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Management Model Applying Lean Six Sigma to Improve the Performance of an SME in the Professional Services Sector

Axel Díaz Guevara
Facultad de Ingeniería
Universidad de Lima, Peru
20183840@aloe.ulima.edu.pe

Mariel Perez Reyes
Facultad de Ingeniería
Universidad de Lima, Peru
20184287@aloe.ulima.edu.pe

Rafael Chavez-Ugaz
Facultad de Ingeniería
Universidad de Lima, Peru
rchavezu@ulima.edu.pe

Abstract

The concepts of Lean Manufacturing and Six Sigma have been applied in manufacturing companies with greater frequency. However, there are few records of its implementation in companies in the service sector. This sector in Peru represents more than 50.6% of the country's Gross Domestic Product and it is composed mainly of small and medium-sized enterprises (SMEs). Nevertheless, this kind of businesses are characterized by having low productivity, lack of organization and monitoring of performance indicators to make good decisions. Therefore, different techniques are required to maintain their efficiency and productivity over time to meet the expectations of the consumers. In this research, the objective is to propose a management model by applying Lean Six Sigma in order to improve the performance of an SME in the professional services sector. Through the DMAIC process, a diagnosis of the company was carried out, finding the root causes of its main problems, Lean tools such as 5s and virtual Kanban were applied in a pilot test in the organization. After implementation, 100% efficiency was obtained, a productivity improvement of 75.56% and a decrease in order delivery time of 42.30%. Finally, the pilot test was validated using a statistical analysis of variance test and demonstrated consistency with the management model applying lean six sigma. This work contributes to practical knowledge with the application of a lean six sigma tool model and to be expanded in future work in companies in the service sector.

Keywords
Lean Six Sigma, Lean Manufacturing, Lean Service, 5s, Kanban.

1. Introduction

The services sector in Peru has a weight of 50.6% of the country's Gross Domestic Product (BCRP, 2022). There are 2,981,098 companies, of which those corresponding to the service sector in general represent 42.09% of the total number of existing companies (INEI, 2022a). In Lima, there are approximately 470,350 business units in the service sector, with the category of professional, technical, and business support services representing the highest percentage, with 25.8% of the total (INEI, 2019). However, in the last quarter of 2021, 1,738 service companies were discharged in Lima (INEI, 2022b). This can be due to various factors. Nowadays, companies face several challenges that can impact their efficiency and, consequently, their economic performance (Jbira et al., 2020). Among them is the intense competition between companies (Ojeda-Safra et al., 2021). In particular, the companies of the services sector need to meet the specific requirements of each and every customer so that they can always stay ahead of their competitors (Vignesh et al., 2016). According to a global survey, 80% of customers place great importance on efficiency or speed in service delivery, it also details that 49% of Latin American consumers would stop interacting with a company after a single bad experience (PwC, 2018). These figures denote the degree of relevance for service firms in delivering requirements to clients quickly to avoid worse consequences in the future. Constant technological advance and changing consumption patterns cause competitiveness to continue growing, which is why organizations look for differentiated practices that reduce costs, improve the quality of goods, and increase productivity, managing to meet the needs of customers (Santos et al., 2021).

In this context, the concept of "Lean manufacturing" appears. This is used to eliminate "waste" or worthless activities in production processes in industry (Edwin Joseph et al., 2020). The reduction in activities that do not generate value increases the profitability and efficiency of organizations, as well as increases customer satisfaction and the quality of the goods delivered (Garza-Reyes, 2015). However, there are few reports of real experiences of using the lean approach in service management (da Silva et al., 2015). The service industry can benefit from the application of lean philosophy through increasing organizational competitiveness, customer satisfaction, reducing process variability and waste (Andrés-López et al., 2015).

95% of Peruvian companies are micro and small businesses, of which 52% belong to the services sector (ComexPerú, 2022). Regarding SMEs in the region, they present low levels of productivity, in Latin America, small and medium-sized companies reach only 23% and 46% of the productivity of a large company respectively (Dini and Stumpo, 2020). On the other hand, SMEs are characterized by their lack of organization and not having procedure manuals that are used by the members of the company, which is why internal control cannot be carried out (Ramírez-Avalo, 2016; Aguirre and Armenta, 2019). This lack of control causes the correct decisions to not be made, since the indicators are not analyzed, nor the performance of the functions is evaluated (Mendoza and Bayon, 2019).

There is a comprehensive methodology called Lean Six Sigma. It includes the union of the concept of Lean and Six Sigma (Becerra et al., 2019). The latter is a business management strategy used by many industries for quality improvement (Ramadan et al., 2022). It is applied to describe and measure performance of any type of process (Andrés-López et al., 2015). That's why this tool could be useful for SMEs to monitor their performance with numerical data. Six Sigma is used quite frequently in the manufacturing sector; however, its use is growing in the service sector, and it is recognized that there is a research gap regarding its use in SMEs (Tjahjono et al., 2010).

Given the great importance of this sector in the country and its challenge to meet the expectations of the customers, along with the management problems faced by SMEs to monitor their performance and the limited research on Lean and Six Sigma tools in service companies despite the great benefits they provide, it is necessary to carry out research that proposes management models that ensure its continuity and good performance.

Therefore, in this research, a management model based on Lean Six Sigma is proposed for an SME in the professional services sector. Among the main problems that were found, the low percentage of efficiency in the delivery process and low productivity stand out. The selected improvement tools were 5S and Kanban, considering successful cases of companies in the sector. As well as other engineering and statistical tools to diagnose, analyze and verify the proposed model. This article will be divided as follows: State of art, where important concepts will be defined, and cases from past studies will be shown to justify the application of the techniques. The Methodology section, which will describe the work model that will be followed. The Results section will detail the initial diagnosis of the company, the implementation of the pilot test and the results after this test to compare the changes in the indicators. Finally, the Conclusion, where the knowledge learned will be summarized and recommendations for future research will be given.

2. State of art

2.1 Six Sigma

Six Sigma is a method for analyzing process problems and variance (De Mast and Lokkerbol, 2012). Its goal is to produce no more than 3.4 defects per million opportunities (Simanova and Gejdoš, 2021). In the context of business organizations, Six Sigma is a strategy that is used to both improve profitability and ensure efficiency in all operations, in order to meet customer demands and expectations (Kwak and Anbari, 2006). This method has five implementation steps that are known as the DMAIC method or Define, Measure, Analyze, Improve and Control (Setyabudhi et al., 2019). The application of this tool decreased the average downtime from 384 to 70 seconds in a wood workshop (Hardy et al., 2021).

2.2 Lean Manufacturing

In organizations, there are actions or activities that do not add value to the processes and even increase production costs without obtaining results of improved productivity (Makwana and Patange, 2019). Lean Manufacturing is used to eliminate these "waste" or valueless activities in production processes in industry (Edwin Joseph et al., 2020). Lean manufacturing tools positively impact companies and achieve a competitive advantage in the global environment (Makwana and Patange, 2019; Singh and Singh Ahuja, 2015). In this research, the Lean tools that will be used are 5S and Kanban.

5s is a method, originated in Japan, used to organize workspaces in an efficient, safe, and clean way, to obtain a productive work environment (Veres et al., 2018). Its name comes from 5 Japanese words, which are Seiri, Seiton, Seiso, Seiketsu and Shitsuke, their translations are sort, set in order, shine, standardize, and sustain respectively (Fauli Marín et al., 2013; Makwana and Patange, 2019). It is considered an essential tool since it forms a safe environment with optimally used resources, as well as guides companies to continuous improvement in productivity, by reducing the number of defects and costs (Thapa et al., 2018). The effectiveness of this tool has been demonstrated in case studies; the time spent on search activities in a welding workshop was reduced by 18.75% when using 5s (Rizkya et al., 2019). In a company in the textile sector, an increase in productivity from 0.38 to 0.89 units per man hour was achieved (Ruiz et al., 2019).

Kanban is a technique used to control the progress of work within a production system (Flores et al., 2020). Kanban is a tool that facilitates more active control by being present throughout production and reduces the possibility of error through Kanban cards and the board (Canales-Jeri et al., 2022). There are studies that demonstrate its effectiveness in reducing delivery times. The application of this tool achieved a reduction from approximately 26 to 10 days in average delivery times in a company (Pato et al., 2020).

2.3 Lean Service

Lean Service is a set of methods and equipment designed to reduce costs, improve performance, reduce waiting times, and eliminate waste so that the quality of services produced can be maximized (Kulsum and Anwari, 2020). However, there are few reports of real experiences of using the lean approach in service management (da Silva et al., 2015). The service industry can benefit from the application of lean philosophy through increasing organizational competitiveness and customer satisfaction and reducing process variability and waste (Andrés-López et al., 2015). In an insurance company, 100% efficiency of the delivery process within established times was achieved (Jacinto et al., 2022). Also, in a consulting company, an increase of 27.85% in process efficiency was obtained through a management model applying Lean Service (Valdivia and Rivas, 2021).

2.4 Lean Six Sigma

As mentioned above, it is the union of the Lean and Six Sigma concept (Becerra et al., 2019). The objective is also to reach the desired levels typical of Six Sigma (Syafrimaini and Husin, 2021). The application of both Lean and Six Sigma methodologies gives better results than using them independently (Mandahawi et al., 2012). Regarding time improvement, time spent on non-value activities was reduced by 300 seconds using Lean Six Sigma (Hardy et al., 2021). Regarding the number of defects, a decrease from 40 to 6 defects per month was achieved by applying Lean Six Sigma in a company in the medical equipment sector in India (Thapa et al., 2018). In the same way, in the offices of a university, the cycle time of a process was reduced, as well as the number of employees working on the process, generating significant savings (Magalhães et al., 2019).

3. Methods

3.1 Research model

The methodology will follow the steps of the Six Sigma DMAIC cycle. First, a diagnosis will be carried out to find the problems and main causes of the delay in delivering reports to clients. From this, we move on to the intervention, where the Lean tools will be implemented through a pilot test for one month. Subsequently, the results will be evaluated in the monitoring phase. Figure 1 shows the research design that will have 3 main steps.

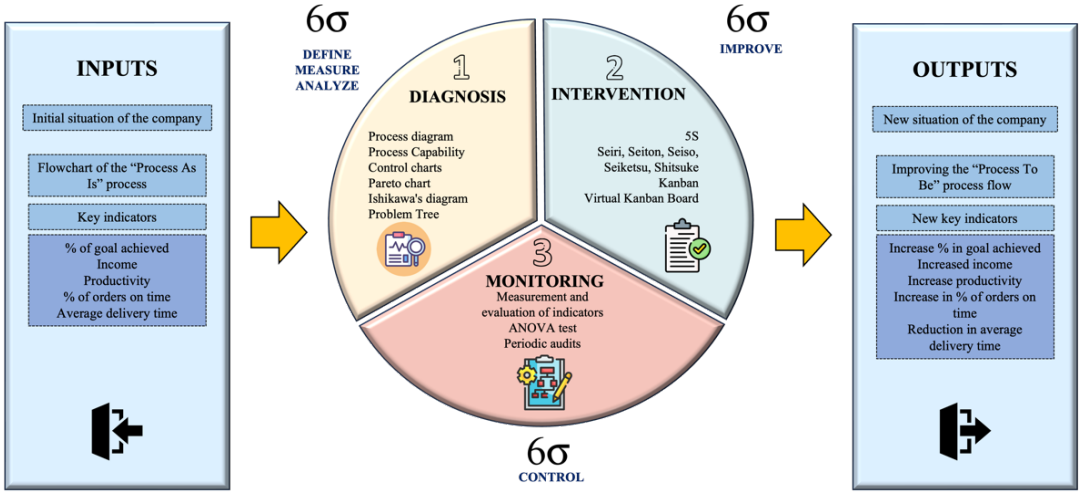


Figure 1. Research model

3.1.1 Diagnosis

The first 3 phases of the DMAIC cycle of the Six Sigma methodology are identified: define, measure, and analyze. The objective of the Define phase is to identify or validate improvement opportunities, define requirements, and establish objectives. The diagram of the process under study will be used to have an overview of the current situation and find the main current problems. In the Measure phase, the state of the process selected in the previous phase will be found numerically. To carry out this measurement, the delivery times of a sample of 5 orders for 10 days will be taken. This data will be placed into Minitab to display control charts and determine process capability, the latter being defined as the assessment of how well a process meets specifications (Simanova and Gejdoš, 2021). Likewise, key indicators such as average time, percentage of on-time deliveries and productivity will be calculated. In the Analyze phase, the root causes of our project under study are identified, prioritized, and verified with data. The techniques that will be used are the Pareto diagram to prioritize the main problems, the Ishikawa diagram to find the root causes and, finally, the problem tree to summarize the current situation and propose improvement tools.

3.1.2 Intervention

The fourth phase of the DMAIC cycle will be applied, which is the Improve phase. In this, ideas will be developed to eliminate root causes, solutions will be tested, and the results will be standardized using Lean tools, from which they will be applied in a pilot test, with prior approval. The Lean techniques that will be used are 5s and Kanban. For the first tool, unnecessary elements will be eliminated, then important items will be organized within the workspaces and the storage of company information and items will be sought to be standardized to facilitate their identification. For the second tool, cards will be designed for each order, and they will be classified on a virtual Kanban board according to the status of the requirement (to be started, confirmed, in process and completed) to maintain good tracking of the orders. After having implemented the 2 techniques, workers will be trained to ensure their correct use in the pilot test. This will be divided into 2 phases of 2 work weeks each. During this period, samples of 5 daily orders will be taken to calculate the effectiveness of the model. At the end of the first phase of the pilot test, a meeting was organized with the members of the project to review the initial results and in this way, communicate them with the other members of the company. These results are sent to the members of the company as a source of motivation to continue with the same practices in the following two weeks.

3.1.3 Monitoring

It corresponds to the last phase of the DMAIC cycle, which is the Control phase. In this, the changes in the indicators are measured to find the levels of improvement that were achieved with the implemented techniques. The effectiveness of the pilot test will be verified using the ANOVA analysis of variance test. Likewise, activities are proposed to maintain continuous improvement in the future. In Figure 2, the proposed management model for this research is presented.

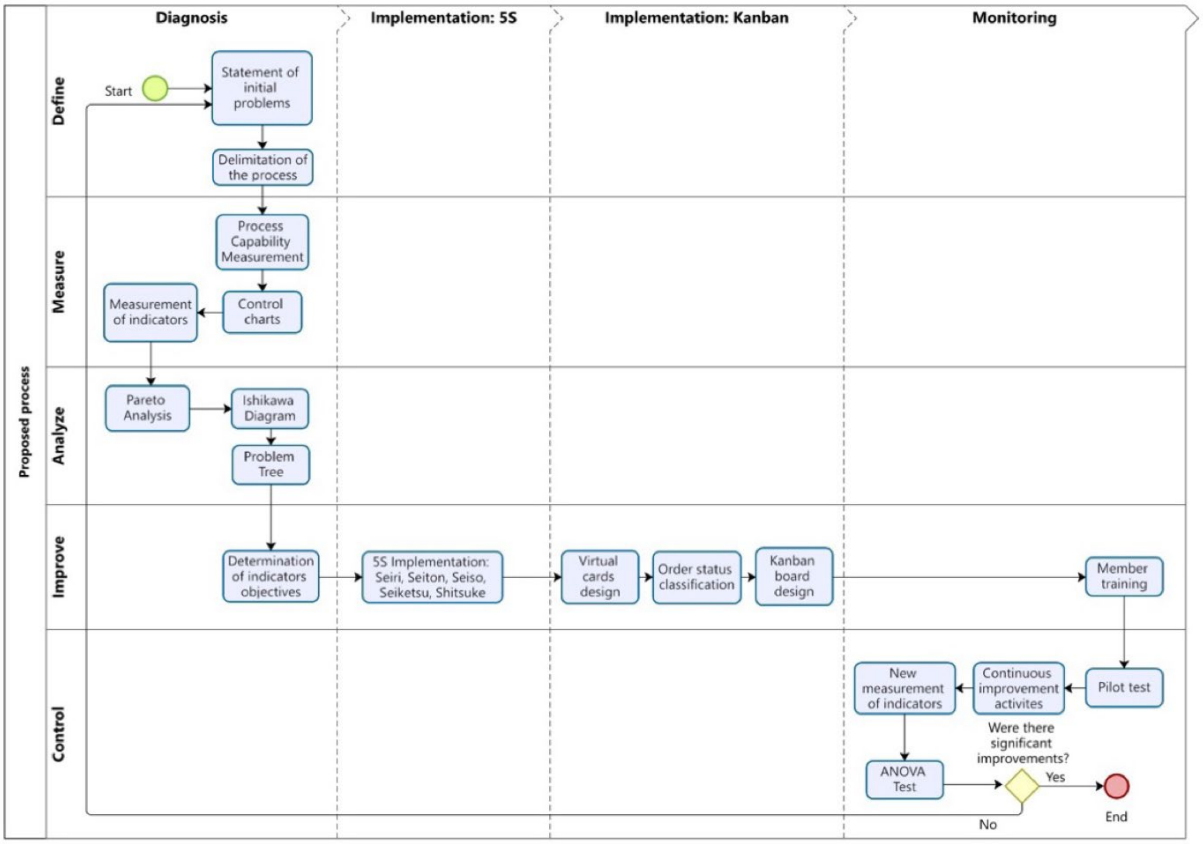


Figure 2. Proposed management model

3.2 Indicators to measure

Table 1 shows the model indicators that will be measured before and after the pilot test.

Table 1. Model indicators

Indicator	**Content/Formula**
Average report delivery time	Average order delivery in hours
Productivity	Number of oders delivered per man hour employed
% Orders on time	Percentage of orders delivered within the established time
Cp	Process Capability
% Goal achieved	Percentage of income received with respect to those initially planned
Income	Monthly income in American dollars

4. Results

4.1 Measurement of current situation

In a recent satisfaction survey of the company, it was found that 30% consider that orders attention times should be improved. Likewise, only a little more than 50% are satisfied with the speed of delivery. This has caused the company to receive between 3 to 4 complaints daily about the delay. Furthermore, in the last month only 90.94% of the planned income was obtained, resulting in a deficit of 1,375 American dollars. These data indicate that the report delivery process must be studied and improved.

Figure 3 shows the diagram of the customer report delivery process. As can be seen, it is made up of the following activities: order request, receipt and referral of the order, search for the required documents and sending the order to the customer. The documentation search activity is the one that takes the most time.

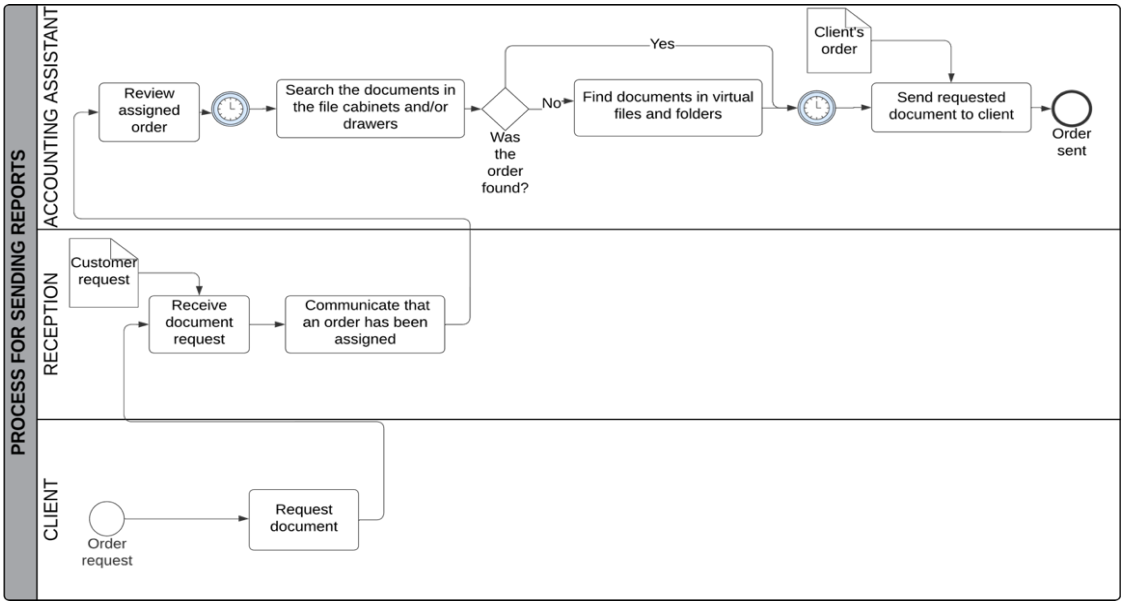


Figure 3. Order delivery process

After identifying the main process, the performance of the process is numerically evaluated. The capacity of the order delivery process is found using the process capability index (Cp) and the real capacity index of the process (Cpk). The delivery times of a sample of 5 orders were measured for 10 days. From these data, a productivity of 0.32 orders per man hour is obtained. Through Minitab, the indexes mentioned above are determined. As can be seen in Figure 4, a Cp of 0.35 was obtained, indicating that the process is awful. Likewise, there is a Cpk of -0.02, denoting that the process is not capable. Finally, an average of 3.085 hours is shown for the delivery of these documents. In addition, the P-type control chart of the process was obtained. This graph details the percentage of defective items found in the reported sample. The order that is sent with a time greater than the upper specification limit (USL) is specified as defective, that is, 3 hours. It is obtained that 42% of the reports are defective, in other words, just 58% of the orders are delivered on time.

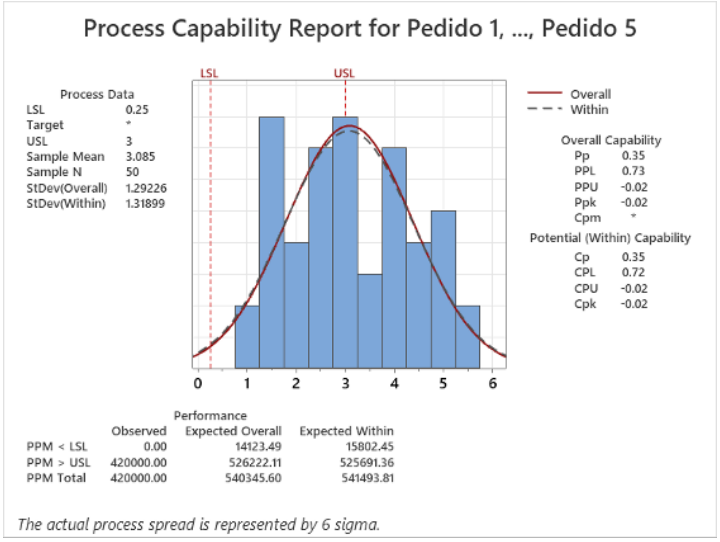


Figure 4. Current results in Minitab

After the measurement, the causes of poor performance for on-time order delivery are analyzed. The Pareto Diagram was used to determine the most important problems according to their degree of frequency. Through this, it is determined that there are two main problems that represent 79.8%, which are the delay in searching for customer reports (47.6%) and the lack of follow-up of the order by the person in charge (32.1%). Having identified the main and most important problems found in the work area and the possible root causes of them through the Ishikawa Diagram, Figure 5 shows the problem tree in which we identify in detail the nature and the context of the main problem, as well as the Lean tools that will be applied to address the problem in question and improve the respective indicators.

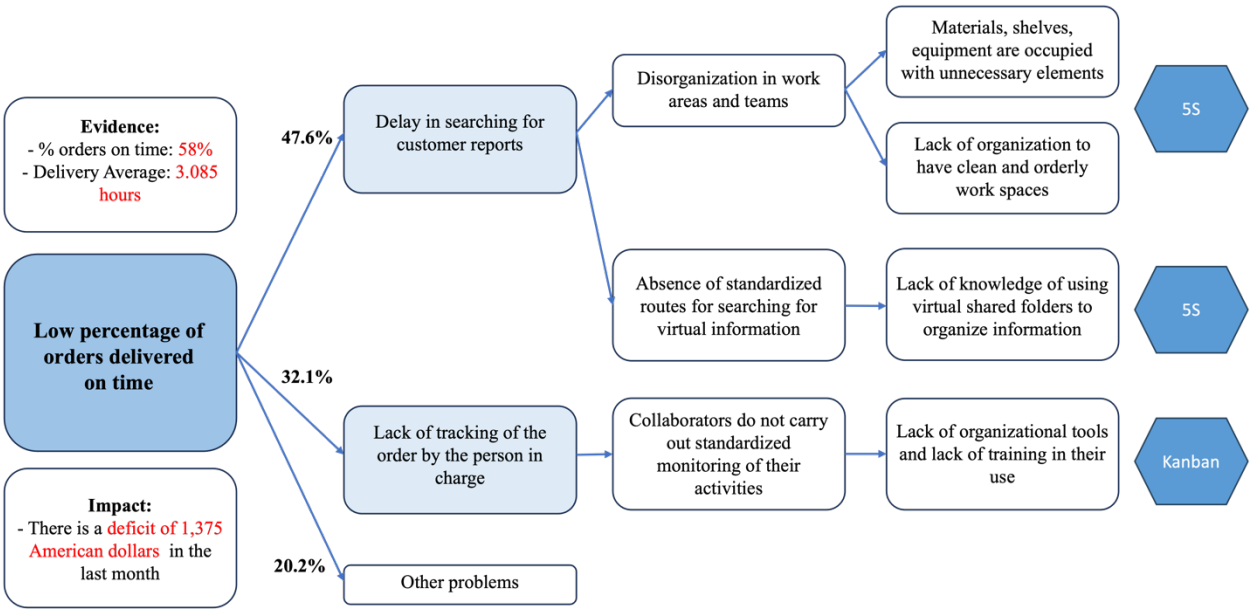


Figure 5. Problem tree

Below is a summary Table 2 of the indicators mentioned and found previously. As well as the objective value that is expected to be obtained after the implementation of Lean tools.

Table 2. Summary of current indicators

Indicator	As is	Objective
Average report delivery time (hours)	3.085	2.00
Productivity (orders/man hours)	0.32	0.45
% Orders on time	58%	80%
Cp	0.35	0.70
% Goal achieved	90.94%	95.00%
Income (American dollars)	13,811.19	15,192.31

4.2 Implementation of pilot test

Continuous improvement tools are applied that will solve the problems found in the previous stage. The 5S tool was chosen to manage disorder and disorganization in the work areas corresponding to the problem of delay in searching for reports. This tool was implemented in physical and virtual workspaces. Figure 6 shows the implementation in the company.

- Seiri: unnecessary elements were identified with a red card detailing their action plan to move or eliminate them permanently.
- Seiton: the necessary elements are organized considering their frequency of use.
- Seiso: a cleaning plan was established, and a warehouse was assigned to store cleaning supplies and facilitate their identification.

- Seiketsu: the objective is to standardize the processes and elements in the area. Among the main activities carried out were the creation of a client database, creation of folders in One Drive for each client, grouping of physical documents using correctly labeled file cabinets and shelves, assignment of spaces for items in labeled drawers.
- Shitsuke: the aim is to convert standard actions and methods into habits that last over time. Documents and follow-up actions were established.

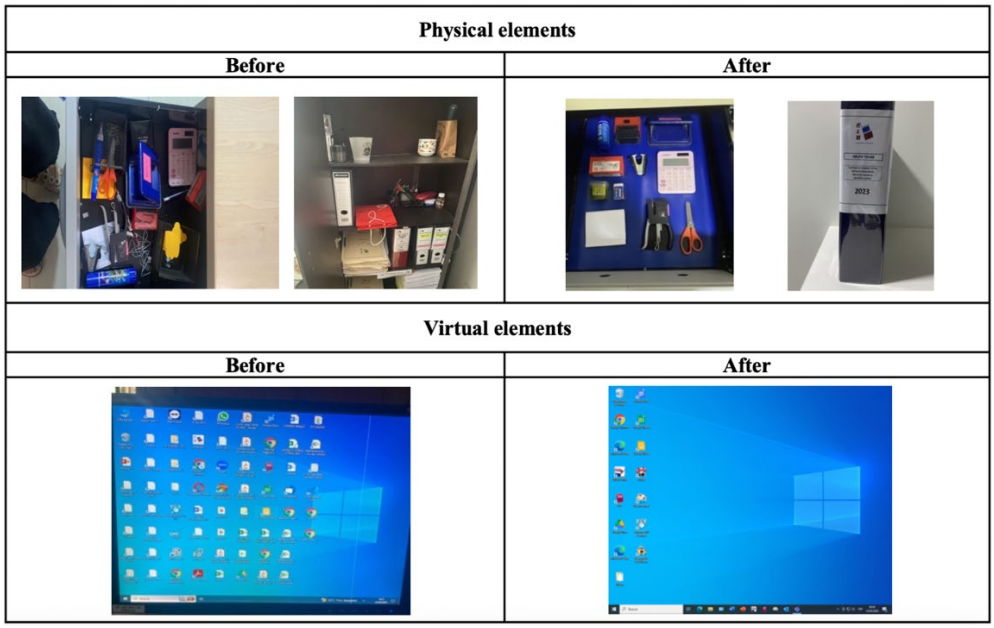


Figure 6. 5S Implementation

The next tool to be implemented is Kanban to improve the tracking of customer orders. In Figure 7, a virtual Kanban board was designed in the Trello application, where cards will be placed with the specific orders of each client and the assigned manager.

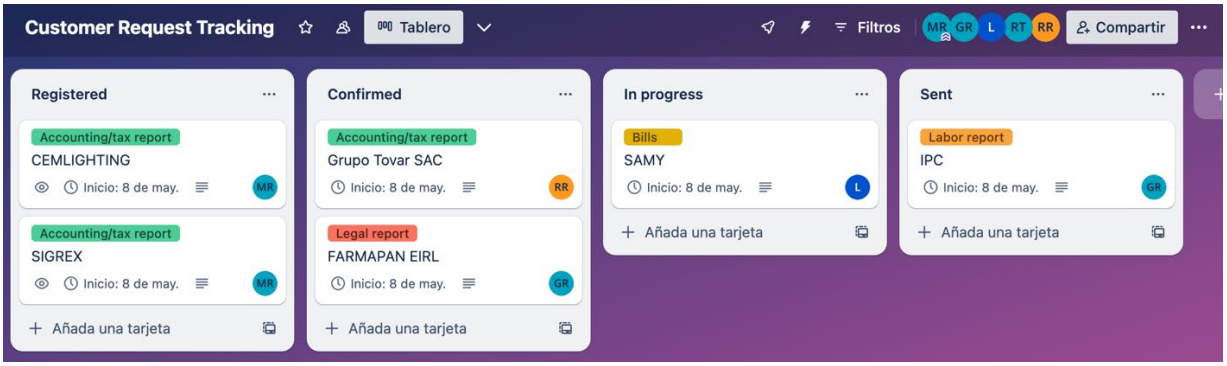
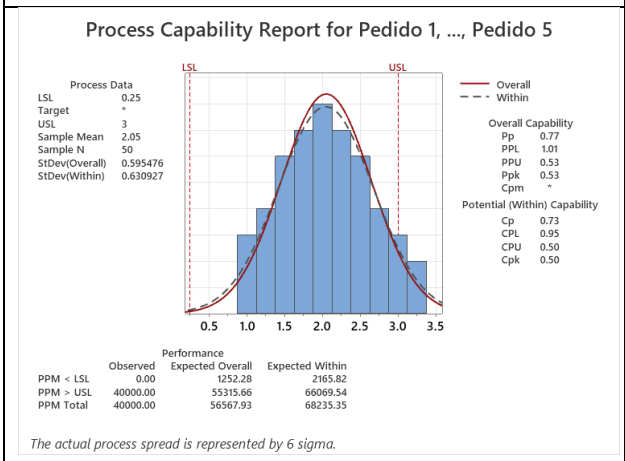
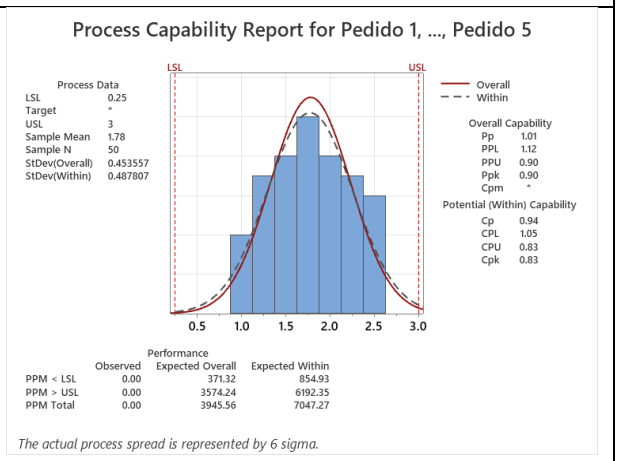


Figure 7. Virtual Kanban board

4.3 Results of the pilot test

A pilot test was carried out in the company with 2 phases of 2 weeks each, that is, 20 business days. In both phases, a sample of 5 daily orders was taken, obtaining results from 50 reports sent to clients in each one. This data was collected from the Kanban board. Table 3 shows the process capability graphs for the two phases of the pilot test. As it can be seen, a more focused and organized process is shown, revealing a positive evolution throughout the pilot test. A Cp of 0.94 was obtained. Although the ideal value of 1 was not reached, this indicator increased more than 100%. Therefore, by definitively implementing this model and training staff correctly, more favorable results could be obtained.

Table 3. Results of pilot test

Pilot test: First phase	**Pilot test: Second phase**
	
Cp: 0.73 Cpk: 0.50 Mean: 2.05 hours	Cp: 0.94 Cpk: 0.83 Mean: 1.78 hours

After having calculated the indicators after the pilot test, they are compared with the values initially obtained. The 5s tool made it possible to establish correctly organized and labeled physical and virtual spaces to store documentation. Due to this, the time spent searching for reports was reduced, decreasing the average delivery time to 1.78 hours and an increase in productivity of 75.56%. The Kanban board allowed for better visualization and control of the status of the requests, thus avoiding delays due to lack of follow-up or forgetfulness on the part of the person in charge. Both tools together managed to increase the percentage of on-time deliveries to 100%. At the end of the pilot test, by having better efficiency in the process, an increase in income of 11.75% was achieved and the percentage of the goal achieved reached 99.08%. Table 4 shows both results along with the percentage of variation after carrying out the pilot test.

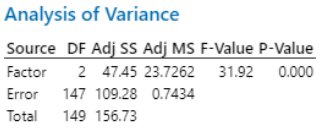
Table 4. Summary of final indicators

Indicator	**Before**	**Objective**	**After**	**Unit**	**Variation**
Average report delivery time	3.085	2.00	1.78	hours	42.30%
Productivity	0.32	0.45	0.56	orders/MH	75.56%
% Orders on time	58%	80%	100%	-	72.41%
Cp	0.35	0.70	0.94	-	168.57%
% Goal achieved	90.94%	95.00%	99.08%	-	8.95%
Income	13,811.19	15,192.31	15,434.64	American dollars	11.75%

4.4 Validation

After having carried out the pilot test and identifying the results in the initially measured indicators, the effectiveness of the pilot test is validated. In this investigation, the ANOVA analysis will be used to find if there are significant differences between the results of delivery times obtained before and after the implementation of the pilot test. This will allow us to decide if the Lean Six Sigma model applied actually results in significant changes for the company. In the ANOVA analysis, a null hypothesis is established that the means of the factors under study are equal, therefore, if this hypothesis is rejected, it is determined that the model does influence the response variable (Minitab, 2023). The null hypothesis is rejected if the p value obtained in the analysis of variance is less than 0.05. The hypotheses used in this analysis are shown below.

- Null hypothesis: The average delivery times of the orders obtained initially are equal to the results obtained after the pilot test.
- Alternative hypothesis: The average delivery times obtained before and after the pilot test are different.



Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Factor	2	47.45	23.7262	31.92	0.000
Error	147	109.28	0.7434		
Total	149	156.73			

Figure 8. Analysis of variance obtained.

In Figure 8, ANOVA analysis of variance was performed in this program and a p-value of 0 was obtained, in other words, the null hypothesis is rejected. It is concluded that the average delivery times obtained before and after the pilot test are different.

5. Conclusion

After having analyzed and interpreted the results obtained in the pilot test, a management model based on Lean Six Sigma for an SME in the professional services sector does increase its efficiency, using the respective tools at each step of the DMAIC methodology and having a good knowledge of the situation of the organization. It is relevant to clarify that this model must be developed together with the members of the company to ensure an implementation in accordance with the exact requirements of the company. The Six Sigma tool served to identify critical processes in the company and numerically measure their status along with its DMAIC cycle. Lean tools served to reduce non-value activities, maintain more organized spaces, standardize the identified process, and create a mentality of continuous improvement in the organization. Both tools used together worked as a management model to maintain better monitoring and increase the performance. It may serve as a guide to diagnose, implement, and control other critical processes in the company.

Through control charts, it was determined that the process was awful and only 58% of orders were delivered on time. Using the Pareto diagram, it was found that 79.8% of the causes of this problem were explained by the difficulty in finding documents and the lack of tracking customer orders. Due to this, the Lean 5s and Kanban tools were proposed to obtain better performance in the processes considering the root causes identified with the Ishikawa diagram. The indicators improved their performance after carrying out the 4-week pilot test. The average report delivery decreased from 3.085 to 1.78 hours, productivity increased from 0.32 to 0.56 reports per man hour, the percentage of orders on time increased to 100% and an increase in income for the month was obtained from 13,811.19 to 15,434.64 dollars. After having carried out the ANOVA analysis of variance test, it is concluded that the Lean Six sigma management model implemented is effective, therefore, the pilot test is validated and can be implemented definitively. With the application of the tools and methodologies used in this research, we can use the study to apply to other companies in the service sector and improve the indicators and meet the proposed objectives.

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Biographies

Axel Díaz Guevara is Graduated from the Industrial Engineering degree at the University of Lima. He is interested in the areas of Project Management in Business with mastery in agile methodologies for monitoring and executing

projects. Experience in the area of Banking and Digitalization in Yape, leading key initiatives and supporting the execution and acceleration of strategic Projects.

Mariel Perez Reyes is Bachelor of Industrial Engineering from the University of Lima. Interested in the areas of Human Talent Management with knowledge in project profitability evaluation, data analysis and human resources information systems. Experience in the software industry participating in value engineering activities in SAP, and in the fishing industry, supporting the execution of the payroll area.

Rafael Chavez-Ugaz is PhD (c) from Universidad Pablo de Olavide, Spain. Masters in strategic business administration from CENTRUM Católica, Peru. MBA in General and Strategic Management from Maastricht School of Management, Netherlands. Industrial Engineer from Universidad de Lima, Peru. Executive with experience in service, pharmaceutical, and telecommunications companies, in commercial, quality, and operations areas. Consultant specialized in strategy and business improvement. Associate professor with 18 years of experience in Engineering and Business.