Improvement Proposal Applying Lean Manufacturing in a Mype: Case Study in a Dental Center

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Abstract

In recent years, Mypes in the health sector have been affected by the SARS-CoV-2 virus, which allowed the identification of certain deficiencies present in the service model. This case study focuses on dental centers because according to research, it is one of the areas with the highest risk of contagion, which is why they saw the need to implement new procedures that guarantee the safety of the service, which decreased their operational performance. This article proposes an integrated application of Lean Healthcare in a dental center, managing to improve its performance through the measurement of KPI's. The Lean Healthcare application improved the performance of dental centers, which was evidenced by the results of indicators such as decreased cycle time and waiting time.

Keywords
Lean Healthcare, 5S, VSM, Dental Centers and SME's.

1. Introduction
On March 11, 2020, the World Health Organization declared a health pandemic caused by COVID-19 [1]. Consequently, the Peruvian government promulgated, on March 15, through Supreme Decree No. 184-2020-PCM, mandatory social immobilization. This measure had various multisectoral impacts, where the most affected were small and medium-sized companies.

In Peru, MYPES represented 19% of GDP in 2019, reaching a sale of 148,276 million soles and employing 8.75 million workers; therefore, they are classified as key pieces of the country's economy. However, in 2020, they represented 8% of GDP, which reduced their contribution by 57.9% compared to the previous year [2]. MYPES in the health sector have not been indifferent to these impacts; for example, dental centers have been pointed out as potential points of contagion, this because dental procedures have a high risk of infection by Covid-19 and dentistry has been identified as one of the professions with the highest risk of infection [3]. For this reason, dental centers are obliged to follow the procedures issued by the Colegio Odontológico del Perú (COP) to act during the health emergency caused by COVID 19 and after it, because the procedures that they carry out daily expose them to contaminating particles that affect the staff health.

This has led to an accidental rethinking of the service model offered, generating increased waste, disorganization, increased waiting time for patients and a longer cycle time. This change in the model has highlighted and aggravated the current operational problems, that translate into a decrease of the capacity service.

In line with the above, this research aims to improve the performance of dental centers, through the application of the Lean Healthcare methodology. Regarding this objective, the general hypothesis is that using a Lean Healthcare management model optimizes the performance of dental centers.
Finally, to be sure about the accomplishment of the general objective, it is divided in 3 items: efficient use of workspace, reduce the cycle time and decrease "the waste" of the service model.

1.1 Objectives

- Efficiently use the work area.
- Reduce service model cycle time.
- Reduce “waste” in the service model.

2. Revisión de la literatura

2.1. Lean Health care

Lean, is a work methodology originated in Toyota, which specifies how to improve and optimize systems with a focus on the identification and elimination of all kinds of ‘waste’. Lean Healthcare is aimed at achieving efficiency in health services, looking for alternatives to improve traditional methodologies to reach a leaner process in the customer service, achieving a decrease in lead time (Rodrigues & Tobal 2018).

According to Cohen, the final objective of this philosophy is to create a lean focus in health care, looking for new ways to redesign clinical processes to reduce the resources used providing simplified and effective care (Cohen, 2010).

2.2. 5S in healthcare centers

The 5S tool corresponds to the Japanese initials of the five words that define it: seiri, seiton, seiso, seiketsu, shitsuke; which mean, respectively, eliminate the unnecessary, order, clean and inspect, standardize and discipline; therefore, this tool implies the systematic use of the principles of order and cleanliness in the workplace (Hernández & Vizán, 2013, p. 36).

According to José Cárdenas, in his study carried out in the San Juan de Lurigancho clinical laboratory, the purpose of implementing a 5'S methodology is to reduce the error rate in the delivery of results, the reduction in the delivery of materials. From the implementation, a greater traceability in the process was observed, and the handling of instruments, achieving an increase in productivity from 44.4% to 70% (Cárdenas 2021).

2.3. VSM

Value Stream Mapping (VSM) is a graphic model that represents the value chain and shows the materials flow as well as information. This tool facilitates the identification of activities that don´t add value to the business to eliminate them and gain efficiency. In addition, among its main benefits, are the greater visualization of the process. Obtaining from a structured system to implement improvements; and vision of what the ideal system should be like (Hernández & Vizán 2013, p. 90-91).

3. Método

The method is based on the collection and study of scientific articles related to our case study as shown in Table 1, to take these proposals as references in which the main Lean Healthcare tools are used and be able to make our contribution, selected.

Table 1. State of the art

Title	Author(s)	Tool(s)	Objective
Implementation and evaluation of Lean Healthcare tools through the FlexSim simulator	Saraí García	5S, Takt Time, Kanban	Optimize processes that have deficiencies in resource management.
Lean Healthcare Improvement Model Using Simulation-Based Lean Six-Sigma and TRIZ	Sri Indrawati, Enif Ramadhan Madarja	Lean Six-Sigma, TRIZ, VSM	Improving service performance at Indonesia's community health center.
Applying Value Stream Mapping to Improve the Delivery of Patient Care in the Oncolgy Day Hospital	Pilar I. Vidal-Carreras, Julio J. Garcia-Sabater and Juan A. Marin-Garcia	VSM	Improve the delivery of care to cancer patients and the working conditions of health care staff.
Evaluation of Waste Realted to the Admission Process of Low-Complexity Patients in Emergency Services, in Light of the Lean Heathcare Philosophy	Leticia Bianchini de Barros, Laura Passos, Elena Bohomol, Alice Sarntopoulos, Vinicius Minatogawa and Renata Cristina	VSM, Ishikawa	Map and analyze the value stream of classified patients.
Implementation of 5S management method for lean healthcare at a health center in Senegal: a qualitative study of staff perception	Shogo Kanamori, Seydou Sow, Marcia C. Castro, Rui Matsuno, Akiko Tsuru & Masamine Jimba	5S	Assess how 5S creates changes in the workplace, process, and outcomes of healthcare services in a resource-poor environment.

3.1 Modelo Propuesto

In this case study, the application of Lean Healthcare tools is carried out where the object of the research is a dental center. This analysis is focused on improving the performance of the object of study.
Provide a work model applying Lean Healthcare focused on dental centers (Peruvian MYPES), given that today the evidence of the application of this methodology in Latin America is scarce.
This study follows the DMAIC methodology (define, mesuare, analyze, improve, control) through its five main stages, which are detailed below:

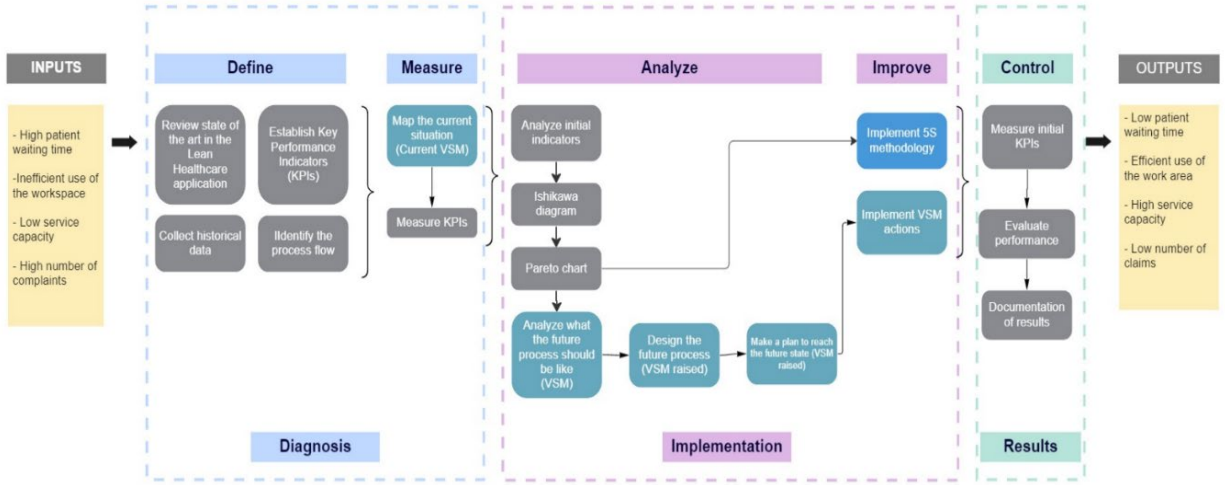

Figure 1. Design Model

3.1.1 Phase 1: Define

Se evalúa el estado del arte de las herramientas Lean Healthcare en el Perú y en el mundo para conocer la situación actual de sus aplicaciones. Posteriormente se recopila la data histórica del objeto de estudio y se identifica el flujo de proceso, mediante un flujograma del servicio, esta información ayuda a establecer correctamente los Key Performance Indicator (KPI The state of the art of Lean Healthcare tools in Peru and in the world is evaluated to know the current situation of their applications. Subsequently, the historical data of the object of study is collected and the process flow is identified, through a service flowchart, this information helps to correctly establish the Key Performance Indicator (KPI).

Table 2. Key Performance Indicators

Parametric Indicators	Equation
Cycle time	∑ standard time
Waiting time	∑ standard waiting time
Workspace usage percentage	Total work area used / Total work area
Service capacity	Productive time available per day/ cycle time
Number of claims	∑Total claims

3.1.2 Phase 2: Measure

Value Stream Mapping (VSM) is done where a time study is carried out to quantify cycle time waiting time. The identified VSM is classified as "VSM As Is" because it reflects the current state of the object of study, it serves as an input for the measurement of the established KPIs that facilitate subsequent analysis.

3.1.3 Phase 3: Analyze

The initial indicators are analyzed, the Pareto chart is elaborated to identify the most relevant problems and the Ishikawa diagram is made in order to determine the main causes of these. Likewise, it is evaluated how the future process flow should be, which is cataloged as "VSM to be". Finally, at this stage the plan is designed to achieve the proposed VSM. At this stage, the following objectives of the key indicators were established:

- Cycle time: it is expected to decrease by 30% compared to the initial indicator
- Waiting time: a maximum reduction in this indicator is expected in order to reduce the time used in activities that do not add value to the customer.
- Percentage of use of the work area: it is expected, at least, to reduce this indicator to 60%, since this way it will be possible to have the necessary space to position the materials and instruments that the dentist will use for each particular treatment.
- Service capacity: it has been measured based on the dental filling procedure, managing to have 9 dental fillings per day, it is expected to increase by at least 30%.
- Number of complaints: this indicator is expected to be minimized to improve the company's reputation.

3.1.4 Phase 4: Improve

The implementation of improvement activities for the process flow is carried out, accompanied by an improvement in the organization of the dental center, through the application of the 5S methodology, in order to reduce the search times for dental materials and instruments that increase waiting times in the flow.

3.1.5 Phase 5: Controller

The future VSM is prepared with the new cycle times obtained after implementing the improvements, in order to carry out continuous monitoring. In this way, the improvement is controlled based on the results obtained in the measurement.

Likewise, in this stage, the final indicators are measured, and the results obtained are analyzed, the relationship between the dependent and independent variable is evaluated and, finally, the hypotheses are validated.

Table 3. Key Performance Indicators

Parametric Indicators	Algorithm
Cycle time	$\sum Standard.total\ time$
Wait time	$\sum Standard\ time.wait\ time$
Percentage of use of work area	$\frac{Total\ work\ area\ used}{Total\ work\ area}$
Service Capacity	$\frac{Productive\ time\ available\ per\ day}{Cycle\ time}$
Number of claims	$\sum total\ claims$

4. Data collection

The dental center presents various procedures that are performed daily; For this reason, a data collection was carried out during the period January - August 2022 and it is corroborated that the procedure that had the most demand was that of cures, for which the present work focuses on this procedure.
Immediately afterwards, an Ishikawa diagram was made with the purpose of finding the root causes of the main problem.

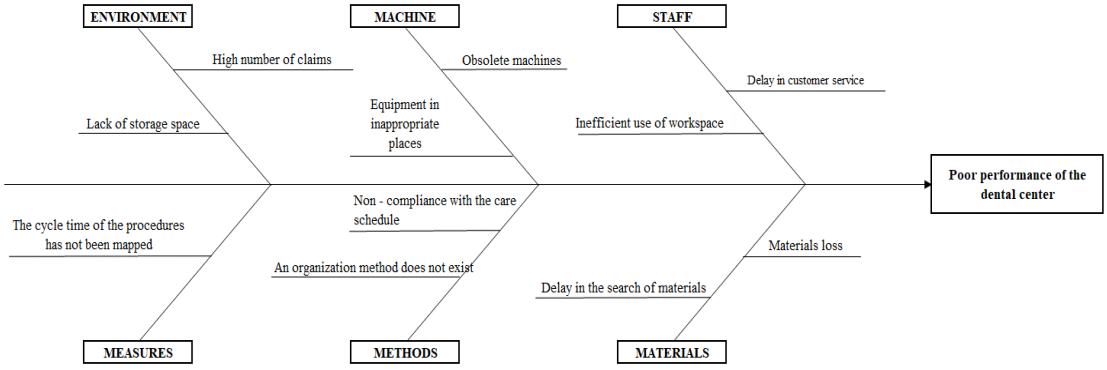

Figure 2. Ishikawa's diagram

Also, within 15 days, the number of days in which the problems were present was quantified, considering these data, a Pareto Diagram is made, which is shown below.

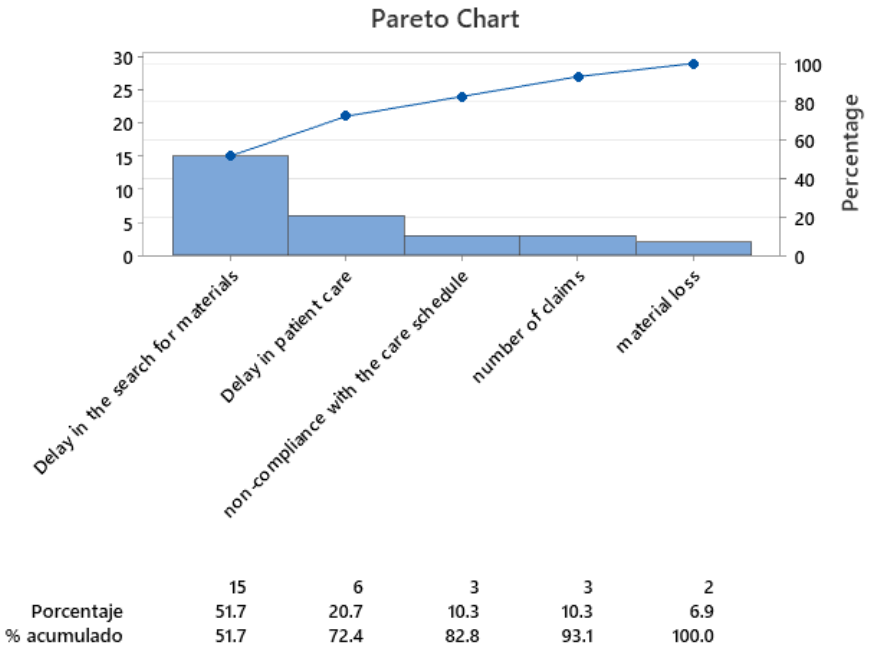

Figure 3. Pareto chart

Considering the findings found, we proceed to consider, to be solved, the problems that are within the top 80% because they are the most relevant.

5. Results and discussion

5.1 Results and discussion

Based on the implementation that was carried out in the present case study, it can be indicated that the application of this methodology improved the performance of the company since it decreased the cycle time, the waiting time, the percentage of use of the work area, the number of claims and improved service capacity.
Barros et al. (2022) identified in their research waste generated and related to the prolonged waiting time that a patient received, which is concomitant with results obtained in the present investigation in the application stage of the 5S methodology. On the other hand, Kanamori et al. (2015) managed to create changes in the work environment, improvements in the quality of the service and in the attitude of the collaborators, the aforementioned is reflected in this investigation in the decrease in the number of claims and in the satisfaction of the workers.

In the same way, in the study developed by García & Montenegro (2021), this methodology was implemented, managing to increase productivity and reduce waiting time, likewise, in the article by Vidal, García & Marín (2022) it was possible to reduce waiting times. waiting time and non-value-added activities, these results are analogous to the results obtained in this research regarding these same variables, which corroborates that the implementation of Lean Healthcare improves the performance of companies.

5.2 Graphic Results

With the new measurement of time that is carried out after the implementation, the VSM shown below was carried out.

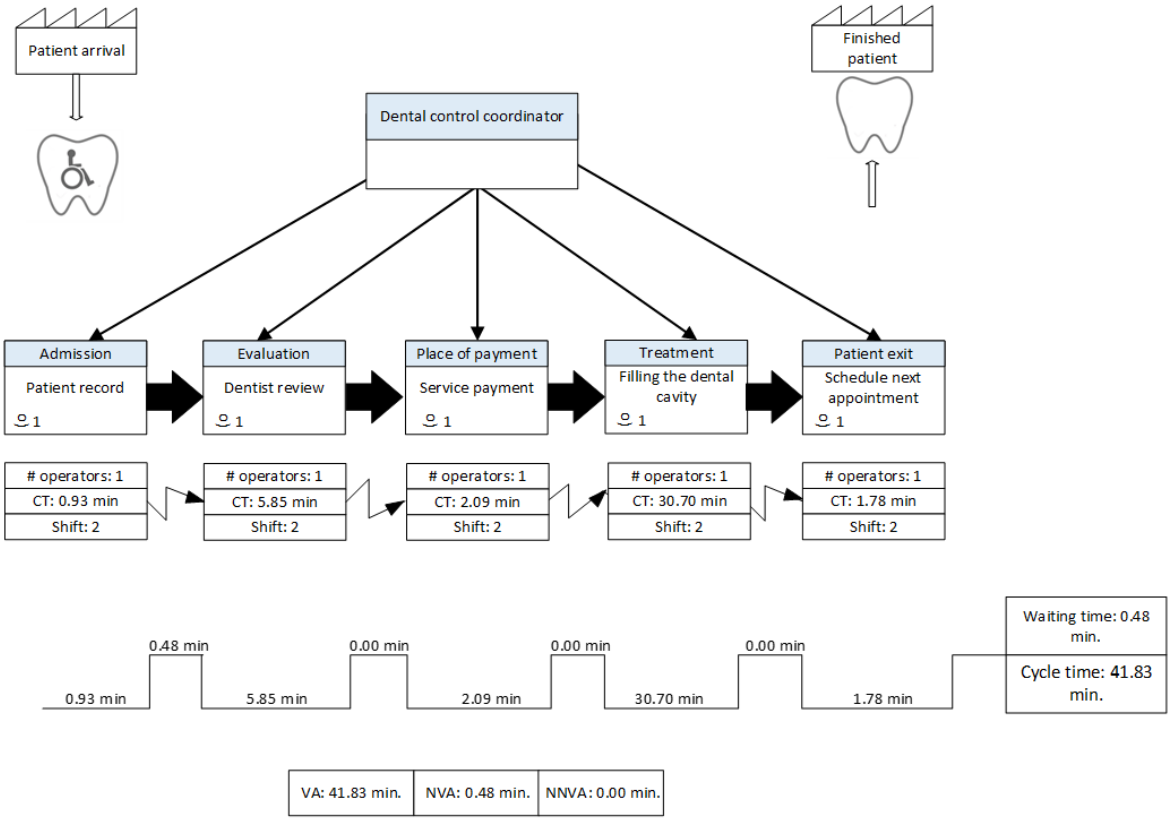

Figure 4. Final State

5.3 Proposed Improvements

The solutions that were proposed to each of the root causes are presented below.

Table 4. Root causes and solutions

Root Causes	Solutions
Delay in the search for materials	5S methodology
Delay in patient care	
Lack of storage space	
Equipment in inappropriate places	
Obsolete Machines	
Inefficient use of work area	
There is no method of organization	
Failure to comply with the care schedule	Virtual Diary
The cycle time has not been mapped	Value Stream mapping

5.4 Validation

The comparison of the current indicators with respect to the initial ones was made and compliance with the indicators was verified.

Table 5. Comparison of KPI's

Indicator	Initial	Current	Expected	Compliance
Cycle time	97.68	41.83	-30%	-57.18% (accomplished)
Wait time	11.64	0.48	Min.	(accomplished)
Percentage of use of work area	73	55	60	(accomplished)
Service Capacity	7.37	17.21	+30%	+133.51% (accomplished)
Number of claims	3	1	Min.	(accomplished)
Percentage of compliance with the 5S Methodology		88.8%		

The results obtained reach a 133.51% increase in service capacity, which represents a total care level of 17 patients, obtaining an increase in patient care of 10. According to these results and considering approximate costs of the company, an economic impact of approximately 71.43% of the sales level is estimated and this increases the Net Margin by 19.49 percentage points with respect to the previous one.

For the simulation in @Risk, 5000 tests were used, where 2 input variables were considered: sales, which follows a triangular distribution; and cost of sales, which follows a uniform distribution. Likewise, the output variable is net profit.

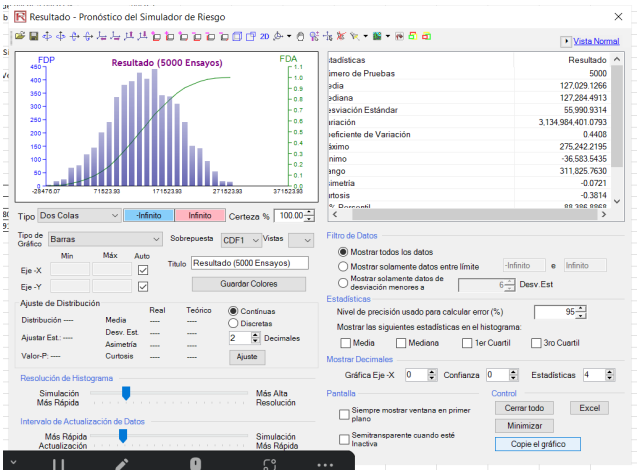

Figure 5. Rentability Simulation in @Risk

Considering the values obtained in @Risk, a comparison of the previous scenario with the current one was made, obtaining the following results:

Table 6. Rentability Analysis

	Before	Now
Patients attended	7.00	12.00
Sale Price	70.00	70.00
Variable Cost	5.00	5.00

Fixed Cost	5500.00	5500.00
Total Cost	37.74	24.10
Net Profit	32.26	45.90
Net Margin	46.09%	65.58%

6. Conclusion

In this case study, it was identified that the healing procedure is the most frequent; Therefore, the improvements focused on the service flow of this. However, many of the improvements impact the service flow of the other procedures.

In line with what was mentioned, there were quantifiable and non-quantifiable root causes, of which all the non-quantifiable ones were solved and the most relevant 80% of the quantifiable ones were selected. These root causes were reflected in the long waiting time of patients; inefficient use of the work area, low service capacity and high number of claims, for these inputs the 5S and VSM tool was selected, although the use of each tool was specifically established for each input, they had a synergistic effect.

The deployment of this research followed the DMAIC methodology, which established the stages to follow in logical sequence to achieve improvements, it can be concluded that the use of this methodology helped to maintain order and continuous monitoring throughout the research process.

Finally, it was evidenced that these improvements had a positive impact on the financial results of the company, obtaining an increase of 19.49 percentage points in the net margin, for which a demand of 12 patients per day was considered. Likewise, the service capacity amounts to 17 patients; Therefore, if efforts are made to increase demand and work at 100% of its capacity, a net margin of 73.60% would be reached, which increases by 8.02 percentage points with respect to the margin obtained with 12 patients.

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Biography

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