SEVEN publicações acadêmicas
EM PARCERIA COM: IEMS UNIASSELVI

Principles of lean manufacturing in construction

Sandro Roberto Sousa de Oliveira[1], Mauricio Johnny Loos[2].

ABSTRACT
According to Pádua (2014), Brazil is experiencing a major increase in the competitive-market sphere; companies are increasingly seeking to amplify their performance in the face of the challenges of modernity. It is therefore common for organizations to test new production methods and philosophies to withstand this wave of competitiveness.

Keywords: Lean manufacturing, Construction**.**

INTRODUCTION

According to Pádua (2014), Brazil is experiencing a great increase within the competitive-market sphere; Companies are increasingly looking to amplify their performance in the face of the challenges of modernity. Soon then, it is common for organizations to test new production methods and philosophies to support this wave of competitiveness.

Within the marketing sphere, the present work focused specifically on the civil construction market. Pádua (2014) states that the civil construction sector, in recent years, has notoriously followed the GDP growth, especially when compared to other sectors of the market. In recent years, it is possible to notice an increase in the demand of the civil construction market and a change in its numbers, with the appearance of several new companies that meet this market demand. The aforementioned author states that since 2014, the sector has always remained aligned with GDP, that is: rising in times of growth and falling in times of fall.

One way for companies to remain stable and become prominent within the competitive market is to face such difficulties as new opportunities to improve production processes and value chains, seeking to create innovative processes so that their competitiveness is amplified within the branches in which they intend to operate. Krajewski, Ritzmam and Malhotra (2009) state that productive improvements in the work environment have been studied since the 1970s, and the Japanese are prominent in the science of productivity.

From several studies developed since the 70's about the productive performance of companies, it is observed that *Lean Manufacturing* (also called Lean Manufacturing, Lean Production, *Lean Production*,

[1] FBUni – Centro Universitário Farias Brito - CE
[2] FBUni – Centro Universitário Farias Brito - CE

etc.) is one of the oldest and most effective methods when it comes to organizing a company in order to make it more productive. In order to effectively reduce waste, superfluous tasks must be eliminated by the organization.

To this end, it is common for organizations from the most diverse sectors to look for adaptation methods to fit into the *lean* philosophy, seeking to subordinate all sectors of the company within the methodologies that are commented on by the main authors of this method. One of the sub-methodologies commonly used by companies that have adopted *Lean Manufacturing* is Value Stream Mapping, which is one of the main sub-methodologies derived from *Lean Manufacturing* and one of the most effective for the organization of the production chain.

However, the adoption of sub-methodologies derived from Lean Manufacturing are not easily applicable and do not always generate the increase in productivity that is expected by the company's managers. The introduction of a productive culture within a company depends a lot on the predisposition that the individuals of a given company have to receive this new culture. For this, it is important that there are professionals who know how to analyze the *Lean Manufacturing models* and who can follow the introduction of this method within the company.

It is not necessary for an organization to demonstrate a high productivity coefficient in order to perform at a high level. However, the readjustment of productivity is still a fundamental variable when you want to obtain good results.

However, for this to become a reality in the company (especially in the area of civil construction), it is necessary that managers have effective knowledge about the allocation of human resources and cost reduction.

OBJECTIVE

This article aims to narrate the historical emergence of *Lean Manufacturing* and present the concepts and sub-methodologies that are part of this philosophy, also showing its importance within civil construction. In order to achieve the proposed objective, the methodology chosen for the production of the work was the literature review combined with the qualitative approach.

METHODOLOGY

This research is bibliographic, explanatory, descriptive, with integrative analysis of the literature and with a qualitative approach.

Literature review is a modality of study and analysis of scientific documents such as books, periodicals, encyclopedias, critical essays, dictionaries and scientific articles. How differentiating

characteristic, she points out that it is a type of "direct study in scientific sources, without having to resort directly to the facts/phenomena of empirical reality" (OLIVEIRA, 2007, p. 69).

According to Gil (2002), descriptive research seeks to describe the characteristics of the phenomenon studied or of a certain population studied. The author also says that explanatory research identifies the factors that determine or contribute to the occurrence of phenomena, being the type that deepens the knowledge of reality, because it explains the reason, that is, the why of things.

In order for the research to gain quality and scientific notoriety, it is necessary to go through the technical and doctrinal rules established in the field of scientific methodology literature and that underlie the didactic path to be developed by the researcher.

Zanella (2009, p. 54), descreve method such as:

> Methodological procedures that make it possible to investigate reality in an organized, orderly way, following stages, norms and techniques, through the application of pre-established methods, seeking to answer how and why facts and phenomena occur. In other words, scientific knowledge results from methodical and systematic research into the reality of facts.

In this way, scientific research will contemplate research based on a line of authors, guidelines, and theories that will be supported throughout the process of deepening the studies for the analysis of this theme.

DEVELOPMENT

CONCEPTS ABOUT LEAN MANUFACTURING

From a strictly historical point of view, it is necessary, before entering into the subject, to make some brief comments about what work means by productivity and how this idea has developed throughout history. During the early ages of history, there is no certain concept of productivity as humans lived essentially. Such a scenario only changed from the creation of colonies and tribes, where the agricultural scenario began to develop and an adequate production of game and food was necessary for the maintenance of the tribe. Agriculture (thinking from the sphere of productivity) was a great source of livelihood for a large part of humanity until at least the eighteenth century (OHNO, 1997).

These productive processes occurred spontaneously and without major methodological and conceptual controls in the way that occurs today, in addition to knowledge being transmitted in an empirical and hereditary way by families. With the growth of humanity and the need for institutions governed by the State, these productive processes began to take more shape and began to be regulated by the State. Producers at this time were treated socially according to their profession (sculptor, farmer, etc.).

Even though there was this distinction between the professions, there were still several doubts about the control of a production process and methodologies that would improve the quantity of production as a function of the available resources (OHNO, 1997).

In the nineteenth century, after the industrial revolution and the genesis of the automobile industry, there were individuals who checked the number of suppliers, employees, consumers and correlated this information with the amount of parts and inputs that would be needed to meet the demand that had been measured. It can be said that the history of Lean Manufacturing and other production methodologies began with this event.

Posthumously, several methodological innovations began to be born in the productive area, the most notorious being the scientific management of production applied by the Fordist and Taylorist concepts that developed studies to know the best way to allocate materials, labor and time, from there the first ideas and concepts about productivity were born. From these first two authors, the productive culture began to hover over Europe and later America.

For Womack, Jones and Roos (2004), Henry Ford is the great father of production philosophies and methodologies, being the first man to start production of the Model A in 1903. However, it was only in 1908 that Ford was able to complete its most famous production chain known as the Model T. The vehicle designed by Ford was a major milestone in the automobile industry at the time. From the initial kick-off given by Ford, a great evolution began in the production processes until the present day, where the concepts of in-line assembly and other concepts that are very important for companies today were established.

The manufacture of products on a large scale, which was made possible by the emergence of Fordist theory, was a phenomenon that became a fever throughout Europe until the 1960s. However, from this decade on, other production theories such as Lean Manufacturing were adopted by European company managers.

The ideas of mass production and various sub-methodologies that originated through Fordist ideas were adopted throughout Europe until the 1960s, when other philosophies from the Asian continent proved effective and took hold of companies and organizations. Among the methodologies created by the Asians, Lean Manufacturing is commented on in this work, being a great productive milestone of all eras.

The manufacture of products on a large scale, nickname of Fordism, was a production philosophy that guided not only the automobile industry, but other industries during the twentieth century, being also incorporated into factories and industries in North America. Even though they are still widely used currently, it is visible that many of them are adopting the principles of lean production (WOMACK, JONES and ROOS, 2004, p. 18).

At the end of World War II, it is historically true that Japan was facing a major crisis because of the devastation caused by the war. The Japanese economy was in a state of decay and needed help from other countries.

Within this context of crisis, Eiji Toyoda, a notable president of a Japanese car company that is now known worldwide (Toyota) made an intercourse to a Fordist company to better understand how the production chain of the Ford Motor Company worked, which at the time had already consolidated itself as the main company in the field. Toyoda sought to absorb all Fordist concepts to leverage his company's productivity. However, he later noticed that the mass production that was one of the main Fordist paradigms did not fully suit the Japanese context, which was in crisis.

After a period of observing how the Fordist philosophy operated in practice, Toyoda conducted several experiments within his newly opened company. From these experiments, Toyoda and production engineer Taiichi Ohno created an arsenal of methods and techniques that aimed to improve production. This series of experiments gave rise to what is now known as the Toyota Production System (TPS). Like the Fordist system, the Toyota System is based on the workflow system (OHNO, 1997).

However, the essential difference between the two systems mentioned is that the Fordist system is based on the stock and storage of parts, while the Toyota system does not take into account this variable, that is: the inventory of large batches of parts is one of the keys of the Fordist System, while the Toyota System works from the idea of excluding any type of overproduction generated through inventory (OHNO, 1997).

Given all the historical panorama that started from the beginnings of productivity to the genesis of the STP, it is now necessary to explain more about what this system is about and how it relates to the main productive philosophy that is addressed in this work.

According to Dennis (2008), STP can also be called Lean Manufacturing, since both seek to reduce production as much as possible, aiming to maintain a medium-high production using a low amount of time, effort, space, resources, etc. At the same time, there is a concern to maintain a high standard of quality in the product so that the consumer remains satisfied.

With this production philosophy in mind, Toyota aimed to increase profits by reducing costs rather than making a profit from increasing prices, which was a brilliant move when compared to other production systems that prevailed at the time.

Lean Manufacturing, unlike the other production philosophies of the time, aimed to increase productivity without affecting the final price of the product while maintaining its quality. In view of these essential characteristics of this methodology, Toyoda was able to achieve success with his company, making it one of the most profitable companies in Japan in the post-war period (OHNO, 1997).

Liker (2006) states that Toyoda's success in his endeavor is due to the genius of streamlining the production chain at the same time that he sought to know for sure what the consumer's expectation was in relation to the product. In addition, it was notable that Toyoda possessed a great ability to motivate and lead his team of employees, as well as possessing a charisma that earned him good contacts and relationships with suppliers.

Moving on to the conceptual field, Liker (2006) states that Lean Manufacturing has 5 basic principles that unfold into other sub-methodologies that will be explained throughout this work. The five principles can be described as follows:

- Use the consumer's point of view to measure exactly where the value of the product lies, thus seeking to meet the customer's needs at a price that is affordable to them;
- Know specifically where the value stream of the product passes, that is: know which processes in the production chain add value to the product; identify which processes are superfluous and do not generate any value, and finally, identify which ones do not generate value, but which are indispensable for the product to be manufactured;
- After defining the value stream of the product, the company must eliminate all the steps that generate waste and that do not add value so that the indispensable steps flow correctly, focusing more on the product than on the equipment that is necessary for its manufacture;
- Production must take place in a contingent way, that is, produce only according to customer demand, reducing inventories and possible waste.

After all the previous 4 steps, managers should strive for perfection, making all principles interact cohesively in order to keep customers happy.

Pathak (2012) lists that all these principles have as their main objective to make companies more flexible in order to satisfy the consumer, who is the main target of all efforts of any company. Going beyond that, the aforementioned author comments that *Lean Manufacturing* establishes the value of a product from the perspective of the customer's eyes. For the most part, customers don't care about which production processes a particular product passes on to their final result, that is, only the final result interests them.

In short, customers value the product to the extent that it meets their needs. Based on this premise, it is possible to reduce various operations and waste and reduce operating costs without the product failing to meet the customer's needs. However, for this to be possible, it is necessary for companies to follow the principles of *Lean Manufacturing* and know for sure which processes value the product and which do not make a difference.

Hines and Taylor (2000) separate value stream activities into 3 categories.

- Activities that add value and make the productive attractive to the consumer;
- Activities that are necessary for the manufacture of the product and that do not add value from the customer's perspective, but that cannot be eliminated because of their need;
- Activities considered unnecessary and that do not add value, can be seen as waste and that can be eliminated without generating losses for the final product.

The identification and categorization of these activities according to the value stream of the product generates more confidence and security in the consumer at the time of purchasing the product.

Paying attention to production waste, Hines and Taylor (2000), in a study carried out on *Lean Manufacturing*, separate the types of waste into 7 categories:

- Overproduction waste, i.e., producing products above demand or early, which can generate other possible waste;
- Waste of time, i.e., idleness of equipment, manpower, or information;
- Wasteful handling, i.e., unnecessary displacement of labor, products, or information;
- Waste of space, i.e., an environment with a lack of ergonomic adaptations or poor distribution of equipment and labor in the workspace;
- Waste of products due to failures in the production process, generating disposal of defective products;
- Waste of inventory, i.e., excess of materials or labor beyond what is necessary to meet customer demand;
- Tool waste, i.e., the use of tools beyond what is necessary to meet the quality standard that is demanded by consumers.

Therefore, Lean Manufacturing seeks to reduce all waste and superfluous production processes as much as possible, while trying to keep the price of products as low as possible and quality at an average accepted by customers. With this in mind, the competitive advantage provided by this productive philosophy is notorious. In the view of several authors, Lean can be observed as a philosophy that mitigates waste along the product value stream, i.e. the manufacturing process that adds value to the product.

LEAN CONSTRUCTION AS A PRODUCTIVE ALTERNATIVE

According to Sohler and Santos (2017), Lean Manufacturing has become a milestone in the entire manufacturing industry, establishing a new model not only for the automotive sector, but for several other areas. Lean manufacturing has boosted production models and practices in many countries around the world. From this, research and work are conducted on the application of this methodology in different areas of production.

Hirota and Formoso (2003) state that in 1992, several researchers suggested that studies be produced on the application of this methodology in the area of Civil Construction. The group was known by the name "International Lean Construction Group", its main mentor was Lauri Koskela. Everything that exists today about lean construction is mainly due to the efforts of Koskela and the group of researchers.

For Peretti, Faria and Santos (2013), Lean Manufacturing, as previously explained, is not restricted to just one type of production, but can be applied in various types of businesses and in other areas of the economy, such as civil construction.

Lean construction is unprecedented because it enables new tools to solve problems, in addition to providing a greater understanding of the problems that are part of production chains from the perspective of new concepts. The application of lean concepts is the main solution to put an end to several production problems that constitute one of the biggest obstacles for civil construction in Brazil (ROSENBLUM et al., 2008; BROCKMAN, 2013).

It can be said that within companies in the field of civil construction, improving the management of works is essential. Lean concepts should be used in all sectors of civil construction in order to leverage productivity. Koskela (1992) states that the main methodologies to be used within civil construction are:

- Grouping of tools such as *kanban*, 5S, among others;
- Manufacturing methods such as *Just in time*;
- Production management concepts such as *Total Quality Control*.

The adaptation of these techniques to the area of civil construction inevitably results in a refinement of the quality and productivity of constructions, which also ends up generating a greater demand for labor, motivating the creation of new technologies for the area.

In addition to organization and lean concepts being essential for the area of civil construction, several authors state that the mediocrity of certain areas of the civil sector is due to unqualified labor, generating waste and other construction defects within the construction site. Thus, civil construction needs a qualified workforce even more than other areas (KOSKELA, 1992; AMARAL et al., 2004; PANAINO and PALIARI, 2015).

The construction industry, according to the author Brioso (2015), is an industry based on projects and planning. These projects and plans take place in different planes and are usually not directly visualized by those workers who are on site, making this a major obstacle to achieving efficiency within the site. Based on this, the aforementioned author comments on Lean Construction, as it works to implant the lean mindset within a given space, fostering the exchange of information between systems and sources of work.

In the same sense, Panaino and Palliario (2015) list that Lean Construction seeks to encompass construction projects in a global way, encompassing both the definitions of the project and the chain of human resources that will work on behalf of the project. This link between design and human resources is necessary for the optimization of product manufacturing and logistics, as this provides a coherent visualization of the project's information flow.

However, the flow of information within the construction site is highly unstable, mainly due to the number of people and operations happening simultaneously. Soon after, it is realized that for the flow of information to flow in a stable way, it depends on a series of factors.

The aforementioned authors state that a lean construction system must take into account all the variables and the very dynamic nature of the construction process on the construction site.

Brioso (2015) defines the construction industry as a project-based industry, in which information often resides in different systems that are not always evaluated by site workers or even perceptible by one or the other, which becomes a major obstacle to achieving efficiency.

In this sense, Brioso (2015) suggests that in a dynamic and fragmented development, the integration and exchange of information between various systems and information sources is crucial for the efficient management of information.

In this way, Panaino and Palliari (2015) highlight that lean construction encompasses the complete life cycle of construction projects, covering project definitions, the supply chain, and the manufacturing, logistics, and implementation of the work on site should also be analyzed, thus forming a coherent view of the project's information flow, integrating and interpreting the monitoring of data gathered from various sources.

Like Lean Manufacturing, Lean Construction has sub-methodologies that help in the organization and management of the production chain within the area of civil construction. Among these sub-methodologies, the Last Planner System is one of the most used, being divided by Bernardes (2003) into three different levels of organization:

- Short-term production chain planning, also called operational planning;
- The planning of the production chain in the medium term, also called tactical planning;
- Long-term production chain planning, also called strategic planning.

The Last Planner System aims to apply lean production in civil construction within the temporal sphere, and managers must pay attention to all the operations necessary for the execution of a given work and categorize them according to their urgency, with the most urgent operations being part of the short-term planning and the less urgent ones being part of the long-term planning.

In addition to the methodology mentioned above, Koskela (1992), who was one of the pioneers in the interpretation of the Lean Manufacturing philosophy in the context of civil construction, brings several other contributions to the subject. The aforementioned author is the main exponent of the 11 principles of lean construction, which are based on lean production. The principles are described as follows:

- Eliminate or reduce all activities that do not generate value to the final product;
- Maximize the value of the product through the knowledge of the customer's desires and needs in relation to the product;
- Reduce cycle time;
- Reduce variability;
- Simplify the number of processes or steps until the final product arrives;
- Increase the flexibility of process output;
- Increased transparency between the stages of the production chain, i.e., making something simple to understand;
- There is always something that can be improved;
- Perform benchmarking;
- Balance improvements between flow and conversion.

In short, the principles work to eliminate everything that does not add value to the product through the customer's considerations and points of view, in addition to reducing cycle time, simplifying the number of steps, increasing the flexibility of cycles, transparency between steps, managerial focus on the entire process, improving conversions and benchmarking (POLITO, 2015).

According to Koskela (1992), even though lean construction has a range of advantages, it has a serious tendency to value sub-processes and forget about the overall process, which is one of the most important factors to generate the final product. This tendency can lead to serious problems, such as manufacturing products that are unsuitable for the customer's tastes.

Thus, some palliative actions are proposed by Koskela (1992) to avoid problems. The aforementioned author proposes some preventive actions within the production chain: minimizing and reducing intermediate stocks and production batches; geographically organize, in the work environment,

the production of components, Kanban cards, level production, increase leadership and service outsourcing, and work with automated deliveries.

All of the above principles can be reduced to a subset of characteristics that every lean system should strive for. These characteristics are broken down into five different performance areas:

- Reduction of losses;
- Flexibility of processes;
- Process control;
- Reduction of labor idleness;
- Optimization.

All the authors mentioned in this work agree that the principles mentioned can also be reduced to just one principle: adding value to the product.

The above principles, when followed to the letter, avoid waste and extra work on the part of the company. It is generally agreed that when the final result is different from what is expected by the customer, this generates more effort on the part of the company, since the final process added waste instead of adding value.

PRESENTATION AND DISCUSSION OF RESULTS

The technology used on the construction site and the entire project management are key factors that can define the course of a construction project. However, Aziz and Hafez (2013) and Guo (2010) state that although the technology of current times is exponentially superior to the technologies used in past years, the construction industry has not yet reached a level of excellence in terms of production.

Authors such as Hosseini, NIkakhtar and Ghoddousi (2012) affirm that civil construction, due to its several characteristics that differ from other areas of production, needs new productive interpretations in order to obtain a production philosophy capable of generating concrete results within the field of civil construction.

Koskela et al. (2014) state that obstacles such as organizational styles and cultural barriers within the production industry are phenomena that need to be abolished if one wants to pursue the continuous improvement of the production process. In order for there to be improvement, there needs to be a delivery of greater value to the customer. The concepts contained in Lean Manufacturing and Lean Construction, as has already been exposed throughout the work, are more about habits and a modus operandi of acting than specific strategies or tasks. These mentalities seek more to be an inherent part of the production process than a cake recipe that has certain steps and ingredients (JORGENSEN et al., 2007).

All the authors cited in this chapter converge in stating that, in order to be successful in the implementation of Lean, it is necessary to have a change of culture and mentality in employees, which according to Nonaka and Takeuchi (2008), in a market system marked by uncertainty, the only real and tangible advantage is knowledge.

When all markets evolve, technologies metamorphose, the number of individuals competing increases exponentially, and products become outdated in a matter of months, the companies that manage to remain successful are all those that consistently create knowledge that is usable and disseminate it throughout the organization.

At the end of the day, it can be interpreted that this knowledge, when useful and usable, is converted into new products and technologies that are valuable from the customer's point of view.

All this branch of activities makes the company not only a creator of products, but a creator of knowledge. According to Lyles (2014), the main business in today's market is not the manufacture of the product, but constant innovation.

The combination of technological variables with knowledge, experiences and experiences in decision-making are valuable allies in obtaining good results within an organization. Zhang and Chen (2016) state that lean construction, although there are its principles, must always be renewed and depends on updating current knowledge.

The above-mentioned authors state that the process of knowledge renewal requires an interaction of all individuals involved in the construction site and in the production process. Zhang and Chen (2016), going beyond what has been explained, state that the transformation of knowledge occurs when a certain member discovers something new and shares it with his or her surroundings, transforming knowledge into something meaningful for that particular organizational body.

FINAL THOUGHTS

The knowledge imparted by Toyoda, Koskela and other authors mentioned has provided the productive industry with an exponential growth never seen before. Intellectual capital, as labor points out, is just as important as physical capital.

Through the content pointed out in the work and the invaluable contributions left by all authors, it is possible to conclude that all the productive philosophies listed during the work point out that Lean Construction and Lean Manufacturing cooperate for the improvement and valuation of projects in civil construction.

Although both processes have their applications in different sectors, a proper contextualization for other areas can bring a series of benefits and help in the extinction of one of the main evils of the industry, which is the waste of time and resources.

Even though there is not a wide range of studies on the practical applications of these production philosophies in physical companies, the methods prove to be quite effective and punctual. Therefore, it is necessary to point out that there is still a lack of initiatives to promote studies and research that accurately quantify the productivity benefits brought by the Lean philosophy.

Finally, it is pointed out that there is a need for the Lean philosophy to be absorbed by both society and academia, since its contextualization for other areas not only brings benefits to the economy, but to the individual's personal life. A philosophical culture is implanted in society from the moment that cultural obstacles are overcome and knowledge begins to overflow from the top down.

REFERENCES

Amaral, T. G. (2004). Metodologia de qualificação para trabalhadores da construção civil com base dos conhecimentos gerenciais da construção enxuta. Tese de Doutorado em Engenharia Civil. Florianópolis.

Aziz, R. F., & Hafez, S. M. (2013). Applying lean thinking in construction and performance improvement. Alexandria Engineering Journal, 52(4), 679-695.

Brioso, X. (2015). Teaching Lean Construction: Pontifical Catholic University of Peru Training Course in Lean Project & Construction Management. Journal of Engineering, 123, 85-93.

Brockman, J. B. (2013). Introdução à engenharia: modelagem e solução de problemas. Rio de Janeiro, RJ: LTC.

Dennis, P. (2008). Produção lean simplificada: Um guia para entender o sistema de produção mais poderoso do mundo (2nd ed.). Porto Alegre: Bookman.

Gil, A. C. (2002). Como elaborar projetos de pesquisa (4th ed.). São Paulo: Atlas.

Guo, H. (2020). Rethinking construction project management using the VP-based manufacturing management model. Brazilian Journal of Development, 6(4), 22082-22100.

Hines, P., & Taylor, D. (2000). Going Lean: A guide to implementation. Cardiff: Lean Enterprise Research Center.

Hirota, E. H., & Formoso, C. T. (2003). O processo de aprendizagem na transferência dos conceitos e princípios da produção enxuta para a construção. NORIE/UFRGS - Porto Alegre, RS.

Hosseini, S. A. A., Nikaktar, A., & Ghoddousi, P. (2012). Flow production of construction process through implementing lean construction principles and simulation. International Journal of Engineering and Technology, 4(4), 475-479.

Jorgensen, F., Marthiessen, R., Nielsen, J., & Johansen, J. (2007). Lean maturity, lean sustainability. In J. Olhager & F. Persson (Eds.), Advances in Production Management Systems (Vol. 246, pp. 371-378).

Koskela, L. (1992). Application of the new production philosophy to construction. Salford: Center for Integrated Facility Engineering, CIFE Technical Report, 72.

Koskela, L., Howellt, G., Ballardt, G., & Tommelein, I. (2014). The foundations of lean construction (Chapter 14, pp. 211-226).

Krajewski, L. J., Ritsman, L. P., & Malhotra, M. K. (2009). Administração de produção e operações (8th ed.). São Paulo: Pearson Prentice Hall.

Liker, J. K., & Morgan, J. M. (2006). The Toyota Way in Services: The Case of Lean Product Development, 5–21.

Lyles, M. A. (2014). Organizational learning, knowledge creation, problem formulation and innovation in messy problems. European Management Journal, 32(1), 132-136.

Nonaka, I., & Takeuchi, H. (2008). Gestão do Conhecimento. Porto Alegre: Bookman.

Ohno, T. (1997). O Sistema Toyota de Produção: além da produção em larga escala (5th ed.). Porto Alegre: Editora Bookman.

Oliveira, M. M. (2007). Como fazer pesquisa qualitativa. Petrópolis: Vozes.

Pádua, R. C. (2014). Implementação de Práticas de Lean Construction em uma Obra Residencial em Goiânia – Estudo de Caso (Trabalho de Conclusão de Curso). UFG, Goiânia.

Panaino, B. B. F., & Paliari, J. C. (2015). Método de treinamento e capacitação de equipe da construção civil baseado na mentalidade enxuta. SIBRAGEC ELAGEC 2015, Universidade Federal de São Carlos.

Pathak, A. K. (2012). Some Aspects of Lean Manufacturing. In Advanced Materials Research (pp. 1142-1146). Trans Tech Publications.

Peretti, L. C., Faria, A. C. de, & Santos, I. C. dos. (2013). Aplicação dos princípios da Construção Enxuta em construtoras verticais: estudos de casos múltiplos na região metropolitana de São Paulo. XXXVII Encontro da ANPAD, Rio de Janeiro, RJ.

Polito, G. (2015). Gerenciamento de obras: boas práticas para a melhoria da qualidade e da produtividade. São Paulo: Ed. Pini.

Rosenblum, A., Azevedo, V. da S. de, Junior, C. A. B., & Tavares, M. E. da N. (2008). Avaliação da Mentalidade Enxuta (Lean Thinking) na construção civil – Uma visão estratégica de implantação. SEGeT - Simpósio de Excelência em Gestão e Tecnologia, Rio de Janeiro.

Sohler, F. A. S., & Santos, S. B. dos. (2017). Gerenciamento de Obras, qualidade e desempenho da construção. Rio de Janeiro: Ed. Ciência Moderna.

Womack, J. P., & Jones, D. T. (1998). A mentalidade enxuta nas empresas. Rio de Janeiro: Editora Campus.

Zanella, L. (2009). Metodologia de Estudo e de Pesquisa em Administração. Brasília: CAPES.

Zhang, L., & Chen, X. (2016). Role of lean tools in supporting knowledge creation and performance in lean construction. Procedia Engineering, 145, 1267-1274.