# PROMOTING INNOVATION IN A COLOMBIAN SOCIAL HOUSING CONSTRUCTION COMPANY

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## ABSTRACT

Lean Construction (LC) and innovation have been two widely discussed concepts in the Colombian construction industry for the last few years. However, the relationship among the previous topics have not been properly analysed in the local context. The objective of the article is to analyse the importance of applying LC in terms of promoting innovation. The research method for the investigation has been the embedded single case study approach. The case study is developed in a social housing construction company called Urbansa S.A. Thus, how and why LC can boost innovation on Colombian construction projects are the research questions for this study. This is important because the Colombian industry can start to learn that Lean is more than measuring task times.

Results show that applying concepts such as collaboration, transparency, workflow reliability, and pull production enhances innovation if the implementation is undertaken through a process-focused approach. New developments have been registered in the operation phase of housing construction projects. By finding that LC concepts have a direct impact on innovation, the construction industry might have an increased interest in learning about the true potential of LC for improving processes and delivering more client oriented products. Further work is required to develop a strategy for expanding the understanding of lean concepts at operational and management levels.

## KEY WORDS

Lean construction, innovation, housing construction, small wins.

## INTRODUCTION

The case study Firm, Urbansa S.A., promotes, builds, manages, and sells housing projects. With an annual turnover of US$50m, it is estimated that 65% of the company's housing products are low-income units. These kinds of projects are characterised for being labour intensive and for having a reinforced masonry structural system. Since profit margins for social housing projects are extremely

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limited, issues such as productivity, quality and client satisfaction are paramount in order to remain competitive in an aggressive market. Therefore, most of the social housing firms need to be in constant pursuit of improving their operational efficiency.

Over the last few years, the Colombian Construction Chamber (CAMACOL) has promoted several initiatives focused on delivering residential projects more efficiently. These have been supported by a growing and sustained positive economic trend in the housing sector. Among CAMACOL's improvement programs, LC and innovation have been two widely discussed topics. However, the relationship among the previous concepts has not been properly analysed in the local context.

According to Henrich et al. (2006), construction companies need to see some empirical results before assuming the challenge of exerting innovation efforts by themselves. Based on this idea, the objective of the article is to analyse the importance of applying LC in terms of promoting innovation. First, a brief discussion about Colombian innovation programs and LC implementation is provided. Second, the relationship among innovation and LC is explored based on a literature review. Finally, the case study Company is analysed and conclusions are given in terms of how and why LC can encourage innovation in the Colombian construction sector.

## INNOVATION AND LC IN THE COLOMBIAN CONSTRUCTION INDUSTRY

As in many other countries, the construction industry in Colombia is in need of improvement. One of the most recent efforts for innovating construction is the programme called Colombian Technological Platform for Construction (PTCC). This initiative is focused on enhancing IT in construction by analysing several aspects regarding society, sustainability, etc. Construction firms, suppliers, and universities are the main contributors to the platform. The PTCC has been primarily implemented in Medellin and has worked in conjunction with the Centre for Research and Innovation in Construction (CIDICO) and the EAFIT University. As a renewal programme, the PTCC is a good effort. However, it does not directly promote the paradigm shift encouraged by the LC community (Koskela et al. 2003)

LC concepts started to be known in Colombia in 2002 (Botero, 2009). Research studies at University of Los Andes (ULA) suggest that LC implementation efforts have been widely directed towards measuring waste in construction sites and applying concepts regarding the Last Planner System (LPS). These kinds of studies are similar to other investigations undertaken in countries such as Sri Lanka and Singapore (Senaratne and Wijesiri, 2008). Since 2006, several industry-oriented studies have been carried out with the objective of measuring productivity ratings on construction sites. On the other hand, applying the LPS has been difficult due to the big resistance to change among project participants (Estrada, 2009). Estrada presents a study based on three institutional buildings in which LPS ideas were not applied successfully. As a consequence, LC concepts are not unknown to the Colombian construction sector; nevertheless, implementation efforts have not been as effective as in countries such as Brazil or Chile.

We contend that LC implementation, as a performance improvement process, could be more successful in Colombia if it were applied both as a process-focused approach and as a new production template. The former is about achieving operational improvements not by reinforcing responsibility and accountability skills

(i.e.: result-focused programs), but by focusing on activity prerequisites, interdependencies among parties, and operational process design. The latter refers to the implementation of the Transformation-Flow-Value (TFV) theory in construction tasks. If this were possible, LC application would help to promote innovation as defined by authors from the International Group for Lean Construction. Through studying Urbansa S.A., this study seeks to demonstrate the previous assertions.

## THE CONCEPT OF INNOVATION IN THE INTERNATIONAL GROUP FOR LEAN CONSTRUCTION

There is not a unique definition for the concept of innovation in the LC community. Koskela and Vrijhoef (2001) define innovation as the actual use of a nontrivial change and improvement in a process, product or system that is novel to the institution developing the change. In addition, Slaughter (2000) proposes five innovation models (e.g.: incremental, architectural, modular, system, and radical innovation) and Winch (1998) suggests innovation types focused on both institutional and firm approaches.

Based on these approaches, Koskela and Vrijhoef claim that construction needs a radical innovation (as defined by Slaughter) that facilitates both top-down and bottom-up changes (as specified by Winch). It is argued that in order to achieve radical innovation, construction needs a new production template. This has to be based on an integrated and systematic theoretical approach (TFV theory).

Alves et al. (2010) agree with respect to consider LC as a radical managerial innovation, but further argue that it can also be contemplated as a change in the way industry operates. Based on that, innovation is defined as a new practice implemented in an organisation (incremental improvement) and breakthrough is seen as something entirely new across the industry (radical innovation). Among innovations, those that support traditional and lean methods have been differentiated and classified. As a result, Alves et al. show that LC practices are innovative processes by themselves.

However, there are some authors who argue that LC principles may hamper innovation. Polesie (2010) claims that in the LC movement there is a delicate balance between effectiveness and efficiency. The former involves controllability and standardisation; the latter entails willingness to innovate and perceived freedom. Green (1999) suggests that high levels of effectiveness may decrease motivation, which in turn may reduce innovation and continuous improvement efforts.

In contrast to Polesie and Green, Spear and Bowen (1999) argue that Toyota's success lies in understanding the contradictory combination of rigid specifications with flexible and adaptable procedures. The authors explain that the paradox is unravelled in Toyota because of the tacit application of the scientific method. This has allowed Toyota's workers to understand each procedure as a set of hypotheses capable of being challenged. In other words, processes are always being examined in terms of creating a better and innovative way to undertake them. Since LC has accepted the Toyota Production System (TPS) postulates (Henrich et al. 2006), it is feasible to think that innovation in construction may take the same path as in Toyota.

In brief, it is clear that LC practices can be seen as a set of innovative processes for traditional construction (Alves et al 2010). These practices need a radical mindset innovation before they can be applied (Koskela and Vrijhoef 2001). If the application is not properly carried out, some authors claim LC implementation may hamper

motivation and individual freedom. However, if lean ideas are successfully applied, they promote innovation (Spear & Bowen, 1999).

Therefore, for the purposes of this study, innovation is defined as a nontrivial change implemented in an organisation that has not experienced that change before. Although, implementation of lean can be seen as an example of innovation, this study focuses on how the application of lean processes has improved operational processes and produced innovative outcomes.

## IMPLEMENTING LC IN CONSTRUCTION COMPANIES

Implementing LC is not an easy task. Morrey et al. (2010) examine the extent up to which traditional ways of working (i.e.: path dependencies) can influence and constrain the organisation's ability to implement change. Based on Morrey's experience, it is clear that the application of LC practices needs a new path-generation process. This may start to be implemented by applying action-learning approaches. Hirota and Formoso (2001) have shown the usefulness of these learning procedures by presenting a case through which workers and managers changed their focus from transformation (traditional project management) to process management (LC ideas).

Although using learning procedures is a step towards applying LC, these concepts may not endure in the organisation if they are not implemented systemically through an innovation adoption model. This model should be directed towards achieving systemic change, i.e. a holistic improvement. Since this is difficult due to the industry fragmentation, it is advisable to start from operational processes (Koskela et al. 2003).

Henrich et al. (2006) showed the connection between the innovation model suggested by Slaughter (2000) and the concept of "small wins" proposed by Weick (1984). Henrich's ideas can be further complemented by the process-focused implementation approach proposed by Mitropoulos and Howell (2001) Both Henrich's concepts and the approach suggested by Mitropoulos and Howell are further examined in the next sections.

Summarizing, there is not a unique way for implementing LC. However, a successful implementation should be based on a holistic innovation model. This paper assumes that the model suggested by Slaughter (2000) and slightly modified by Henrich et al. (2006) is an appropriate way to apply LC. The model will be used as a tool to explain how/why LC has promoted innovation in Urbansa S.A.

## RESEARCH METHODS

In 2010, it was decided to develop a research study focused on the LC ideas implemented by Urbansa S.A. The authors knew that the firm had consciously applied some LC tools. However, we did not know up to what point those techniques had been successful in the construction company (Figure 1).

It was rapidly evident that what Urbansa had applied, had played a key role in increasing project performance through developing new processes and products. Consequently, a research project was designed aiming to answer two main questions: how lean construction concepts promoted innovation in Urbansa's construction tasks and why those ideas were able to boost the development of innovative solutions for some construction-phase problems.

An embedded case study methodology was selected for this investigation. This approach was considered appropriate because of the type of research questions

selected and the lack of control over behavioural issues in a contemporary event such as the adoption of LC in Urbansa (Yin, 2003). Since the study was only focused on a single company, three units of analysis were adopted. Each unit was established in order to contribute to answer the research questions by formulating three propositions (i.e.: a research proposition per unit). The propositions were examined thanks to data collected from interviews, analysis of archives, and site visits.

| SUMMARY OF THE LEAN IMPLEMENTATION PROCESS IN URBANSA SA | | | | |
|---|---|---|---|---|
| **STAGES** | **MEASURING WASTE** | **SITE LAYOUT REORGANISATION** | **LAST PLANNER CONCEPTS** | **RESULTS EVALUATION** |
| **OBJECTIVES** | Identificate waste as defined by Ohno, Liker, and Koskela.<br>Eliminate or reduce non-value adding tasks | Optimise space to increase flexibility<br>Implement visual-management tools<br>Create suitable material storage and delivery systems | Balance production rates and reduce waiting times (Master Plan thorugh Line of Balance)<br>Increase Reliability (Lookahead Plan)<br>Control Work Flow (Lookahead and Weekly Work Plan) | Reduction in costs, times, accidents, and post-sale complaints.<br>Development of new techniques and processes. |
| **SUPPORT PROCESSES** | Learning workshops for: workers, engineers, and management personnel.<br>LC implementation team: lean champion, lean coordinator, and lean engineers. | | | |

Figure 1: Summary of the LC Implementation Process in Urbansa S.A.

The first proposition is focused on the LC practices implemented in the firm; the second is concerned about LC implementation techniques. The last one seeks to examine the innovative developments generated in the company and their relationship with LC. However, it is important to highlight the following limitations for this study: only the construction stage was analysed; similar innovation programmes implemented by other "no-lean" companies were not documented; and LC practices implemented by other construction firms were not explored.

## LEAN CONSTRUCTION PRACTICES IN URBANSA S.A.

This section intends to verify the first unit of analysis. Thus, "LC practices in Urbansa comply with LC principles such as transparency, reduce variability, workflow reliability, standardisation, continuous improvement, and pull production" is the proposition to be proven.

- Finding 1 - Transparency: it was observed that the site layout was communicated over a magnetic board; this allowed workers to interact about deciding the location of supplies. Site visits made clear that the company applied some 5S-management ideas (e.g.: identified storage locations). Interviews revealed that one of the most important visual management tools was the subcontractor/supplier evaluation board due to the relevance given to a public assessment.
- Finding 2 – reduced variability and workflow reliability: the LPS has been considered as a good tool for reducing variability and controlling flow (Vrijhoef et al. 2001). Analysis of archives and site visits allow to claim that LPS ideas have been implemented through three main techniques. First, the line of balance (LOB) was utilised for developing master schedules. Second, whiteboards were used to instantly publish look-ahead plans. Finally, fishbone diagrams were employed to determine non-completion causes during the development of weekly-work plans.
- Finding 3 – standardisation and continuous improvement: planning processes and construction tasks present good levels of standardisation in Urbansa. On one hand,

for instance, it was observed a collaborative standardised procedure for drawing LOB on MS Excel. On the other hand, critical construction activities such as masonry-related operations were specified regarding productive, non-productive, and contributory processes; material location, type of walls, type of bricks, etc.

- Finding 4 – Pull production: kanbans and heijunka boxes are useful tools for implementing pull production. Although it was found no evidence of heijunka boxes, kanbans systems were used for masonry and mortar-related tasks. Every internal and external wall was analysed in terms of the number and types of bricks. Different brick classes were organized in devices similar to supermarket shelves. Supplies were placed on the racks, accordingly with the LOB plan.

To sum up, LC practices applied in the company are very similar to the ones reported by various LC authors. Some of the transparency practices documented by Tezel et al. (2010) have been found on the analysed projects. Regarding LPS implementation, although phase scheduling is not applied, it is clear that planning meetings are carried out in a collaborative environment and the techniques utilised comply with LC principles. The utilisation of the LOB is an example of the efforts directed towards standardise operational tasks and planning processes. Finally, pull production is applied by using shelves where bricks are placed in waiting for being collected on as-needed basis; this resembles the kanbans used in Fortaleza, Brazil (Alves et al. 2010).

## THE LC IMPLEMENTATION PROGRAMME IN URBANSA S.A.

After verifying the LC practices applied in Urbansa, it is worth analysing how these procedures were implemented in the firm. Thus, "*Urbansa has successfully adopted several LC concepts thanks to the implementation of a process-focused improvement program"* is the proposition formulated for this phase.

According to Mitropoulos & Howell (2001), process-focused programs, in contrast to result-focused initiatives, emphasize not only the process' components but also their interdependencies. For example, a result-focused quality improvement strategy relies on inspections and subcontractors responsibilities whilst a process-focused quality improvement procedure is based on work process design. Thus process-focused schemes are aimed to prevent, plan, and learn through recognizing that the sources of the problems are inside the processes. It is argued that Urbansa has implemented a process-focused approach due to the following reasons:

- Work-site signals highlight the goal of the improvement program: "the goal of LC is to do the right things, in the right place, at the right time, with the right quantities and right quality, to the right client, with the right cost".
- The causes of problems are explained to labourers and management personnel by using the types of waste suggested by many LC authors (e.g.: Ohno's wastes). Root causes are established in special workshops in which attendees are encouraged to take pictures and identify problems by themselves.
- The emphasis of the improvement effort has been on designing better operational processes, thanks to the implementation of LOB and LPS practices.
- Project participants regard learning workshops and planning meetings as an opportunity to get more improvements. For example, some interviewees mentioned

that LOB was initially designed through specialized software. However, people involved in the planning exercise decided to draw it in MS Excel in order to achieve a better overall understanding.

- Interdependencies between process participants, requirements, and work processes have been properly managed through an adequate management support. This is because the firm's Design-and-Construction Director is the lean champion in charge of the transformation. He leads the firm's LC team, which is responsible for sustaining the lean improvements and for encouraging more enhancements.

Based on the above reasons, it is clear that LC ideas have been successfully adopted. Obviously, there is plenty of space for applying more LC techniques and achieving more changes. However, it is evident that all project participants have embraced the improvement program. Therefore, the suggested proposition has been verified.

## THE INNOVATION PROCESS IN URBANSA S.A.

After showing that LC concepts have been properly applied and implemented in the construction firm, it is suitable to establish the following proposition: "*LC has been a major contributor to the innovations that have taken place in Urbansa's construction projects"*. This is examined in two different phases. First, LC in the company is analysed as a radical mindset innovation in the light of the model proposed by Slaughter (2000). Second, innovations on operational processes are discussed by using the "small wins" concept suggested by Weick (1994).

Slaughter proposes an innovation adoption model that consists of a cycle of six stages. In Figure 2, each implementation phase is analysed through the information collected in the construction firm.

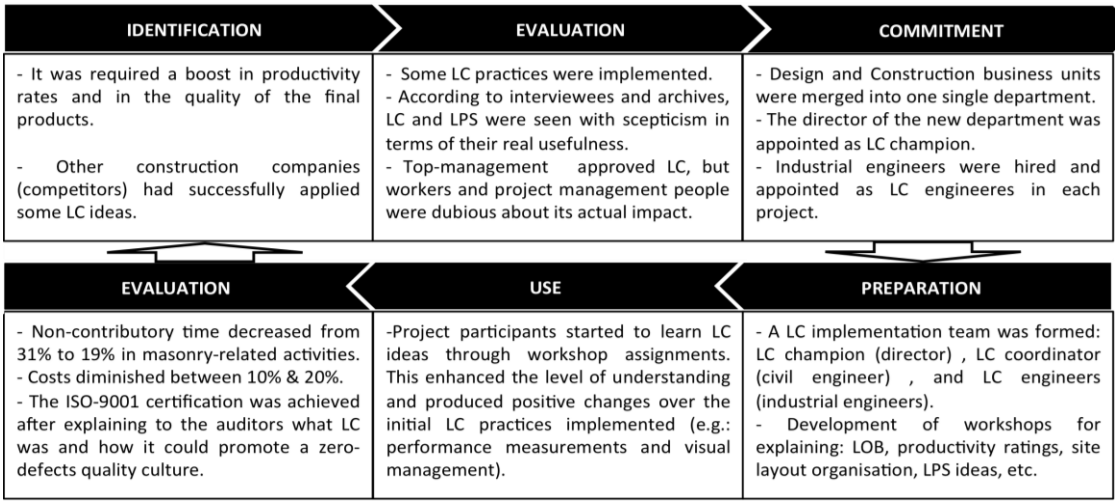


Figure 2: Slaughter 's Innovation Model for LC Implementation in Urbansa S.A

According to Figure 2, it is claimed that Urbansa is on its way to implement a completely new production template. Although this constitutes a managerial innovation, it has also led to many other minor operational improvements such as: new tools for moving bricks, special platforms for receiving bricks from tower cranes, a new grout mix design for reinforced masonry operations, and a levelling-and-plumbing device for bricklaying (i.e.: masonry guiding tool). It is argued that all the

previously mentioned minor improvements are "small wins". Henrich el al. (2006) explain this concept as a way of dividing a problem into a set of mini-problems so that stakeholders can identify mini-solutions that can be gathered together to provide major enhancements.

Vrijhoef et al. (2001) examine LC and the LPS through the lens of small wins. They show that the LPS provides a structure to apply small wins into construction because it allows people to redefine apparently unmanageable problems into a group of controllable opportunities. In this sense, the concept is different from the idea of "business as usual" in which construction difficulties are regarded as being caused by "forces beyond control". Since one small win begets another through a snowballing cycle (Vrijhoef el al. 2001), it is suggested that implementing LC in Urbansa has triggered the minor improvements described before and shown in Figure 3.

| INITIAL STATUS (BIG PROBLEM) | LC IMPLEMENTATION | IMPROVED STATUS |
|---|---|---|
| Disorganised site layout, lack of control in material deliveries, inadequate brick cutting operations, careless material storage and handling, excessive disparity between work planned and work performed, loss of materials, adversarial relationships among crews, etc. | Site layout organisaton<br>Kanbans for brickwork tasks<br>Line of Balance (Master Plan)<br>Lookahead Plans<br>Weekly Work Plans<br>Learning Workshops<br>Periodic Assessments | Standardised scheduling process (LOB, lookahead, and weekly plans).<br>Enhanced material storage and handling.<br>Standardised worksheets for material distribution, productivity rates, etc.<br>Reduction in non-contributory activities.<br>Increased workers' satisfaction. |

| RESULTS | SMALL WINS | NEW SMALL PROBLEMS |
|---|---|---|
| - With the new grout mix design, pouring times decreased from 45 seconds to 32 seconds per brick unit.<br>- With the new masonry guide, levelling and plumbing tasks reduced their executing time from 104 seconds to 64 seconds | - Special platforms for receiving bricks from towercranes.<br>- New basket for transporting bricks through tower cranes.<br>- New grout mix design.<br>- New masonry guide. | - Delivery of bricks to upper floors through tower cranes.<br>- Excessive waste in pouring grout for reinforced masonry walls.<br>- Delays in levelling and plumbing masonry walls. |

Figure 3: Small Wins in Urbansa S.A.

The work-site advancements accomplished by Urbansa can also be considered as operational innovations. This is based on the connection between the concept of "small wins" and the Slaughter's innovation cycle proposed by Henrich et al. (2006). In accordance with Henrich et al. (2006), the Slaughter's innovation cycle for one of the Urbansa's small wins (i.e.: new masonry guiding tool) is described in Figure 4.

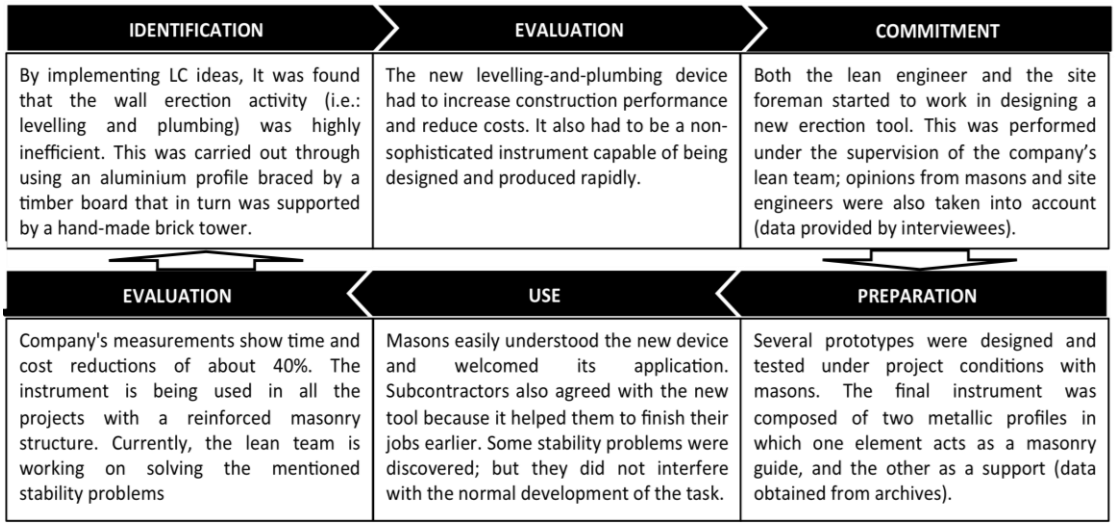


Figure 4: Slaughter's Cycle for developing a New Masonry Guiding Device

## CONCLUSIONS

The paper analysed the Urbansa's experience with LC. Firstly, it was showed that the practices implemented in the company complied with lean principles promoted by the International Group for Lean Construction. Secondly, it was concluded that the application of those practices was carried out through implementing a process-focused approach. Finally, it was argued that thanks to a proper application and correct implementation, minor operational improvements were possible. These "small wins" were the result of a radical mindset change inside the company (Figure 5 shows a picture of an innovative development that resulted from a "small win" process).

In other words, LC concepts have helped to encourage innovation in Urbansa through: (a) making operational processes more transparent; (b) encouraging a learning culture within the company's projects; (c) helping Urbansa to recognise that projects had to be seen as a whole and not a set of isolated activities; and (d) motivating workers and management people to feel construction projects as their own.

In addition, it is claimed that LC ideas have promoted innovation in the analysed projects because: (a) the implementation process was not carried out as an imposition but as a method to put into practice a new thinking pattern that took into account opinions from different project participants; (b) the company created an adequate project team to sustain the performance improvement effort; (c) several pedagogical workshops were held in order to explain LC ideas and hear worker's opinions; and (d) new ideas about minor operations started to be seen as something valuable.

(a) (b)

Figure 5: (a) Traditional Masonry Guiding device; (b) New Masonry Guiding Tool

Consequently, this study shows that LC plays an important role in generating innovative solutions for operational problems. The authors expect to increase the industry's interest on the true potential of LC for improving processes and delivering more client oriented products. This can be done through showing that big problems (i.e.: increasing productivity at construction sites) can be tackled by establishing a new production template that allows large difficulties to be broken down in small situations capable of being solved in an innovative way. Although implementing LC is not an easy task, this paper intends to show that LC is more than measuring task times and its correct application implies huge impacts for the overall firm performance. As the industry improves, the public sector might be encouraged to respond to new construction demands. Further work is needed to develop a strategy for explaining and applying lean ideas at operational and management levels.

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