=98)

Independent variable	"t" value	"t" sig	B	R	R^2	"f" value	"f" sig
LLS	8.429	0.00	0.508	0.652	0.425	71.055	0.00

*** Dependent variable: Cost of Quality**

Table (5) shows there is a statistically significant effect at significant level (P≤0.05) of LLS tools on the Cost of Quality (f [1] = 71.055, P < .001). Also, the table shows a statistically significant effect of LLS tools on the Cost of Quality (t [1] = 8.429, P= .000), so the first hypothesis is accepted. The independent variable explained the 65% of changes in dependent variables (r^2= .425, N= 98, P<0.00). The variable effect of the LLS, which represents the beta value (β=0.508).

Table 6. Result of the (Linear Regressions) analysis of LLS on Fulfilling of Competitive Advantage of Firm (n= 98)

Independent variable	"t" value	"t" sig	B	R	R^2	"f" value	"f" sig
LLS	2.004	0.048	0.132	0.200	0.040	4.015	0.048

*** Dependent variable: Competitive Advantage**

Table (6) shows the value of (R) (0.20), which means the positive impact of LLS on Fulfilling of Competitive Advantage of Firm. Therefore, there is a statistically significant effect of LLS on Fulfilling of Competitive Advantage of Firm, where "f" is (4.015) and statistically significant (0.048), the variable effect of the LLS, which represents the beta value (β=0.132).

VII. Conclusion

The aim of this study was to explore the influence of LLS tools on reducing COQ and fulfilling the competitive advantage of firms. LLS have a significant impact on firms. Regarding the cost of quality, LLS assists firms to

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

achieve their goals related to the quality of their services and products. LLS have improved the quality of their services and products in line with increased their financial savings. The study also shows that there is appositive relationship between quality and competitive advantage. Thus, the improvement of quality was reflected on the competitive advantage of the firms. LLS implementation has fostered the competitive advantage for intends firms.

The theoretical review for many studies that have addressed this topic was revised. The outcomes of this study show that LLS can be considered as a meaningful strategy for firms that concern in the following aspects:

- Reducing the lifecycle of their process.
- Increased the efficiency of their process.
- Decreased the variation of their process in order to get DPMO equals to 3.4.
- Improve the quality of their services and products.
- Improve the satisfaction of their customers.
- Increase their financial savings.
- Foster their competitive advantage in market.

VIII. Bibliography

[1] S. Rakusa, "Business Process Improvement Using Lean Six Sigma: AN Example of Improving the Onboarding Process," University of Slovenian, Slovenian, 2016.

[2] M. Aboelmaged, "Six Sigma quality: A structured review and implications for future research," *International Journal of Quality & Reliability Management,* vol. 27, no. 3, pp. 268-317, 2010.

[3] D. Thompson and P. Mintz, "Lean manufacturing," *Business Journal*, 1999.

[4] A. Al-Refaie and B. Hanayneh , "Influences of TPM, TQM, Six Sigma practices on firms performance in Jordan," *Int. J. Productivity and Quality Management,* vol. 13, no. 2, pp. 219-235, 2014.

[5] C. Dumitrescu and M. Dumitrache, "The Impact of Lean Six Sigma on the Overall Results of Companies," *Economic Seria Management,* vol. 14, no. 2, pp. 535-544, 2011.

[6] P. Pande and L. Holpp, "WHAT IS SIX SIGMA?," McGraw-Hill, New York, 2002.

[7] R. Andersson, H. Eriksson and H. Torstensson, "Similarities and differences between TQM, Six Sigma and lean," *The TQM Magazine,* vol. 18, no. 3, pp. 282-296, 2006.

[8] H. Gitlow and D. Levine, Six Sigma for Green Belts and Champions: Foundations, DMAIC, Tools, Cases, and Certification, Upper Saddle River, NJ: Prentice-Hall, 2005.

[9] R. Hoerl and R. Snee, Leading Six Sigma., Upper Saddle River, NJ: Prentice-Hall, 2003.

[10] N. Fursule, S. Bansod and S. Fursule, "Understanding the Benifits and Limitations of Six Sigma Methodology," *International Journal of Scientific and Research Publications,* vol. 2, no. 1, pp. 1-9, 2012.

[11] J. Oliver and G. Freisinger, "Lean and Six Sigma Training," Reinischkogel, 2015.

[12] F. Anbari and Y. H. Kwak, "Benifits, obstacles and future of six sigma approach," *Technovation,* pp. 1-8, 2004.

[13] J. Johnson, H. Gitlow, S. Widener and E. Popvich, "Designing New Housing at the University of Miami: A “Six Sigma” DMADV/DFSS Case Study," *Quality Engineering,* vol. 18, p. 299–323, 2006.

[14] R. Majumdar and K. Selvi, "Six Sigma- Overview of DMAIC and DMADV," *International Journal of Innovative Science and Modern Engineering,* vol. 2, no. 5, pp. 16-19, 2014.

[15] A. Cherrafi, S. Elfezazi, A. Chiarini, A. Mokhlis and K. Benhida, "The integration of lean manufacturing, Six Sigma and sustainability: A literature review and future research directions for

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

developing a specific model," *Journal of Cleaner Production,* pp. 828-846, 2016.

[16] A. Chiarini and E. Vagnoni, "Worldeclass manufacturing by Fiat. Comparison with Toyota production system from a strategic management, management accounting, operations management and performance measurement dimension," *Int. J. Prod. Res,* vol. 53, pp. 590-606, 2015.

[17] F. Abdullah, "LEAN MANUFACTURING TOOLS AND TECHNIQUES IN THE PROCESS INDUSTRY WITH A FOCUS ON STEEL," Uinversity of Pittsburg, Pittsburg, 2003.

[18] Y. Monden, Toyota Production System-An Integrated Approach to Just-In-Time, Norcross, Georgia: Engineering and Management Press, 1998.

[19] J. Womack, D. Jones and D. Ross, The Machine That Changed The World, Canada: Macmillan Publishing Company, 1990.

[20] R. Snee, "Lean Six Sigmae getting better all the time," *Int. J. Lean Six. Sigma,* vol. 1, no. 1, pp. 9-29, 2010.

[21] R. Schroeder, K. Linderman, C. Liedtke and A. Choo, "Six Sigma: Definition and underlying theory," *Journal of Operations Management,* vol. 26, no. 4, pp. 536-554, 2008.

[22] R. Cagliano, F. Caniato and G. Spina, "Lean, Agile and traditional supply: How do they impact manufacturing performance?," *Journal of Purchasing & Supply Management,* vol. 10, pp. 151-164, 2004.

[23] C. Brett and P. Queen, "Streamlining Enterprise Records Management with Lean Six Sigma," *Information Management Journal,* vol. 39, no. 6, pp. 58-62, 2005.

[24] S. De Treville and J. Antonakis, "Could lean production job design be intrinsically motivating? Contextual, configurational, and levels-of-analysis issues," *Journal of Operations Management,* vol. 24, no. 2, pp. 99-123, 2006.

[25] K. Linderman, R. Schroeder, S. Zaheer and A. Choo, "Six Sigma: A goal-theoretic perspective," *Journal of Operations Management,* vol. 21, no. 2, pp. 193-203, 2003.

[26] S. Kumar and K. Bauer, "Exploring the use of Lean Thinking and Six Sigma in public housing authorities," *The Quality Management Journal,* vol. 17, no. 1, pp. 29-46, 2010.

[27] A. Schiffauerova and V. Thomson, "A review of research on cost of quality models and best practices," *International Journal of Quality and Reliability Management,* vol. 23, no. 6, pp. 647 - 669, 2006.

[28] B. Dale and J. Plunkett, Quality costing, London: Chapman and Hall, 1995.

[29] S. Cheah, A. Shahbudin and M. Taib, "Tracking hidden quality cost in manufacturing company: an action research," *International journal of quality and reliability management,* vol. 28, pp. 405-425, 2011.

[30] R. Martin, "Do we practice quality principles in the performance measurement of critical success factors?," *Total quality management,* vol. 8, no. 6, p. 429–444, 1997.

[31] D. Desai, "Cost of quality in small- and medium-sized enterprises: case of an Indian engineering company," *Production Planning & Control: The Management of Operations,* vol. 19, no. 1, pp. 25-34, 2008.

[32] Y. Azis and H. Osada, "Innovation in management system by Six Sigma: an empirical study of world-class companies," *International Journal of Lean Six Sigma,* vol. 1, no. 3, pp. 172-190, 2010.

[33] B. Fauss, L. Munukutla, L. Main, G. Polesky and A. Kannan, "Optimizing the DSSC Fabrication Process using Lean Six Sigma," *Materials Research Society,* vol. 1537, pp. 1-6, 2013.

[34] R. Gowen and W. Tallon, "Effect of technological intensity on the relationships among Six Sigma design, electronic-business, and competative advantage: A dynamic capabilities model study," *The Journal of High Technology Management Research,* vol. 16, no. 1, pp. 59-87, 2005.

[35] G. Manville, R. Greatbanks, R. Krishnasamy and D. Parker, "Critical success factors for Lean Six Sigma programmes: a view from middle management," *International Journal of Quality & Reliability Management,* vol. 29, no. 1, pp. 7-20, 2012.

[36] P. Dennis, "Lean Production Simplified," Productivity Press, New York, 2007.

[37] J. Liker, Becoming Lean, New York: Free Press, 1996.

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

[38] R. Russell and B. Taylor, Operation Management, Englewood Cliffs: Prentice-Hall, 2000.

[39] B. Bergman and B. Klefsjo, Quality from Customer Needs to Customer Satisfaction, Lund, Sweden: Studentlitteratur, 2003.

[40] K. Magnusson, D. Kroslid and B. Bergman, Six Sigmae the Pragmatic Approach, Lund, Sweden: Studentlitteratur, 2003.

[41] F. Breyfogle III, Implementing Six Sigma: Smarter Solutions Using Statistical Methods., New York: Wiely, 1999.

[42] K. Hoerl, "Six Sigma and the future of the quality profession," *Quality Progress,* vol. 31, no. 6, pp. 35-42, 1998.

[43] K. Ishikawa, What Is Total Quality Control? The JapaneseWay. Lu, D.J. (Trans.), Englewood Cliffs, NJ: Prentice-Hall, 1985.

[44] H. Kume, Statistical Methods for Quality Improvement. Loftus,, Tokyo, Japan: The Association for Overseas Technical, 1985.

[45] H. Kume, Management by Quality., Tokyo, Japan: 3A Corporation, 1995.

[46] K. Sinha and A. Van de Ven, "Designing work within and between organizations," *Organization Science,* vol. 16, no. 4, p. 389–408, 2005.

[47] M. Barney, "Macro, meso, micro: Six Sigma," *The Industrial Organizational Psychologis,* vol. 39, no. 4, p. 104–107, 2002.

[48] M. Barney, "Motorola's second generation," *Six Sigma Forum Magazine,* vol. 1, no. 3, p. 13–16, 2002.

[49] A.M.T. successfactory and Uckert Sigma Consulting , "Lean Six Sigma Black Belt in Administration," Training material, Leoben, 2015.

[50] M. George, "Lean Sisx Sigma Combining Six Sigma and Quality With Lean Production Speed," CWL, Wisconsin-Madison, 2003.

[51] R. Fullerton and W. Wempe, "Lean manufacturing, non-financial performance measures, and financial performance," *International Journal of Operations & Production Management,* vol. 29, no. 3, pp. 214-240, 2009.

[52] R. Shah and P. Ward, "Defining and developing measures of lean production," *Journal of Operations Management,* vol. 25, no. 4, pp. 785-805, 2007.

[53] S. Pavnaskar, J. Gershenson and A. Jambekar, "Classification scheme for lean manufacturing tools," *International Journal of Production Research,* vol. 41, no. 13, p. 3075–3090, 2003.

[54] M. George, D. Rowlands and B. Kastle, What is Lean Six Sigma?, New York: McGraw-Hil, 2004.

[55] X. Zu, L. Fredendall and T. Douglas, "The evolving theory of quality management: The role of Six Sigma," *Journal of Operations Management,* vol. 26, no. 5, pp. 630-650, 2008.

[56] N. Vaxevanidis and G. Petropoulos, "A Litreature Survey of Cost of Quality Models," *Journal of Engineering,* pp. 274-285, 2008.

[57] J. Barney, "Firm Resources and Sustained Competitive Advantage," *Advances in Strategic Management,* vol. 17, pp. 203-227, 2000.

[58] J. Verver, R. Does and J. Heuvel, "Lean Six Sigma in Healthcare," *Journal for Healthcare Quality,* vol. 28, no. 2, pp. 4-11, 2006.

[59] R. Does, H. Koning and S. Bisgaard, "Lean Six Sigma in Financial Services," *International Journal of Six Sigma and Competitive Advantage,* vol. 4, no. 1, pp. 1-18, 2008.

[60] K.-l. Lee, T. Cheng-Ting and S. Gwo-Ji, "Using LSS to improve the efficiency and quality of a refund process in a logistics center," *International Journal of Lean Six Sigma,* vol. 4, no. 4, pp. 409-424, 2013.

[61] M. KROL, P. Wright and R. Heiens, "The contribution of product quality to competative advantage: Impacts on systematic variance and unexplined variance in returns," *Strategic Management Journal,* vol. 20, pp. 375-384, 1999.

[62] L. Lakhal, "Impact of quality on competitive advantage and organizational performance," *Operational Research Society,* pp. 637-645, 2009.

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020

[63] A. Das, R. Handfield, R. Calantone and S. Ghosh, "A Contingent View of Quality Management-The Impact of International Competition on Quality," *Decision Sciences,* vol. 31, no. 3, pp. 649-690, 2000.

[64] E. Drohomeretsk, S. Gouvea da Costa, . E. de Lima and A. Garbuio, "Lean, Six Sigma and Lean Six Sigma: an analysis based on operations strategy," *International Journal of Production Research,* vol. 52, no. 3, p. 804–824, 2013.

[65] K. Lee and B. Choi, "Six Sigma management activities and their influence on corporate competitiveness," *Total Quality Management,* vol. 17, no. 7, p. 893–911, 2006.

[66] M. Prieto-avalos, C. Navarro-gonzález, A. González-angeles and S. Medina-león, "Reduction Waste by Combining Lean Manufacturing and Six Sigma in an Electronics Industry," *Research Journal of Applied Sciences, Engineering and Technology,* vol. 8, no. 13, pp. 1558-1562, 2014.

[67] A. Thomas, R. Barton and C. Chuke- Okafor, "Applying lean six sigma in a small engineering company – a model for change," *Journal of Manufacturing Technology Management,* vol. 20, no. 1, pp. 113-129, 2009.

[68] J. Antony, R. Hilton and A. Sohal, "A conceptual model for the successful deployment of Lean Six Sigma," *International Journal of Quality & Reliability Management,* vol. 29, no. 1, pp. 54-70, 2009.

[69] S. Shafer and S. Moeller, "The effects of Six Sigma on corporate performance: An empirical investigation," *Journal of Operations Management,* vol. 30, p. 521–532, 2012.

[70] F.-K. Wang and K.-S. Chen, "Applying Lean Six Sigma and TRIZ methodology in banking services," *Total Quality Management,* vol. 21, no. 3, p. 301 –315, 2010.

DOI: 10.37200/IJPR/V24I3/PR200810
Received: 12 Jan 2020 | Revised: 30 Jan 2020 | Accepted: 02 Feb 2020