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# **SERVICE MODEL UNDER THE LEAN APPROACH AND THEORY OF CONSTRAINTS TO INCREASE THE LEVEL OF SERVICE IN SMEs IN THE HEALTH SECTOR**

Tesis para optar el Título Profesional de Ingeniero Industrial

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# Service Model under the Lean Approach and Theory of Constraints to Increase the Level of Service in SMEs in the Health Sector

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**Abstract**—Companies in the health sector face the challenge of offering optimal patient care, knowing that they come to establishments with some pain or illness that afflicts them, thus hindering well-being during the care processes. The level of service represents around 16% of the annual costs of Peruvian SMEs in the health sector, analyzing the waiting time of patients, the quality of care received and the flow of people who come to the establishment according to capacity of this. Therefore, a model based on the Lean methodology and the theory of constraints was developed to improve the level of service. It was validated by carrying out a case study in a company in the sector located in the Peruvian province of Cañete. The results showed an increase in the level of service, improvement of workstations with the availability of necessary tools, reduction of cycle times from 5.1 hours to 1.2 hours, also reducing waiting times for office care from 1.81 hours at 0.35 hours.

**Keywords**—lean, 5S, theory of constraints, level of service

## I. INTRODUCTION

Mostly in countries with a high population density in the world, access to medical care with an optimal level of service is a privilege that can only be accessed by a certain group of the population and is evidenced mainly by the lack of medical resources, as well as the lack of oversaturation of health centers [1]. In Latin America, there is a very homogeneous situation in the provision of medical services, which are not properly timely, accessible and of quality. The research highlights the importance of controlling customer satisfaction and continuously improving the services offered to improve the quality of Peruvian medical care. [2].

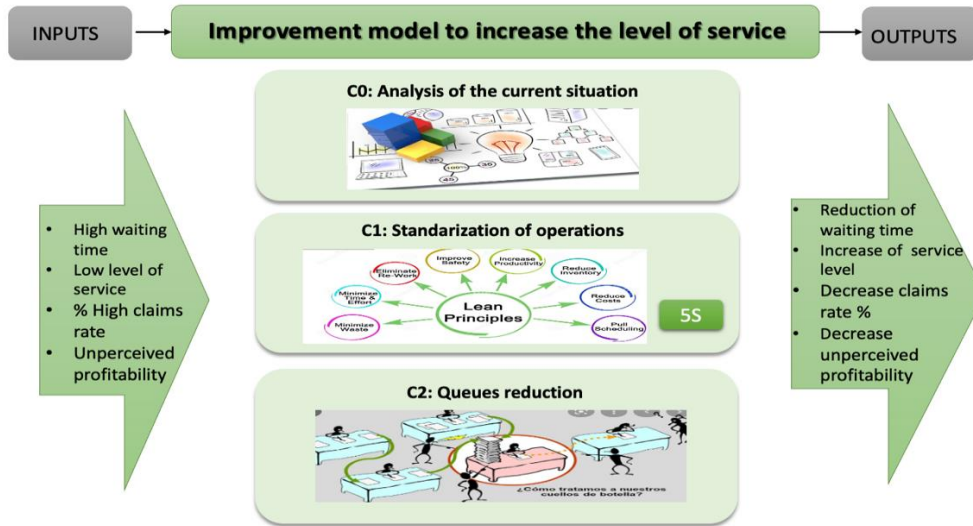
The problem found was the low level of service provided to patients in Peruvian health centers. This problem whose search for a solution is important for improving the quality of life of the population, could be identified in research carried out in various countries of the region and the world; For example, in the United States, a country that, although developed, reported the challenge of balancing quality and costs for health care, registering high waste and low reliability in care delivery systems. [3]. An investigation focused about a group of hospitals in Malaysia identified that they did not have standardized processes, there was waste and a high degree of waiting in the care processes [4]. Following the same line of the previous case, in Tanzania an investigation was carried out that highlights the high waiting times that are registered in hospitals in the north of the country, showing that this is caused by the disorder and low training of health personnel [5].

Having recognized the importance of solving the problem of the level of service in Peruvian medical centers, a case study was selected that showed customers in their operations not very satisfied with the care received and an inefficient management of waiting times that had a substantial financial impact. to the business. To solve and mitigate the causes of the problem, a model based on the Theory of Constraints and Lean applying 5s was used, which aimed to improve the level of service. The Lean methodology serves to generate value for customers, optimizing the number of necessary resources and achieving the reduction and elimination of waste [6]. On the other hand, 5s tool contributes to the organization of workplaces based on 5 Japanese words translated into English as: order, set, shine, standardize and sustain [7]. Finally, the theory of constraints facilitates the reduction of waiting times.

The scientific articles reviewed contain little information on the application of models with industrial engineering tools to improve the level of service in the health sector. For that reason, the need arises to carry out the present investigation, which is

divided into six parts that are introduction, state of the art, contribution, validation, conclusions, and bibliographic references.

FIGURE I. MODEL IMPLEMENTATION



## II. STATE OF THE ART

### A. Service Level Management in private SMEs in the Health Sector

An optimal service generates a perception of customer satisfaction, which also raises the perception of the company or institution that provides the service; represents an efficient development of operations, without delays or delays, as long as the service delivered is fast and accessible [8]. The health sector faces continuous improvement frequently, to reduce times in operations, waiting times, and satisfy the client's medical needs. The most relevant problems in the health sector are associated with patient dissatisfaction with the service received [9]. These are associated with customer satisfaction, mainly due to an overuse of medical services, underuse of the institution's services and resources, as well as their misuse.

It is the level of service that is sought to improve in this research, since it is the one that favors the good image of the business and directly contributes to the return of customers in a next service opportunity. It can be measured by the experiences reported by the patients, it is also necessary that it be measured periodically for the assurance and accreditation of this [2]. One of the pillars of the level of service is the quality of the care offered, which is decisive for people's health due to its criticality, leading to the fact that, if poor service provision is provided, it will influence a worn-out state of population health [10].

### B. Application of Lean Service in the Health Sector

The Lean methodology is considered a philosophy applied to both processes and services, to achieve an improvement in quality, profitability, productivity, and customer service. Many companies worldwide use these methodologies to achieve greater profitability and market positioning. Human actions are

integrated, such as leadership, customer focus and adaptation to changes, it also integrates operational aspects such as process capacity, management, and analytical thinking [11]. According to a qualitative analysis of 35 articles based on medical cases, it was evidenced that the implementation of Lean contributes to process optimization, reduces waiting times, improves patient flow, which increases patient satisfaction using tools [12].

The research on 5s as part of the Lean methodology reviewed for this research work had a focus on the health sector, with articles of cases of application of the tool in different clinics and hospitals around the world, as well as articles that analyze publications on the use of 5S in the sector. This methodology is receiving greater attention in recent years in the health sector because it provides solutions to improve the quality of services provided in private and state medical centers, including those found in low-income countries with low or middle income such as Peru [13]. 5S optimally organizes the workplace of health personnel so that the work is efficient, and the time spent searching for the elements necessary to provide services is reduced, recognizing that many medical centers do not maintain medical records files and administrative documents in an orderly manner [5].

Analyzing some cases experienced on the use of 5S, we have information from the scientific study carried out in Senegal, a country with many economic inequalities and few empirical studies was able to improve the level of service perceived by patients, managing to affirm that patients with fewer resources They were the ones with the highest level of satisfaction and it is proposed to analyze the change in the attitude of the staff when they perceive a better satisfaction of the patients for the service they provided [14]. Similarly, in Egypt it was possible to improve the quality of care and mainly train leaders on this tool so that they are aware of the importance for continuous

improvement of the companies they manage, ensuring monitoring and follow-up of 5S activities for its sustainability over time [7]. Likewise, mentioning the importance of the changes that originate when using 5S, it is possible to maintain available stocks of medicines, have the necessary movements and transfers of patients, greater cooperation, and teamwork of the staff, as well as generating confidence in their patients and family members by working with safe practices [15]. Finally, the methodology manages to reduce the cycle time by more than 50%, believing the health personnel that they are saved time, money, and efforts, which generates a greater motivation to attend kindly and generate the objective, the improvement of the level of service [16].

*C. Applications of Theory of Constraints in the Health Sector*

The Theory of Constraints is a scientific process used for solving generic problems, initially focused on manufacturing industries and has been developed in the last two decades to reach implications in various processes as in services. The main objective of companies was often reaching ways on cost reduction, when instead it should be to obtain a well profit through increased performance. The Theory of Constraints is carried out by identifying the bottleneck and designing an improvement in the process, generating a beneficial impact on business final indicators, as in a healthcare context, on aspects like waiting lists and patient quality attendance. Furthermore, the theory of constraints has the potential effect in generating complex changes in systems rather than local efficiencies, as evidenced by the movement of the results showed by several indicators. The theory of constraints has the advantage of not being a technique made equally in every system for achieving organizational change because all the stakeholders of the company are involved in identifying problems and unique solutions depending on the initial situation. Therefore, it can be adapted to local needs in order the be a tool for promoting ownership of change initiatives.

The change of SMEs in the health sector to meet the high expectations demanded by customers has made the management is focus on applying various solutions such as the theory of restrictions. This provides a new approach to management with the aim of improving business profitability, as well as administrative objectives through continuous improvement. In addition, the advantage of using the theory of restrictions in a company in the health sector is that it helps to identify the cause of the process restriction and provides a solution guide. The theory of restrictions provides a series of processes and rules for simple and complex processes that generate a synchronization of this, thus achieving the improvement of the SME system of the health sector [17].

III. CONTRIBUTION

*A. Model Basis*

Companies continually seek to stay at the forefront of the market, which implies a constant renewal of the forms and contents of their processes. Currently there are various tools, methodologies and models that support the continuous improvement of organizations. In the literature review, it was found that the Lean model, supported by the theory of restrictions, would contribute to the solution to the problem

found. The following table explains the interrelationship of the main articles selected by type with the impact it would have on the design of the proposal.

TABLE I. COMPARATIVE MATRIX

<i>Objectives</i>	Attention quality increasing	Reduction of queues	Continuous flows improvement	Standardization of operations
<i>Scientific articles</i>				
-Bhat, S., Antony, J., Gijo, E., & Cudney, E. (2019)	Lean			
-Honda, A., Zanetti, V., Gerolamo, M., & Davis, M. (2018)				Lean
-Ishijima, H., Eliakimu, E., Scharo, J. (2016)	5s			
-Tabish, S. & Syed, N. (2015)		Theory of constraints	Theory of constraints	
<b>Prproposal</b>	Lean /5S	Theory of constraints	Theory of constraints	Lean

*B. Proposed Model*

This model is made up of the Lean tools and Theory of Restrictions, which will contribute to the improvement of the service level of the Campos clinic. The main advantages to be offered to companies in the sector are the reduction of waiting times and the rate of claims, the increase in customer satisfaction and the improvement of the quality of care.

*C. Model Components*

For the development of the proposal, 2 components were implemented and the previous presentation of the proposal as a project, which will be detailed below:

- Analysis of the current situation

It consists of the previous preparation before the start-up of the model. Training and awareness of the importance of meeting the objective, the duration of the project, the project team and the investment are defined.

- Component: Standardization of operations

Lean is used, which consists of 5 stages (DMAIC), in the first the problems are defined by means of a Pareto diagram; Then, the situation is measured using the proposed indicators, with the current situation of the organization, the problem is analyzed and the root causes are identified through the tree diagram, once identified the respective tools are implemented for each cause, first the 5s are applied in order to improve the work environment, then the Kanban board to achieve the optimization of staff time. Finally, internal, and external audits will be carried out to maintain a standardization of what is proposed.

- Component: Reduction of queues

The Theory of Constraints tool is used, which will be used to manage the times in the process flow, in this case, optimize the waiting times in each triage and standardize them.

*D. Indicators of the Proposed Model*

3 key indicators will be used to measure the evolution of the improvement and thus validate the increase in patient satisfaction.

- Wait time

This indicator measures the waiting time before triage and the time before going to the clinic.

It seeks to reduce waiting time by 40%, at the same time, achieve a standard time reducing variability.

- Claim rate

Complaints significantly impact the level of care. The most recurrent are due to long waits prior to your consultation.

- Level of quality of care

It is the indicator that depends on the previous two since everything is evaluated during the patient's stay in the clinic. This indicator is measured through satisfaction surveys.

It seeks to increase the level of attention perceived by the patient to 75%.

- Non-quality cost

Costs incurred by the deficiency of the quality of the care process.

It is calculated by monetarily measuring the number of patients not treated with respect to the total number of patients.

IV. VALIDATION

To validate the proposed model, a simulation of the present process and its improvement was developed in the Arena software using the tools that compose it. Improvements are not going to be implemented for the present study.

*A. Initial Diagnosis*

When analyzing the initial situation of the company, the main problem found was the level of service, which represents 15.88% of the annual costs of the SME and means \$ / 47,650 per year. The main causes found are inefficient management of waiting times, lack of standardization of processes and inefficient purchase planning for clinic supplies. The results of the application of the proposed model are presented later, in addition to the measurement of the indicators.

*B. Design of Validation and Comparison with the Initial Diagnosis*

The validation process of this research was conducted through a pilot test of a period of 3 months that covered the months of August, September and October 2021, considering from the arrival of the patients to the clinic, as well as the entire process that is carried out to receive care by outpatient consultation and finally, the scope will culminate when patients leave the clinic. To calculate the replications, the output analyzer tool was used, which provided valuable information about the number of repetitions necessary for the values to be significant.

According to the proposed model and its implementation, the variables that are counted such as working hours, number of

clinic workers, availability of work tools, as well as arrival times and process delay are first analyzed. By implementing the test of the standardization component through Lean and the 5s tool, it would be possible to reduce the variation of times and an increase in the order of workstations, eliminating waste or non-useful tools for workers, freeing up space and greater comfort for carrying out work.

TABLE II. CURRENT SITUATION

Indicator	Current situation	Expected situation
Waiting time for triage	1.68 hrs.	0.3 hrs.
Waiting time for medical consultation	1.81 hrs.	0.5 hrs.
Level of quality of care	56%	75%
Claims rate	15%	5%
Unperceived Profitability (annual)	\$ 9,600	\$ 0

*C. Simulation of the Improvement Proposal*

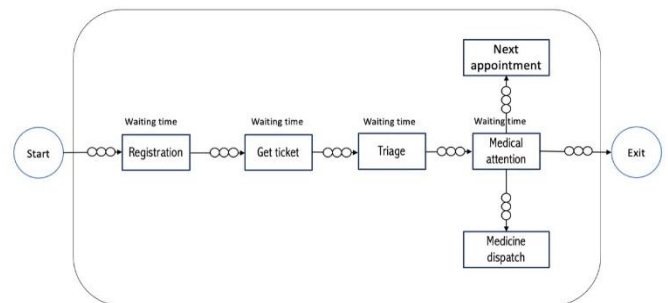
The proposed model was implemented through simulation with the Arena software to corroborate the improvement in the service level of the study SME. The distribution data of the arrivals and times that were previously collected and granted privately by the study company were placed. The formula for the sample size was used through the input analyzer, determining an optimal number of runs thrown in 132. The results obtained are found below.

TABLE III. IMPROVED SITUATION

Indicator	Current situation	Improved situation
Waiting time for triage	1.68 hrs.	0.20 hrs.
Waiting time for medical consultation	1.81 hrs.	0.39 hrs.
Level of quality of care	56%	76%
Claims rate	15%	3%
Unperceived Profitability (Annual)	\$ 9,600	\$ 1,920

A considerable reduction in waiting times was achieved, such as the delay for office care from 1.81 hrs. to 0.39 hrs., this being the longest wait in the care process. In addition, standardizing operations and ordering workstations increases the level of quality of care and decreases the rate of claims.

FIGURE II. SYSTEM REPRESENTATION



## V. CONCLUSIONS

This study has led to a better understanding of the level of service in a SME in the health sector in Peru. The results have shown a considerable improvement of the initially proposed indicators. The conclusions identified are presented below.

- Waiting times for office care was the stage of the process with the longest delay, which was reduced through the application of the theory of restrictions from 1.81 hours to 0.35 hours.
- The low level of service represented 16% of the annual costs of the clinic under study, however, by using the proposed model there would be a reduction to 3% of the total costs, meaning a saving of \$ 9,600 per year.
- The model proposed in this study validated through simulation is unique and innovative in employing various engineering tools to increase the service level of SMEs in the Peruvian health sector.

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