

PRESENCE OF LEAN CONSTRUCTION PRINCIPLES IN THE CIVIL CONSTRUCTION MARKET IN THE STATE OF GOIÁS

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ABSTRACT

The principles classified by Koskela (1992), adapted from Toyota production system to civil construction, constitute important tools to the companies acting at the construction market. This paper evaluate the presence and identity the principles in three of the main companies acting in the civil construction market in the State of Goiás, the companies were named A, B and C, and it is shown their strong and weak points in relation to the execution stage. The evaluation was done based in a questionnaire, consisting in verifying the treatment of each of the eleven principles defined by Koskela (1992), by the presence of specific actions to each of these principles, based in a scale of zero to ten. It was found that the implementation of lean practices in the civil construction in the region, represented by the companies A and B, is not well disseminated and incorporated as a management methodology, but when it happens, it is usually partial and to meet requirements of the quality management system, many times focusing in measurements to maintain safety and health at the construction site. In relation to company C, despite being active at the local market, comes from foreign markets and it is a great national area representative, it was observed greater service to the principles of Lean Construction and a greater presence of Lean Thinking in the company's technical team.

KEY WORDS

Lean construction, Koskela's Principles, Companies from the State of Goiás.

INTRODUCTION

Civil construction was always criticized mainly due to the high cost of their products, besides presenting high level of material waste and low productivity. From the 90s, a new theoretical framework has been built for process management in Civil Construction, it was noticed a great effort of academics and professionals from the construction area (Koskela, 1992; Ballard, 200; Isatto et al., 2000), with the aim of

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adapting some concepts and general principles in the area of management production to peculiarities of the sector.

This effort has been called *Lean Construction*, because it is heavily based on the paradigm of Lean Production, which contrasts to the paradigm of Mass Production rooted in Taylorism and Fordism. The ideas of this new paradigm emerged in Japan in the 50s, from two basic philosophies, the Total Quality Management (TQM) and the Just in Time (JIT), being Toyota Motor System (STP) Japan's most prominent application.

Lean Production is a system that aims to improve productivity of a particular company or enterprise. Its principles are aimed at reducing waste, adding value to its products or services. According to Womack & Jones (1998), the lean seeks to "do more with less – less human effort, less equipment, less time and space – and, at the same time, and approach increasingly to offer customers exactly what they want". Furthermore, it is expected that the companies which use it, optimize their management capacity in a short run, reducing uncertainties related to decision making at the involved hierarchical levels.

Heineck and Machado (2001) advocate the application of the Lean Construction, because it is centered on a philosophy of production which is not based on the implementation of new technologies, but at the admission of basic management principles and theories related to the improvement of production processes. They complete the argument claiming that the Lean Construction presents a low use of technologies of computer management system, which can be replaced by simple technological solutions, based on the involvement of workforce.

Regarding the implementation of this philosophy, many difficulties are found along the way. According to Rosenblum *et al.* (2008), the ignorance of the subject and the fact that this has no trivial solution, contributes to this difficulty. According to Barros Neto *et al.* (2008), the literature shortly discusses the implementation process, the aspects and the strategic issues involved in the process, concentrating only on the study of principles application and on the tools in many areas of knowledge.

To Francelino *et al.* (2006), the greatest of all difficulties, is the employees resistance to the changes that come from this philosophy, by the fact that this new way of experiencing the internal environment of the organization remove the comfort zone of all their members. This way, it can be noticed that the commitment of the workers in learning/use new techniques/tools that seek to improve the processes is an essential path to the success of the implementation of the Lean Construction philosophy.

It is valid to focus that the application of this philosophy also requires adaptation time (training) and high initial investment. Moreover, many of the companies that try to implement it, are moving forward without clear maps of the company's project. Womack (2007) believes that this makes the advancement of lean tools – regardless their sophistication level and conscious application – very difficult to sustain.

However, despite the weak points discourage the adoption of this system, the competitive advantages are strongly mentioned as being motivator. In Brazil the Northeast region is highlighted in the implementation of this philosophy. That is the case of some companies at Fortaleza (CE-Brazil), as the construction companies Castelo Branco and Fibra. This can be explained because of the high concentration of

researchers who focus on this issue, which facilitates a better and major dissemination of Lean Construction among the companies.

1 OBJECTIVE

The objective of this work is to evaluate the presence of actions related to the principles of Lean Construction, in the execution stage, in the three main companies working in the construction market in the State of Goiás.

METHODOLOGY

The study was based on multiple cases analysis, with the evaluation of three different companies operating in the construction market in the State of Goiás. The evaluation was made by the use of a questionnaire, whereby the service level for each action in each of the 11 classified principles; it was evaluated through interviews with the Engineers of the companies and with visits to the construction site, to prove the real presence of the principles evaluated.

PARTICIPATING COMPANIES

For the proper implementation of the questionnaire, three companies operating in the civil construction market in the State of Goiás (Goiânia) were studied; these companies were building multi-floor residential buildings.

The companies were chosen according to their representativeness at the local market, the amount of work and organizational structure. These criteria were adopted, in order to choose those that presented in the context of lean construction a minimal organizational structure.

Company A

Company founded in 1984, with several delivered projects, most of them in the city of Goiânia and some in the Federal District (Brasília). Currently, the company has three new projects launched in the market, all of them in the State of Goiás. Three other projects are being implemented; one of them was visited in order to be evaluated some actions considered important in the questionnaire. In terms of certifications the company has a Quality Management System ISO 9001:2008 and the Brazilian Program of Quality and Productivity of HABITAT (PBQP-H), this certified at level A.

Company B

Company founded for 24 years, has several delivered projects, most of them in the city of Goiânia. Currently, it has three projects being launched and five being implemented, most of them residential multi-floor buildings. For the complete evaluation of the framework of this company, according to the principles of Lean Construction, it was carried out, beyond the interview with the engineer responsible for the building; a visit was done to the construction site at one of the under-implementation constructions. Company B has the same quality and management certificates as company A. It is possible to notice that the two companies “A” and “B” have similar organizational structures, when it is compared the characteristics of implementation service and decision-making done by the two engineers responsible for the work.

Company C

The last company to be evaluated was found in 1954. It has in the local market two projects under implementation, one launched and two soon to be launched. This company was placed in the local market recently, because of this, it has not many projects delivered, but it has several projects already implemented and being implemented in many States in the county, in more than 40 cities. Its enterprises, in general, have high standard finish, aimed A and B socioeconomic classes. The research methodology used at this company was the same used at the previous companies, taking as evaluation parameter, the answers given by the engineers in charge of the construction sites and the analysis of the projects and execution plans.

EVALUATION METHOD

The companies were evaluated in order to determine their framing within the 11 principles classified by Koskela (1992), cited below:

1. Reduce the proportion of activities that do not add value;
2. Increase the value of the product/service through systematic consideration of customer's requirements;
3. Reduce variability;
4. Reduce (cycle) time;
5. Simplify things through reduction of stages/steps and parts;
6. Increase output flexibility;
7. Increase the transparency of the process;
8. Focus control in the global process;
9. Introduce continuous improvement of the process;
10. Balance improvements in flow and conversions;
11. Carry out Benchmarking.

For each principle, five questions based on the most representative actions for the operation and execution at the construction site were developed. Each question was designed to question and serve as parameter to measure Lean percentage of each company in relation to the principles.

After conducted the interview using the questionnaire, to each action (question), the authors gave a classificatory grade. The actions were evaluated by the use of a rating scale with eleven different levels, which are presented below:

0. No presence in the observed context;
1. Initial studies on the topic;
2. Thorough understanding of the topic, but no activity or implantation;
3. Early attempts to implement the action in some processes of the company;
4. Presence of the action already implemented, but there are major inconsistencies in its implementation;
5. Presence of the action already implemented, with no inconsistencies in its implementation, but without monitored results;
6. First collected results of actions implemented in some processes;

7. Action implemented in many processes of the company;
8. Action implemented in many processes of the company and monitored results;
9. Action effectively applied, monitored results and in Constant improvement;
10. The action is effectively implemented and shows improvements in its implementation, in the last 12 months.

After the ratings assigned to each action, it was done a table to analyze the results. Each classification level corresponds to the percentage of attendance for each action.

The evaluation of each action was graded the same, within its respective principles. Then it was done an average of the scores assigned for each action, generation the attendance percentage for each principle. And then, it was calculated the general average, in percentage, of the company's attendance to the eleven principles. This general average was the parameter used to verify, each company, in its current state, in order to verify how the presence of Lean Construction is, in their practices, especially the ones related to the execution processes.

RESULT ANALYSIS

In this section the results regarding each company's attendance to the eleven basic principles of Lean Construction defined by Koskela (1992), are going to be presented.

EVALUATION OF THE PRINCIPLES PRESENCE

F 1 illustrates, to each company's, the presence in percentage, of each of the principles, before the answers to the actions.

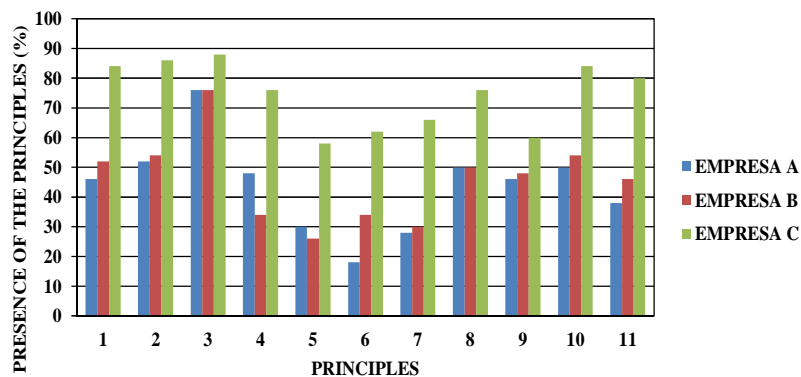


Figure 1: Evaluation of the presence of Lean Construction principles in the evaluated companies.

It can be observed that for three of the companies, the principles 5, 6 and 7, related to the industrialization capacity; personalization flexibility; and transparency in the process, present low percentage in the evaluation. In companies A and B, the principles 5, 6 and 7, presented percentages under 35%, showing a low attendance to

the actions related to these principles. Company C, presented results ranged between 58% to 66%, showing a medium attendance to the actions.

On the other hand, the principles 1, 2 and 3, related to the capacity of reduction of activities that do not add value; increase of the production price/service by the systematic consideration of client's requirements; and variability reduction, presented the highest percentages. In the three companies, principle three presented the best result, being above 75% in the attendance of the action, showing that there are preoccupations and implemented actions in many of the companies' processes, which are also monitored, aiming the reduction of the variability in the execution of several existent processes, what is achieved by the implementation of procedures of standardization.

Company A

Analyzing company A's results, it can be observed low attendance to principles 5, 6, 7, and 11, all of them with percentages lower than 40%. According to the evaluation criteria, this was especially because:

- Principle 5 (Simplify things through reduction of stages/steps and parts): there is lack of planning to prevent clash among work teams; rare use of pre-fabricated elements; absence of production cells in the productive process; and little use of equipments and machines that could decrease some parts, steps and/or labor of the process.
- Principle 6 (Increase output flexibility): the low use of materials that would allow the flexibility or customization of the construction as late as possible in time; and little offer of different kind of products and services in the same construction to different kinds of clients;
- Principle 7 (Increase the transparence of the process): the effective lack of program 5S; and deficiency in publicizing, as for example display in the work place information about work instructions, as for example each step and its execution sequence;
- Principle 11 (Carry out Benchmarking): the low technological innovation development and edge references in the area.

The principle that was highlighted the most was the 3rd (reduce variability) with percentage of 76% of attendance, justified by the standardization of execution of different kind of services; because of certifications as ISO and PBQP-H; there was good organization at the construction site, facilitating the identification of different areas such as, toilets, canteens, material inventory and warehouse; evaluation of suppliers; and control of the material used.

The other principles, 1, 2, 4, 8, 9 and 10, presented an intermediate level with average percentages of 49% of attendance.

Company B

For company B's results, it was noticed that principles 4, 5, 6, and 7, obtained an attendance percentage that was lower than 35%. The main reasons among the evaluation criteria were:

- Principle 4 (Reduce (cycle) time): reducing flow planning of material and people to ensure greater agility, for example, the construction of preferential

and smaller paths in the construction site; inefficiency in the application of tools of production control, as for example, the Kanban;

- Principle 5 (Simplify things through reduction of stages/steps and parts): rare use of prefabricated elements; absence of production cells in all the production process;
- Principle 6 (Increase output flexibility): lack of training for multipurpose workers;
- Principle 7 (Increase the transparency of the process): the effective lack of program 5S; and deficiency in the publicizing way, as for example display in the work place information about work instructions, as for example each step and its execution sequence;

As company A, the best evaluation of the principles at company B, was in relation to principle 3 (Reduce variability), with 76% of attendance, for the same reasons given by company A: because of certifications as ISO and PBQP-H; a good organization at the construction site, facilitating the identification of different areas such as, toilets, canteens, material inventory and warehouse; evaluation of suppliers; and control of the material used.

The other principles, 1, 2, 8, 9, 10 and 11, presented an intermediate level with average percentages of 51% of attendance.

COMPANY C

Company C was the one which presented best evaluation to all the eleven principles, it does not have percentage of attendance below 58%, showing it has already incorporated in the execution processes much more actions of the Lean thought and Lean construction.

As the other companies, to principles 5, 6 and 7, it obtained its lowest results, also beyond 9, even better classified in relation to the other two companies, having average percentage of 62% of attendance.

To the other principles, 1, 2, 3, 4, 8, 10 and 11, the evaluation presented percentages above 76% of attendance, justified as follows:

- Principle 1 (Reduce the proportion of activities that do not add value): the distribution of the material within the construction site, that are preferentially placed close to the work field, where they are going to be used; by arranging the routes previously defined, by which the materials should go within the construction site, from the warehouse to the work place; by carrying out planned activities to ensure the continuity of the execution; by careful storage of wood material in a way they cannot be damaged; by the existence of more efficient equipments to assist vertical and horizontal transportation of material;
- Principle 2 (Increase the value of the product/service through systematic consideration of customer's requirements): by carrying out satisfaction surveys with final customers and potential customers, through market research to determine the type of project to be launched; by cleaning the enterprise during the implementation, by employees awareness; and by the performing inspection and maintenance throughout the work life cycle;

- Principle 3 (Reduce variability): by the standardization of work instructions to different types of service; presence of certifications, as for example ISO and PBQP-H; good organization at the construction site, facilitating the identification of different areas such as, toilets, canteens, material inventory and warehouse; evaluation of suppliers; and control of the material used.
- Principle 4 (Reduce (cycle) time): by the existence of mandatory inspection of the activities performed by workers; good organization of the construction site, ensuring greater flexibility in the flow of materials and people, by preferential and smaller paths; and strategic positioning and storage in the construction site;
- Principle 8 (Focus control in the global process): for the control of contacts, deadlines and performance of suppliers and workers; performing short, medium and long-term planning according to the overall objectives of the company; and good control and analysis and fulfillment of the planned goals in relation to the schedule, budget and employee productivity;
- Principle 10 (Balance improvements in flow and conversions): for concern and action, in order to improve information and material flow; and making improvements in stock conversation activities, in respect to processing material into products;
- Principle 11 (Carry out Benchmarking): by the development of technological innovations in the area; and by the search of information and implementation of good practices observed by peer market.

OVERVIEW OF THE EVALUATED COMPANIES

In general, companies A and B had intermediate performance, when evaluated in relation to the actions corresponding to the eleven principles of lean construction, showing that although they have practices of lean behavior, there is in general, major inconsistencies in its implementation and difficulties in monitoring results. Considering all the principles, they were evaluated with a final overall average of 44% and 46% in percentage of attendance.

Company C obtained good overall performance to all the principles, evaluated with final overall average of attendance of 75%, showing that there exists the implementation of actions related to Lean Construction in the several processes of the company, with a good level of results monitoring.

Figure 2, presents the overall percentage of attendance of each of the three companies that were evaluated, in relation to the implementation of actions considered in the execution processes that constitute the eleven principles of Lean Construction.

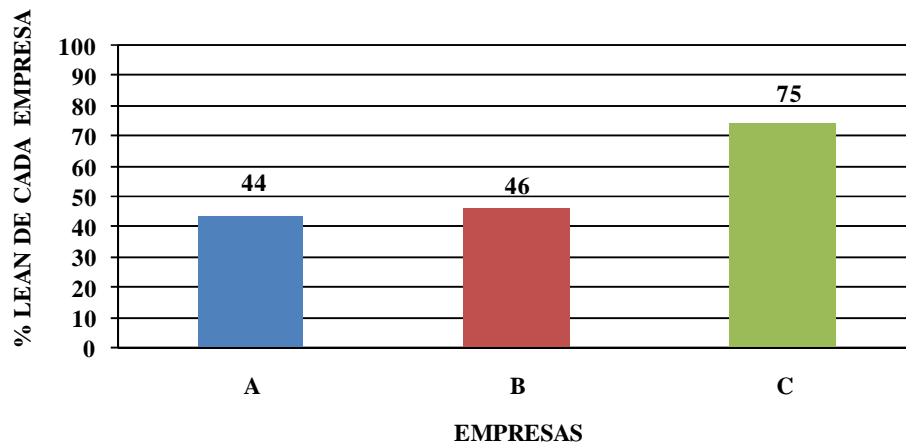


Figure 2: General Percentage of attendance of each of the evaluated companies.

CONCLUSION

The survey done with the major companies acting in the goiano market, being two local companies (A and B), and one national (C), it was found that, in relation to the local companies, the lean thinking and implementation of the principles of Lean Construction, when it happens, often occurs not because it is a methodology of management of the company, but to meet requirements, generally, of the quality management system, often focusing in measures for maintaining the safety and health at the building site.

It is believed that the lean thinking and practices are not well disseminated and incorporated in the local companies, because in fact, it is a recent management philosophy even in higher education of the region, responsible for the formation of the management staff in most of the main constructions.

In addition to these concepts, it is not incorporated in the builders' minds, they still do not constitute a relevant point to the local consumer market as other methodologies are considered, as for example, the certifications such as ISO and PBQP-H, that even end up working beyond management tools, as marketing instruments.

Referring to company C, which comes from foreign markets, and which is a high standard construction company, of national level, it could be observed a better attendance to the lean principles and a greater presence of Lean Thinking in the companies' technical staff. This company is a good example for the others, essentially to be taken into account for the benchmarking practice of local market.

In relation of Koskela's principles, it was found, many times, difficulties to identify them only by considering the execution process, since they were initially designed for the entire production process.

It is noteworthy that the found results have close connection with the evaluation methodology used, i.e., a company had been well or poorly evaluated in one of the principles, corresponds to an evaluation according to the criteria adopted, represented by the five chosen actions, taken as the most representative to each principle. It is considered the possibility of being insufficient the number of the actions (five) taken to cover each principle.

It is suggested for future works, evaluation of implementation of the principles to all the productive processes of the company; adoption of a greater number of representative actions to each principle; and to a better representation of goiano's market, a directed research to a greater number of companies and a major quantity of constructions by company, as much as possible.

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