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Operations Management in Servuction Systems A Systematic Review of Literature: A Case Study in the Health Sector

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Abstract

The objective of this literature review is to provide an updated synthesis of knowledge on operations management in the sector's service systems with an international and national focus, in which the current context shows a growth in the demand for health services, and this exceeds the response capacity of the institutions that comprise it. In the face of this, significant challenges arise that affect the quality of service and patient satisfaction. Factors such as resource scarcity, changes in government policies, and operational constraints are factors that exacerbate these problems.
To address this problem, the methodology implemented follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach, which includes the identification, selection and evaluation of scientific articles from various academic databases. Studies focused on operational management in the health sector and the application of continuous improvement methodologies were reviewed. In particular, management tools such as Theory of Constraints, Lean Manufacturing and Six Sigma are analyzed, highlighting their potential to increase operational efficiency and improve the quality of service in health institutions, in a period of time of 10 years (2014 - 2024).

This review seeks to offer a comprehensive view of the challenges and opportunities in the management of operations within the health sector in Cartagena, as well as to lay the foundations for future research and possible interventions that optimize operational processes in this critical sector.

Keywords
Theory of Constraints, Lean Service, Six Sigma, Operations Management, Service System, Prisma Model.

1. Introduction
In Colombia, the health system operates under the 'Bismarckian' model of social security, in which the State acts as the regulatory entity through the General Social Security System – SGSSS. To guarantee the best results in health care, control and monitoring criteria have been established with five fundamental characteristics: Accessibility, Opportunity, Safety, Relevance and Continuity. (Ministerio de la Protección Social, 2006).

The historical behavior of affiliation to the SGSSS, which integrates the contributory, subsidized, special and exception regimes, shows a sustained growth over the years. In this way, affiliation coverage has grown from 29.21% in 1995 to 98.56% at the end of 2024. (Ministerio de Salud y Protección Social, 2024). However, there are various challenges such as: long waiting lists, deficit of specialized medical personnel and insufficient infrastructure. An example of these difficulties can be seen in the department of Bolívar. According to the report "Actor Evaluation and Qualification System 2023" by the Quality Office of the Ministry of Health and Social Protection, at the end of 2021, the average appointment assignment time in the region reached 9.5 days, more than double the national average of 4.1 days. (Ministerio de Salud y Protección Social O. d., 2023), underscoring a mismatch between supply and operational capacity to meet demand without compromising service quality.

In the face of these challenges, it is essential to examine how companies in the health sector in Cartagena are managing their operations. What are the main operational failures that hinder an efficient health care system? What strategies can be implemented to optimize operations management in this sector?

1.1. Objectives
- Establish a comprehensive vision of the Operations Management strategies implemented in the health sector during the last decade (2014-2024), through a systematic review based on the PRISMA model.
- To propose a roadmap that facilitates the identification of opportunities and possible interventions in the management of operations within the health sector in Cartagena de Indias, Colombia.

2. Literature Review
2.1. Servuction Systems
The term Servuction, proposed by the French academics Pierre Eiglier and Eric Langeard in their work "Servuction: The Marketing of Services", is defined as the systematic and coherent organization of the physical and human elements that intervene in the customer-company relationship. (Pierre, 1987)

Like production, service requires a productive structure in which activities are carried out sequentially, integrating tangible and intangible resources. They interact in a controlled environment to generate a final product, which is then distributed and marketed to meet the needs of a market. However, in the production of services, there is a crucial difference: the unique and unrepeatable interaction between three essential components: the physical agent, the customer, and the contact personnel, which gives rise to what is called the moment of truth. This moment is decisive for the customer's perception and constitutes the starting point for designing strategies that guarantee positive experiences. (Gómez, 2015)

In this context, services are often classified as highly complex production systems, particularly in the category of project production, due to their focus on meeting specific, non-standardized needs. The health sector is an example of this, where the standardization of processes is a challenge. Although the symptoms of a disease may be similar, the underlying causes often vary, requiring personalized treatments tailored to each case (Garzon, et. al 2017). In this order of ideas, there are writings in which the application of this concept has had promising results, for example (Saenz and Redchuk, 2021) describes the development of a conceptual model for the assignment of shifts to medical staff in an ambulatory care service and (Garzón, et. al 2023) presents the conceptualization of the manufacture of outpatient

services under a Lean Healthcare approach, in which it reaffirms how complex it is to standardize this type of service, due to the randomness and variability of the patients and symptoms treated in the health company.

2.2. Theory of constraints

The Theory of Constraints (TOC) is a management tool developed by Dr. Eliyahu Goldratt in the 1970s and presented in his novel "The Goal" (1984). Through fictitious situations faced by the manager of a production plant, Goldratt introduced a new way of programming and controlling resources and stocks in companies. In his analysis, he started from a fundamental question: What is the objective of a company? Although organizations can have multiple purposes (such as generating jobs, consuming raw materials, or increasing their market share), Goldratt concluded that these goals do not guarantee a company's survival. His answer was blunt: "The goal of a company is to make money." Goldratt also proposed to envision the organization as an interconnected system, using the metaphor of a chain that is only as strong as its weakest link. This weak link, called a constraint or bottleneck, represents the critical point that limits the performance of the entire system (Sierra, et. al 2019).
TOC is structured in a five-step cycle:

- Identify the restrictions.
- Exploit the restriction, maximizing its capacity without incurring higher costs.
- Subordinate processes to the performance of the constraint.
- Raise the restriction, increasing its capacity.
- Return to step one, initiating the continuous improvement cycle.

In the health sector, according to the study Outcomes of managing healthcare services using the Theory of Constraints: A systematic review (Bacelar, et. al 2020). The application of TOC has shown significant benefits. These include reduced wait times for appointments and procedures, decreased hospital stay, improved emergency services care, reduced overtime for medical staff, and increased organizational revenue with minimal investment. Another example of this, (Bacelar-Silva, et. al* 2022) en in which he describes how the application of TOC in an ophthalmology clinic in Brazil contributed to improving the performance of the service, increasing its care from 14 patients (12 regular and 2 acute) to 23 patients (18 regular and 5 acute), which represents an addition of 9 patients (an increase of 64%) attended using existing resources (at no additional cost). In addition, it has been found that combining the TOC approach with other methodologies such as Lean and Six Sigma generates superior results compared to the isolated use of these tools. (Morales, et. al 2020)

2.3. Lean Service

The Lean Manufacturing methodology is widely recognized for improving operational efficiency and competitiveness in various sectors, including services. Defined as "the process of constantly and gradually improving the different areas of a company, seeking greater productivity and competitiveness of the company" (Rother and Shook, 1999). This methodology has been developed for various applications that are not only used in manufacturing but also in services such as governments (Lean Government), hotels (Lean Hotel) and accounting (Lean Accounting). In the health sector, this methodology is applied under the concept of Lean Healthcare, focused on optimizing clinical and administrative processes, eliminating inefficient practices and meeting patient expectations. (Graban, 2016).

Several recent studies reinforce the effectiveness of Lean in hospital settings. For example, in a type II-1 hospital, a 16.8% decrease in care times in the emergency area was achieved after the implementation of Lean Healthcare and Collective System Design (Suarez and Puertas, 2023). Likewise, waste has been identified in the process of admitting low-complexity patients to emergency departments, highlighting the usefulness of tools such as Value Stream Mapping to eliminate bottlenecks (Barros, et. al 2022). The economic impact is also significant: in the surgical field, the introduction of Lean generated annual operating savings of more than 8.5 million euros (Sales Coll, et. to 2024), while in intensive care units it reduced discharge time by 61% (Zimmermann and Bohomo, et. al 2023). On the other hand, the adoption of Lean thinking in shift changes between surgeries allowed to reduce the preparation time between procedures by up to 25% (Amati, et. al 2022). Similarly, the use of Case Management in combination with this methodology proved to be effective in streamlining the flow of patients in tertiary hospitals, improving occupancy indicators and reducing operating costs (Al Harbi, et. al 2024). In terms of outpatient care, Lean-based digitization drastically reduced the waiting time from 336 to 39 minutes (Astiena, et. al 2022); and the optimization of extended hospital stays using Lean tools generated savings estimates of more than 417,000 euros per year in a Polish hospital (Zdęba-Mozoła, et. al 2023).

These positive results in the implementation of Lean Healthcare not only reflect improvements in operational indicators, but also respond to the growing expectations of users of the health system. In this context, patients increasingly value safe, fast and specialized care, with a focus on the full recovery of their well-being (Pestana, et. al 2016). To achieve these objectives, the pillars of Lean Manufacturing, also adapted to the health sector, are continuous improvement (Kaizen), Quality Control and Just-in-Time (Liker, 2004) that together, these initiatives not only improve the patient experience, but also increase the efficiency of the system and promote the financial sustainability of health institutions.

2.4. Six Sigma

Six Sigma is a continuous improvement methodology developed by Motorola in the 80s, whose fundamental principle is customer focus. It is based on the DMAIC (Define, Measure, Analyze, Improve and Control) process and uses statistical tools to address problems in a structured way. It aims to identify areas for improvement, analyze collected data, implement effective solutions, and sustain results over the long term (Montgomery, 2019).

In the case of health services, it took almost a decade for these individual methodologies (Six Sigma and Lean) to be implemented (Buck,et. al 1998). In this order, healthcare is a very crucial and complex sector, involving several departments, and a failure in one department can have a negative impact on patient care. (Rathi, et. al 2021).

One of the main strengths of Six Sigma is its ability to identify and eliminate problems accurately, evidencing the improvements achieved through advanced statistical techniques (Jiju, et. al 2020). For example, in a private hospital in India, the application of the DMAIC approach reduced the average turnaround time in blood sampling from 164 to 84 minutes, demonstrating a marked improvement in laboratory efficiency (Kumar, et. al 2022). Similarly, in the field of orthopedic traumatology, this methodology made it possible to reduce the waiting time for appointments and reduce the points of contact in the registration process by 51%, optimizing the administrative burden and improving clinical efficiency (Pierce, et. al 2023). Other results after the application of this methodology show that in the reduction of the length of hospital stay, for example, in patients undergoing reconstruction of the anterior cruciate ligament, a reduction of almost 16 hours in the stay was achieved, which allowed to free up beds and generate considerable savings (Moffatt, et. al 2022). In the pediatric emergency area, the combination of DMAIC with discrete event simulation managed to decrease the average waiting time from 74.94 to 20.24 minutes, which contributed to alleviating overcrowding and improving the overall efficiency of the service (Mistarihi, et. al 2023). Finally, in the field of cardiology, the implementation of Lean Six Sigma in multidisciplinary team meetings made it easier to optimize decision-making and the use of resources, raising the quality of care (Hoefsmit, et. al 2023).

These studies show that the application of Six Sigma in the healthcare sector not only improves operational efficiency and reduces process variability, but also has a positive impact on the quality of care and the optimization of resources. Overall, the results obtained reinforce the importance of adopting data-driven methodologies to achieve sustainable improvements, ensuring a safer, more efficient and patient-oriented health service.

2.5. PRISMA 2020 Declaration

The PRISMA 2020 (Preferred Reporting Items for Systematic reviews and Meta-Analyses) statement replaces the PRISMA 2009 version and is a guide designed primarily to help authors transparently document the purpose of the review, the procedures carried out and the findings obtained. This guide is composed of 27 items, which include an extended checklist with specific recommendations for each section, a structured summary under the PRISMA 2020 format and a revised flowchart, all aimed at improving the quality and clarity of systematic reviews.

Although the guideline was originally mapped for systematic reviews of studies assessing the effects of health interventions, regardless of the design of the included studies, it is equally applicable to non-health-related interventions (e.g. social or educational interventions). Its relevance lies in the fact that it allows readers to assess the adequacy of the methods, the quality of the presentation and the synthesis of the characteristics of the studies reviewed. This, in turn, makes it easier for health policymakers and healthcare providers to assess the applicability of the results in their respective contexts. (Page, et. al 2021).

3. Methodology

The methodological strategy implemented in this article is the documentary review, developed according to the systematic review approach described in the PRISMA 2020 Declaration. The methodological process was structured in three main phases: identification, review and inclusion, each divided into specific stages to ensure a rigorous and detailed analysis. (see Figure 1)

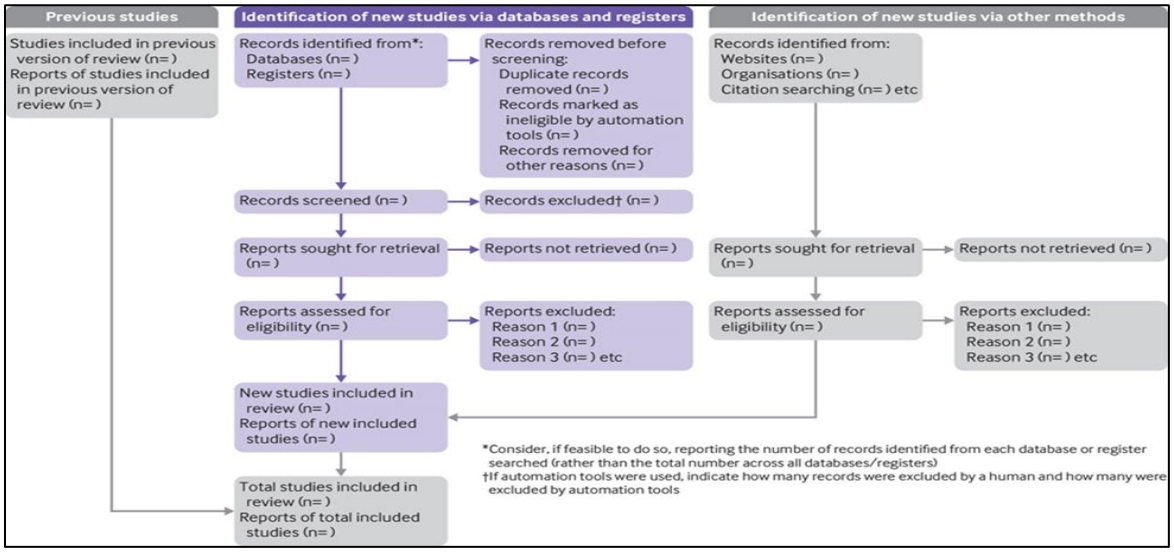


Figure 1. PRISMA 2020 Flow chart

3.1. Articles identification

3.1.1. Eligibility criteria

In order to achieve a systematic and structured research, as set out in the PRISMA 2020 Declaration, a main problem question was posed, complemented by sub-questions, which were crucial in the selection of the information of interest. (see Figure 2).

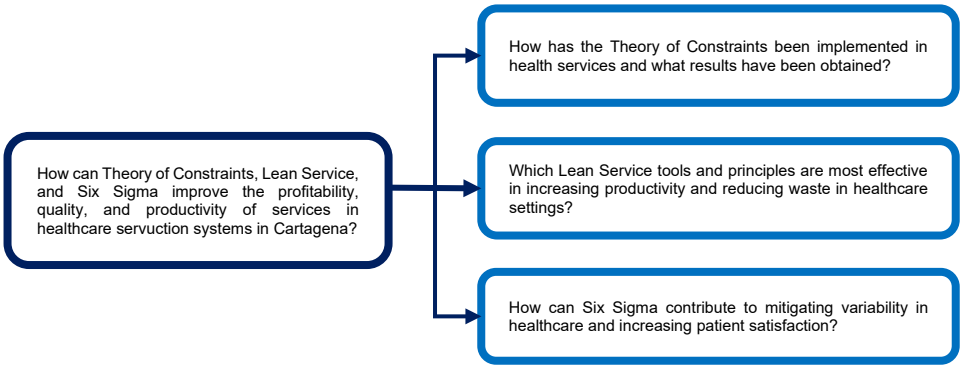


Figure 2. Search Problem Question and Subquestions

3.1.1.1. Inclusion criteria

A. Present theoretical and practical studies and case studies (qualitative and quantitative) in which the methodologies of interest are applied.
B. Files in English and Spanish (research articles, proceedings, theses, degree work, conference videos, among others), which address problems related to care in the health sector (outpatient consultation, emergencies, health care, specialties, etc.).

C. Peer-reviewed publications, written during the last 10 years ensuring relevant information over time.
D. Studies carried out in relevant contexts in which operations management is applied in the health sector.

3.1.1.2. Exclusion criteria

A. Articles that are duplicates or repeat content without offering relevant new information or insights.
B. Non-peer-reviewed sources, such as blogs, opinions of non-academic experts, or articles from popular newspapers and magazines with no solid scientific basis.

3.1.2. Source of Information

The following databases were used for the literature search: TOCICO Healthcare Portal, Taylor & Francis Group, PubMed, Science & Direct and Google Scholar, due to their easy access and a wide range of texts.

3.1.3 Search Strategies

For this search, a series of keywords related to each methodology were used, combined with Boolean connectors (AND, OR and NOT) and defined a time horizon between 2014 - 2024, relevant information was obtained for the research. Additionally, two search languages, English and Spanish, were chosen due to their dominance in many academic and scientific disciplines. (see Table 1):

Table 1. Search strategies

Methodology	Database	Keywords	Files Found
TOC	Portal TOCICO Healthcare	"Health"	74
	Taylor & Francis Group	[All: toc in health care] AND [in Journal: Health Systems]	6
	Pub Med	((Theory of Constraints) AND (Healthcare OR Patient flow))	107
	Science Direct	By reference	1
	Google Scholar	By reference	3
Lean Service	Google Scholar	By reference	12
	Pub Med	(Lean Service) AND (Healthcare)	485
Six Sigma	Pub Med	((Six sigma) AND (Healthcare))	332
	Science Direct	By reference	3
	Google Scholar	Six sigma AND Healthcare AND Hospital, sort by relevance	300
Total			**1323**

3.2. Information Review

The articles found were reviewed independently, taking into account aspects such as title and abstract, selecting those that are related to the topic of interest, eliminating duplicate files and those that did not meet the established criteria. Subsequently, the individual results of each review were evaluated together to reach a consensus on the articles that should be included in the present work. This collaborative process guaranteed the validity and relevance of the final selection.

3.3. Included studies

Once the articles for review were selected, a set of key data was collected, such as: sector under study, subsector, name of the database, type of document, title of the article, author and nationality, year of publication, abstract, objective, methodology implemented, problem addressed, results and conclusions. This process allowed the information to be organized in a systematic way, facilitating its analysis and the identification of relevant patterns for the research.

Finally, taking advantage of the information obtained from the documents that met the previously defined criteria, an analysis was carried out using statistical tools to describe and correlate the research approaches in the methodologies of interest.

4. Results and Discussion

4.1. Study selection

According to everything established in the identification phase, 62 articles were selected for analysis. (Figure 3)

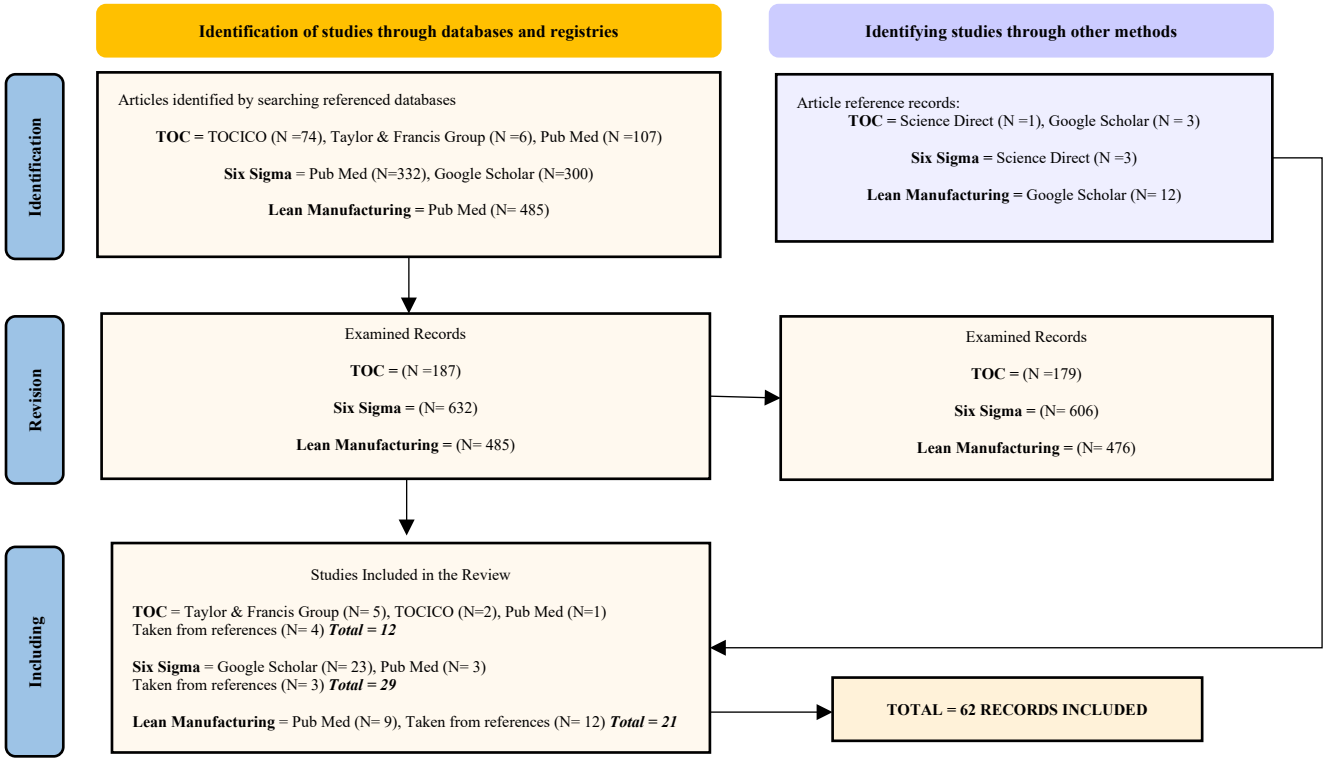


Figure 3. Flowchart of selected studies – PRISMA 2020 Model

4.2. Information Analysis

Continuing with the research, we carried out an exploratory analysis of the information from the databases, revealing the following findings:

4.2.1. Bibliometric analysis of methodologies and document typology

Through the application of various search strategies, a total of 1,323 documents were found. Of these, after applying the established eligibility criteria, 62 articles were selected, distributed by methodology as follows: 12 belonging to Theory of Constraints (19.35%), 29 to Six Sigma (46.77%) and 21 to Lean Manufacturing (33.87%).

For the Theory of Constraints, 2 case studies, 2 conference proceedings and 8 research articles were analyzed; regarding Six Sigma, 27 research articles and 2 case studies were reviewed; Finally, for Lean Service, 13 research articles, 3 case studies, 3 theses and 2-degree projects were evaluated.

4.2.2. Analysis by country or territory

By analyzing the geographical distribution of the revised documents, breaking them down by methodology, a precise understanding of the relevance and application of these philosophies in each country and continent is obtained.

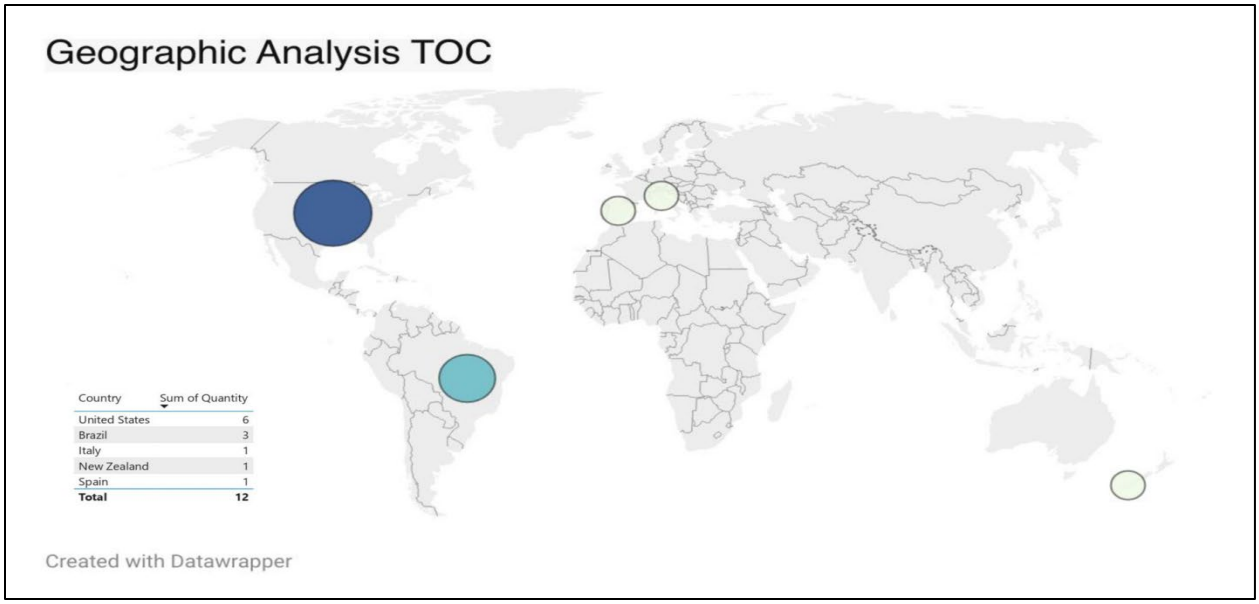


Figure 4. Geographic Analysis TOC

In Figure 4, the geographical analysis revealed that research on the applicability of Theory of Constraints (TOC) in health systems is concentrated in four countries. The United States leads with 4 publications, followed by Brazil with 3, while Spain and New Zealand register 1 publication each. This distribution shows a predominance of research in the American continent, which accounts for 77.77% of the studies reviewed.

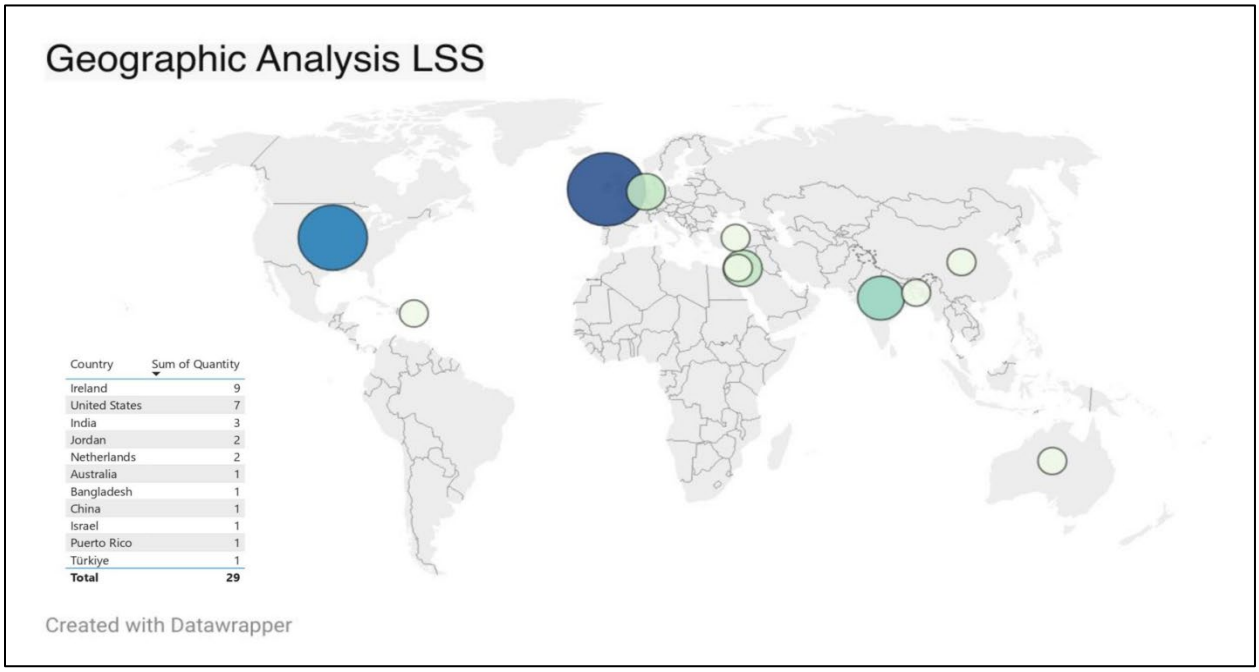


Figure 5. LSS Geographic Analysis

Figure 5 highlights Lean Six Sigma as one of the most applied methodologies in the health sector globally, with research registered in 12 countries and a presence on all continents. Ireland leads with 9 studies, followed by the United States with 7 and India with 3. Jordan and the Netherlands contribute 2 research each, while Australia,

Bangladesh, China, Israel, Puerto Rico and Turkey have 1 publication respectively. In terms of continental distribution, Europe accounts for 36.66% of the studies, Asia and America share 30% each, and Oceania contributes 3.33%.

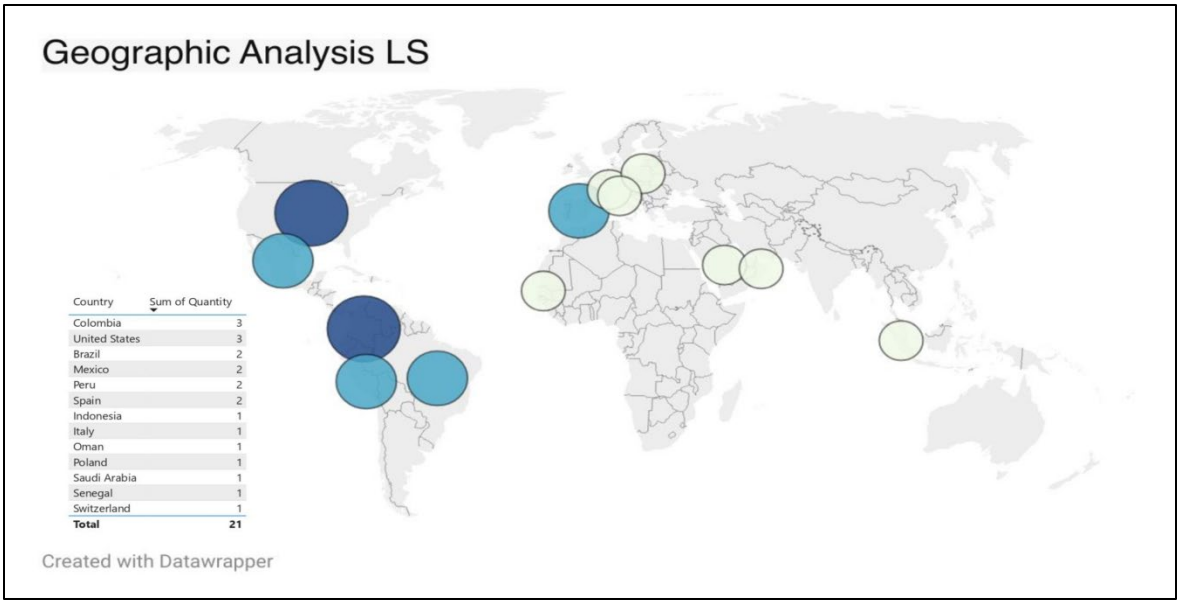


Figure 6. LS Geographic Analysis

Figure 6 reveals that Lean Service is the second most widely implemented methodology in the health sector, with studies recorded in 13 countries. Colombia and the United States lead with 3 investigations each, followed by Brazil, Spain, Mexico and Peru with 2 publications each. Countries such as Saudi Arabia, Indonesia, Italy, Oman, Poland, Senegal and Switzerland register 1 study respectively. At the continental level, America concentrates 57.14% of the documents, Europe 23.80%, Asia 14.28% and Africa 4.76%. These results suggest that the implementation of Lean Manufacturing in the health sector is particularly relevant in the Americas, where countries with emerging economies that seek to improve the efficiency of their health systems stand out.

4.2.3. Analysis by application area

The analysis by area of application allows the identification of the specific areas in which each methodology is used, the patterns of use and areas of opportunity, this approach provides a comprehensive understanding of its impact and relevance in the different environments of the health sector.

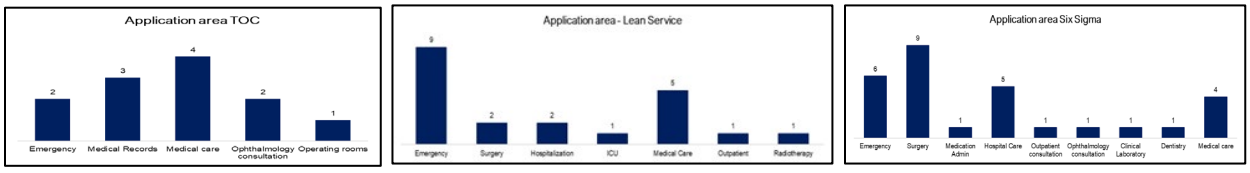


Figure 7. Areas of greatest application TOC, Lean Service and Six Sigma

Figure 7 shows that Theory of Constraints, Lean Service, and Six Sigma share areas of application, such as medical care and emergencies. This shows that, from their respective approaches, each methodology is highly useful to address these high-demand departments, reducing waste and optimizing processes

4.2.4. Analysis of Tools Implemented by Methodology

Once the areas of greatest application of each methodology were identified, we proceeded to review which tools are most regularly implemented in each philosophy, understanding the methodological preferences and the operational benefits that these tools provide in the cases analyzed.

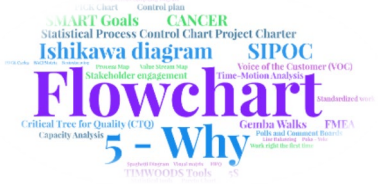
Tools used in TOC	Tools used in Lean Service	Tools used in Six Sigma
		

Figure 8. Most applied tools in each methodology

Figure 8 shows that the most commonly used tools in Theory of Constraints (TOC) include the Five Focusing Steps (5FS), implemented in 8 of the 12 articles analyzed, followed by Buffer Management, used in 7 of them, and Drum-Buffer-Rope programming, used in 4 studies. Finally, the Change Question Sequence (CQS) tool was applied in 3 articles, all of them proving to be effective in identifying constraints, managing resources and optimizing processes.

On the other hand, Lean Manufacturing and Six Sigma methodologies share a wide variety of tools, including the Value Stream Map, the Ishikawa Diagram, flowcharts, SIPOC, histograms, the Problem Tree, the Critical Tree for Quality (CTQ), the Voice of the Customer (VOC) and the RACI Matrix, among others. These tools are frequently implemented due to their ability to analyze, diagnose and improve the efficiency of processes.

4.2.5. Publication trend analysis by years

After identifying the areas of greatest applicability and the most used tools in the health sector, an analysis of the publications related to each methodology was carried out throughout the period studied. In order to understand the evolution of interest, identify trends and explore the factors that could have influenced its application in different periods.

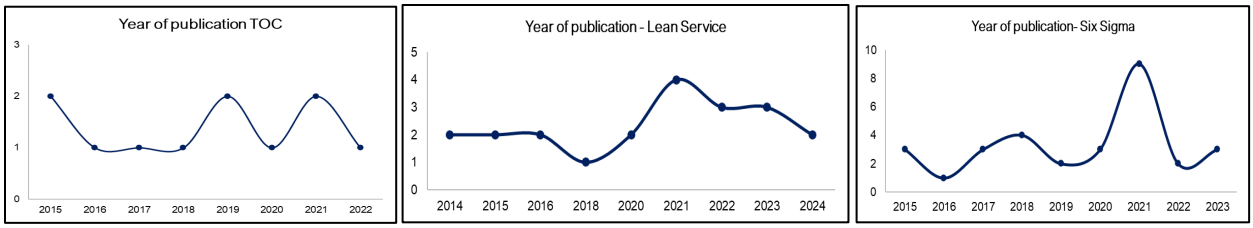


Figure 9. Publications by year TOC, Lean Service and Six Sigma

Figure 9 shows a cyclical trend in publications on TOC over the years analyzed, with notable peaks in 2019 and 2021, followed by periods of lower activity. This suggests that interest in the application of this methodology in health systems is intermittent. On the other hand, in Lean Manufacturing, there is a growing trend in the number of publications, with a significant increase in 2020, possibly driven by the COVID-19 pandemic, which generated the need to optimize processes in the health sector. As for Six Sigma, there is evidence of fluctuating behavior: in the years prior to 2021 there was little research related to its application, but in 2021 there was a sudden increase in publications, reflecting a sporadic interest in this methodology.

4.2.6. Analysis of the problems addressed

As a complement to the analysis of the evolution of publications, the specific problems that have been addressed through the implementation of each methodology were identified. This allows us to observe the circumstances in which these tools have proven to be more applicable and effective in solving challenges in the health sector (Figure 10)

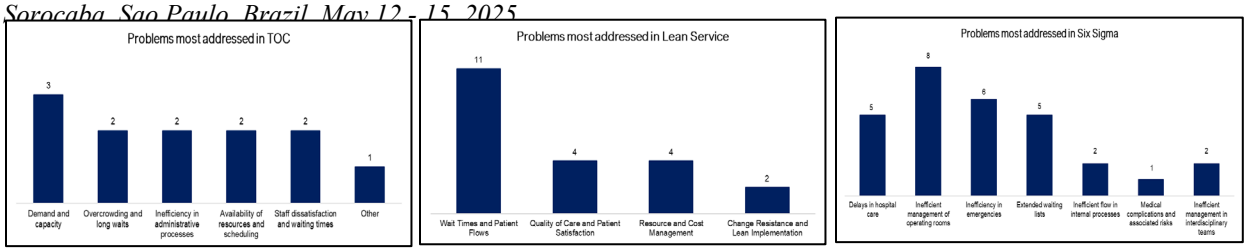


Figure 10. Problems addressed TOC, Lean Services and Six Sigma

According to Figure 10, Theory of Constraints is mainly applied to address the lack of capacity in health care services, especially in situations associated with crowding and the long lines that often occur in emergency departments. In addition, it addresses inefficiencies in administrative management, such as medical records and the scheduling of resources in outpatient and emergency consultations. Its implementation contributes significantly to the reduction of waiting times, a key factor in improving patient experience and satisfaction. On the other hand, Lean Service is mainly used to optimize waiting times and patient flows, improve the quality of care, increase patient satisfaction and efficiently manage resources and costs. However, a common challenge in its implementation is resistance to change. Finally, Six Sigma, although less frequent, is primarily applied to address inefficiencies in surgical settings, including supply chain issues and surgery cancellations. It is also used in emergency departments to mitigate problems such as excessive process duration, patients who leave without receiving care, and deficiencies in the flow of hospital discharge. Inefficiencies that prolong unnecessary use of resources, generate long waiting lists, and hinder internal flows.

4.6. Roadmap: opportunities and interventions

Since health is a fundamental component for the well-being of societies, directly impacting the quality of life of people and the economic development of nations, it is crucial to rigorously improve the health care system in terms of efficiency and productivity. In this context and being aware of the problems and inefficiencies that the system is going through, it is vital to address these situations proactively.

It is important to recognize that healthcare involves multiple departments, and failure in one department can leave a significant footprint on the entire service. Implementing effective solutions requires time, consistency, and the proper use of resources, which can limit the speed of results. However, an integrated and sustained approach can lead to significant Improvement in the medium and long term. Therefore, and considering the findings obtained, a roadmap is proposed that integrates operations management tools with the aim of intervening and improving the quality of services in the health sector of Cartagena de Indias, Colombia (see Figure 11).

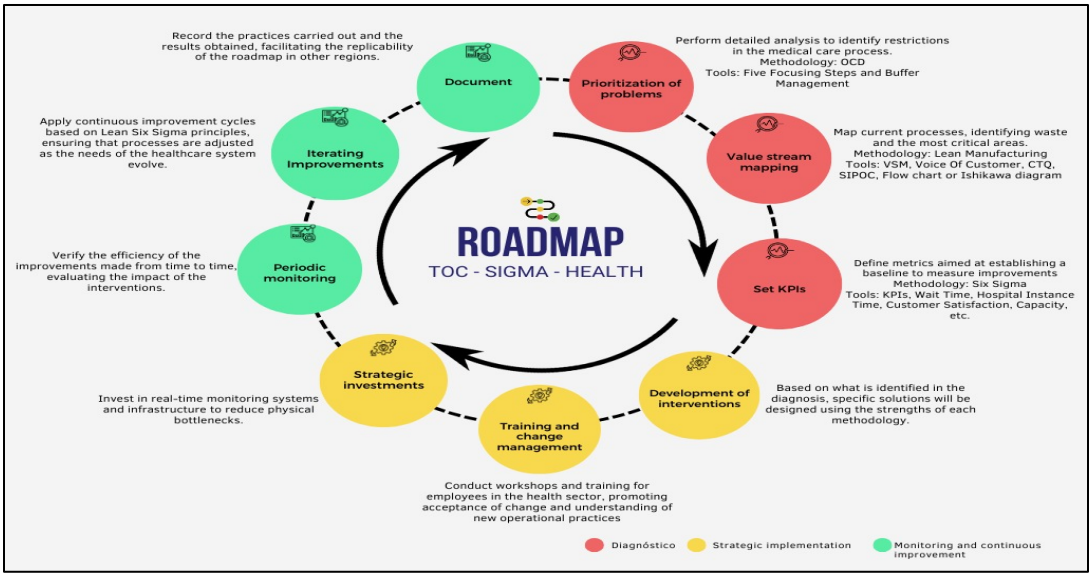


Figure 11. Roadmap

Diagnosis: This phase involves a detailed analysis of the care system with the aim of identifying the most critical constraints in the processes. In addition, the current flow will be analyzed to detect areas where there is waste and key metrics will be established to define a baseline that allows future improvements to be measured.

Strategic implementation: In this stage, specific solutions will be designed for the identified problems, taking advantage of the strengths of each methodology. In addition, staff will be integrated into the change process, ensuring their understanding of new operational practices. Priority will be given to the investments necessary to guarantee the development and sustainability of the proposed strategies.

Monitoring and continuous improvement: Monitoring systems will be established based on the metrics defined in the diagnostic phase, allowing the impact of the implemented interventions to be evaluated. Based on the results, improvements will be applied that evolve according to the needs of the health system. Finally, the practices and results obtained will be documented, facilitating the replicability of the roadmap in other regions.

5. Conclusions

The implementation of continuous improvement methodologies such as Lean Manufacturing, Theory of Constraints, and Lean Six Sigma in the healthcare sector has proven to be a promising approach to optimize processes, reduce costs, and improve the quality of care. However, this review has shown that the adoption of these methodologies in healthcare presents unique challenges, such as optimizing patient flows, managing the complexity of clinical processes, and resistance to change.

In this sense, although OCD has had few implementations in the health sector, throughout the period analyzed it is evident that its application has been sporadic or limited. In some years, only one or two publications are registered, although after the COVID-19 pandemic there is an increase in interest, this is not of major significance. Likewise, its application has been highlighted mainly in departments of high complexity and demand, such as emergencies and medical care (primary and health), environments where it is essential to minimize the waste of time and resources. Finally, in general, it can be highlighted that the techniques of this methodology (Five Focusing Steps (5FS), Buffer Management and Drum-Buffer-Rope programming) can be applied easily and quickly, achieving significant improvements in the performance of the organization almost immediately using existing resources or with a minimum investment.

Likewise, the Lean approach in the health sector has been gaining more and more strength, being more visible in Latin America and North America, where more than half of the studies related to its application are concentrated, representing 57.14% of the registered research. Countries such as Colombia, Brazil, Mexico and Peru stand out for looking for ways to make the use of resources more efficient in health systems that face high levels of demand or are in the process of improving. Lean Service has been especially focused on reducing wait times, improving patient flows, raising the quality of care, and increasing patient satisfaction. In practice, tools such as the Value Stream Map, the flowchart and the Ishikawa diagram are the most widely used, as they allow mapping processes, identifying waste and acting on the root causes of operational problems. Due to these results, its use has been increasing, especially since the COVID-19 pandemic, when the need to respond quickly and efficiently to the demands of the health system became more evident.

On the other hand, Lean Six Sigma is positioned as the most widespread methodology globally, with applied research in 12 countries and a presence on all continents, Ireland, the United States and India leading this field. Its structured approach, based on the DMAIC cycle, has proven to be highly effective in reducing variability, improving quality, and optimizing the use of clinical resources. In hospital settings, LSS has been applied especially in critical areas such as operating rooms, emergencies and hospital discharge processes, helping to mitigate inefficiencies such as surgical cancellations, bottlenecks and prolonged delays in care. This approach is supported by tools such as the flowchart, 5-Why analysis, SIPOC, control charts, and the CTQ Tree, all of which are key to diagnosing complex problems and mapping out lasting solutions from the patient's voice (VOC) to outcome measurement. Although its use fluctuates in the literature, the peak of publications in 2021 suggests a renewed interest in its applicability, especially in areas such as surgery, emergencies and hospital discharge management.

In conclusion, this review suggests that the application of Lean Service, Theory of Constraints and Lean Six Sigma in highly complex environments and with a focus on the satisfaction of specific and non-standardized needs, as is the case of the health sector, has great potential, since it allows addressing problems associated with quality, efficiency of

care, Resource optimization and user satisfaction. However, the need to continue researching and developing new tools and strategies to face the particular challenges of this sector is identified. Future research could explore combining these methodologies with each other, in order to obtain even more robust results.

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