v. 1, n. 1, 2021

Journal of
Engineering
Research

VALUE FLOW MAPPING: SERVICE PROCESS IN A CLINICAL ANALYSIS LABORATORY

Ananda Santa Rosa Santos
http://lattes.cnpq.br/5041230299847921

Denise Simões Dupont Bernini
http://lattes.cnpq.br/0289245860222291

All content in this magazine is licensed under a Creative Commons Attribution License. Attribution-Non-Commercial-Non-Derivatives 4.0 International (CC BY-NC-ND 4.0).

Abstract: This research was carried out with the identification of the authors with the theme, realizing the need to map the value stream through the care process in a clinical analysis laboratory. This work aims to map the value stream of patient care, in order to reduce the time of care. It highlights that the lean production philosophy was used to appropriate the knowledge to be presented. With the general objective, it was thought to reduce the time (waiting) for patient care, while the specific objectives were to create a value stream map of the current state, identify waste in the laboratory's production system, apply the tools of the Toyota System of Production and perform the future state value stream mapping.
Keywords: Value stream mapping, patient care, quality, process.

INTRODUCTION

The present work presents the concept of the Toyota Production System, philosophy of *lean manufacturing*, definition and application of value stream mapping, with a view to proposing an improvement in the flow of care in a clinical analysis laboratory.

The research took place from the identification of the authors with the theme, where the lean production philosophy was used to appropriate the knowledge to be presented in this study.

According to Jackson (2013), among the main techniques used in lean production, Value Stream Mapping (MFV) is presented as a tool for identifying bottlenecks and implementing improvements. Through the technique it is possible to make coherent decisions that envision the improvement of processes, being one of the pillars of lean production (XAVIER; SARMENTO, 2011).

The research has as a general objective to reduce the time (waiting) for patient care, while the specific objectives are to create a value stream map of the current state, identify waste in the laboratory's production system, identify opportunities to apply the tools of the Toyota Production System and finally, propose a value stream map of the future state.

TOYOTA PRODUCTION SYSTEM

According to Monden (2015), the Toyota System is a philosophy whose main objective is profit by reducing costs or increasing productivity, and these factors, in turn, are obtained by eliminating waste, such as excess stock and personnel.

According to Liker (2005) Eiji Toyoda and his team took a trip to the United States to check progress in American industry in the 1950s. The result, however, showed that American industries still based their process on mass production, or overproduction . They noted that manufacturing processes were based on large volumes, with disruptions that created large inventories and very uneven flow.

The Toyota Production System (TPS) emerged shortly after World War II. Its founders were the president of *Toyoda Spinning* and *Weaving*, *Sakichi Toyoda*, his son: *Kiichiro Toyoda*, Toyota Company Motor founder, the engineer *Taiichi Ohno* and the business consultant: *Shingeo Shingo*. They contributed principles, techniques and tools to improve process performance. This system has been improved over decades with the aim of reducing costs by eliminating waste and increasing quality and customer satisfaction. Its success occurred worldwide and was mainly due to its effectiveness in reducing complexities and steps that do not add value (ALBERTIN and PONTES, 2016).

With the economy totally devastated after World War II, Japan spared no effort to rebuild its industry. The Toyota Production System, as its name suggests, was developed at Toyota Motor Company by a production manager

named Taiichi Ohno, with the objective of making the Japanese automobile industry competitive (CÔRREA & CÔRREA, 2012).

The lean production system has quality and flexibility as its fundamental operational objectives. To achieve these goals, it establishes management goals: continuous improvement and the incessant attack on waste (CORRÊA & CORRÊA, 2009).

According to Bessant, Caffyn and Gallagher (2000), continuous improvement can be defined as a process of incremental, focused and continuous innovation, involving the entire organization. Its small steps, high frequency and small change cycles seen separately have small impacts, but together they can make a significant contribution to the company's performance.

Costa and Jardim (2010) state that the best way to identify waste through a lean view is to put yourself in the customer's position and critically reflect on production processes and how it is carried out.

Thus, losses due to overproduction, transport, processing, inventory and rework are related to the process function, so that they aim to control the flow of the work object in time and space. As for losses due to waiting and movement, they are related to the Operation Function, as they are focused on the analysis of the work subject (people and equipment) (ANTUNES, 2008).

LEAN MANUFACTURING PHILOSOPHY

As mentioned by Riani (2006), Lean tools are of fundamental importance for manufacturing to achieve its goals, as they are instruments applied to the implementation of a lean system that dictate how the principles must be followed in practice.

Through the Lean philosophy model, organizations are able to obtain a differential and position themselves competitively in the globalized environment, thus responding to the growing need for leaner and more flexible structures (MACEDO; POSSAMAI, 2013).

Perdas	**Perguntas necessárias à identificação**
Transporte	Você move materiais de forma eficiente?
Estoque	Seus níveis de estoque de suprimentos, equipamentos e informações são muito altos?
Movimentação	As pessoas e equipamentos entre as tarefas movimentam-se de forma eficiente?
Espera	Quanto tempo de atraso existe entre as etapas de produção?
Superprodução	Você está produzindo mais do que a demanda dos consumidores?
Processamento	Você trabalha no produto muitas vezes, ou não funciona de forma eficiente?
Defeitos	Quanto tempo você gasta para encontrar e corrigir erros de produção?

Losses	Necessary Identification Questions
Transportation	Do you move materials efficiently?
Inventory	Are your inventory and supplies, equipment and information levels too high?
Movement	Do people and equipment between tasks move efficiently?
Wait	How much delay is there between production steps?
Super production	Are you producing more than consumer demand?
Processing	Do you work on the product often, or does it not work efficiently?
Defects	How much time do you spend finding and fixing production errors?

Figure I – Identification of the seven losses.

Source: Adapted from Robinson & Kirsch (2015); Maruthi & Rashmi (2015)

VALUE FLOW MAPPING

In an extensive literature review, Marodin and Saurin (2013) identified Value Stream Mapping as one of the most used techniques for implementing Lean, presenting increased productivity and reduced lead-time as typical results. This popularity can be explained by the ease of use and focus on implementation.

According to Silva et al. (2012), the Value Stream Map, is one of the lean production tools for optimizing the production process. Also according to the same authors, a value stream is every action that brings a material through all the essential flows to each product, from the raw material to the final consumer, offering a detailed and easy-to-view description of the manufacturing operations, allowing identification and location of current process constraints, which in future mapping will turn into improvement opportunities.

Carvalho and Paladini (2012), however, point out that the process mapping tool is important and enables the knowledge of operations in a richer way, presenting the details that occur in the production of a service or in the manufacture of a product. The two methods are similar, differing only in the amount of focus on the processes.

Xavier and Sarmento (2014) comment that the main objective of the Value Stream Mapping is to allow a clear visualization of the productive processes in the companies and of some of the resulting wastes. This tool is also used as a way to define effective strategies for the elaboration of projects to improve the flow and reduce losses in its most diverse forms of occurrence.

According to Tavares (2017), it is based on the value stream mapping that the application of STP techniques is developed, with improvement and optimization actions, in a complete process.

According to Rother and Shook (2012), the VSM known as: *Value Stream Mapping* is a tool to analyze the entire flow of information, processes and materials, helping organizations to visualize and identify their main sources of waste or activities that do not add value, allowing them to direct their actions to obtain a better flow performance.

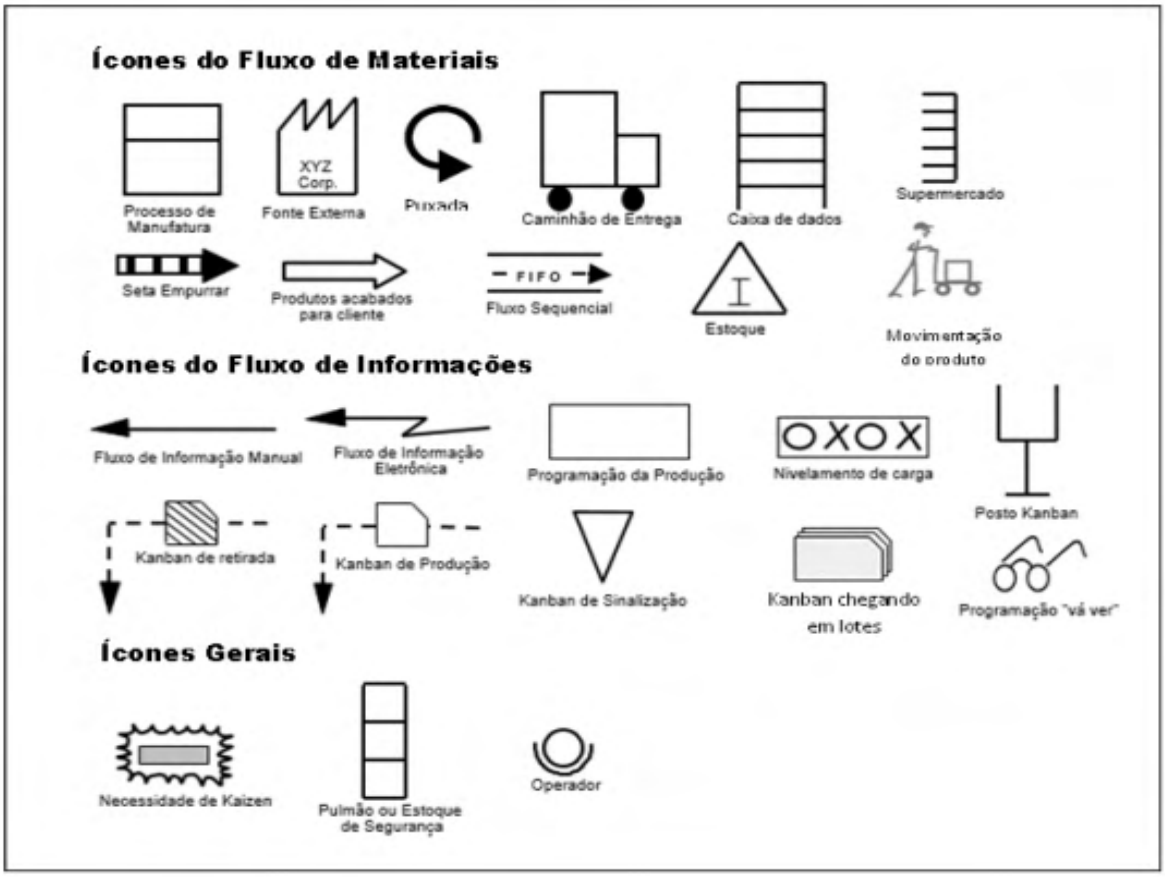
Based on the statement of Rother and Shook (2012), the VSM tool allows the connection of all processes that make up the production flow, from the supplier to the final consumer, mapping all the steps in order to apply lean thinking techniques. According to the same authors, the VSM must be developed through the following steps: a) Establish the product family: from a group of products that undergo similar processing steps; b) Map of the current and future state: prepare the map of the current and future state, using collected information; c) Work plan and implementation: prepare an implementation plan that describes how you want to get to the future state.

Rosa (2008) reports the steps of the MFV, arguing that it can be used as a communication tool, a business tool and a tool to manage the process of change. The MFV begins by identifying some fundamental steps, which are described below: 1. Product family: it identifies which product must be focused on; 2. Current state drawing: current status of the process - this information is taken directly from the shop floor; 3. Future state design: where you want to go; 4. Work plan: How will this transition between current and future state be made.

For Werkema (2011), the VSM is a tool that uses graphic symbols that are considered standard, so that there is a unique understanding of its application in any world location.

According to Werkema (2012), some possible effects identified through the use of Value Stream Mapping:

- Understanding of the organization's processes as a whole, not just isolated stages or departments;



Material Flow Icons Manufacturing Process Pulled External Source delivery truck data box Supermarket arrow push Finished products for customers sequential flow Product Movement Inventory
Information Flow Icons Manual Information Flow Electronic Information Flow Product Programming Load Leveling Kanban station withdrawal kanban Production Kanban Signal Kanban Kanban arriving in batches “go see” programming
General Icons need for kaizen Lung or Security Stock Operator

Figure II - Symbols used in the MFV. Source: Adapted from Rother & Shook (2003)

product family
current state drawing
future state design
work plan and implementation

Figure III - Initial Steps of the Value Stream Mapping. Source: ROTHER AND SHOOK (2003).

- Awareness of the true state of the organization, identifying the steps that generate value and waste points;
- Visualization of relationships between activities, in addition to noting the impact on lead time caused by information and material flows;
- Location and separation of activities that add value to the customer from those that do not add value.

METHODOLOGY

Research is the set of planned, integrated and harmonized actions and strategies applied in an investigation project. This project aims to build a systematic knowledge process, proving the application or improvement of a knowledge or tool, becoming a learning object for everyone (MAGALHÃES, 2011).

The research can be considered applied, as knowledge was obtained through its application. According to Vergara (2013), applied research aims at practice and is motivated by an immediate need or not.

The bibliographical research according to Fachim (2010) is the basis for the others. While for Lakatos and Marconi (2009), bibliographic research refers to that which is carried out from available material, arising from previous research in printed documents, such as periodical books, articles and others.

The study approach is classified as quanti-qualitative, as the description of the processes was carried out, followed by the application of the value stream mapping.

The qualitative-quantitative research modality "interprets quantitative information through numerical symbols and qualitative data through observation, participatory interaction and interpretation of the subjects' discourse (semantics)" (KNECHTEL, 2014, p. 106).

Regarding the objectives, the research can be defined as descriptive, as interviews and conversations were carried out with the company's employees for a better understanding of the entire process flows.

Descriptive research, according to Gil (2007), is an in-depth analysis that aims to describe, classify and interpret the studied object. It uses more systematic and rigorous techniques. They can go beyond the mere identification of variables, approaching, in this case, explanatory research, analyzing facts and phenomena in detail. And, in cases where a new view of the object is provided, it approaches exploratory research.

The present study was carried out in a small clinical analysis laboratory. The company is open from Monday to Friday from 7 am to 4 pm. Its target audience is patients from the Unified Health System - SUS, private and health insurance, with an average daily care of 40 (forty) patients, dividing the provision of services into blood collection, toxicological test collection, DNA test collection, between others. Patient care is carried out on a first-come, first-served basis.

It is verified that the maximum waiting time for each patient does not exceed 01 (one) hour. In the figure below, some research results will be presented.

RESULTS AND DISCUSSION

According to the surveys carried out and the customer service flowchart, it was possible to obtain the Value Stream Map of the entire service process, as shown in Figure V below.

Four (4) key steps were considered for care: Delivery of the patient's document, service by the receptionist, registration in the system and service by the collector.

The Cycle-time all 100% efficiency was taken into account *(Uptime)* of the key steps, that being said, all of the production time was used to carry out the tasks. There were 10 (ten) visits to patients to mention the time of each activity, thus being able to consider the *Cycle-time* like 10 (ten) minutes.

According to Table I below, it was possible to mention other production indicators. The calculation of *Takt-time* was obtained with an average of 40 (forty) patient consultations in a period of 08 (eight) hours a day, resulting in a time of 12 (twelve) minutes to perform 1 (one) assistance to 1 (one) patient. With less time than the *Lead Time*, the work is necessary.

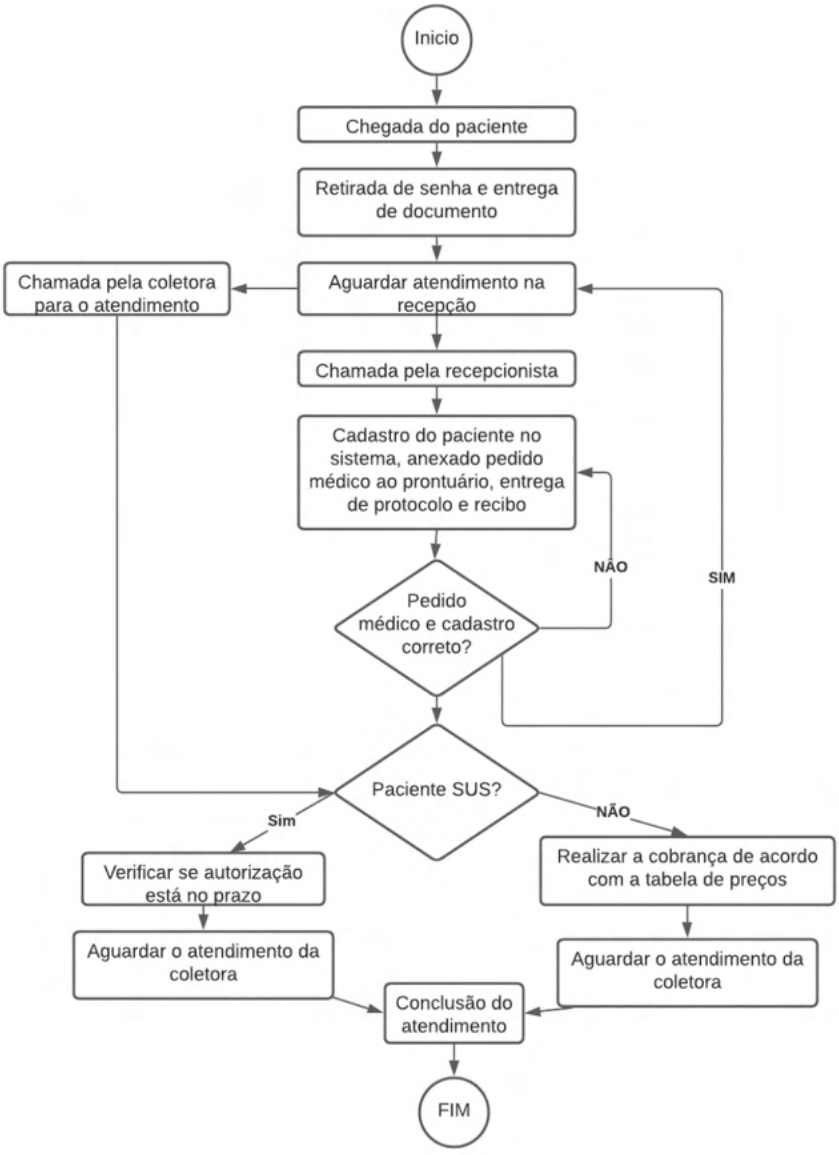
It was noticed that time is between the registration in the system and the service provided by the collector, which is justified by the following situations: system lock up, internet speed oscillate, receptionists' level of knowledge, lack of patient flow management.

Another situation that is important to highlight is that the receptionists, in addition to assisting patients, also provide telephone assistance, which has a large daily demand for calls, budgeting for exams and delivering exam results. With this, it is believed that it would be important to provide one more employee to perform this task or these tasks, which would reduce the time of patient care.

FINAL CONSIDERATIONS

This article presented the application of the value stream mapping tool in a clinical analysis laboratory in patient care, where it was possible to verify the main processes, such as: bottlenecks, productive time, unproductive time, efficiency and other performance indicators .

It was found that the longest waiting time is during the registration of patients in the system and in the service provided by the collector, the delay in registering in the system occurs due to fluctuations in the system used by the receptionist, such as system crash, network failure and also lack of knowledge of using the information; in the matter of the service provided by the collector, it was observed that the system is half manual and the other automated, which means that the collector, at the time of care, has to write the patient's identification on the tubes, the type of tube to be used and also mark the exams to be performed on the forms.



Start
Patient arrival
Withdrawal of password and delivery of document
Wait for service at reception
Call by the broker for assistance
Call by receptionist
Patient registration in the system, medical request attached to the medical record, delivery of the protocol and receipt

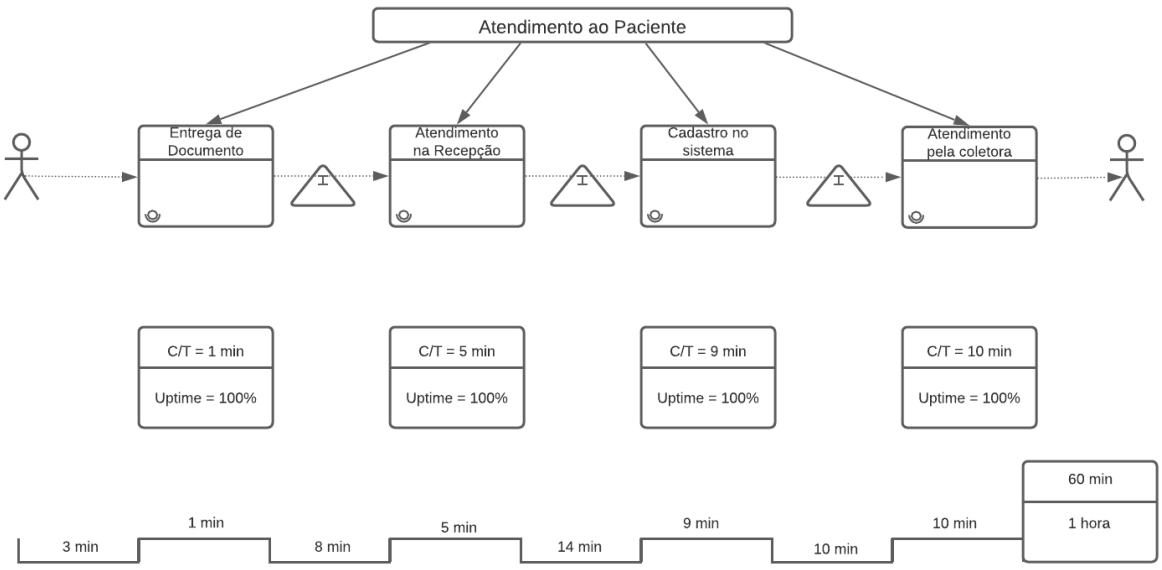
Medical order and correct registration?
Yes
Not
Patient from the Unified Health System?
Yes
Check if the authorization is within the deadline
Wait for the collector's service
Not
Charge according to the price list
Wait for the collector's service
Completion of service
THE END

Figure IV - Flowchart of care for 01 (one) patient. Source: Authors

Performance indicators	Results
Lead Time	60 min
Cycle Time	10 min
Takt-Time	12 min
Production time	25 min
Unproductive time	35 min
Efficiency	41,66%

Table I – Performance indicators and results.

Source: Authors



Patient Care Document Delivery Reception assistance Registration in the system Service by the collector
C/T = 1 min Uptime = 100% C/T = 5 min Uptime = 100% C/T = 9 min Uptime = 100% C/T = 01 min Uptime = 100%
3 min 1 min 8 min 5 min 14 min 9 min 10 min 10 min 60 min 1 hour

Figure V - Patient Care Value Stream Mapping. Source: Authors

It is noteworthy that some improvements can be implemented to eliminate these bottlenecks, such as: password system to direct the patient to the specific care service (private, SUS - Unified Health System, health insurance, toxicology, COVID-19, DNA, among others).

Improve system performance by contacting the person in charge in order to avoid recurring errors, connecting the entire reception service with the collection rooms electronically, which will avoid unnecessary waiting and errors.

Conduct training with receptionists and collectors, aiming to improve the performance of the service, as well as solve possible clarifications or doubts that are not resolved on a day-to-day basis, and thus standardize the service so that the laboratory obtains more quality in the provision of the service.

With this, it will be possible to visualize improvements throughout the process, to have satisfied employees and customers.

REFERENCES

ALBERTIN, M. R., PONTES, J. L. H. **Gestão de processos e técnicas de produção enxuta**. Edição 1. Ano Edição 2016. Páginas 159. Editora InterSaberes. Curitiba. Paraná. ISBN 978- 85-443-0354-2.

ANTUNES, Junico. Sistemas de Produção: **Conceitos e práticas para o projeto e gestão da produção enxuta.** Porto Alegre: Editora Bookman, 2008.

BESSANT, J.; CAFFYN, S.; GALLAGHER, M. **An evolutionary model of continuous improvement behavior.** Technovation, v. 21, p. 67-77, 2000. Disponível em: http://dx.doi. org/10.1016/S0166-4972(00)00023-7. Accessed on: October 20, 2021.

CARVALHO, Marly M. de; PALADINI, Edson P. **Gestão da qualidade**. 2. ed. Rio de Janeiro: Campus, 2012.

CORRÊA, Henrique L. CORRÊA, Carlos A. **Administração da produção e operações: manufaturas e serviços: uma abordagem estratégica.** São Paulo: Atlas, 2012.

CORRÊA, H. L; CORRÊA, C. A. **Administração da Produção e de Operações.Manufatura e serviços: uma abordagem estratégica.** São Paulo: Editora Atlas, 2009.

COSTA R.S.; JARDIM E. G. M. **Os cinco passos do pensamento enxuto net**. Rio de Janeiro, 2010.

FACHIN, Odília. **Fundamentos de Metodologia**. 3. ed. São Paulo: Saraiva, 2001.

GIL, Antonio Carlos. **Como elaborar projetos de pesquisa**. São Paulo: Atlas, 2007.

JACKSON, T. L. **Mapping Clinical Value Streams.** New York: CRC Press.2013.

KNECHTEL, Maria do Rosário. **Metodologia da pesquisa em educação: uma abordagem teórico-prática dialogada**. Curitiba: Intersaberes, 2014.

LIKER, Jeffrey K. **O Modelo Toyota: 14 princípios de gestão da maior fabricante do mundo.** Porto Alegre: Bookman, 2005.

MAGALHÃES, M. C. C. **Pesquisa crítica de colaboração: escolhas epistemometodológicas na organização e condução de pesquisas de intervenção no contexto escolar.** In: MAGALHÃES, M. C. C.; FIDALGO, S. S. (Org.). Questões de método e de linguagem na formação docente. Campinas: Mercado de Letras, 2011. p.13-39.

MARCONI, Maria de Andrade. Lakatos, Eva Maria. **Metodologia Científica**. 2. ed. São Paulo: Altas 1990.

MARUTHI, G. D.; RASHMI, R. **Green Manufacturing: It's Tools and Techniques that can be implemented in Manufacturing Sectors. Materials Today: Proceedings**, v.2, n. 4 - 5, p. 3350 – 3355, 2015.

MACEDO, M; POSSAMAI, E. **Impactos da implementação do Lean Manufacturing na obtenção de vantagem competitiva: um estudo de casos múltiplos**. Revista Gestão Industrial, v. 9, n. 2, 2013.

MARODIN, G. A.; SAURIN, T. A. **Implementing lean production systems: research areas and opportunities for future studies. International Journal of Production Research**, v. 51, n. 22, p. 6663-6680, 2013.Available on the website: <http://dx.doi.org/10.1080/00207543.2013.826831>. Accessed on: October 20, 2021.

MONDEN, Y. **Sistema Toyota de produção: uma abordagem integrada ao just-in-time.** 4.ed. Porto Alegre: Bookman, 2015.

RIANI, Aline Mattos. Estudo de caso: **O lean manufacturing aplicado na Becton Dickinson. Monografia de engenharia de produção**. Universidade federal de Juiz de Fora, Juiz de Fora, 2006.

ROBINSON, S. T.; KIRSCH, J. R. **Lean Strategies in the Operating Room. Anesthesiology Clinics**, v. 33, n. 4, p. 713 – 730, 2015.

ROTHER, M., & SHOOK, J. **Aprendendo a enxergar mapeando o fluxo de valor para agregar valor e eliminar desperdício.** São Paulo: Lean Institute Brasil, 2003.

ROTHER, M.; SHOOK, J. **Aprendendo a enxergar: Mapeando o fluxo de valor para agregar valor e eliminar o desperdício.** São Paulo: Lean Institute Brasil, 2012.

ROSA, D. C. **Aplicação do mapeamento do fluxo de valor em uma empresa do setor metal-mecânico.** Monografia pós graduação – Engenharia Mecânica, Universidade Federal de Santa Catarina, Florianópolis, 2008.

ROTHER, Mike. SHOOK, John. **Aprendendo a enxergar o fluxo de valor para agregar valor eliminando o desperdício**. 1ª Edição – Rio de Janeiro, 2003.

SILVA, Arielton Freire, PEREIRA, Fabio André Honorato, BELO, Jodibel Niklas de Andrade, SOUZA, Judeison Rocha, SANTOS, Renan de Souza**. Value stream mapping: uma importante ferramenta na implementação da manufatura enxuta, um estudo de caso em uma indústria têxtil de moda praia**. XXXII ENCONTRO NACIONAL DE ENGENHARIA DE PRODUCAO, Bento Gonçalves, 2012.

TAVARES, P. R. D. S. **Logística lean: Aplicando as ferramentas lean na cadeia de suprimentos para gestão e geração de valor**. Maringá: MAG Editora, v. I, 2017.

VERGARA, Sylvia Constant. **Projetos e Relatórios de Pesquisa em Administração.**12. ed. São Paulo: Atlas, 2010.

XAVIER, G. V.; SARMENTO, S. S. **Lean Production e mapeamento do fluxo de valor.** Disponível em: http://www.techoje.com.br/site/techoje/categoria/detalhe_artigo. Accessed on: October 20, 2021.

XAVIER, Giuliano Vitor; SARMENTO, Sérgio da Silva**. Lean Production e mapeamento do fluxo de valor.** Article available at http://www.techoje.com.br /site/techoje/categoria/detalhe_artigo/316. Accessed on: October 20, 2021.

WERKEMA, CRISTINA. **Lean seis sigma: introdução às ferramentas do lean manufacturing**. 2. ed. Rio de Janeiro: Elsevier, 2011.

WERKEMA, CRISTINA. **Lean seis sigma: introdução às ferramentas do lean manufacturing.** 2. ed. Rio de Janeiro: Elsevier, 2012.