LABOR TRAINING IN THE CIVIL CONSTRUCTION INDUSTRY BASED ON LEAN CONSTRUCTION CONCEPTS

T.G.d. Amaral
Universidade Federal de Uberlândia
Faculdade de Engenharia Civil
Brasil, Brazil

C.G. Cesar
Centro Federal de Educação Tecnológica de Minas Gerais
Departamento de Engenharia Civil
Brasil, Brazil

ABSTRACT

This work presents the results of a PhD thesis that seeks to prove that the principles of lean construction applied to situations of professional qualification in buildings sites bring benefits for the work processes oriented by this paradigm. For this, the work starts from a new categorization of the lean concepts, which was created in an evolutionary way (evolved) from the teachings of Womack and Jones, Koskella and Ghinato, proposing to emphasize managerial actions connected to six main areas, which are: cycle, flow, process coordination, value, continuous improvement and quality of life at work. These elements are presented in form of programs for training courses for professionals of the civil construction industry. To the evaluation of the proposed method a qualitative research was conducted through the application of a questionnaire in many managerial levels of the participating company. As a result, it can be verified that the application of the experiment proved the feasibility of facilitating teaching/learning situations mediated by the principles of the lean construction.
Key words: Lean construction, qualification, labor.

Introduction

The Leaning Construction consists on the adaptation of the Lean Production philosophy to the civil construction sector. According to Conte [1], the term lean construction describes a philosophy of construction management that is aimed to the consolidation of the knowledge obtained in the manufacture industry, applying this knowledge to the civil construction, taking into account the peculiarities of this sector. Such production philosophy drives from lean production; a denomination of a new conception of production systems, which had its origin in the Japanese industry, specifically in the Toyota Motor Company, starting from the work developed by Taiichi Ohno and Shigeo Shingo [2].

The present article is aimed to contribute at the discussion of concepts and principles related to the introduction and application of the Lean Construction philosophy in the civil construction industry in Brazil. It can be noticed many adaptation problems related to the construction sector, which needs to improve itself in many aspects, among them, those related to the human resources [3].

It is verified that although to exist diverse publications that register practical applications of the lean principles approaching the case particular of the civil construction, such references do not specify a methodology of incorporation of these principles to the workers, what makes it excessively difficult to apply such principles in the reality of civil construction [4].

Moreover, the objectives of the lean thinking redefine the way to co-ordinate the productive action, since to implement the lean thinking in the construction sector requires more than a change in procedures; it requires a change in the way of thinking and building of the company. On this form, it should be recognized that the lean thinking suggests that its concepts would be applied on the whole company, considering its main flows: from the raw material request to its receiving and from the project launching by the company to the final owner acceptance.

Still, for the proposal to become real as a factor of change the involvement of all is necessary, from the factory to the management, besides that it is not possible to think of results of the proposal as simple modification of behavior. It is fundamental for the process to go beyond the behavioral level and reach the organization in its structural aspect, even if causing gradual alterations, what depends on Company willingness to make this happen [5].

The professional practice in different occupations that form the panel of workers of the civil construction industry is not usually preceded by a period of technical
formation recommendable for a qualified performance and in accordance with the modern productive paradigms. Usually, this formation happens in the construction site itself, which not always can be considered adequate.

Having in sight the inexistence and/or insufficiency of the professional formation for this segment of workers, the present article moves forward in this issue, aiming at a solid action for qualification of the civil construction workers, thus using a methodology of qualification that would allow the incorporation of the lean construction principles.

The article is based upon the premise that it is possible to prove that the principles of lean construction can guide educational actions of concepts incorporation for workers of civil construction, in the prospective that the professional formation is not only a way of adaptation or training to the work post, but a favorable instance to the development of autonomy demanded by the new social and work relations.

**Objectives**

To prove the thesis that the principles of the lean construction applied to the situations of professional qualification on the working site brings benefits for the process of work.

**Methodology**

The research was developed in the city of Florianópolis-SC – Brazil, in a big construction company dedicated mainly to the construction of high standard residential multi-familiar buildings that employs its own staffs. The survey is part of a more extensive research of a PhD thesis labeled Methodology of Qualification for Workers of the Civil Construction on The Basis of The Management Knowledge of the Lean Construction, carried through in the same construction company.

Methodological procedures used for the definition of the research

The presented study can be classified as an action-research for having some characteristics such as the use of a scientific approach to solve organizational issues in conjunction with the company collaborators, the active participation of the elements of the system studied in the process, the simultaneity of the action to the construction of a body of scientific knowledge and the systemic approach of data collection, analysis, planning, intervention and new collection of data, that are presented to people involved in the process [6].
The development of this study was divided in two fronts, with parallel evolution. One front had the objective of survey through bibliographic research the issues related to the categorization of lean concepts. The other one had the objective of diagnosing the necessities of interventions in construction sites, aiming at acting on the whole of activities that give support to the productive process with the objective of stabilize it. To apply, finally, a methodology of qualification that would allow the transference of the lean construction principles for civil construction workers, being it the focus of this article.

Application of the method

In the following section, principles of Lean Production are deep presented through the themes dealt in the presentations for the training process. Basically, Lean Production proposes that every action in a production site be guided by six macro principles, which must be coherently integrated in a model

1) Working Cycles Identification;
2) Insertion of the Cycles in Working Flow;
3) Pro-Active coordination of the Production Resources.

To these three basic principles, of operational nature, come to add three others of adding value nature:

4) Continuous Improvement;
5) Life Quality at Work;
6) Added Value Increase for the Client.

These, initially linked to the management, are in a general way unfolded in specific actions as the measurement of the lean production, the programming of lean buildings and the lean training. In a wider way, these concepts are used for the integration of the logistic chain in a lean way, for the lean project and the judgment of new construction technologies according to parameters of Lean Production.

According to Amaral [7], this collection of information was organized within a model which involves the main acting forms of the Lean Production, among them: the flow, the cycle, the coordination, the continuous improvement and the life quality at work.

Believing that the theory of Lean Production is based on the practice experience in the construction site, it is relevant not to miss two central points of the discussion. In order to be lean, the practical application needs to serve the minimum group of aspects of the theory being developed. On the other hand, the approach must always be systemic, leaving behind the usual trend of punctual interventions, either improving the quality systems, or increasing the efficiency of the production process, or strategically redirecting the resources of the company, or even improving the life quality of those involved in the job. In order to be lean, all the areas must be completed [8]. Some specific principles of the Lean Construction philosophy were more emphatically dealt with. Among them the application of the continuous
improvement can be cited, once the staffs were motivated to work to the identification of problems, so that they can eliminate the causes of the problems.

Of this form, through the weekly meetings approaching the principles of the Lean Production, in which technical knowledge are transmitted - in a propitious environment (intrinsic and extrinsic mechanisms) – the work sought to develop lean skills and knowledge to solve problems in contexts representing real cases.

Among the intrinsic mechanisms that can be cited are: the developed activities must constitute a meaning of life/work, the opening of a space for the flexibility of the activities and the innovation and possibility of abrangency of the responsibilities of the workers. Among the extrinsic mechanisms that can be cited are: less authority the relations with the management, creation of communication channels so that the workers can express their point of view and give their suggestions, and also be used to collect the feedback referent to the developed activities on the project.

For the following topics were defined the objectives sought, the themes to be thought, the learning methodology, the actions carried out in the construction sites (when applicable) and the time spent.

1) Work identification (value, cycle and “packaging” (group of activities));
2) Procedures externalization (in relation to the supply chain);
3) In relation to the communication on site, and dissemination of information;
4) In relation of the work schedule;
5) Measurement of the productive processes;
6) Equipments utilization and development;
7) Human Resources guiding and motivation.

Method validation

To evaluate method a qualitative research was conducted through the application of a questionnaire in many managerial levels of the participating company. In this evaluation, the use of a qualitative research model was chosen, as the level of reality being dealt with could no be evaluated through a quantitative model. The qualitative research deals with the universe of meanings, motives, aspirations, beliefs, values and attitudes of the people involved in the process [9]. For the proposed method be considered valid by the participating company, the chosen criteria was the answers given by the ones participating on the questionnaire. Were considered the parts on the presented context that would indicate the taking of conscience in relation to the relevance of the actions carried through in the construction site associated to the topics presented in item 3.2, being these underlined in the text. Were considered the several managerial levels of the company for the questions in which the workers would have direct responsibility for the proposed themes and the opinions were transcribed in their original form with the questions categorized in nine different groups.
Results Analysis

The results of the evaluation of the proposed method are analyzed taking into account the text of the responses produced by the participants, as well as the attitudes observed during the research. In addition, data collected in informal interviews carried out in different moments were analyzed.

The evaluation of the performance of the participants could not be measured while they were learning, but it was measured through a series of indicators, such as the participation in the development of the activities, and verbal interactions, which indicate the awareness in relation to the relevance of the jobs carried out, as well as the importance of their role in the overall development of the intervention carried out. Finally, the results of the enquiry, as well as the responses obtained in the development of this work are presented.

1) To Elaborate and apply qualification methodology that would allow the transference of the lean construction principles to the civil construction workers

As a result, it can be verified that the application of the experiment proved the feasibility of facilitating teaching/learning situations mediated by the principles of the lean construction.

It was possible to affirm that limitations like the low level of schooling could not hinder the favorable performance of the proposed objectives.

When suggesting alternative solutions for the improvement of the constructive processes, not basing exclusively on the implementation of new technologies and directing the efforts for the rationalization of the processes, through the existing flows optimization between the diverse activities necessary to the execution of a project, the lean construction is capable to adapt to the peculiarities of the construction. Therefore, it achieves the intention of the proposal that aims to develop in a way, given the specificities and peculiarities of the considered company, would be possible to maximize the competitive performance of the productive process, using the tools offered by the new paradigm.

2) To apply learning techniques that allow to rescue the sense of participation on the development of the service, and to awake the curiosity and the dignity through the valuing the workers’ initiatives

The experiment consisted in an opportunity of continuous education and self learning in the workplace.
The implementation of meetings on site generated results that stimulate the improvement of this qualification method, promoting the integration of the involved parties, providing solutions to the problems on site and establishing an environment of synergy to the achievement of results.

3) To apply learning techniques able to rescue the workers autonomy in their service development

Two factors are pointed out to explain the difficulties in the application of the Japanese model in Brazil. The first difficulty is that the company’s structure is vertical and the second one is the existence of a strong managerial culture.

Despite several advances reached in the company, it can be highlighted the existence of the division of the work, the individual prescription of the tasks and the allocation of the activities in elapsing of the working hours.

For this, it is necessary to invest strongly in the process management and in human resources that directly influences in the production and to awake the role of the production function in the competitiveness of the organizations, once the organization of production is related to the professional specializations around stages of process or parts distinct of product, that requires a domain of knowing to make workforce, of each one of the global productive parts to suit, making with that the workers assume a basic role, as much in the conception as in the execution of the task. The workers are devoid of technical information that characterizes them professionally, being receptive to all the forms to learn their jobs.

4) To provide learning regarding daily work, assisting it to identify and to prevent non productive times and waste in its process

The time wasting on the process was related mainly to the distribution of the material on the working places and on the storage places. Yet, the wasting of raw material was related to its incorrect handling.

When creating routines that delineated the amount to be carried and the form of transport and storage of the materials, it was possible to reduce the probability of failures related to the distribution, besides improving the flow in the building area. In relation to the process, it was observed that, when evaluating the information that approached the sequence of the work, were possible to identify and to analyze the causes of the fails and the adoption of more efficient actions for the execution of the services.
5) To improve the competitiveness, the effectiveness and the flexibility of the organization, supported for the development of the human potentialities

One point that must be highlighted is the active participation of the employees in all the stages of the intervention, either in the interest to understand the new concepts, either for the increment of the improvements these concepts added.

When differentiating the intervention of traditional pedagogical practices, it was possible to observe new ways of information access and creation of new thinking and knowledge styles, while the worker on their own were responsible for their knowledge construction.

Intervention on the Construction site

Creation of a Favorable Environment

Management actions had been developed aiming to improve the organizational environment by using motivational methods, amongst which: the establishment of efficient of communication channels, the organization of the working environment, the involvement of the workers in the process of decision taking, the provision of good conditions for healthy meals taking in the construction site, the offers of health plans, the stimulation of activities of work and recreation in group, the recognition of the workers for the merit in the execution of the work, the provision of all the necessary resources the accomplishment of the programmed activities, the detailing of the projects in order to facilitate the execution, the supervision of the activities, the implantation of actions towards the reduction of work and the supply to the workers of feedback about the accomplishment of the activities and the evolution of project.

a) 5S Program

The organization and cleanliness become related to the principle of the transparency of the productive process.

It’s worth to note that the provision of better and adequate working conditions to the execution of the services provides the generation of a productive environment more favorable to the improvement of the efficiency in the processes, through the generated motivation, that in turn can result in productivity increase, besides creating a favorable environment previewed in the process of implantation of the intervention realized.

b) The Sharing and the Dissemination of Ideas

When clarifying, to the workers, the relevant information about the production and its productive performance (productivity, organization, cleanliness, security and self-discipline) and when allowing the opening for suggestions of improvements, with the
direct participation of the workers, it was possible to create a space for their greater insertion on the production, considering that the worker needs to know and to become involved himself more deeply with his own performance. This dialogue provided the increase of the contact between the workers and contributed to the commitment between the production teams.

The communicational process passed to be faced as a form of creation of commitments around the objectives of the company and the necessity of organizational change. These initiatives are coherent with the necessity of making the workers daily decision processes became compounded by better knowledge of the company and the production.

It was possible to create an environment that stimulated the worker to argue and to develop improvements in the working process, turning the environment of the daily routine propitious to the continuous and collective learning.

The communicational process passed to be faced as mean of commitment creation around the objectives of the organization, building a space of communication based on the reasons on which the company take its decisions about the market, the technologies and the necessities of organizational change.

The development, either of the processes or the organization, occurred much more for the introduction of incremental improvements than for the implantation of revolutionary ideas that generated brusque changes. On this way, it was aimed to magnifying the employees’ participation in the management of the production units and the increase of the workers conscience to the occurred problems.

c) The Processes Standardization

The insertion of instructions about processes in the workstations was basic to get an auto-clarifying production environment. Through the availability of such information the understanding of the production process could be extended, of the used technology and the final produce item in each unit of production. Of this way it was possible to improve the transparency of the processes, once the work instructions had been identified, becoming the environment auto-clarifying. The transparency is one of the main stones of the lean construction philosophy. In a simplified way it can be said that this aspect involves the ability of a productive system in communicating with people involved in the production.

From the explosion of the constructive process of the services in activities on, which represent important parts of the constructive process in comment, it was possible to generate transparency in the process analysis, making easier the users understanding in relation to the obtained information.
With the standardized methods and skilled workers inside the accepted standards by norm, the company obtained considerable reduction of the variability in the productive process, mainly with the tolerances established by rules and that were not respected before. So it was possible to create a standardized communication, by unfolding the practical objectives of the production, improving, in that way, the existing methods of work, as well as the production flow on the construction site. From the standardization of the methods on, it was still possible to detect errors, to register them and to argue possible solutions, using these data for the continuous improvement of the processes.

Another important aspect is that the operations pointed to the transparency provision, as is the case of the standardization of the processes, are destined to the improvement of the flow of information in the productive process.

In general it is observed that the lack of time and the unfamiliarity regarding the processes in the construction lead to not the formalization of the referring knowledge to these. This generates problems like loss of information, necessity of constant changes in the projects, difficulties in the decision taking and the deficient distribution of human resources and materials what causes the waste of resources.

The company focused on the study did not have the practical habit to register the procedures of execution of each service and the criteria of inspection of these, what caused a much limited and changeable technological domain in function of the used workforce. This knowledge’s were passed verbally to the workers, without any organization, what caused inefficient information of the constructive processes in the company.

The adopted systematic of information transmission related to the processes standardization came up to be supported by a periodic change of the nature and the tasks standard. Each new presented stage, the ability of the individuals was increased, as well as the work techniques were developed and improved. The changes happened in an interactive form between the researcher, the laborers and the management. It can be noticed that the ergonomic work principles had not been used in the practice, indicating the necessity of a more specialized accompaniment with the workers. Yet, it could be observed that despite the worker’s knowledge of the working place, he has great difficulty in organizing and distributing his material without preventing the unnecessary movements.

d) Materials Management:

The material flow is one of the basic units of analysis in the lean construction. It is characterized by a sequence of activities destined to make available, physically, the involved materials in the execution of some production processes stages. This flow of material search is to guarantee that the materials are available to be processed. It
initiates with the arrival of the material (acquisition) on the construction site and it finishes with the available material in its end point of application (consumption point). This way, it’s believed that if the flow of materials will be understood and controlled - as for the requirements rational distribution, acquisition, manuscript, storage and control of suppliers - it represents a potential of time and production costs reduction.

The management of materials has contributed:

- For the reduction of variability in the productive process through the quality control in the act of receiving the materials to be used;
- For the reduction of lead times in the process by providing necessary inputs to the services at the right moment and preparation of appropriate physical space for storage and finally:
- For increasing the transparency in the process;

The material transport or its frequently moving represents a cost that does not add value. Making reference to the material handling, when possible the transport operations were optimized, thus increasing production efficiency. This was possible by determining previously the storage places and improvements of layout.

c) Executed Services Control

When assuring that all the requirements of a processing operation have been reached, the benefit can be gotten from the guarantee of the production flow in the accomplishment of preceding operations. It is possible through these controls to register the most frequent problems and work to prevent them.

The necessity of inspections appears in all the services, guaranteeing the flow at the end of an analyzed process, assuring that all the necessary aspects to the execution of subsequent services to the production process have been contemplated. The inspections deal to avoid mistakes that can occur in the productive process and could provoke interruptions in the production flows at its end).

References


