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Effect of Lean Six Sigma on order fulfilment process: evidence from manufacturing companies in Gauteng, South Africa

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ABSTRACT

This study examines the collaboration between Lean Six Sigma principles and order fulfilment procedures, which are essential for facilitating international trade. The objective is to ascertain the extent to which sustainable and effective lean processes improve customer satisfaction and accelerate global product delivery. The study employs a dual methodology: initially, doing a comprehensive analysis of the current body of literature on the integration of Lean Six Sigma in order fulfilment inside various manufacturing companies, with the aim of finding any deficiencies or areas that require further investigation. Furthermore, we utilise a quantitative approach by administering surveys to professionals in the South African manufacturing industry. Deductive reasoning examines responses using random sampling to ensure unbiased selection. The findings emphasise that using Lean Six Sigma practices in the South African manufacturing sector can address customer concerns regarding the quality of orders and the timeliness of deliveries. This can provide a competitive advantage in the global market. The study validates that the inclusion of Lean Six Sigma measurements alleviates bottlenecks by focusing on improvements in operations, procedures, and communication. The study demonstrates the effectiveness of Lean Six Sigma methodologies in improving order fulfilment for enterprises engaged in international trade. It promotes these concepts to optimise processes, assuring timely deliveries and increased customer satisfaction. This study addresses several deficiencies in the current research on the incorporation of Lean Six Sigma in the manufacturing order fulfilment process. These gaps encompass the challenges of incorporating emerging technology, integrating collaborative supply chains, and incorporating sustainable practices. The distinctive methodology of integrating a comprehensive analysis of existing literature with empirical evidence enhances the novelty of the research outcomes. Manufacturing companies that aim to achieve global market excellence get practical advantages.

Introduction

Lean is a waste elimination methodology, while Six Sigma is a scientific approach aimed at decreasing errors (Tampubolon & Purba, 2021). Several firms have incorporated the combination of Lean Six Sigma (LSS) methodologies to optimise their operations by leveraging individual strengths and improving workflow efficiency while minimising losses. LSS has enhanced operational procedures on a global scale, and Australia is a notable illustration of this improvement (Price *et al.*, 2018). Notwithstanding these progressions, there are still obstacles that remain, namely in the manufacturing sector, where delays in fulfilling orders have a negative effect on customer service, leading to the loss of clients and revenue (Arndt *et al.*, 2019). The research gap exists in the need for a thorough comprehension of how Lean Six Sigma (LSS) can effectively tackle the underlying problems that impede operational efficiency and customer satisfaction in the manufacturing industry, particularly in relation to order fulfilment.

Manufacturing firms work within a market and commercial environment where client expectations are highly prioritised in terms of product quality, pricing, and delivery (Tampubolon & Purba, 2021). The organisation must manage this demand using a

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comprehensive framework and approach. Tampubolon and Purba (2021) illustrate in a systematic review how the concept and methodology of Lean Six Sigma (LSS) may effectively meet these requirements. Multiple sectors or industries employ the notion or methodology. The utilisation of LSS is widespread throughout several disciplines of study and its application is continuously growing (Thomas *et al,* 2016). The utilisation of LSS continues to be deployed as a means to help organisations improve their competitiveness and quality, decrease expenses, and enhance customer happiness, productivity, and employee morale (Tapubolon & Purba, 2021). The method has to be reassessed to verify that the pertinent concepts and techniques may effectively contribute to improving the business and satisfying the consumer. If a manufacturing firm encounters obstacles that impede its capacity to accomplish the mentioned goals, it might be challenging for the organisation to deliver outstanding customer service. The LSS promotes the minimization of waste and the provision of excellent service (Singh & Rathi, 2019). Several prosperous South African organisations have employed Lean Six Sigma (LSS) to harmonise their operations, while others dismiss its significance and perceive its adoption as excessively expensive.

Efficient order management plays a vital role in ensuring the smooth functioning of the supply chain and maximising customer satisfaction (Copacino, 2019). The steps of order processing are intricately linked to the information flows inside the system. The sales order technique generates internal documentation to facilitate the management of sales transactions. Customers may need to fill out a form in order to place an order. During this procedure, they are submitting and verifying their orders. The subsequent action involves verifying the credit status and confirming the availability of the item. After being packaged and shipped along with the necessary shipping documentation, stock or manufactured products can be retrieved at a later time. It is essential to keep customers informed about the current status of their order. Traditionally, the task of processing orders has accounted for 70% of the total time required to complete an order cycle (Zhan *et.al,* 2022).

Given this information, order fulfilment is primarily focused on creating a product that is able to compete effectively. Efficient businesses that provide superior goods are among the other elements that lead to the increasing sales (Muganyi *et al.,* 2019). Timely order fulfilment enhances consumer demand and happiness, whereas a surge in orders leads to customer attrition and financial losses. Research undertaken in South Africa, as summarised by Martin (2021), suggests that implementing LSS (Lean Six Sigma) is necessary to reduce delays in subsequent operations and practically ensures improved efficiency. This article aims to examine the impact of Lean Six Sigma on the process of order fulfilment. To do this, one must first establish the crucial criteria for order fulfilment in manufacturing enterprises in South Africa. Then, it is necessary to analyse the manufacturing benefits of Lean Six Sigma and also identify any manufacturing issues associated with Lean Six Sigma. Consequently, the study's objective is to offer suggestions for improving order processing in order to decrease cycle times while still ensuring high levels of customer satisfaction. These findings will empower the management to execute Lean methodologies. The study's recommendations on streamlining order processes will have a positive impact on the manufacturing sector. Subsequent researchers can utilise the results of this study to undertake more investigations on how Lean Six Sigma (LSS) might improve business operations. This text provides a comprehensive analysis of the existing literature about order processing in the manufacturing industry, with a specific emphasis on the operational performance of Lean Six Sigma.

This study examines the effect of Lean Six Sigma on the process of order fulfilment in manufacturing companies in South Africa. The objective is to determine the essential criteria for fulfilling orders, evaluate the manufacturing benefits of LSS, and identify the related challenges. The study aims to offer practical suggestions for improving order processing, minimising cycle times, and upholding high levels of customer satisfaction. The discovery of these results will enable management to efficiently use Lean methodologies, thereby enhancing the industrial sector through the streamlining of order procedures. Moreover, the findings of the study can provide valuable guidance to future researchers in their exploration of innovative approaches to using Lean Six Sigma (LSS) to improve business operations in the manufacturing sector.

Literature Review

Theoretical and Conceptual Background

Manufacturing operational performance causes delays, production schedule disruptions, higher project costs, and more. This chapter defines order processing and LSS. Processing delays, manufacturing order issues, and the benefits of LSS in South African businesses are also discussed. The economic prosperity of numerous nations is dependent upon the presence and growth of the Lean Manufacturing Industry (LMI). Transport plays a crucial role in facilitating the growth and development of manufacturers in emerging countries. (Aripin *et al.,* 2023). The utilisation of (LMI) has the potential to facilitate the expansion of the manufacturing sector, hence contributing to overall economic growth. The manufacturing sector plays a crucial role in boosting the economic growth of any nation. (Basu *et al.,* 2021). Additionally, Basu et al., (2021) stated that LMI must manage infrastructure planning and all mechanical engineering tasks. According to Singh et al., (2021), in 2002, over 500,000 Malaysians worked in manufacturing, contributing 9.5% of GDP in Malaysia. Lean and Six Sigma on the other hand, has separate business improvement methods with different performance measures. The implementation of LSS contributes to the enhancement of operational excellence in the context of globalisation. However, it is important to note that there are distinct differences in the approaches employed by LMI and LSS. Nevertheless, both systems were trailblazers in enhancing corporate operations, encompassing every aspect of order processing. (Basu *et al.,* 2023). Lean methods eliminate wastes like overproduction of work-in-process inventory and excess warehouse inventory to process and deliver orders faster (Velmurugan *et al.,* 2020). The lean technique's five principles are defining value from a customer's perspective, identifying non-value-added activities in the value stream, creating continuous flow in all processes, establishing pull systems, and pursuing perfection (Andersson et al., 2019). According to Kumar et al. (2021), the term "4IR" is also referred to as smart manufacturing, intelligent manufacturing, and digital manufacturing. It aims to enhance the flexibility, agility, and intelligence of existing manufacturing processes in order to satisfy the demands of the global market (Zhong et al., 2017). Kamble et al. (2019) provided an in-depth analysis of the impact of Industry 4.0 on Lean manufacturing and the sustainable performance of organisations. In the manufacturing industry, organisations must adapt their production, quality, and supply chain strategies in accordance with the latest emerging trends in these areas. The attainment of lean aims can be expedited through the use of contemporary advanced technologies, such as Industry 4.0 (I4.0) and the Internet of Things (IoT). Companies that adhere to the Lean methodology strive to align Lean principles with the key factors driving smart production. The literature study reveals that a limited number of writers have proposed a hybrid model incorporating Lean and I4.0 characteristics for the evaluation of small and medium enterprises (SMEs) in the global market, with the aim of enhancing their competitiveness (Kolla *et al.,* 2019; Tortorella *et al.,* 2018). In their study, Satoglu et al. (2018) provided evidence to support the notion that organisations can enhance their management and organisational capabilities by integrating Industry 4.0 technologies with Lean activities.

In the realm of manufacturing, it has become imperative to discover and incorporate Industry 4.0 applications within various processes in order to integrate digital solutions seamlessly. It is well acknowledged that throughout the past several decades, firms have been engaged in a process of acquiring knowledge and implementing Lean systems in their production processes. However, it is imperative for these companies to now comprehend the most effective practises that are aligned with the current market dynamics, specifically pertaining to digital solutions. It is imperative for organisations to link themselves with intelligent and digital technology in order to properly implement Lean processes. Industry 4.0 technologies have the capability to remove obstacles that hinder the implementation of Lean practises in manufacturing organisations. Consequently, the adoption of Lean manufacturing practises presents significant opportunities for the effective deployment of automation technologies (Sanders *et al.,* 2016). A fundamental principle or belief that is considered important or desirable in a certain context.

Lean Six-Sigma Order Processing

Orders are received and subsequently delivered within the framework of the Order Processing Process (OPP). The order fulfilment cycle time refers to the duration between the receipt of an order and its subsequent shipment. The Order Fulfilment Process (OFP) is a multifaceted procedure that encompasses numerous functional units. The concept under consideration has a strong correlation with the management of tasks, allocation of resources, and engagement of agents. (Laurikainen, 2020). This process entails the coordination of activities across several organisational units, involving sales commitments, credit assessments, production operations, logistical processes, accounts receivable management, and collaborations with external suppliers for procurement or transportation purposes. (Heydari *et al.,* 2020). The OFP's goals are:

i. Order management accepts and commits orders.
ii. Manufacturing—shop floor control, material planning, capacity planning, and production scheduling.
iii. Logistics, including transportation and inventories, is distribution.

Sales orders list the item, amount, delivery date, and prior balance order. Sales orders contain customer order details. The production department will check with the warehouse to make sure there are enough materials to make the products. If there aren't enough raw materials to make the goods, the production department will suggest the buying department buy them (Laurikainen, 2020). The filing program receives a production report after the item is made. When the production department requests supplies, the purchasing department sends a buy order to the supplier. The purchasing department will track the previous balance order, and suppliers will meet all requirements. The file system will store the delivery order after receiving the materials (Laguna and Marklund, 2018). Six sigma sets customer expectations for high-quality products. LSS integrates lean (value creation and waste reduction) and six sigma Critical to Quality elimination (CTQ) to improve business (Madhani, 2018). Correctly applying lean principles can improve company efficiency, cycle time, cost savings, and competitiveness. Lean eliminates waste (non-value-added components in any process). Lean applies beyond manufacturing. Lean can improve inventory management and client interaction, improving teamwork.

Common Order Processing Factors

Dumas et al., (2018) defined order management as more of a phase that addresses how businesses handle incoming orders. This is the flow of events that occur between the time a company receives an order and the time the warehouse is told to send the items to satisfy the request (Laureani & Antony, 2019). Outbound logistics order managers need quick and reliable order information, according to (Demir, et al.,2020). Furthermore, they stated that the efficiency of a Supply Chain's operations and customer satisfaction depend on proper order management. Additionally, order management is one of the core processes in SCM that deals with four basic factors which are: planning tools, supply chain relationships, relationship with suppliers, and lean six sigma.

Planning tools

Business planning tools encompass various planning technologies such as resource planning tasks, MRP, MRPII, and ERP, all of which are widely used (Al-Amin *et al.,* 2023). According to Oluyisola, (2021), MRP aids companies in meeting tight deadlines by leveraging information from the bill of materials, inventory, and master production schedule. MRPII integrates manufacturing and

MRP processes, while ERP streamlines supply chain data processing. There is often an overlap between order management, inventory delivery, financial planning, and customer service within these systems, supporting overall business logistics (Demir, 2020).

According to King. (2019), The concept of Lean is optimizing57ed as a methodical and continuous approach to discovering and eliminating inefficiencies, while concurrently 0ptimizing the flow of processes, with a notable focus on actively involving individuals. Despite its origins in manufacturing, Lean thinking can be applied to any industry, with a central focus on enhancing product and service quality since customers ultimately determine value and price (Chen *et al.,* 2021). One of the fundamental principles of Lean involves the identification of value flow, wherein a clear distinction is made between operations that add value and those that do not contribute value for each individual product. Value flow refers to the series of activities that occur from the initial concept to the final delivery, with the aim of meeting customer expectations. The principal objective of Lean methodology is to eradicate activities that do not contribute value. Within the realm of manufacturing, there are seven distinct categories of waste that can be identified, encompassing various operations that fail to contribute any significant value. In general, it is seen that a minority, specifically fewer than 1%, of activities yield significant value, leading to a tendency to allocate resources towards the improvement of this select fraction. Consequently, the remaining 99% of chances are frequently neglected or disregarded. (Gaikwad & Sunnapwar, 2020). To ensure a smooth product delivery process, value-adding steps must be organized. Once non-value-added activities are identified in the value flow, they are eliminated, and flow and pull mechanisms are introduced. Furthermore, Lameijer *et al.,* (2023) concur that, the continuous improvement process is iterated until all waste is transformed into perfect value. In essence, Lean manufacturing involves reducing waste to enhance productivity, with a primary focus on maximizing customer value while minimizing resource utilization. Consequently, any customer-unvalued activity is considered waste.

The Main Benefits of Implementing Lean Six-Sigma

The implementation of Lean Six Sigma provides numerous substantial advantages to organisations. Firstly, the decrease in project lifecycle time holds significant importance in the contemporary globalised corporate landscape, wherein customer satisfaction is a primary concern, particularly with regard to lead time and order processing speed. (Noto, & Cosenz, 2021). Manufacturers are under increasing pressure to meet customer demands for rapid delivery and product quality. Lean Six Sigma's integrated approach, which combines the strengths of both Lean and Six Sigma methodologies, is crucial for achieving this goal. This integrated approach utilizes value-stream mapping (VSM) as a foundation, incorporates Six Sigma tools to optimize process parameters, integrates Lean techniques into the Define-Measure-Analyze-Improve-Control (DMAIC) framework, and restructures processes based on future state VSM (Brown, 2023). Through this synergy, organizations can enhance their operational efficiency, eliminate defects, and deliver products quickly and cost-effectively.

Lean Six Sigma does not only decrease the duration of project lifecycles but also greatly improves customer satisfaction. Organisations can achieve a consistent delivery of high-quality products or services to their consumers by effectively correcting defects and enhancing process efficiency. (Noto & Cosenz, 2021). Moreover, Samantha et al., (2023), stated that the integration of Lean principles into the Six Sigma framework allows for the elimination of waste, thereby reducing costs and ultimately enabling organizations to provide more value to customers. Furthermore, the emphasis on continuous improvement embedded within Lean Six Sigma ensures that organizations remain adaptable and responsive to changing customer needs and market dynamics (Antony et al., 2023). In conclusion, Lean Six Sigma's holistic approach not only streamlines operations but also creates a customer-centric culture that fosters customer loyalty and trust, positioning organizations for long-term success in today's competitive global landscape.

Application of DMAIC in Order Processing

The DMAIC cycle outlines a structured approach for process improvement, encompassing the definition of the improvement process, the measurement of its initial and desired performance levels, the analysis of process data to identify critical process inputs that impact outputs, the optimisation of the process to enhance outputs, and the implementation of controls to ensure the sustained improvement of the process. (Daniyan, 2022; Foster, 2010). Six sigma teams use sophisticated root-cause analysis and statistical tools throughout the DMAIC cycle to improve continuously. Six sigma and lean principles aim to eliminate process variation without affecting core processes. The Six Sigma Process Improvement team finds the critical X (cause) that causes the process's undesirable Y (defect). 5S improves workplace processes, practices, and products through visual control and lean implementation. It underpins continuous improvement, zero defects, cost reduction, and workplace safety. These phases lead the team from defining the problem to implementing root-cause solutions and establishing best practices to maintain solutions (Brown, 2023).

Lean six sigma is widely acknowledged as a key enabler of industrial competitiveness in terms of process effectiveness and enhancements. For a manufacturer to achieve above-average performance, its order processing procedures and efficiency must be enhanced. This objective ought to be incorporated into the company's entire production strategy. DMAIC appears to be a useful strategy for improving order processing and eliminating any delays that can result in client loss and brand damage, as indicated by the method. The following section presents the research methodology adopted in this paper.

Research and Methodology

This section describes the techniques and methods used to collect, modify, and analyze the obtained data. The research employed a quantitative approach. Mohajan (2020) defines quantitative research as a formal, objective, and value-free strategy for establishing and analyzing correlations and investigating causes and effects interactions between variables. Ingham-Broomfield (2014) defined quantitative research as "a survey to collect information from a sample of people through self-report, in which participants respond to a series of questions posed by the researcher."

In terms of research methodology, quantitative research methodology was utilized. Cooksey (2020) asserts that quantitative procedures place a strong emphasis on numerical data, intricate mathematical techniques that incorporate probability theory, and substantial computational processes employing machines. Quantitative research commences by building upon an existing body of knowledge that encompasses generalisations and explanations, specifically theories pertaining to the correlations between various phenomena. One example of research is based on the premise that being exposed to linguistically stimulating surroundings enhances the development of intellect. South Africa's Gauteng province served as the study's geographical scope.

The population includes operations Managers, who overseeing day-to-day manufacturing operations, optimizing processes for efficiency, ensuring quality control, and implementing lean principles in production. And possess an extensive background in manufacturing, leadership skills, knowledge of lean methodologies, and a track record of improving operational efficiency. Supply Chain Specialists who manage the end-to-end supply chain, optimizing logistics, inventory management, and collaborating with suppliers to ensure a smooth flow of materials. With expertise in supply chain management, knowledge of lean supply chain principles, experience in demand forecasting, and a focus on reducing lead times and costs. Procurement Officials whose main focus is sourcing and acquiring materials, negotiating with suppliers, managing vendor relationships, and implementing cost-effective procurement strategies. With strong negotiation skills, understanding of lean procurement principles, experience in supplier management, and a track record of cost savings.

Consultants who provide expert advice on lean manufacturing implementation, conducting assessments, recommending improvements, and guiding organizations through the lean transformation process. With diverse industry experience, deep knowledge of lean methodologies, problem-solving skills, and a history of successfully guiding organizations through lean transformations. registered with various professional organizations in other parts of Southern Africa. Collectively, 700 individuals are employed by the five Johannesburg companies. Random sampling was chosen and applied to this population because it provided each participant with an equal chance of being selected and because it enabled the selection of everyone who met the requirement of being a South African manufacturing professional.

Everyone in the target population has the same performance or qualities, or the sample size is large enough to accurately represent the population, and everyone has an equal chance of being selected as a respondent. Two hundred workers who knew LSS were selected as the sample based on the intended audience. This includes operations managers, supply chain specialists, procurement managers, consultants, and financial analysts. In this study, a questionnaire was used to collect data because it enabled the researcher to gain a comprehensive understanding of the respondents by allowing them sufficient time and space to respond and express their opinions. In addition, the survey method enabled remote data collection by the researcher. Given the travel restrictions and other restrictions imposed by Covid-19 in South Africa at the time, it would have been difficult for the researcher to reach people in Gauteng Province. Due to the fact that the data was collected during the continued spread of the COVID-19 epidemic, a structured online questionnaire was required as the research methodology for this investigation. The questionnaire design utilized a five-point Likert scale consistent with the objectives of the study. Therefore, the questionnaires were written in English, as all respondents were highly educated manufacturing professionals. The confidentiality of the responses of the respondents was ensured. The survey consisted of three sections. In Section A, biographical information was requested, such as gender, age, education, positions held, tenure in a particular position within the organization, etc. This information would assist the researcher in evaluating the findings from Section B, which focused on order processing delays, and Section C, which examined lean six-sigma performance indicators.

The collected data were presented as frequency distributions and percentages for purposes of data analysis. Following the creation of frequency tables, the data were presented in tables, bar graphs, and pie chart diagrams. To analyze the quantitative data collected, the researcher employed statistical Package for the Social Science (SPSS), a computer program used for analyzing data pertaining to social phenomena. Internal consistency was determined using Cronbach's coefficient alpha to ensure the validity of the data collected. In addition, as an ethical consideration, this study examined the responsibilities to the field professionals whose work was properly cited and acknowledged in the literature. Participants in the survey were required to keep their responses confidential and use them solely for educational purposes. Participants in the survey had the option to decline to answer any questions they deemed inappropriate. Throughout the duration of the study, confidentiality and anonymity were upheld. When respondents are anonymous, neither the researcher nor the respondent can be linked to specific responses.

The questionnaire included factors under investigation. On a five-point Likert scale, 1 was strong disagreement, 2 disagreement, 3 uncertainty, 4 agreement, and 5 strong agreements. Before processing, the completed questionnaires were checked for usability. Since the quantitative data were pre-coded by listing various number codes against various replies, it was necessary to convert the textual data to a numerical format before entering it into SPSS for analysis using the appropriate statistical procedures. A 5-point

Likert scale was also used to evaluate lean six-sigma methods in manufacturing based on the literature. The scale included 1 for strongly disagreeing, 2 for disagreeing, 3 for not sure, 4 for agreeing, and 5 for strongly agreeing. The respondents' five-point mean item score (MIS) was converted for each factor. The indices were used to rank each item. After statistical analysis, the criteria are sorted by decreasing relevance index and the results are presented in the following section.

Findings and Discussions

Three hundred questionnaires were administered to the study sample. Of the 300 disseminated, 276 were returned (indicating an 92 percent response rate), and all 276 were usable. The first section presents demographic statistics of the participants. Based on the results of the 158 usable questionnaires, the results in Table 1. depicts the respondents' years of experience in the manufacturing sector.

Table 1: Demographic statistics of the participants

Demographics	Category	Frequency
Gender	Male	43%
	Female	48%
	other	9%
Age	< 20 years	6%
	20 to 25 years	16%
	26 to 35 years	18%
	36 to 45 years	26%
	46 to 55 years	25%
	56 years and above	9%
Education level	High School	8%
	Grade 12	13%
	Diploma	12%
	Degree	24%
	Master's degree	38%
	Doctrate	3%
	Not classified	2%
Race	Indians	7%
	Coloured	19%
	White	15%
	Black	32%
	other	27%
Experience	Less than 5 years	13%
	5 – 10 years	12%
	11 – 15 years	13%
	16-20 years	20%
	21-25 years	35%
	26 – 30 years	4%
	Over 30 years	4%
Number of steel production projects	1 -2	8%
	3-4	15%
	5-6	15%
	7-8	27%
	9-10	30%
	More than 10	4%

According to the results, 13.3 percent of respondents had less than five years of experience in the manufacturing sector. 12 percent had experience ranging from 5 to 10 years, 12.7 percent had experience ranging from 11 to 15 years, 19.6 percent had experience ranging from 16 to 20 years, and 34.2 percent had experience ranging from 21 to 25 years. Table 1.1 displays the number of steel productions in which each respondent has participated in the manufacturing industry. 7.6% of respondents had 1 to 2 years, 14.6% had 3 to 4 years and 5 to 6 years, 26.6% had 7 to 8 years, 29.7% had 9 to 10 years, 3.8% had more than 10 years, and 3.1% did not indicate. The results in Table 1 show that the participants of the study were the correct respondents to give accurate data. For example, it is noted that the majority of the participants have some form of education and have worked in some projects for over 5 years. As such, the researcher concludes that the data was collected from the right participants.

Order Processing Delays and Benefits of Lean Six-Sigma (OPDBLSS)

This section outlines the findings regarding order processing delays and potential LSS benefits in South African manufacturing firms. The results of the paired samples T-test are reported, along with the mean item score (MIS) and skewness of the items. The table contains the mean and standard deviation values for the paired samples T-test. The descriptive result lists all T-test values from highest to lowest. Paired sample t-tests are one of the three forms of T-test analysis. Frost (2020) states that the paired T-test is utilized when each subject has comparison measurements, in order to differentiate the score before and after. To determine the change in the mean value, a paired sample t-test is employed to determine the significance of the deviation from zero. This test is an illustration of an inferential statistical procedure because it uses samples to draw conclusions about populations. In the initial phases of research, it is common practise to employ this method to gather data pertaining to the interrelationships among a specific collection of variables. (Cooksey, 2020). The paired sample T-test was accepted using IBM SPSS. The necessary tests were completed to determine whether the example measure was adequate to continue the paired sample T-Test research. Frost (2020) states that the population parametric test must have correlations of t - value = 0 in order to determine whether the hypothesis is testable. To determine the applicability and reliability of the logic hypothesis testing, its significance differences between sample means or proportions must be determined (Sürücü. 2020).

Deductions

Order Processing possible delays perceptions of OP systems in the South African manufacturing industry, as presented in Table 2. This method is used to test hypotheses regarding the mean of a small sample drawn from a normally distributed population when the population standard deviation is unknown. Due to the inability to analyze the frequencies, it was adopted and only descriptive testing was considered.

Table 2: Order Processing

Perceived roles of OPD system: Manufacturing Solution	$\bar{x}$	**σX**	**R**
The current order processing system is customer orientated	3.79	1.123	1
The improved manufacturing processes handle customers' problem and provide services right at the first time	3.76	1.121	2
Planning staff is trained	3.69	0.977	3
Current order process system benefits the customer.	3.64	1.039	4
The production space is effectively designed	3.52	0.942	5
The improved operational processes instils customer confidence	3.52	1.188	6
The current order process is effective	3.49	0.958	7
The improved operational processes provide prompt service to customer	3.46	1.070	8
Production process is designed for unexpected demand or peak season	3.43	1.162	9
Manufacturing staff is engaged	3.25	1.245	10

Below is a presentation and discussion of the results and skewness of the MIS analysis of the questions.

$\bar{x}$ = Mean item score; σX = Standard deviation; R = Rank

There are several statements that can be used to assess the possible delays of processing orders. Table 2 displays the respondents' evaluations of order processing delays in the manufacturing sector, particularly in Gauteng. The study's results indicate that the The current order processing system was ranked first, with a mean score of 3.79 and a standard deviation (SD) of 1.123; the improved manufacturing processes handle customers' problems and provide services correctly the first time, was ranked second, with a mean score of 3.76 and a standard deviation (SD) of 1.121; planning staff is trained was ranked third, with a mean score of 3.69 and SDs of 0.91; the current order processing system is customer oriented. ranked fourth with a mean score of 3.64 and a standard deviation of 1.039; the production space is effectively designed and improved operational processes instil customer confidence tied for fifth with a mean score of 3.52 and standard deviations of 0.942 and 1.188, respectively. From a production perspective, these were the top five potential order processing system delays. In addition, the sixth-ranked item, the current order process is effective, had a mean score of 3.49 and a standard deviation of 0.958; the seventh-ranked item, the improved operational processes provide prompt service to customers, had a mean score of 3.46 and a standard deviation of 1.070; the ninth-ranked item, the production process is designed for unexpected demand or peak, had a mean score of 3.43 and a standard deviation of 1.162; and the tenth-ranked item.

Lean Six-Sigma Performance Indicator (LSSPI)

The ranking of elements that the respondents believe are essential for the effective use of the LSS indicator in the South African manufacturing sector is shown in Table 3 below is a presentation and discussion of the results of the MIS of the questions and the skewness of the data using Paired samples T- Test method.

Table 3: Critical factors for successful implementation of LSSPI

Paired Samples Statistics					
		Mean	**N**	**Std. Deviation**	**Std. Error Mean**
Pair 1	C52 Frequency and quality of communication between workstations. – closer "not sure"	3.33	138	1.042	.089
	C26 Frequency and quality of communication between workstations. - agree	3.67	138	1.033	.088
Pair 2	C51 Accessibility of manufacturing tools.	3.65	155	1.029	.083
	C25 Accessibility of manufacturing tools.	3.65	155	1.043	.084
Pair 3	C50 Use of the latest manufacturing plant by employees.	3.75	155	.983	.079
	C24 Use of the latest manufacturing plant by employees.	3.83	155	.986	.079
Pair 4	C49 Ability of the company to adapt to current technology.	3.63	155	1.087	.087
	C23 Ability of the company to adapt to current technology.	3.82	155	1.066	.086
Pair 5	C48 Relationship between targets and incentive rewards.	3.86	157	.937	.075
	C22 Relationship between targets and incentive rewards.	3.69	157	1.067	.085
Pair 6	C47 Competitiveness of employees' salaries (relative to competitors). – closer to not sure	3.19	153	1.099	.089
	C21 Competitiveness of employees' salaries (relative to competitors). -closer to agree	3.75	153	1.059	.086
Pair 7	C46 Extent to which the company provides a safe and healthy working environment.	3.33	150	1.208	.099
	C20 Extent to which the company provides a safe and healthy working environment.	3.28	150	1.088	.089
Pair 8	C45 Extent to which the plant layout promotes efficiency.	3.23	155	1.193	.096
	C19 Extent to which the plant layout promotes efficiency.	3.38	155	1.058	.085
Pair 9	C44 Extent to which floor plan design supports manufacturing.	3.61	155	1.066	.086
	C18 Extent to which floor plan design supports manufacturing.	3.58	155	1.156	.093
Pair 10	C43 Frequency of quality housekeeping.	3.58	154	1.153	.093
	C17 Frequency of quality housekeeping.	3.69	154	1.005	.081
Pair 11	C42 Use of material handling equipment.	3.18	154	1.243	.100
	C16 Use of material handling equipment.	3.91	154	.979	.079
Pair 12	C41 Extent to which customer complaints are kept to a minimum level.	3.32	155	1.109	.089
	C15 Extent to which customer complaints are kept to a minimum level.	3.74	155	1.063	.085
Pair 13	C40 Extent to which customer return are kept to a minimum level.	3.34	157	1.107	.088
	C14 Extent to which customer return are kept to a minimum level.	3.55	157	1.179	.094
Pair 14	C39 Availability of manufacturing tools.	3.35	153	1.084	.088
	C13 Availability of manufacturing tools.	3.57	153	1.018	.082
Pair 15	C38 Availability of machine parts when needed for breakdown repairs.	3.21	155	1.155	.093
	C12 Availability of machine parts when needed for breakdown repairs.	3.77	155	1.126	.090
Pair 16	C37 Ability to the business to adhere to scheduled maintenance of machinery.	3.40	154	1.045	.084

Table Cont'd	C11 Ability to the business to adhere to scheduled maintenance of machinery.	3.94	154	.919	.074
Pair 17	C36 Extent to which plant machinery is used to full capacity. - closer to agree	3.71	154	1.003	.081
	C10 Extent to which plant machinery is used to full capacity. – closer to not sure	3.42	154	1.131	.091
Pair 18	C35 Ability of the business to remove bottlenecks.	3.59	154	1.076	.087
	C9 Ability of the business to remove bottlenecks.	3.43	154	1.131	.091
Pair 19	C34 Access to finance.	3.63	155	1.027	.082
	C8 Access to finance.	3.37	155	1.123	.090
Pair 20	C33 Ability of the business to reduce costs.	3.47	156	1.133	.091
	C7 Ability of the business to reduce costs.	3.96	156	.936	.075
Pair 21	C32 Experience level of employees.	3.72	152	1.117	.091
	C6 Experience level of employees.	3.62	152	1.168	.095
Pair 22	C31 Level of education of employees.	3.34	155	.742	.060
	C5 Level of education of employees.	3.80	155	1.015	.082
Pair 23	C30 Motivation level of employees.	3.15	119	.945	.087
	C4 Motivation level of employees.	3.03	119	1.248	.114
Pair 24	C29 Investing in training.	3.58	153	2.567	.208
	C3 Investing in training.	3.25	153	1.189	.096
Pair 25	C28 Investing in knowledge transfer.	3.22	154	.659	.053
	C2 Investing in knowledge transfer.	3.53	154	1.030	.083
Pair 26	C27 Investing in skills development.	3.39	151	.683	.056
	C1 Investing in skills development.	3.58	151	1.277	.104

According to the results of the paired samples T-test, the crucial implementation success elements of LSSPI are paired based on the probability of their occurrence as follows: C1 to C26 are statements in column A, while C27 to C52 are statements in column B. The first pair, C52 and C26 frequency and quality of communication between workstations, received a mean score of 3.33, with respondents leaning toward not sure, and 3.67, with respondents agreeing. The second paired samples, C51 and C25, had a mean score of 3.65 for manufacturing tool accessibility; the third paired samples, C50 and 24, had a mean score of 3.75. Fourth paired samples test, C49 and C23 ability of the company to adapt to current technology had a mean score of 3.63 the respondents were close to agree, and had mean score of 3.82 the respondents were close to strongly agree respectively; fifth paired samples,C48 and C23 use of the latest manufacturing plant by employees had a mean score of 3.75 the respondents were close to agree, and had mean score of 3.83 the respondents were close to strongly agree; sixth paired samples,C48 and C23 The respondents were nearly in agreement; paired samples number ten C43 and C17 had mean scores of 3.58 and 3.69, respectively.

The respondents were both close to agree; use of material handling equipment, which came in paired samples number eleven C42 and C16, had a mean score of 3.18; the respondents were close to unsure and had a mean score of 3.91; the respondents were close to strongly agree. Ability of the business to adhere to scheduled maintenance of machinery as paired samples number sixteen, C37 and C11 had a mean score of 3.40; respondents were close to strongly agreeing and had a mean score of 3.94. The respondents were moderately to strongly in agreement; paired samples number seventeen, C36 and C10, had a mean score of 3.71 for the extent to which plant machinery is used to full capacity. the respondents were closely to agree and had a mean score of 3.43 the respondents were closely to not sure respectively; access to finance as paired samples number 19, C34 and C8 had a mean score of 3.63 the respondents were closely to not sure. C29 and C3 were paired samples number twenty-four with a phrase about investing in training, had a mean of 3.58 the respondents were closely to agree and had a mean of 3.25 the respondents were closely to not sure respectively; paired samples number twenty-five C28 and C2, investing in knowledge transfer had a mean of 3.22 the respondents were closely to not sure and had a mean of 3.53 the respondents were closely to agree respectively; paired samples number twenty-six C28 and C2, investing.

Conclusions

Based on the data above, it can be inferred that there is an equitable distribution of participants' gender. The majority of respondents are primarily between the age range of 25 to 40 years, possess a master's degree, and identify as black. In addition, the study presents the findings of the paired samples T-test, which examines order processing delays and possible Lean Six Sigma (LSS) benefits in manufacturing enterprises in South Africa. The report includes the mean item score (MIS) and skewness of the items. Paired sample t-tests are a type of T-test analysis used to test hypotheses about the mean of a small sample taken from a population that follows a normal distribution, when the standard deviation of the population is not known. The paired samples T-test revealed that the key implementation success elements of LSSPI are paired based on the probability of their occurrence. The mean scores for each pair are as follows: the first pair received a score of 3.33, the second pair received a score of 3.65, the third pair received a score of 3.50, the fourth pair received a score of 3.63, the fifth pair received a score of 3.75, the sixth pair received a score of 3.83, and the seventh pair received a score of 3.69. The respondents reached a consensus about the utilisation of material handling equipment, the business's capability to comply with scheduled machinery maintenance, access to financial resources, and investment in knowledge transfer.

To summarise, this study has provided insight into the crucial impact that Lean Six Sigma (LSS) concepts can have on the order fulfilment processes of manufacturing enterprises in Gauteng, South Africa. The research has not only emphasised the theoretical advantages of adopting LSS, but it has also emphasised the practical consequences for enterprises involved in international trade.

Moreover, Lean Six Sigma is widely acknowledged as a vital enabler of corporate competitiveness, namely in enhancing process efficacy and efficiency. To achieve superior performance levels in a factory, it is crucial to enhance both the order processing activities and overall efficiency. It is crucial to incorporate this objective into the company's entire manufacturing strategy. The DMAIC methodology effectively improves order processing efficiency and reduces delays that can result in customer attrition and damage to the brand. This study's findings emphasise the significant influence of Lean Six Sigma on both customer happiness and the efficiency of global product delivery. In today's highly competitive global market, where customers have high expectations for top-notch products and timely delivery, adopting Lean Six Sigma (LSS) approaches can provide a substantial competitive edge. By implementing operational efficiency measures and reducing order processing delays, manufacturing enterprises in South Africa can improve their capacity to meet consumer expectations. Consequently, this can promote stronger consumer allegiance and bolster their competitive edge in the global market.

Implication

This study highlights the strong impact of Lean Six Sigma on customer satisfaction and the acceleration of global product delivery. The use of Lean Six Sigma (LSS) tactics can offer a significant competitive advantage in today's fiercely competitive global market, where customers have high expectations for both product quality and timely deliveries. Through the optimisation of operations and the minimization of order processing delays, manufacturing companies in South Africa may effectively fulfil client expectations, resulting in heightened customer loyalty and enhanced competitiveness in the international arena.

Recommendations

Nevertheless, it is crucial to recognise that this research, similar to all studies, possesses specific constraints. Initially, the research specifically examined manufacturing enterprises located in Gauteng, South Africa. Consequently, the applicability of the results to different regions or industries may be restricted. Furthermore, the study was based on survey data, which is susceptible to respondent bias and may not fully encompass the intricacies of LSS implementation. In order to overcome these constraints and enhance our comprehension of LSS integration in order fulfilment procedures, further research endeavours should take into account the following suggestions:

i. Future research should conduct comprehensive case studies of organisations that have effectively implemented Lean Six Sigma (LSS) to ascertain optimal strategies and possible obstacles in various industrial settings.
ii. Conducting comparative studies across various regions within South Africa and other nations might offer useful insights into the cultural and regulatory issues that influence the adoption of LSS. According to the research and survey findings, it is advisable to apply Lean Six Sigma in order to streamline and enhance the order fulfilment operations. In order to ensure that the ordering process flows smoothly, it is advisable to utilise approaches such as DMAIC.

Further investigation is required to explore efficient communication tactics for the implementation of LSS concepts in organisational settings. This may involve analysing the utilisation of different communication channels and their influence on employee acceptance and engagement. Examine the impact of change management methods on allowing a seamless transition to Lean Six Sigma (LSS) adoption, specifically in organisations that have a substantial and varied workforce. The study suggests that effective communication should be a fundamental component of the company's strategy. This is crucial to ensure that the employees who will be largely responsible for integrating LSS in the order fulfilment process are well-informed about the upcoming changes and are less inclined to oppose them. Communicating with each individual employee through channels such as meetings would be challenging for the organisation if it has a substantial workforce. The organisation may communicate with the employees by email to inquire about their plans for implementing LSS, the potential impact on their current workplace, and any thoughts or recommendations they may have regarding LSS. Utilising email as a means of communication may provide a more accessible option for employees who are hesitant to express their thoughts at meetings. In addition, correspondence and brochures could be utilised to communicate with staff. Furthermore, it is advisable to guarantee that all employees, particularly those who are sceptical or resistant, are thoroughly educated about the advantages of LSS in the order fulfilment procedure, how it would directly impact them, and their responsibilities in the implementation and upkeep procedures.

Research should prioritise investigating the enduring effects of LSS on order fulfilment processes, particularly its sustainability and adaptability in dynamic corporate situations. Evaluate the financial and operational performance metrics of organisations that have adopted Lean Six Sigma (LSS) over a long period of time to ascertain its enduring impact on competitiveness. Overall, this study has not only enhanced the comprehension of Lean Six Sigma integration in order fulfilment, but it has also established a foundation for future research efforts to explore this crucial field in greater detail. By acknowledging and overcoming the constraints of this study and implementing these suggestions, researchers can further enhance understanding in the field and offer significant perspectives for organisations aiming to flourish in global marketplaces by optimising and effective order fulfilment procedures.

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