ISSN 2237-8960 (Online)

CASE STUDY

Lean construction: value stream mapping benefits in the procurement department of a construction company

Paloma Garrido Correia Teles[1], Alberto Eduardo Besser Freitag[1], Marcelle Candido Cordeiro[2], Marcelo Jasmim Meiriño[3]

[1]Candido Mendes University (UCAM), Rio de Janeiro, RJ, Brazil.
[2]State University Rio de Janeiro (UERJ), Rio de Janeiro, RJ, Brazil.
[3]Fluminense Federal University (UFF), Rio de janeiro, RJ, Brazil.

How to cite: Teles, P. G. C. et al. (2026), "Lean construction: value stream mapping benefits in the procurement department of a construction company", *Brazilian Journal of Operations and Production Management*, Vol. 23, No. 2, e20263066. https://doi.org/10.14488/BJOPM.3066.2026

ABSTRACT

Goal: the purpose of this study was to report how the use of Lean Construction tools helped the procurement department of a medium-sized Brazilian construction company to reduce the lead time of delivered materials on the site, during the COVID-19 pandemic.

Design / Methodology / Approach: this applied research adopts both exploratory and descriptive objectives, utilizing a qualitative case study strategy. Data collection involved triangulating sources such as documents, interviews, and field observations.

Results: the current Value Stream Map (VSM) pointed out that takt time of material requisitions received per day (RPD) is faster than the pace of the procurement stream. The future VSM simulated with an additional employee showed that it would be possible to reach an effective capacity of 10 RPD, meeting the engineering department's demand, with lead time reduction from 84 to 49.5 hours.

Limitations of the investigation: the primary limitation concerns the generalizability of the conclusions, models, or theories derived from this single case study. Nonetheless, these constraints do not diminish the significance of the findings, which contributed to the company's decision to employ an additional staff member in the procurement department.

Practical implications: the procedures used in this study—including takt time calculation, processing time analysis, and the development of current and future-state VSMs—can be applied by other organizations to reduce value-stream lead times.

Originality / Value: this research differs from existing studies by combining VSM, takt time and lead time in the procurement department of a construction company.

Keywords: Lean construction, Procurement, Value stream map, Quality management, Supply chain.

1 INTRODUCTION

The construction industry was one of the sectors that helped sustain the labor market during the economic downturn, even as the COVID-19 pandemic affected much of Brazil's economy through isolation measures and strict health controls. According to Agência Brasil (2024), citing data from the Annual Survey of the Construction Industry released by the Brazilian Institute of Geography and Statistics (IBGE) on May 29, 2024, employment in the construction sector grew in 2020, 2021, and 2022, adding 411,600 jobs—an increase of 21.6% over the period. The survey also reported that, in 2022, the sector included 174,700 companies, which paid USD 15.26 billion in wages and other compensation to 2.3 million workers and generated USD 84.14 billion in real estate development, construction, and related services.

Financial support: none.
Conflict of interest: The authors have no conflict of interest to declare.
Corresponding author: abesser@uol.com.br
Received: 29 December 2025.
Accepted: 25 June 2026.
Editor: Osvaldo Luiz Gonçalves Quelhas.

The expansion of activities in the Brazilian construction industry during the pandemic has created challenges for the procurement departments of construction companies, due to restrictions on the supply of construction materials in the retail trade. It becomes essential the ability to manage a supply chain in construction, since its management must be conducted in several approaches from various departments to perform the interaction of all for the purpose of efficiency in distribution, suppliers and customers according to the Just-In-Time demand, not having losses and waste. The supply chain is necessary for the supply of materials but contributes by integrating into the life cycle of the product, as well as the financial flow of the company, acting throughout the lead time of final delivery. It is important for the correct supply, resulting in improved quality and productivity, with cost reduction and customer satisfaction (Fourie and Umeh, 2017).

Arbulu et al. (2003) explain that supply chains can be modeled and analyzed using value stream mapping (VSM), a Lean Construction (LC) tool that helps examine production processes, identify waste, and improve process flow. Although VSM was originally developed for products, it has been widely adapted for use in the construction industry by considering its production cycles (Vivan et al., 2012). Over time, LC—derived from lean manufacturing in the automotive industry—has evolved to include several tools that can be applied across all departments of an organization to support continuous process improvement and waste reduction. Adapting these tools is essential, because the construction sector is highly complex and differs significantly from manufacturing, directly influencing business efficiency and productivity (Pfaffenzeller et al., 2015).

There are few LC studies in international literature connecting VSM and procurement, which will be critically discussed next. Barkokebas et al. (2021) introduced a comprehensive framework aimed at advancing premanufacturing processes—encompassing design, procurement, and bidding—for the digitalization of offsite construction planning and execution. The framework establishes building information modelling (BIM) as the core enabling technology and integrates lean principles to enhance operational efficiency and reduce waste. Its structured approach comprises data collection, value-stream mapping, and simulation activities to evaluate current workflows and guide the formulation of targeted process improvements. Arbulu et al. (2003) presented the most common configuration of the supply chain for pipe supports used in power plants in the USA. This supply chain, like many others in construction, has numerous inefficiencies, many of which occur at the interfaces between processes, disciplines or organizations. The study describes how industry practices are changing to yield shorter supply chain lead times. To illustrate the mechanisms behind these changes, data are collected from industry practices using value stream maps. These maps cover various organizational disciplines and company boundaries, showing the flow of work during the design, procurement, and fabrication phases of pipe supports. Salifu-Asubay and Adjei Mensah (2015) examined how lean construction principles are used in Ghana's cities and ways to improve their application. They found that principles like value, flow, and pull are applied in less than half of projects. Major barriers include long lead times, poor procurement and contracts, cultural and human issues, political influence, and limited financial or management commitment.

Arbulu et al. (2003) reported that an increasing number of practitioners in the power plant industry have been observing that 'pipe supports often arrive late on site', which could be prejudicial to the success of the undertaking. To address this issue, they have aimed to enhance delivery processes and shorten lead times in the pipe support supply chain. Similarly, the expansion of the construction industry's activities in Brazil during the pandemic period has led to a problem of delayed delivery of materials, which leads to the following research question: "How can practices of lean construction benefit the procurement department of construction companies and shorten lead times in material supply?" The aim is to answer this question through a case study, whose objective is to report how the use of VSM and complementary tools helped the procurement department of a medium-sized Brazilian construction company to reduce the lead time of delivered materials on the site. This research differs from existing studies by applying a combination of VSM, takt time and lead time in the procurement department of a construction company. The studied case was a warehouse refurbishment in the state of Rio de Janeiro, over a period of sixty days during the months of February to April 2020. The analysis focused on the decrease in the waiting time of materials, the increase in the % value added in the execution time, and the reduction in labor costs, shortage of materials, and payment of penalties due to additives in contracts.

The research began in the first quarter of 2020, coinciding with the date of the contract opening and the commencement of onsite work. It was discovered that during the first twenty days, there were no materials available to start the services, leading to productivity issues and consequently wasting manpower, which increased costs. The study is justified as it aims to analyze ways to reduce the waiting time for materials and labor costs, avoid excess or shortage of materials, and prevent non-payment of penalties related to contract additives. This prioritization of complete execution of the planning will contribute to delivering the work on schedule, providing a comprehensive view of the current customer and future potential customers, while also enhancing internal best practices for securing new bids.

After this introductory section, the paper presents a literature review of LC tools used in the study, outlines the methodology, and describes a case study. It then discusses the results—particularly how the procurement department reduced lead time for delivering materials to the construction site. The paper concludes with final remarks and references.

2 LITERATURE REVIEW

The literature reviewed in peer-reviewed journals was summarised using an "Overview," which is a broad term for any summary aiming to examine and describe the characteristics of existing research (Grant and Booth, 2009). Overviews offer a wide-ranging and often thorough summary of a particular field, making them useful for newcomers seeking to understand a subject. The topics covered include the Toyota Production System, which inspired the Lean Construction management approach, as well as Value Stream Mapping, Lead Time and Takt Time tools applied in this study.

2.1 Toyota Production System

The Toyota Production System (TPS) was established to enhance efficiency and productivity within the automobile industry. This system has revolutionized manufacturing processes across various industries for the long term. Unlike the outdated Ford Production model, TPS operates on the principles of "just in time" production, which involves meeting only the required quantity for production and eliminating waste. In the implementation of this system, positive numbers were achieved in the economic environment of Japan, which was going through an industrial crisis in the 70s. The applicability of the Toyota Production System spread to other industrial areas besides the automotive (Mariz and Picchi, 2014).

Toyota identified seven wastes, according to Tomioka et al. (2020), among them: overproduction, which results in excess of inventory; waiting, which can keep the workforce idle, generating unnecessary costs; transport, which can become unnecessary and inefficient; overprocessing, which can generate losses, defects, and rework later; excessive inventory, which generates unnecessary costs; unnecessary movement of employees, which can increase cycle times, and defects, resulting from lack of quality in the processes. Some lean tools can be adapted such as Kanban, Just-In-Time, work standardization, multifunctional work, and focus on product layout, however, the takt time concepts for production management cannot be forgotten (Favoni et al., 2013).

2.2 Lean construction

In civil construction organizations, traditional project management models are not very productive and do not add value to the processes, becoming stagnated, thus productivity focused on improvements is needed to meet fixed schedules, reducing the general costs of the project (Melo et al., 2017).

LC philosophy was developed as an alternative to conventional production systems, which typically regard the manufacturing process as a sequence of numerous conversions leading to the finished product. Lucena and De Mori (2018), referencing Oliveira et al. (2010), note that in civil construction, conversion typically refers to changes in materials or labor, with the finished building as the end product. However, from the Lean methodology viewpoint, this process is better seen as a flow of information and/or materials, where raw materials are transformed into the final output. The main distinction from the traditional model is that, within this flow-based approach, not only is the raw material processed (converted) throughout the cycle, but it is also subject to inspection, transport, and storage (Koskela, 1992).

It is important to emphasize the principles of LC in the production process of the construction industry. Koskela (1992) outlines eleven principles: eliminate activities that don't add value, enhance product value by addressing customer needs, minimize variability, shorten both process cycle time and value stream takt time, streamline processes by reducing steps or parts, boost flexibility in output, make processes more transparent, manage the entire process as a whole, promote ongoing process improvement, balance improvements between streams and conversions, and use benchmarking.

Lean construction aims to execute the services in a chain, with pre-established rules within a system, without waste and adding value to the customer. Using schedules is crucial for identifying potential failures during processes. Since some steps must be completed before others, if one step fails, it delays subsequent steps, leading to increased costs due to idle workforce. For Melo et al. (2017), LC has grown over the years because it is an easily applicable methodology and has determined a positive performance in temporary productions, decreasing waste, improving the delivery of buildings, with customer satisfaction. The adoption of specific modeling for waste assessment can provide high results in productivity (Issa and Alqurashi, 2020).

According to Euphrosino et al. (2019), the demands in the construction industry led to adaptations in organizations, beginning in academia and extending into the organizational environment. Process optimization is considered essential for a lean system. The application of lean thinking was a major milestone in the elimination of waste. In studies that have been conducted, it is observed through process mapping that there are variations in the use of LC principles (Nery et al., 2017).

2.3 Value Stream Mapping

The VSM enables the calculation of all the time until the conclusion of a procedure or process, allowing the lead time analysis, working together with the schedule that was prepared for the execution of the construction works (Pires and Fontanini, 2017).

In reducing the tasks that do not add value, VSM is a tool that, in a simplified and easy to understand way, presents all the steps of a particular stream, so that some failures that are contained in it can be identified and analyzed, and then the necessary decisions can be taken to change this flow. Some of the activities that do not add value, are essential for the execution of processes (Gomes, 2019).

It is a method that combines several resources, demonstrating the supply stream. By elaborating the current VSM it is possible to determine the entire production process of a given point to be studied, allowing an analytical verification, facilitating the understanding of operations and identifying failures in production planning and control (Rech et al., 2019). It allows the design of the future state for constructions with a short schedule and efficient delivery of the final work (Pires and Fontanini, 2017).

De Souza Pinto et al. (2017), referencing Womack and Jones (2003) as well as Pepper and Spedding (2010), explain that the VSM tool not only offers dependable qualitative analysis but also helps determine project scope by outlining both the current and future states of the process. The comprehensive nature of the tool facilitates systematic application, resulting in system enhancements and reduction of waste impacts.

2.4 Lead time

Lead time is a term that expresses the time calculated from the beginning of the process to the end of a given activity, highlighting its need for checking the real time in which the processes occur. To reduce lead time, it is essential to thoroughly verify the stability of processes, balance the cycle times of operations, and implement standardized working methods.

Lead time, once introduced, is intended to be decreased, but in some cases, it is a period performed in an activity that can run with productivity or without productivity. Some cases can be observed in the procurement and in the production area. Therefore, it follows that numerous factors determine the improvement of logistics (Eugênio and Bonette, 2019).

Because the structure of in-house customer, operator, and end customer is used, where the in-house customer follows streams for demand sending, the operator for production, and logistics for distribution to the end customer, if the ways in which the three streams are done are not standardized, even if they are done in different areas, they will always cause a bottleneck that will directly impact lead time; therefore, the process model must be adopted under the same premise at the organizational level (Nery et al., 2017).

Applying lean in this situation requires identifying the operation's weak points. And this analysis occurs through the visualization of pre-established goals for each stage. Based on the bidding process, Gomes (2013) describes some of them, such as cycle time reduction and step simplification.

2.5 Takt time

Takt time is calculated according to the time available for production and the amount of time needed to meet a certain demand, avoiding overloading the stage that is being performed and, subsequently, the next stages of the production process (Alvarez and Antunes Jr, 2001). Because it dictates the pace of production required and adjusts to the needs of the demand, it is called takt time (Vatne and Drevland, 2016).

The cycle time is directly related to takt time, as it is determined by the number of employees and the production time necessary to complete a task. This can involve cell work, where each workstation within the cell has a specific cycle time required for the production of an item, contributing to the overall single cycle time. To include the production time, it becomes necessary to adjust with the demand needs (Borges and Regattieri, 2018).

Werkema (2012) defines takt time as the time available for production divided by customer demand. The takt time calculation and the cycle time verification can show the need to increase the number of employees for the decrease of cycle time and increase of productivity, being able to change the characteristics of the production, decreasing the lead time and the production costs, improving the quality and delivery of a project (Alvarez and Antunes Jr, 2001).

3 METHOD

The methodology aims to clearly describe all methods used, the tools for data collection, how the data were analyzed, and the overall steps taken throughout the study. This helps readers understand how the research was constructed and how it achieved its goals (Moraes and Fonseca, 2017).

3.1 Research classification

The study adopts Turrioni and Mello's (2012) classification framework for scientific research in production engineering, focusing on nature, objectives, approach, and method.

a) Nature: applied research, defined by its practical interest. The results are directly applicable or used for solving existing problems. The study found that a single employee in the purchasing sector is insufficient to meet the demand for material requisitions. Consequently, the engineering department analyzed the situation and authorized the company to hire an additional employee for the procurement department to enhance productivity.
b) Research objectives: exploratory and descriptive. The exploratory objective is to increase familiarity with the problem by building hypotheses, using bibliographical surveys and interviews with those experienced in the issue. Data was collected through observation, interviews, and document review, with one author's company experience leveraged. The descriptive objective focuses on identifying characteristics or relationships within a population or phenomenon, using standardized techniques like questionnaires and systematic observation. A specific situation was analyzed, in which it was found that after the contract opening and beginning of the work on site, there were no materials to start the services in the first twenty days, generating productivity problems and, as a direct consequence, wasting manpower, thus increasing costs.
c) Approach: qualitative. This approach recognises a dynamic connection between reality and the individual, highlighting that objectivity and subjectivity are closely intertwined and cannot be reduced to numerical values. It does not rely on statistical tools or methods. Data is gathered directly from the natural environment, with the researcher serving as the primary instrument. Data on processing time, percentage complete and correct, waiting time, and number of people were collected through interviews conducted by one of the authors of this research. This data facilitated the construction of the VSM and calculation of Lead Time and Takt Time, thereby enabling subsequent analysis.
d) Method: case study. This approach involves a comprehensive examination of one or a few subjects to gain detailed knowledge. According to Creswell (2010), case studies allow researchers to thoroughly explore a program, event, activity, process, or individuals. The case study methodology is frequently employed across disciplines to enhance our understanding of individual, group, organizational, social, political, and related phenomena, typically commencing with a comprehensive review of the relevant literature (Yin, 2015). Among the four recognized types of case studies, this research has selected the single case study approach, specifically focusing on the common case. The primary objective is to examine the context and circumstances of routine situations to derive insights into social processes that inform particular theoretical interests.

In accordance with Yin (2015), case studies can include details and even be limited to quantitative evidence, as in this research. An inductive strategy provides additional guarantees if it is necessary to collect quantitative data, which may be relevant to cover the behavior and events the case study is trying to explain-typically, the "outcomes" in an evaluative case study. Typically, the main factors for choosing the case are convenience, data accessibility, and location. In this study, these criteria were relevant since one of the authors was employed at the company during that period. The case study, conducted in early 2020 during the pandemic, analyzed all stages from material survey to delivery at the construction site.

Concerning the unit of analysis, a case may be an event or entity, as well as a single individual (Yin, 2025). According to the author, it is desirable to establish a specific time frame to define the estimated start and end dates for the purposes of the study. Finally, the case in question should be a real-life phenomenon that manifests itself in some concrete way. For the purposes of this research, the unit of analysis was the procurement department of a medium-sized Brazilian construction company, which was studied during a warehouse refurbishment in the state of Rio de Janeiro, over a period of sixty days during the months of February to April 2020.

3.2 Data collection techniques

Voss et al. (2002) emphasize triangulation in case study data collection, meaning using multiple methods to examine the same phenomenon. Woodside and Wilson (2003) note this often involves direct observation, participant interviews, and document analysis. In this work, triangulation was achieved through interviews, observation, and archival documentation, as detailed below.

a) Interviews: the main purpose of the interview is to obtain information from the respondent on a particular subject or problem. The type used in this work was a non-structured interview, in which the interviewer is free to develop each situation in any direction he or she sees fit. It's a way of being able to explore an issue more widely. Generally, the questions are open-ended and can be addressed through a casual dialogue. Data on processing time, percentage complete and correct, waiting time, and number of people were collected through interviews conducted by one of the authors of this research with the person responsible for the procurement department at the studied company. The answers were written down at the time of the interview, for greater accuracy and veracity of the information, and used later to draw up the VSM and calculation of Lead Time and Takt Time, thereby enabling subsequent analysis.
b) Observation: it involves using our senses to gather information about certain aspects of reality. Observation is more than just seeing and hearing—it includes examining facts or phenomena under study to collect relevant data. The method used in this investigation was participant observation, which consists of the researcher's actual participation with the community or group. Participation took place through face-to-face meetings between the author, who worked at the studied company, and the procurement department employee, as well as through observation of the processes before and after the procurement department in the analyzed VSM.
c) Archival information (documentation): the characteristic of documentary research is that the source of data collection is restricted to documents, written or otherwise, which constitute what are known as primary sources. The authors compiled a table with data from the company under study. To evaluate the processing time, the stages of the procurement stream were inserted in the table, with the definition of which professional performs its work and the time in which each process is performed, the time it takes between one process that is predecessor of the other, in addition to the percentage that is completed in each phase.

3.3 Investigation procedures

Marconi and Lakatos (2019) describe procedures as the specific steps of an investigation. This research intends to show that the adoption of lean production practices impacted positively and considerably on the activities of the studied construction company, with the mapping of the procurement department, analyzing each process, and making each involved employee aware of their role in the activities. The objective was to decrease the lead time for delivering materials to the site during a warehouse refurbishment. To do this, it is necessary that materials requested for the refurbishment arrive on time for the execution of the plan. Therefore, it will be necessary to:

- Calculate the takt time.
- Analyze the processing time; and
- Build the company's current and future VSM in the procurement sector, aiming to identify opportunities for improvement.

4 RESULTS AND DISCUSSIONS

The results are presented in separate sections, beginning with the calculation of takt time, followed by an analysis of processing times. Subsequently, the current state value stream map (VSM) is developed, identifying areas for improvement, which are then illustrated in the future state VSM.

4.1 Takt time calculation

Takt time was calculated according to Werkema (2012), based on the demand of material requisitions received per day (RPD), and the available time, in hours, of the employee of the procurement department. The time available for processing the daily material requisitions, whose value is 7 hours, due to the reduction of 1 hour because of the lunch period, was obtained through an interview with the person responsible for the procurement department at the studied company. In addition, a simulation of different demand values was performed to represent a range of values for the takt time. In this simulation, the decreasing values from 10 to 6 RPD were used, and the first value of 10 RPD was obtained in the interview.

It was found that the takt time for carrying out the processes is faster than the pace of the procurement department for the quantity demanded and the time for delivery of materials to the site is around one week. The current work time is insufficient to handle the daily orders for the procurement department, which typically receive 10 RPD from the engineering department. Only 30% of these requisitions are quoted and equalized in their prices before generating a purchase order. This results in delays in service execution and a backlog of requisitions for subsequent days. The data indicated that reducing daily requisition requests would extend the time needed to complete all actions, but still would not fulfill the total number of requested demands (Table 1 and Figure 1).

Table 1 - Takt time calculation

Simulation	Demand (RPD)	Working time	Downtime	Productive time	Takt time (1 requisition every N minutes)
1	10	8 h/day	1 h/day	7 h/day	42 min
2	9	8 h/day	1 h/day	7 h/day	47 min
3	8	8 h/day	1 h/day	7 h/day	53 min
4	7	8 h/day	1 h/day	7 h/day	60 min
5	6	8 h/day	1 h/day	7 h/day	70 min

Source: The authors themselves (2025).

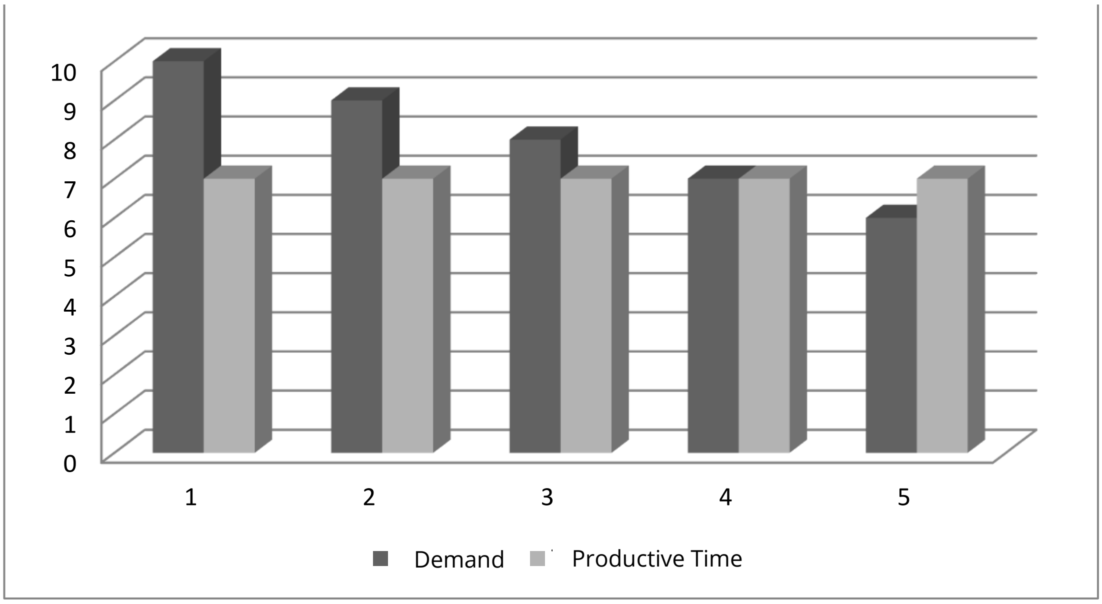

Figure 1 - Relation between demand RPD x Productive time
Source: The authors themselves (2025).

The takt time needed to meet the rhythm of 10 RPD would be to issue a material requisition every 42 min. The current maximum theoretical capacity is 7 RPD, at a takt time of 60 min for issuing a requisition, therefore higher than necessary to meet daily RPD demand. The required takt time is too fast to check all items of several material requisitions, and unforeseen events may occur in the purchase orders, such as requisitions with materials not specified in detail and incomplete vendor registrations for invoiced purchases. The strategic and tactical planning is of great importance, so that the operational planning obtains positive and short-term results, for the total execution of the construction work.

4.2 Processing time analysis

In the interview with the employee responsible for the procurement department, each process that is necessary in the procurement area was described, from the moment of the identification of the need for adequate material, through the requisition of materials, time for purchase authorization by the engineering department, price equalization at competing suppliers, price quotation, purchase order and time of materials delivery, being possible to verify the waiting time between one process and another. The description of each process consists of defining:

a) What is the stage?
b) Who is responsible for each stage?
c) How each stage is conducted?
d) The time available without interruptions, in hours.
e) The complete and correct percentage.
f) The waiting time, in days; and
g) The number of people involved.

After the description of the processes, the complete and correct percentages (% CC) and the waiting time between each one were analyzed, with the purpose of verifying the existing gaps between all the processes, which can cause an increase in lead time. These gaps are a consequence of the delays that exist between the processes. The % CC indicator represents the percentage of how much information and/or materials necessary for the execution of a certain process are correct and complete (LIB, 2016).

The processing time analysis used data compiled in Table 2, which details the processes. To evaluate the processing time, the stages of the procurement stream were inserted in the table, with the definition of which professional performs its work and the time in which each process is performed, the time it takes between one process that is predecessor of the other, in addition to the percentage that is completed in each phase.

It was possible to analyze that the gap between the engineering authorization processes, price equalization and the price quotation is not completed in 100%, due to a very high demand of material requisitions from other construction sites and only one employee for the execution of processes 4, 5 and 6. Besides the processes are not completed in their total percentage, there are backlogs of services to be performed, thus increasing the waiting time in each process involved and the delivery of materials on site, which becomes increasingly dispersed.

4.3 Value Stream Mapping

The current VSM was prepared according to the proposal of Rech et al. (2019), for whom it is possible to verify the current state and reduce the processing time increasing gains in production. Each process described in the processing time was observed, including the waiting times in each process, with the goal of making each item easy to understand and visualize, from the survey of materials on site until their delivery, showing how the cycle of a construction project works. In alignment with Sehnem et al. (2020), it was possible to map the process of a finished product, evaluate its waste, and make a proposal for process improvement.

Analyzing the VSM, it was observed that there is a bottleneck between the stages, which could negatively affect the entire stream if an effective planning is not carried out, because the system involves different suppliers with lead times that make the logistics of delivery difficult, depending on the location of the site and the high quantity of demanded material requisitions. Through the current VSM (Table 2 and Figure 2), it was realized that the takt time, based on demand, is faster than the pace of the procurement stream, and the delay in the authorization of purchases by the engineering management leads to future delays in the quotation, equalization and purchase of the requested materials, as well as the final delivery on site.

Thus, a single employee in the purchasing sector cannot supply all the requisitions that are sent to him, leaving the other requisitions for subsequent days, with a great backlog of work during the days that follow.

Table 2 - Processing time

Process	What?	Who?	How?	Processing time (hours)	% Complete and correct	Waiting time (days)	Number of people
1	Survey of materials needed for work execution	Construction Foreman and Work Safety Technician	On-site evaluation	5 h	100%	0	2
2	Materials Requirement	Construction Foreman	e-mail	1 h	100%	1 d	1
3	Purchase Authorization	Engineering Department	e-mail	7 h	50%	2 d	2
4	**Price quotation**	**Procurement Department**	**e-mail**	**7 h**	**30%**	**1 d**	**1***
5	**Price equalization**	**Procurement Department**	**Spreadsheet**	**7 h**	**30%**	**2 d**	**1***
6	**Purchase order**	**Procurement Department**	**e-mail**	**7 h**	**100%**	**1 d**	**1***
7	Supplier	Deliverer	Truck	7 h	100%	(1 week)	2

Source: The authors themselves (2025). * Same person for processes 4, 5 and 6.

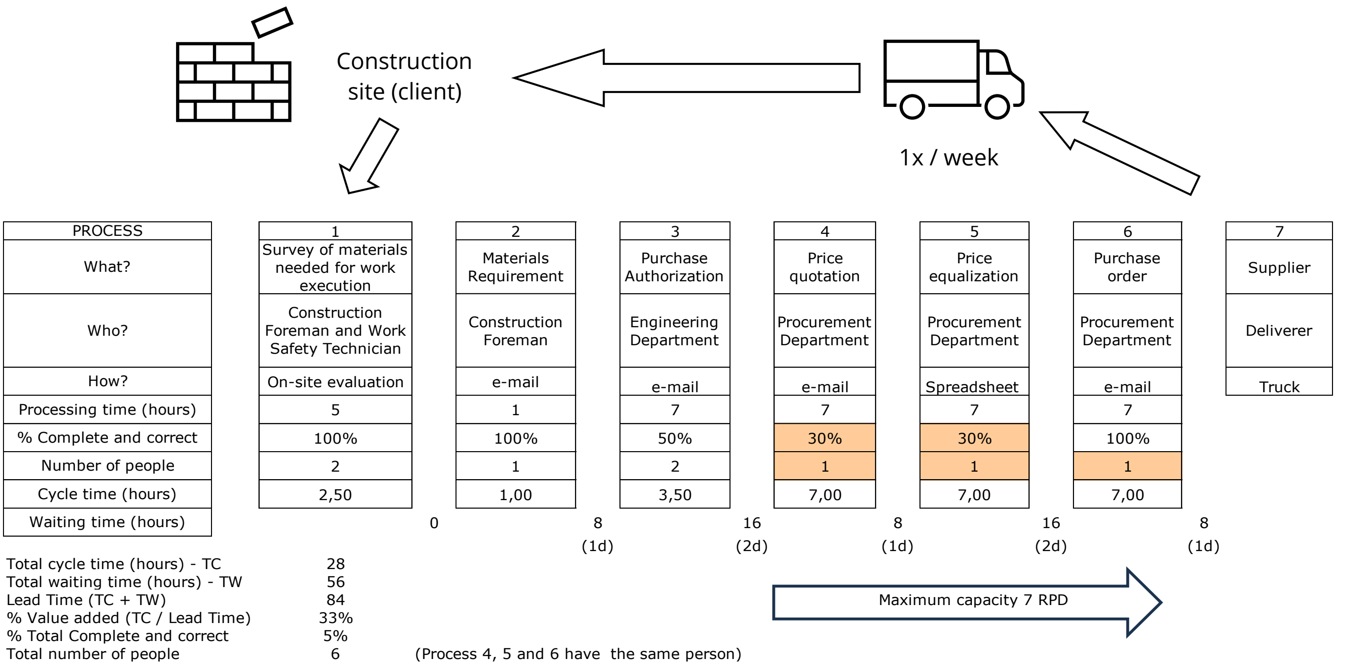

Figure 2 - Current Value Stream Map
Source: The authors themselves (2025).

According to Gnanavel et al. (2015), as referenced by Muralidhar (2018), relocating employees involved in critical operations within a simulated environment can lead to reduced cycle times and increased productivity. Based on this finding, a future VSM was designed (Figure 3), considering a second employee for the procurement department, to raise the %CC from 30% to 75%, halving the cycle time as well as the waiting times between the processes under analysis. The simulation shows that in this situation it would be possible to reach a maximum capacity of 14 RPD and an effective capacity of 10 RPD (considering the %CC of 75%), thus meeting the demand from the engineering department. A reduction in the lead time from 84 hours to 49.5 hours and an increase in the total %CC from 5% to 28% were observed, resulting in an improvement in the quality of the information used to carry out the work.

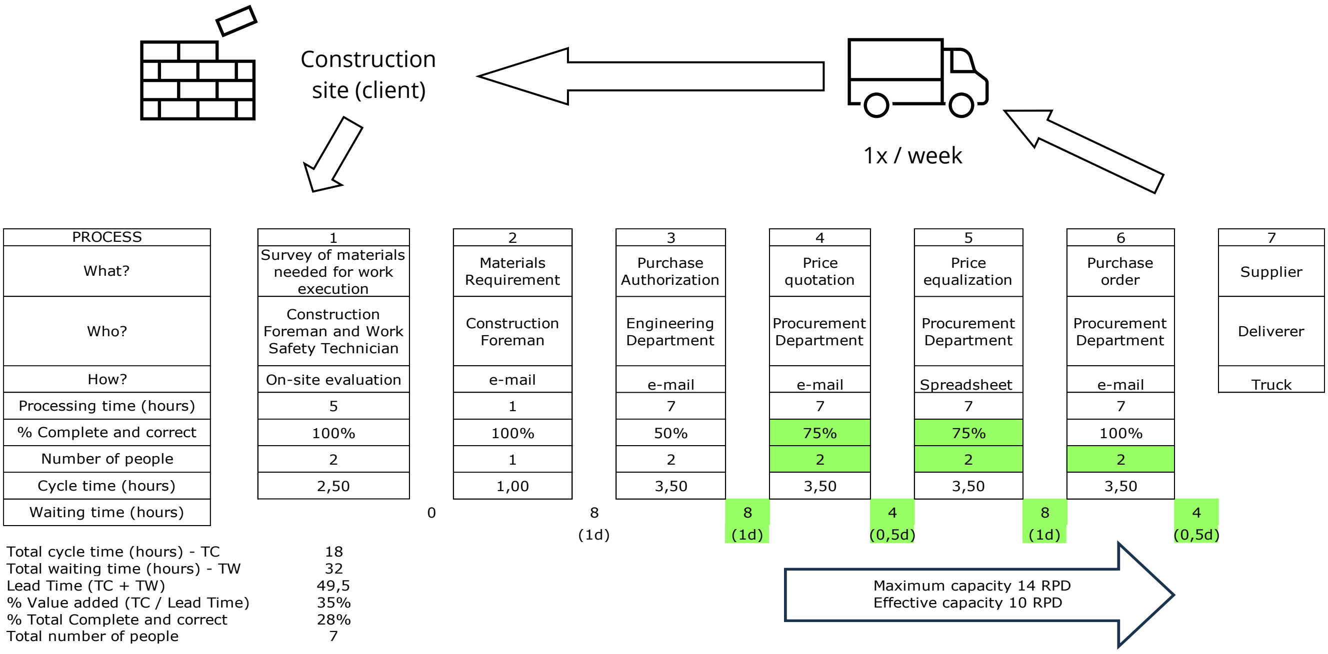

Figure 3 - Future Value Stream Map
Source: The authors themselves (2025).

The positive impact of improvements was taken to the engineering department for analysis, making the studied company hire an additional employee for the procurement department, increasing the company's productivity, and not only the mentioned work in this paper, but also the other ongoing ones were more successful in their completions.

The analysis of the processes in the procurement department aimed to identify the productive bottlenecks that generated delays and unnecessary waiting, without adding value to the services, therefore, an ideal condition for adoption of the lean production philosophy for continuous improvement of the organization. The increase in staff during the purchasing stage may assist the primary buyer by reducing their workload and dividing responsibilities.

5. CONCLUSION

The expansion of activities in the Brazilian construction industry during the COVID-19 pandemic has created challenges for the procurement departments of construction companies, due to restrictions on the supply of construction materials in the retail trade. This case study enabled the opportunity to analyze the implementation of the lean production philosophy within the management of a construction site of a medium-sized civil construction business, especially in the procurement department, in order to allow the standardization and monitoring of processes, through application of VSM, reducing lead time and generating improvements in production processes, avoiding waste in order to deliver the job on time.

To achieve the expected objectives, this study used the takt time calculation, from the procurement of materials to their delivery in the construction site and the processing time of each step, as well as the development of the current and future VSM of the department. The information used in the VSM was obtained by one of the authors, through an interview with the person responsible for the procurement department at the studied company. The right decision of the company in hiring an additional employee for the procurement department is aligned with theory, according to which the calculation of takt time and the verification of cycle times can identify the need to increase the number of employees to reduce cycle time and increase productivity, and can change the characteristics of production, reducing lead time and production costs, improving the quality and delivery of a project.

The strategic and tactical planning is of great importance, so that the operational planning achieves positive and short-term results, for the complete execution of the works on site. The cycle times should uniformly meet the delivery forecasts, so that there is no long waiting period as shown in the figures, tables and the current VSM. The future VSM proves that the purchasing stage can handle all demands within the stipulated deadline, without extrapolating the schedule and final delivery and allowed to briefly evaluate how the construction company performs the processes and inputs necessary to the procurement department.

The single case study approach used in this research has certain limitations, primarily its restricted ability to generalize the conclusions, models, or theories that arise from it. However, these limitations do not diminish the significance of the findings: one employee in the purchasing department was unable to handle all requisition demands alone, prompting the company to hire another staff member for procurement. This decision boosted productivity, and both the work discussed in this paper as well as other ongoing projects saw greater success in completion.

To enhance external validity, a future research project involving multiple cases is recommended, as the resulting evidence is considered more convincing and the overall study is viewed as more robust.

There is room to investigate how these findings could apply beyond just the chosen case study, potentially revealing insights relevant to other industries or contexts. While the practical aspects are well addressed, delving further into theoretical frameworks would strengthen the academic value of any future research, allowing for a deeper understanding of how lean management impacts procurement departments across different sectors. Exploring interdisciplinary approaches might also make the manuscript more valuable by offering a broader and more detailed analysis.

REFERENCES

Agência Brasil (2024), “Mesmo na pandemia, emprego na construção cresceu 21,6%, revela IBGE”, available at: https://agenciabrasil.ebc.com.br/economia/noticia/2024-05/mesmo-na-pandemia-emprego-na-construcao-cresceu-216-revela-ibge (accessed 5 August 2024)

Alvarez, R. dos R. and Antunes Jr, J.A.V. (2001), “Takt-time: concepts and context in Toyota Production System”, Gestão & Produção, v. 8, n.1, p. 1-18, available at: https://www.scielo.br/j/gp/a/RZFdSpRQdjVmWcjT6ZCLJnM/?format=pdf&lang=pt (accessed 3 May 2025).

Arbulu, R., Tommelein, I., Walsh, K. and Hershauer, J. (2003), “Value stream analysis of a re-engineered construction supply chain”, Building Research & Information, 31(2), 161–171, https://doi.org/10.1080/09613210301993.

Barkokebas, B., Khalife, S., Al-Hussein, M. and Hamzeh, F. (2021), “A BIM-lean framework for digitalisation of premanufacturing phases in offsite construction”, Engineering, Construction and Architectural Management, Vol. 28 No. 8, pp. 2155-2175, https://doi.org/10.1108/ECAM-11-2020-0986.

Borges, G.A. and Regattieri, C.R. (2018), “Productive stock management reorganizing the layout using the method systematic and simplified planning of layout (SSLP) for an efficient lead time: case study in a distributor of drawn tubes and solid steels for hydraulic cylinders”, Revista Interface Tecnológica, Taquaritinga, SP, v. 15, n. 1, p. 385–397, https://doi.org/10.31510/infa.v15i1.329.

Creswell, J.W. (2009), Qualitative, Quantitative and Mixed Methods Approaches, 3rd Edition, Sage Publications, Inc.

De Souza Pinto, J., Aoki Schuwarten, L., Cassoli de Oliveira Júnior, G. and Novaski, O. (2017), “Proposal the application of DMAIC tools and value stream mapping under the perspective of the lean philosophy for process improvement: a case study”, Brazilian Journal of Operations & Production Management, 14(4), 556–566, https://doi.org/10.14488/BJOPM.2017.v14.n4.a11.

Eugênio, C.A. and Bonette, L.R. (2019), “Lead time case study of a center for production and reverse distribution of wooden pallets in the Bebedouro region of São Paulo”, SITEFA, 2(1), 457–466, https://doi.org/10.33635/sitefa.v2i1.80.

Euphrosino, C.A., Pimentel, L.L., Camarini, G., Ortigara, Y.V.B., Ruiz, P.V. and Fontanini, P.S.P. (2019), “Soil-cement masonry brick production and construction process mapping for social interest housing”, Revista Matéria, v. 24, n. 4, https://doi.org/10.1590/S1517-707620190004.0848.

Favoni, C., Gambi, L. do N. and Careta, C.B. (2013), “Opportunities for implementation of concepts and tools lean production aiming to improve competitiveness of enterprises of shoe APL Jaú/SP”, Revista Produção Online, 13(3), 1118-1142, https://doi.org/10.14488/1676-1901.v13i3.1404.

Fourie, C.J. and Umeh, N.E. (2017), “Application of Lean tools in the supply chain of a maintenance environment”, South African Journal of Industrial Engineering, Vol 28(1), pp 176-189, https://doi.org/10.7166/28-1-1507.

Gnanavel, S.S., Balasubramanian, V. and Narendran, T.T. (2015), “Suzhal – An alternative layout to improve productivity and worker well-being in labor demanded Lean environment”, Procedia Manufacturing, v. 3, p.574-580, https://10.1016/j.promfg.2015.07.268.

Gomes, E.R.L. (2019), Lean Construction como ferramenta de controle e economia de materiais em obras: uma revisão bibliográfica, Trabalho de conclusão de curso (graduação em Engenharia Civil), Centro Universitário Unifacig, Manhuaçu, 25 p, available at: https://pensaracademico.unifacig.edu.br/index.php/repositoriotcc/article/view/1793_ (accessed 3 May 2025).

Gomes, R.G.B. (2013), Aplicabilidade do programa Lean Seis Sigma na redução do Lead Time de licitações de obras e serviços de engenharia, Dissertação (mestrado) - Universidade Federal de Minas Gerais, 114 p, available at: https://repositorio.ufmg.br/bitstream/1843/ISMS-97RKCG/1/rosemary_geralda_barbosa_gomes__final_com_ficha_catalogr__fica_.pdf_ (accessed 3 May 2025).

Grant, M.J. and Booth, A. (2009), “A typology of reviews: an analysis of 14 review types and associated methodologies”, Health Information & Libraries Journal, 26: 91-108. https://doi.org/10.1111/j.1471-1842.2009.00848.x.

Issa, U.H. and Alqurashi, M. (2020), “A model for evaluating causes of wastes and Lean implementation in construction projects”, Journal of Civil Engineering and Management, 26(4):331-342, https://doi.org/10.3846/jcem.2020.12323.

Koskela, L. (1992), Application of the New Production Philosophy to Construction, Technical Report # 72, Center for Integrated Facility Engineering, Department of Civil Engineering, Stanford University, CA, available at: https://www.researchgate.net/profile/Lauri-Koskela-2/publication/243781224_Application_of_the_New_Production_Philosophy_to_Construction/links/5bcd97a792851cae21b8dd9a/Application-of-the-New-Production-Philosophy-to-Construction.pdf (accessed 3 May 2025).

LIB - Lean Institute Brasil (2016), Mapeamento do Fluxo de Valor – Serviços e Processos Administrativos, Workshop in-company.

Lucena, A.F.E. and De Mori, L.M. (2018), “Critical analysis of Lean Construction measuring tools”, Brazilian Journal of Operations & Production Management, 15(2), 311–321, https://doi.org/10.14488/BJOPM.2018.v15.n2.a13.

Marconi, M. de A. and Lakatos, E.M. (2019), Fundamentals of scientific methodology, 8.ed. São Paulo: Atlas.

Mariz, R.N. and Picchi, F.A. (2014), “Production cell implementation in the facade execution: a construction case study”, Revista Produção Online, 14(2), 703–719, https://doi.org/10.14488/1676-1901.v14i2.1499.

Melo, M., Deschamps, F. and Costa, S. E. G. da. (2017), “Application of Lean Construction − A Systematic Literature Review”, Journal of Lean Systems, v. 2, n. 3, available at: https://ojs.sites.ufsc.br/index.php/lean/article/view/1639 (accessed 3 May 2025).

Moraes, A. M. de. and Fonseca, J. J. S. da (2017), Metodologia da Pesquisa Científica, 1. Ed. Sobral, cap. 1, p. 102-126, 117, available at: https://dirin.s3.amazonaws.com/drive_materias/1649850285.pdf (accessed 3 May 2025).

Muralidhar, P. (2018), “Analysis on improving operational efficiency of construction project site”, Independent Journal of Management & Production, v. 9, n. 3, https://doi.org/10.14807/ijmp.v9i3.686.

Nery, V. F. e S. de O, Zattar, I. C. and Oliveira, V. O. de. (2017), “Application of Lean Construction Philosophy in the Productive Process of a Civil Construction Sector’s Company”, Exacta, 15(4), https://doi.org/10.5585/exactaep.v15n4.7107.

Oliveira, B.F., Freitas, M.C.D., Hofacker, A., Gehbauer, F. and Mendes Júnior, R. (2010), “Um modelo de avaliação do grau de aplicação de Ferramentas Lean em empresas construtoras: o rapid Lean Construction-quality rating Model (LCR)”, Revista Iberoamericana de Engenharia Industrial, v. 2, n. 2, p. 156-174, https://doi.org/10.13084/2175-8018.v02n04a08.

Pepper, M.P.J. and Spedding, T.A. (2010), "The evolution of lean Six Sigma", International Journal of Quality & Reliability Management, Vol. 27 No. 2, pp. 138-155. https://doi.org/10.1108/02656711011014276.

Pfaffenzeller, M.S., Silva, G.G.M.P. da, Barros, A.L. de, Shinji, G. and Salles, M.P. (2015), "Lean Thinking na Construção Civil: Estudo da Utilização de Ferramentas da Filosofia Lean em Diferentes Fluxos da Construção Civil", Iberoamerican Journal of Industrial Engineering, Florianópolis, SC, Brasil, v. 7, n. 14, p. 86-107, available at: https://periodicos.ufsc.br/index.php/IJIE/article/view/104481/pdf_106 (accessed 3 May 2025).

Pires, M.M. de O. and Fontanini, P.S.P. (2017), "Análise do processo construtivo do sistema PVC concreto para abrigo de equipamentos – um estudo de caso de mapeamento de fluxo de valor", in Anais [...]. Porto Alegre: ANTAC, 2017, https://doi.org/10.17648/tecsic-2017-72103.

Rech, A., Fleig, R., Cembranel, P.A., Nascimento, I.B. do and Keine, S. (2019), "Application of value flow mapping in the manufacturing of the platform used in civil construction", Produto & Produção, v. 20, n. 3, https://doi.org/10.22456/1983-8026.94010.

Salifu-Asubay, E.K. and Adjei Mensah, C. (2015), "Improving Delivery of Construction Projects in Ghana's Cities: A Lean Construction Approach", International Journal of Sustainable Construction Engineering and Technology, 6(1), 1-15. https://penerbit.uthm.edu.my/ojs/index.php/IJSCET/article/view/993.

Sehnem, E.H., Kipper, L.M., Silva, J.I. da, Freitas, F. de and Choaire, G.T. (2020), "Utilization of the Lean manufacturing principles and value stream mapping for identification of waste in the finished product stock", Exacta, 8(1), 165–184, https://doi.org/10.5585/exactaep.v18n1.8629.

Tomioka, A.M., Leite, J. de S., Neves, J.M.S. das and Silva, M.L.P. da (2020), "Lean Philosophy in Brazilian Industry: Literature Review", Brazilian Journal of Development, 6(3), 11823–11843, https://doi.org/10.34117/bjdv6n3-154.

Turrioni, J.B. and Mello, C.H.P. (2012), Research methodology in production engineering: strategies, methods, and techniques for conducting quantitative and qualitative research, Programa de Pós-graduação em Engenharia de Produção, Universidade Federal de Itajubá, Itajubá.

Vatne, M.E. and Drevland, F. (2016), "Practical benefits of using Takt Time Planning: A Case study", Proc. 24th Ann. Conf. of the Int'l. Group for Lean Construction, Boston, MA, USA, sect.6 pp. 173–182, available at: www.iglc.net (accessed 3 May 2025).

Vivan, A.L., Ortiz, F.H. and Paliari, J.C. (2012), "Parâmetros de eficácia na aplicação de ferramentas Lean a partir da análise do mapeamento de fluxo de valor", In: XIV ENTAC - Encontro Nacional de Tecnologia do Ambiente Construído, 29 a 31 Outubro, Juiz de Fora Anais... Porto Alegre: ANTAC, 2012.

Voss, C., Tsikriktsis, N. and Frohlich, M. (2002), "Case research in operations management", International Journal of Operations & Production Management, v. 22, n.2, p. 195-219, https://doi.org/10.1108/01443570210414329.

Werkema, C. (2012), Lean seis sigma: introdução às ferramentas do lean manufacturing, 2. ed. Rio de Janeiro: Elsevier.

Womack, J.P. and Jones, D.T. (2003), Lean Thinking: banish waste and create wealth in your corporation, Free Press, New York.

Woodside, A.G. and Wilson, E.J. (2003), "Case studies research methods for theory building", Journal of Business and Industrial Marketing, v. 18, n. 6/7, p. 493-508. http://dx.doi.org/10.1108/08858620310492374.

Yin, R.K. (2015), Case Study Research, 5th Edition, Sage Publications, Inc.

Author Contributions: PGCT: Conceptualization, Data curation, Formal analysis, Investigation; AEBF: Supervision, Methodology, Project administration, Resources, Visualization and Writing – original draft; MCM: Validation and Writing – review and editing; MJM: Validation and Writing – review and editing.