The Lean Healthcare Approach in Health Services: A Systematic Review of The Literature

Rosely Costa da Silva Bandeira
Programa de Pós-Graduação em Engenharia de Produção, Universidade Federal do Amazonas, Amazonas, Brasil.

Armando Araújo de Souza Junior
Postgraduate Program in Production Engineering, Federal University of Amazonas, Amazonas, Brazil.

Sandy Rebelo Bandeira
Dept. of Exact Sciences, Nilton Lins University, Amazonas, Brazil.

Marcelo Albuquerque de Oliveira
Postgraduate Program in Production Engineering, Federal University of Amazonas, Amazonas, Brazil.

Abstract

Lean principles are being successfully applied in the most diverse sectors beyond industry. In the health area, the so-called Lean Healthcare is gaining space with the implementation of lean methods that contribute to the maximization of value and quality to the patient. The objective of this work was to carry out a systematic review of the literature to identify and analyze the practice of Lean Healthcare and its tools in hospital environments. Scientific articles available in the database of the CAPES Periodic Portal were selected, and 161 articles were found, among which, 16 were selected. The results point to recent research, with practical applications where case studies are predominant. Lean tools have been applied in several countries to promote improvements in hospital environments, and the main ones are MFV, 5S, Standardization, Kaizen and Kanban. With this study, it was possible to observe that the use of lean techniques in health has been promoting significant benefits in the work environments, in the team's conduct, and the patients' experience, and that the human factor is what most hinders the implementation of these techniques.

Keywords: Lean Healthcare; Hospital applications; Systematic review.

1. Introduction

In essence, the lean philosophy implements several tools and techniques that aim to reduce waste and reduce costs, in the search for sources of competitive advantage. The objective is also to maximize the

value for the customer, where value means the ability to offer services and products according to the customer's needs, at the exact moment and with convenient prices (Bhamu & Sangwan, 2014; Lacerda, Xambre & Alvelos, 2016).

However, lean principles are not exclusive to the industrial sector and have been used with success in the operations of various sectors, an example of supply chains, in the education, administration, maintenance, product development and also in hospitals (Rauch, Damian, Holzner & Matt, 2016; Dias, Reis, Oliveira, Maruyama & Martinez, 2018).

When it comes to the health sector, the product expected by patients is the cure of their ills, which translates into the value of these services (Spagnol, Min & Newbold, 2013). Therefore, every day, health organizations seek to improve the quality of work and management practices to offer assistance benefits to their target audience, which are the patients (Dias et al., 2018).

Studies report that as a result of applying lean presuppositions to health services, projects are intensifying with the implementation of safe and quality techniques to patients, with the so-called Lean Healthcare (Ferreira, Silva, Tanaka & Zampini, 2016; Costa, Godinho Filho, Rentes, Bertani & Mardegan, 2017).

In this sense, and considering the benefits of Lean philosophy when applied to processes, this study set out to answer the following question: What tools or Lean methods are being applied to promote benefits to health services? As an objective, this study intended to carry out a literature review on Lean Healthcare, derived from the use of Lean principles in health services, to identify and analyze the practice of lean techniques in hospital environments.

The work is divided into five parts: After the introduction, a brief theoretical framework of the concept of lean production and the evolution of its presuppositions to other areas is presented. Next, the methodology that led the research work is presented. The results are presented based on the detailing and analysis of the selected productions. Ultimately, the conclusions are presented.

2. The Lean Concept

The term lean expresses the idea of doing more using less, based on a system where multiple outputs are created with the possible inputs (Bhamu & Sangwan, 2014; Hallam & Contreras, 2018).

The Toyota Production system changed the scenario of mass production with the lean implementation of smaller batches and varied products. Thus, lean production brought the focus on reducing production waste and also on the customer, working to provide products at the right time, with quality and at the lowest cost (Dias et al., 2018; Oliveira, Sousa & Campos, 2019).

As basic principles, Lean presents: 1- Identification of value; 2 - Value stream Mapping; 3 - Creation of continuous flow; 4 - Let the customer pull the service; and 5 - Always seek perfection (D'Andreamatteo, Ianni, Lega & Sargiacomo, 2015; Rauch et al., 2016).

On the other hand, among the tools or techniques are: Just in Time, Jidoka, 5S, Value Stream Mapping (VSM), Quick Tool Change, Standardized processes, Takt time, Cellular Layout, Visual control, Training, Empowerment, Total Productive Maintenance, Level Production (Heijunka) and Zero Defect Quality Control (Regis, Gohr & Santos, 2018).

Given the aspects exposed and its applicability, studies show that the Lean concept has evolved and

extended to other operations and services, such as office processes - Lean Office, in the construction sector - Lean Construction, and also to health area - Lean Healthcare (Ferreira et al., 2016; Rauch et al., 2016; Dias et al., 2018).

2.1 Lean Healthcare

The literature shows that several studies have addressed the lean philosophy in the health sectors since the early 2000s. Bearing in mind that administrative processes are the basis for implementing lean techniques, it is considered that such practices are equally applicable to health care (D'Andreamatteo et al., 2015; Dias et al., 2018; Hallam & Contreras, 2018).

Lean Healthcare adds culture to hospitals based on increasing patient satisfaction through continuous improvements, in which employees identify and eliminate what does not add value (Costa & Godinho Filho, 2016; Doğan & Unutulmaz, 2016).

The main objectives of its implementation are to improve patient care and safety, reduce the patient's stay in hospital facilities, reduce the patient's waiting time and reduce the hospital stock (Rauch et al., 2016; Hallam & Contreras, 2018).

Since the lean focus is reducing waste, Table 1 shows the seven wastes adapted to Lean Healthcare.

Table 1. The seven wastes adapted to Lean Healthcare.

Type of waste	Description	Adapted to Lean Healthcare
Defects	Quality problems during the processes: they require to rework. They are related to the lack of standardization or production control systems	Medical errors
Waiting time	Every pause during the production process of a product, whether due to a lack of people, materials or equipment, means a non-added value for the customer	Waiting for professional assistance, medical prescription, or test results
Inventory	Raw material waiting to be processed. Often the stock of products or materials is associated with production bottlenecks	The excessive stock of medicines
Movement	Unnecessary movement of workers, machines or tools slows down execution and does not add value to the product	Unnecessary movements of people looking for information or documents
Processing	Any operation or step in a process that does not contribute to generating value for the product is considered a waste of production	Excessive processing with unnecessary Form
Excessive Production	Producing more than the demand at the moment are resulting in unnecessary use of resources without a financial return, in addition to generating a lot of stock	Conduct an unnecessary medical investigation
Transport	A product or material transported from one place to another is not being processed, so it does not add value to the customer. In addition, there are costs for transport and	From patients, samples or hospital supplies

	maintenance equipment itself

Source: Elabored from Zakaria *et al.* (2017) and Hallam and Contreras (2018).

Lacerda, Xambre and Alvelos (2016) and Oliveira, Sousa and Campos (2019) mention that an eighth waste must be added to lean processes: wastage with the non-use of human potential. Similarly, in the health sector, the eighth waste is also referred to when reporting that in Lean Healthcare there is a flaw in the "human talent" factor when there is no medical training for agents who could assist in diagnoses (Costa & Godinho Filho, 2016).

3. Methodology

The methodology used in this study was a systematic literature review. An effective literature review is one that creates a firm basis for the advancement of knowledge (Levy & Ellis, 2006). For Tranfield, Denyer and Smart (2003) the importance of this technique is in the survey of the best scientific productions on the theme that is to be addressed.

Levy and Ellis (2006) describe that the literature review process consists of three main steps, being perfectly applied to any field of study. Figure 1 illustrates this process.

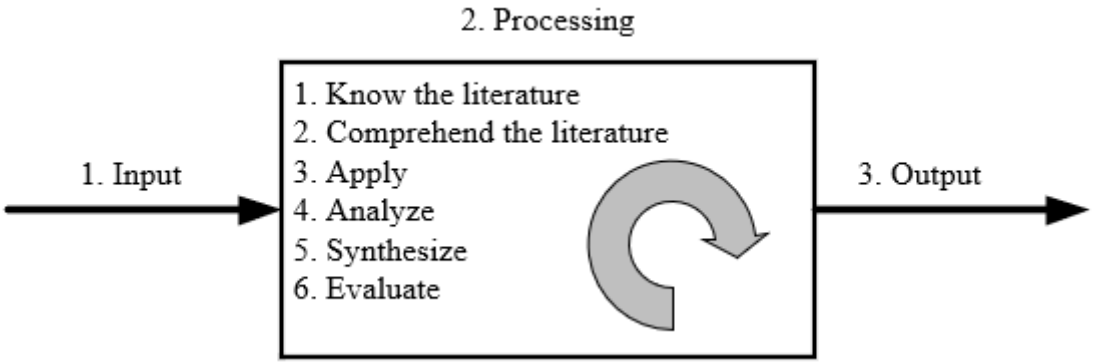


Figure 1. The three phases of the effective literature review process
Source: Levy and Ellis (2006).

The entry phase consisted of literary research adopting a literature review according to the procedures described by Cronin, Ryan and Coughlan (2008) in their article entitled: Undertaking a literature review: a step-by-step approach, as detailed below.

1 - Selection of the database: studies were made available on the CAPES Periodic Portal, which allows free institutional remote access to teachers, technicians, and students, in addition to concentrating a range of easily accessible databases.

2 - Search terms: the "lean healthcare" research axis was defined, which was combined with the Boolean inclusion operators "AND" and "OR," aiming to retrieve posts in the title, abstracts, or even in the keywords

of the articles related to the question and the research objective. Thus, the key terms combined to the axis were: "5S," "kanban," "kaizen," "just in time,"in time," "jidoka," "value stream mapping," "TQM," "TRF," "layout."

3 - Type of material used and period of publication: papers of the type Articles of journals, published in the last five years, from 2015 to 2019 were selected. It should be noted that the period was established to obtain several recent works that address the theme and meet the research objective.

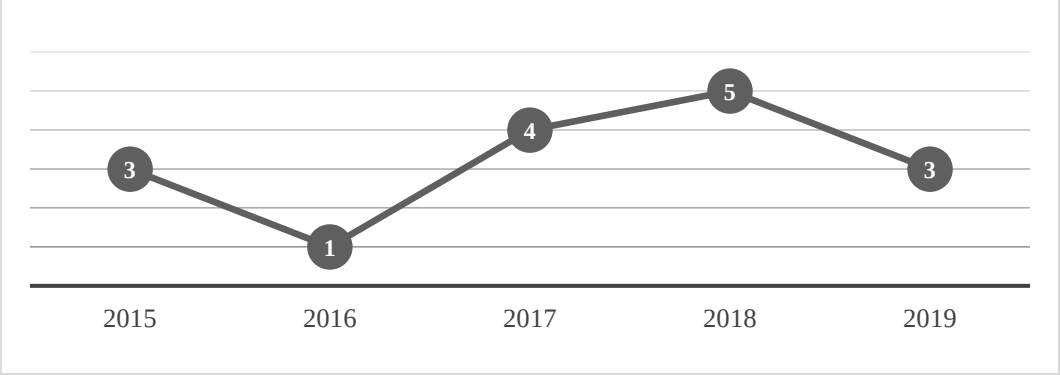
4 - Exclusion Criteria: show only "peer-reviewed journals," "complete texts available for download," and "non-duplicated texts."

In the Processing phase, after applying the parameters: search terms; publication period; show only peer-reviewed journals; and all studies of the Articles type, the result presented a total of 161 productions.
Based on the title of the articles, 3 were duplicated and 10, apparently related, did not present the full texts, so 13 were discarded. Other criteria applied were: adequacy of the title to the objective of the research and reading of the abstracts, from which were excluded: 28 articles where lean techniques or principles were applied in services other than health; 65 articles that did not present empirical studies; 39 articles that did not answer the research question.
After this process, 16 articles remained to be analyzed in full. For this purpose, the final phase of the review was carried out to classify the findings regarding the research methodology, and the tools used. The "Outputs" are exposed in "Analysis and Results."

4. Analysis and Results

Considering the publications in the period defined for the review, the research pointed out that the productions had their growth in the years of 2017 and 2018, with 4 and five articles published, respectively. As shown in Graphic 1, 2016 was the year with the least number of studies that applied lean healthcare tools, however, it is worth mentioning that among the selected period, there was at least one publication related to the theme, demonstrating that the subject remains current and relevant.

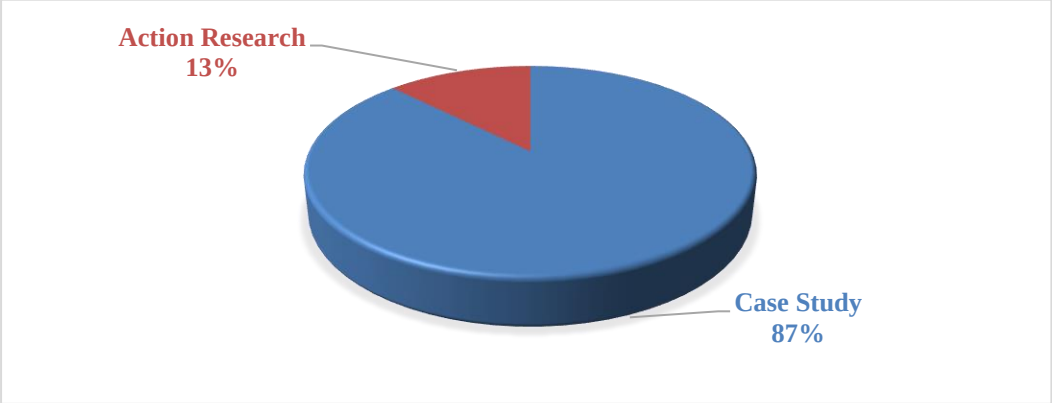
Graphic 1. Production by year



Source: Survey data (2020).

Analyzing the portfolio, tried to identify the methodology addressed in each empirical study. Thus, it was found that the methods adopted in the research were: the Case Study and Action Research. The case study stands out as the most used method among the materials, as shown in Graphic 2:

Graphic 2. Methodologies used in the articles

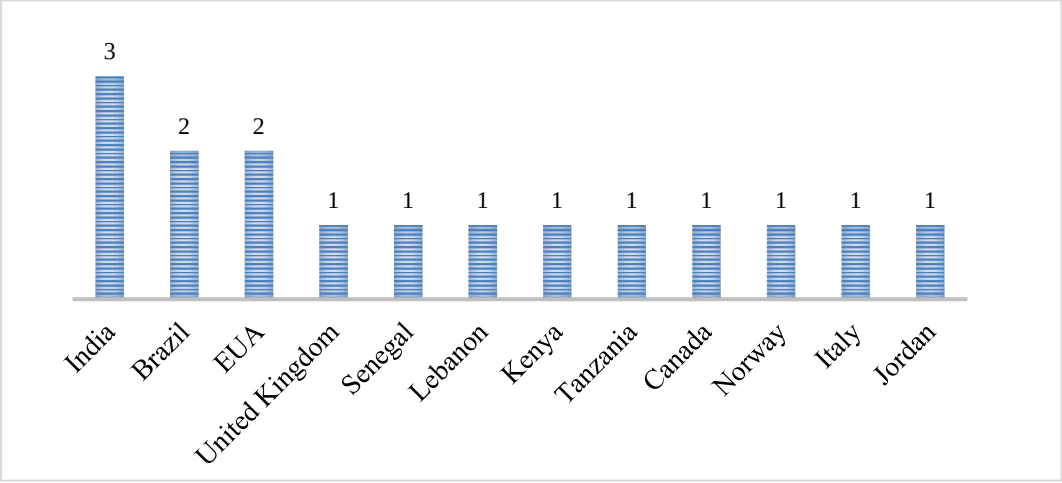


Source: Survey data (2020).

The case study appears as the main methodology among the texts, used in 14 articles and representing a total of 87% of the portfolio. According to Yin (2015), the case study focuses on the analysis of specific phenomena to help in understanding the events that involve individuals and jobs. In that sense, they can perfectly help in expanding the knowledge about the implementation of lean techniques and their different results.

Furthermore, it is worth noting that among the studies, the use of lean techniques in health services proved to be quite comprehensive. According to Graphic 3, the research reports the application of lean tools in environments located in different countries.

Graphic 3. Research countries



Source: Survey data (2020).

4.1 Portfolio analysis

In this step, the information will be listed that will support the analysis of the content of the selected works.

Table 2 shows the list of chosen articles in which the results were achieved with the application of the same tool.

Table 2. Use of the 5S technique

Authors	Objectives	Results
KANAMORI, S *et al.* (2015)	To assess how the 5S method creates changes in the workplace, in the process and the results of health services, and how it can be applied in a low-resource environment	1) Organization of the work environment; 2) Improvement in the attitude and behavior of employees; 3) Improvement in patients' behavior; 4) Increase in the quality of services.
KAMIYA, Y *et al.* (2017)	To evaluate the impact of implementing continuous quality improvement (CQI) methods on patient's experiences and satisfaction in Tanzania.	1) Improvement in the cleanliness of the hospital, in the waiting time and the general classification evaluated by the patients in the outpatient clinic; 2) The effect of 5S on patient satisfaction was not strong.

Source: Survey data (2020).

Considering that 5S is a management tool focused on cleaning and organizing workplaces (Young, 2014; Veres, Marian, Moica & Al-Akel, 2018), Kanamori *et al.* (2015) and Kamiya *et al.* (2017) studied the implementation of this technique in healthcare environments located in Senegal and Tanzania.

As a result, 5S made it possible to improve environments, raise awareness of teams and patients; increase the quality of services in terms of efficiency, patient-centeredness, and safety, and also demonstrated that, even though it did not have such strong effects on patient satisfaction in Tanzania, 5S improved the waiting time and the evaluation performed by patients.

Table 3 shows that the use of this lean tool was useful in the studies to identify bottlenecks, improve the value and reduce outpatient waiting times, remodel hospital discharge planning processes, improve the quality of care in environments and redesign urgency departments, showing significant results in all studies.

Table 3. Use of the VSM technique.

Authors	Objectives	Results
MILLER, R; CHALAPATI, N (2015)	Demonstrate how lean tools have been applied to some issues unique to health service delivery in a developing country	1) Average outpatient waiting times reduced from 1 hour to 15 minutes; 2) Redesigning the process resulted in more than 70% of patients pre-scheduling their appointments; 3) Higher productivity.
MCDERMOTT, C; VENDITTI, F (2015)	To explore the implementation of Lean techniques in the discharge planning process (DPP)	1) Creation of standard work; 2) Reduction of 17 minutes (average) in-hospital stay.
RAMASWAMY, R et al.	Apply Value Stream Mapping to improve service quality	1) More transparency and ease of sharing between the clinical and support staff;

(2017)		2) Created a consensus around the definition of common work in the organization.
JOHANNESSEN, K. A; ALEXANDERSEN, N (2018)	Demonstrate that long waiting times and waiting lists are not necessarily associated with increased demand or changes in resources	1) The average waiting time in all clinics has been reduced; 2) Reduction in the number of new waiting patients from 15,874 to 8,922; 3) Reduction from 18,700 to 5,993 in the number of patients who returned late.
AL HROUB, A. *et al.* (2019)	Improve clinic time efficiency, decrease clinic waiting time and increase patient satisfaction	1) Reduction in waiting time at the clinic to 19.5 and 21 minutes in the two post-intervention conditions; 2) Increase in patient satisfaction to 100% and 96.7% in the two post-intervention trimesters.

Source: Survey data (2020).

Miller and Chalapati (2015), Mcdermott and Venditti (2015), Ramaswamy *et al.* (2017), Johannessen and Alexandersen (2018) and Al Hroub *et al.* (2019) used the VSM (Value Stream Mapping) in their studies as it is a tool that allows them to visualize what happens during the work, identify what adds value or not, and enable the improvement of flows (Verma & Amar, 2015; Suarez-Barraza; Miguel-Davila; Vasquez-García, 2016).

New *et al.* (2016) made use of training and standardization, which consists of constant improvement of the organization, reducing variations, and improving the quality of processes and products (MÍkva, Prajová, Yakimovich, Korshunov & Tyurin, 2016). With that, they proposed to improve the lean participatory process in trauma orthopedics in a UK hospital and as shown in Table 4, they achieved specific improvements in this surgical care.

Table 4. Use of the Standardization technique.

Authors	Objectives	Results
NEW, S *et al.* (2016)	To examine the effectiveness of a "systems" approach using Lean methodology to improve a hospital's surgical care	1) 33% increase in the presence of anesthesiologists at the trauma meeting; 2) The number of changes in the list of operations has decreased; 3) Patients arriving at the anesthesia room 20 minutes before.

Source: Survey data (2020).

Improta *et al.* (2018) and Vashi *et al.* (2019) combined the techniques of 5S, VSM and Standardization to improve processes, reduce times and redesign operations, which after the implementation of the techniques and the respective changes, could see reductions in the waiting time of many processes, as illustrated in the Table 5.

Table 5. Use of 5S, VSM and Standardization techniques.

Authors	Objectives	Results
IMPROTA, G *et al.* (2018)	Increase the flow of patients, improving the processes that contribute to facilitate the flow of patients through the various stages of medical treatment and eliminating all bottlenecks (queue) as well as all activities that generate waste	1) Reduction of the total time of the five phases: screening, examination, diagnostic test, counselling and dispensation; 2) Reduction in post lean performance measurements.
VASHI, A. A *et al.* (2019)	To describe the extent and depth to which Lean methodologies are used to quickly redesign the operations of a US emergency department to reduce waiting times, as well as assess whether the intervention achieved its goal	1) Reduction of Door to the Triage time 16.4 to 10.1 minutes; 2) Reduction in Door to Doctor's time from 34.7 to 22.1.

Source: Survey data (2020)

Considering the multiple tools applied in the other selected studies, below (Table 6), the result of the joint use of the mentioned techniques with at least two or more is presented.

Table 6. Use of various techniques.

Authors	Objectives	Results
COSTA, L.B.M *et al.* *(2017)*	Assess how five sectors of two Brazilian hospitals have implemented lean health care concepts in their operations	Sterile service's sector: 1) 94% reduction in surgery delay; 2) Reduction of 1 to 1.5% to 0.21% in the infection rate; 3) Reduction of the preparation time between the autoclave cycles by 30 minutes; 4) Reduction of the autoclave cycle time by 30 minutes. Pharmacy Sector 1) Reduction of the inventory balance (monthly average) from R $ 2,000,000.00 to R $ 1,600,000.00. Chemotherapy sector: 1) 23% increase in the number of chemotherapy applications 2) 42% reduction in the patient's average waiting time;

		3) 50% reduction in the number of patients waiting for chemotherapy to start. Surgery room: 1) Creation of central scheduling surgery. Radiotherapy sector: 1) Reduction of the time between one application of radiology and another; 2) Increase in the time that professionals had been available for patient care.
HITTI, E. A *et al.* *(2017)*	To assess the impact of a Lean intervention on the response time of transport for simple radiography in an emergency room at a tertiary care center in Lebanon.	1) Transport response time (TAT) dropped from 22.9 to 9.9 minutes; 2) Process reliability improved from 32.3% to 71.6%, with patients being transported in 10 minutes.
GUPTA, S; KAPIL, S; SHARMA, M (2018)	Discuss the implementation of lean methodology to reduce the response time (TAT) of a clinical laboratory in an Indian hospital	1) Reduction in TAT of the CBC laboratory from 179.49 to 94.70 minutes; 2) Reduction in the biochemistry laboratory's TAT from 267.71 to 208 minutes.
BLOUIN-DELISLE, C.H. *et al.* (2018)	To increase efficiency in the operating rooms without affecting the quality of care, improving workflow processes	1) Reduction of 68% of the time lost in the ward; 2) 25% increase in all patient admissions; 3) 29% reduction in time spent in the recovery ward.
REGIS, T.K.O; SANTOS, L.C; GOHR, C.F. (2018)	Analyze the process of implementing lean healthcare in three Brazilian hospitals	Hospital A 1) 23% increase in the capacity to apply chemotherapy; 2) Reduction of the patient's waiting time for chemotherapy infusion to 1h; 3) Reduction in the loading time of the armchairs by 40 minutes (chemotherapy); 4) 74% reduction in the patient's lead time (authorization of procedures); 5) 90% reduction in exam deadlines (laboratories); 6) Increased productivity in the handling of medicines (pharmacy); 7) Reduced waiting time from 50 minutes to 20 (radiotherapy).

		Hospital B 1) Reduction of waiting time (surgical scheduling and reception); 2) Reduction of bed turning time from 5:30 am to 2:30 am; 3) Reduction of time when the patient is admitted to the inpatient unit; 4) Rotation time reduction from 100 to 16min (operating room); 5) 3% reduction in inventory (supplies) Hospital C 1) 30% reduction in waste at the reception; 2) 90% reduction in the central guide; 3) Real-time billing (billing) 4) 70% reduction in inventory (supplies); 5) 170% increase in the capacity of consultations in outpatient clinics; 6) Reduction of waiting time for radiotherapy from 44% to 70%.
BHAT, S; GIJO, E; CUDNEY, E (2019)	**To explore tools and techniques commonly used to implement the Lean Six Sigma (LSS) strategy in private Indian hospitals.**	**Hospital A** **1) 65% reduction in the average cycle time;** **2) 79% reduction in standard deviation;** **3) Savings of US $ 7,000 / year in indirect costs.** **Hospital B** **1) Reduction of the TAC of the IP-MRD process to 39 minutes;** **2) Savings of approximately US $ 10,000 / year in indirect costs and human resources.** **Hospitals C and D** **1) Improvement in the provision of services;** **2) 94% reduction in queue length and a 48% decline in scheduled staff utilization.** **Hospital E**

	1) Reduction of the average waiting time to 9.27 minutes; **2) Improvement in the service quality of the system; 3) Increased productivity;** **4) Decrease in absenteeism rates;** **5) Savings of approximately US $ 15,000 in reducing overtime at the production center**

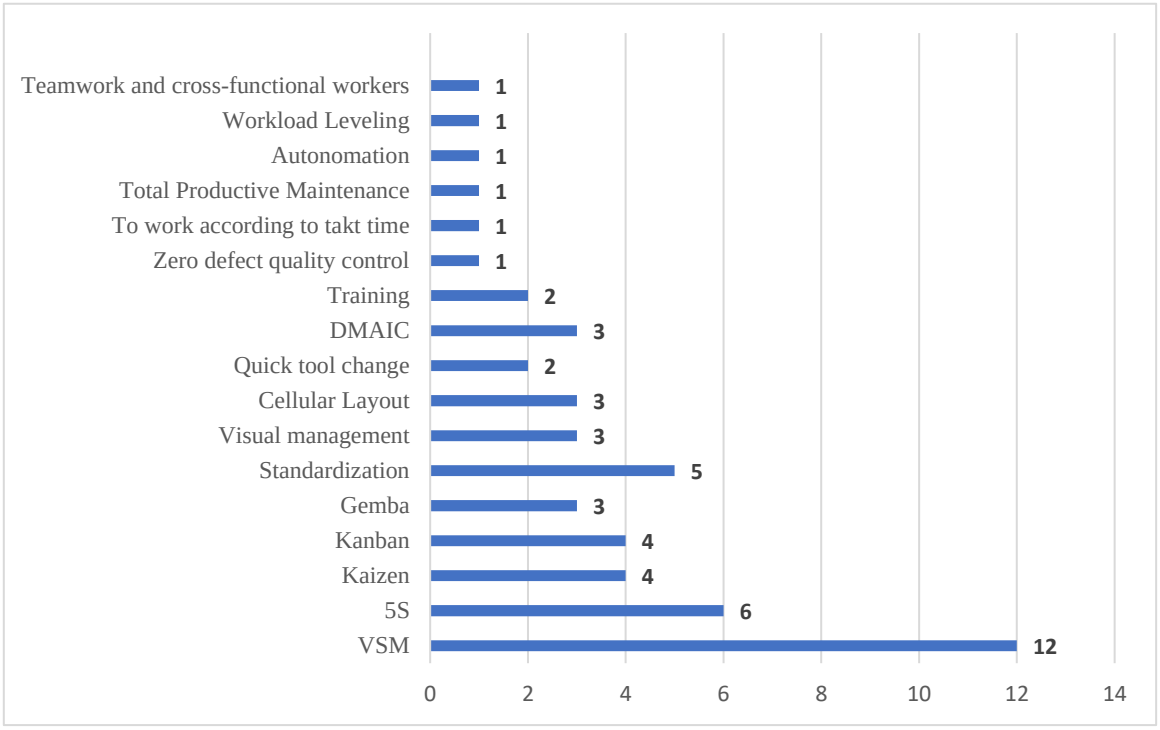
Source: Survey data (2020).

The studies listed in Table 6 report results of using other tools such as Kaizen, Kanban, Gemba, Cellular Layout, TAKT time, DMAIC, Quick tool change, Zero defect quality control, Visual management, Teamwork and multifunctional workers, Leveling of workload, DMAIC, Training, Autonomation and Total Productive Maintenance.

With this, they showed significant reductions in processes/response times, identified sources of waste, improved the reliability of the work, reduced the percentage of cancellation of surgeries, in addition to savings in terms of indirect costs and human resources.

Given the aspects observed, in all studies the most diverse techniques of lean production were applied. In this sense, Graphic 4 shows the synthesis of the techniques used and the number of mentions made with these tools considering the total of studies.

Graphic 4. Techniques and number of uses.

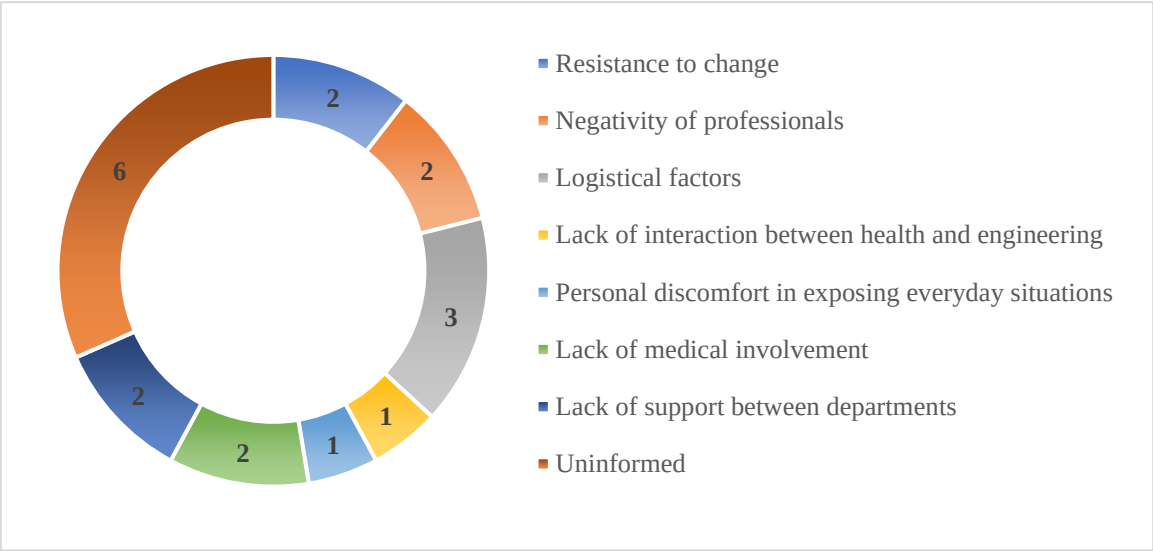


Source: Survey data (2020).

The analysis of the articles also made it possible to find some potential challenges to the implementation

of lean techniques in health services. Considering such barriers or difficulties, it was found that the biggest factor that impacts the implementation of such practices concerns the human factor. Graphic 5 highlights the challenges mentioned in the articles.

Graphic 5. Factors that hindered the implementation of lean techniques



Source: Survey data (2020).

5. Conclusions

This article presents a systematic review of the literature on the topic of lean health and its techniques, demonstrating how and which tools were implemented in the practice of the most diverse health environments, based on the works available on the CAPES Portal.

The results of the study indicate that most studies, considering the period from 2015 to 2019, were published in health journals and that, from the sample, it was possible to observe that the year 2018 had the largest number of published works.

Although productions in Portuguese were not excluded, it was observed that the sample articles were 100% in English, where tools were applied in India - 3 studies, USA and Brazil, with two studies, respectively, in addition to studies applied in the United Kingdom United, Senegal, Lebanon, Kenya, Tanzania, Canada, Norway, Italy and Jordan, with one study each, showing the global relevance of the theme.

It was also observed that among the studies as the main tools used to promote health benefits are MFV, 5S, Standardization, Kaizen and Kanban. However, although they have not been used in many articles, the other techniques mentioned in this study were used in at least one of the selected studies, demonstrating that they are applied considering the specifications of each environment.

The use of multiple lean tools in health brought significant and common results among the articles, such as reduction of waiting times, reduction of operations time, improvement of processes and services provided, detection of restrictions, redesign of works, increased awareness of work team and patients about the importance of the organization, greater patient satisfaction in care, in addition to reducing indirect costs

and costs with human resources.

The study also showed that the human factor still represents a difficulty in implementing lean health techniques, the main problems being reported: resistance to changes, the negativity of professionals in the face of proposals for improvements and the lack of involvement/support from doctors and other servers.

As the study considered only the CAPES Journals as a basis for consultation, it is suggested that future research should deepen the sample in other bases to capture similar studies, as well as continue the examination of the factors limiting the implementation of lean techniques in health.

6. Acknowledgement

This work was conducted in partnership with the Federal University of Amazonas (UFAM) and the Superintendence of Zona Franca de Manaus (SUFRAMA), within the scope of the Master's Program in Production Engineering (PPGEP). The authors thank the support obtained from Fundação de Apoio à Pesquisa do Estado do Amazonas (FAPEAM) for facilitating and finance the research under POSGRAD Project.

7. References

[1] Al Hroub, A., Obaid, A., Yaseen, R., El-Aqoul, A., Zghool, N., Abu-Khudair, H., Al Kakani, D., & Alloubani, A. (2019). Improving the Workflow Efficiency of an Outpatient Pain Clinic at a Specialized Oncology Center by Implementing Lean Principles. Asia-Pacific Journal of Oncology Nursing, 6(4), 381.

[2] Bhamu, J., & Sangwan, K. S. (2014). Lean manufacturing: literature review and research issues. International Journal of Operations & Production Management.

[3] Bhat, S., Antony, J., Gijo, E. V., & Cudney, E. A. (2019). Lean Six Sigma for the healthcare sector: a multiple case study analysis from the Indian context. International Journal of Quality & Reliability Management.

[4] Blouin-Delisle, C. H., Drolet, R., Gagnon, S., Turcotte, S., Boutet, S., Coulombe, M., & Daneau, E. (2018). Improving flow in the OR. International Journal of Health Care Quality Assurance.

[5] Costa, L. B. M., Filho, M. G., Rentes, A. F., Bertani, T. M., & Mardegan, R. (2017). Lean healthcare in developing countries: evidence from Brazilian hospitals. The International Journal of Health Planning and Management, 32(1), e99-e120.

[6] Costa, L. B. M., & Godinho Filho, M. (2016). Lean healthcare: review, classification and analysis of literature. Production Planning & Control, 27(10), 823-836.

[7] Cronin, P., Ryan, F., & Coughlan, M. (2008). Undertaking a literature review: a step-by-step

approach. British Journal of Nursing, 17(1), 38-43.

[8] D'Andreamatteo, A., Ianni, L., Lega, F., & Sargiacomo, M. (2015). Lean in healthcare: a comprehensive review. Health Policy, 119(9), 1197-1209.

[9] Dias, A. C., Reis, A. C., Oliveira, R. P., Maruyama, Ú., & Martinez, P. (2018). Lean manufacturing in healthcare: a systematic review of literature. Revista Produção e Desenvolvimento, 4(2), 111-122.

[10] Doğan, N. Ö., & Unutulmaz, O. (2016). Lean production in healthcare: a simulation-based value stream mapping in the physical therapy and rehabilitation department of a public hospital. Total Quality Management & Business Excellence, 27(1-2), 64-80.

[11] Ferreira, W. de P., da Silva, A. M., Tanaka, W. Y., & de Felice Zampini, E. (2016). Lean & Healthcare organizations-a systematic literature review with bibliometric analysis on application of Lean Healthcare in Brazil. Brazilian Journal of Operations & Production Management, 13(4), 422-428.

[12] Gupta, S., Kapil, S., & Sharma, M. (2018). Improvement of laboratory turnaround time using lean methodology. International Journal of Health Care Quality Assurance.

[13] Hallam, C. R., & Contreras, C. (2018). Lean healthcare: scale, scope and sustainability. International Journal of Health Care Quality Assurance.

[14] Hitti, E. A., El-Eid, G. R., Tamim, H., Saleh, R., Saliba, M., & Naffaa, L. (2017). Improving emergency department radiology transportation time: a successful implementation of lean methodology. BMC Health Services Research, 17(1), 625.

[15] Hussain, A., Stewart, L. M., Rivers, P. A., & Munchus, G. (2015). Managerial process improvement: a lean approach to eliminating medication delivery. International Journal of Health Care Quality Assurance.

[16] Improta, G., Romano, M., Di Cicco, M. V., Ferraro, A., Borrelli, A., Verdoliva, C., Triassi, M., & Cesarelli, M. (2018). Lean thinking to improve emergency department throughput at AORN Cardarelli hospital. BMC Health Services Research, 18(1), 914.

[17] Johannessen, K. A., & Alexandersen, N. (2018). Improving accessibility for outpatients in specialist clinics: reducing long waiting times and waiting lists with a simple analytic approach. BMC Health Services Research, 18(1), 827.

[18] Kamiya, Y., Ishijma, H., Hagiwara, A., Takahashi, S., Ngonyani, H. A., & Samky, E. (2017). Evaluating the impact of continuous quality improvement methods at hospitals in Tanzania: a cluster-randomized trial. International Journal for Quality in Health Care, 29(1), 32-39.

[19] Kanamori, S., Sow, S., Castro, M. C., Matsuno, R., Tsuru, A., & Jimba, M. (2015). Implementation of 5S management method for lean healthcare at a health center in Senegal: a qualitative study of staff perception. Global Health Action, 8(1), 27256.

[20] Lacerda, A. P., Xambre, A. R., & Alvelos, H. M. (2016). Applying Value Stream Mapping to eliminate waste: a case study of an original equipment manufacturer for the automotive industry. International Journal of Production Research, 54(6), 1708-1720.

[21] Levy, Y., & Ellis, T. J. (2006). A systems approach to conduct an effective literature review in support of information systems research. Informing Science, 9.

[22] McDermott, C. M., & Venditti, F. J. (2015). Implementing lean in knowledge work: Implications from a study of the hospital discharge planning process. Operations Management Research, 8(3-4), 118-130.

[23] Miller, R., & Chalapati, N. (2015). Utilizing lean tools to improve value and reduce outpatient wait times in an Indian hospital. Leadership in Health Services.

[24] MÍkva, M., Prajová, V., Yakimovich, B., Korshunov, A., & Tyurin, I. (2016). Standardization–one of the tools of continuous improvement. Procedia Engineering, 149, 329-332.

[25] New, S., Hadi, M., Pickering, S., Robertson, E., Morgan, L., Griffin, D., Collins, G., Rivero-Arias, O., Catchpole, K., & McCulloch, P. (2016). Lean Participative Process Improvement: Outcomes and Obstacles in Trauma Orthopaedics. PloS One, 11(4).

[26] Oliveira, R. I. de, Sousa, S. O., & de Campos, F. C. (2019). Lean manufacturing implementation: bibliometric analysis 2007–2018. The International Journal of Advanced Manufacturing Technology, 101(1-4), 979-988.

[27] Ramaswamy, R., Rothschild, C., Alabi, F., Wachira, E., Muigai, F., & Pearson, N. (2017). Using Value Stream Mapping to improve quality of care in low-resource facility settings. International Journal for Quality in Health Care, 1-5.

[28] Rauch, E., Damian, A., Holzner, P., & Matt, D. T. (2016). Lean Hospitality-Application of Lean Management methods in the hotel sector. Procedia CIRP; 41:614-619.

[29] Regis, T. K. O., Gohr, C. F., & Santos, L. C. (2018). Lean Healthcare Implementation: experiences and lessons learned from Brazilian hospitals. Revista de Administração de Empresas, 58(1), 30-43.

[30] Spagnol, G. S., Min, L. L., & Newbold, D. (2013, September). Lean principles in Healthcare: an

overview of challenges and improvements. In IFAC Proc (Vol. 2013, p. 46).

[31] Suarez-Barraza, M. F., Miguel-Davila, J. A., & Fabiola Vasquez-Garcia, C. (2016). Supply chain value stream mapping: a new tool of operation management. International Journal of Quality & Reliability Management, 33(4), 518-534.

[32] Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. British journal of management, 14(3), 207-222.

[33] Vashi, A. A., Sheikhi, F. H., Nashton, L. A., Ellman, J., Rajagopal, P., & Asch, S. M. (2019). Applying lean principles to reduce wait times in a VA emergency department. Military medicine, 184(1-2), e169-e178.

[34] Veres, C., Marian, L., Moica, S., & Al-Akel, K. (2018). Case study concerning 5S method impact in an automotive company. Procedia Manufacturing, 22, 900-905.

[35] Verma, J. Y., & Amar, C. (2015). Can a Healthcare" Lean Sweep" Deliver on What Matters to Patients?: Comment on" Improving Wait Times to Care for Individuals with Multimorbidities and Complex Conditions Using Value Stream Mapping". International journal of health policy and management, 4(11), 783.

[36] Yin, R. K. (2015). Estudo de Caso-: Planejamento e métodos. Bookman editora.

[37] Young, F. Y. (2014). The use of 5S in healthcare services: A literature review. International Journal of Business and Social Science, 5(10).

[38] Zakaria, N. H., Mohamed, N. M. Z. N., Ab Rahid, M. F. F., & Rose, A. N. M. (2017). Lean manufacturing implementation in reducing waste for electronic assembly line. In MATEC Web of Conferences (Vol. 90, p. 01048). EDP Sciences.