# RECOMMENDATIONS FOR PRACTICAL APPLICATION OF TRANSPARENCY IN CONSTRUCTION SITE

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## ABSTRACT

Lean construction is a new set of ideas that seeks to achieve perfection by eliminating waste that may be waste of materials, time, effort or even satisfaction. One of its principles is transparency and can be used as an instrument to increase the motivation of workers for improvement, reduce the propensity of errors and, most certainly, increase the visibility of errors.

The aim of this paper is to propose a set of recommendations for the application of transparency practices aiming to improve production planning and control, quality and cost processes, while also evaluating its benefits. The main research strategy used was case studies, which initially involved a benchmarking study carried out in three different industries (hospital, car factory and retail store) in order to identify good transparency practices to apply in construction sites. Based on this and in the literature review twenty transparency practices were selected, being implemented during the construction of a commercial building.

The main results of this research are related to experiences gained in the practical application of the principle of transparency and the identification of positive effects of these practices in different managerial processes such as better consistency in decision making, participation and motivation of employees, more effectiveness in scheduled activities and quick understanding of and response to problems. Also, new practices of transparency are suggested and practical recommendations for new applications were established.

## KEY WORDS:

Lean Construction; Transparency; Visual Management; Benchmarking.

## INTRODUCTION

According to Koskela *et al.* (2002), lean construction is a way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value and one way of seeing these errors and waste is through the application of the principle of transparency.

According to Womack *et al.* (1990), transparency is the ability of outsiders to see the system in action, understand its logic and verify is performance. In lean production is a lean system where all subcontractors, suppliers, system integrators, distributors, customers and employees have easily available and accessible

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information, facilitating the discovery of abnormalities of the system (Womack *et al.* 1990).

Galsworth (1997) points out that process transparency, when applied adequately, forms a base upon which other improvement approaches are built and, for this reason, can be adopted as one of the first steps in improvement programs.

The application of process transparency principles during construction represents a substantial change in production management as it aims to transform the traditional "silent" processes into ones that communicate in an active manner. In conventional communication, information is "transmitted." However, when using the transparency, nothing is transmitted: the network of information (information field) and respective access to it is created in such a way that the information is obtained quickly without the need to ask (Formoso et al. 2002).

Due to the fact that construction sites are in general information scarce workplaces, people ask lots of question and a lot of the same questions repeatedly. As a consequence of this, the company suffers long lead time, late deliveries, poor quality, accidents, low operators and managerial morale, and runway costs (Galsworth 2005). Besides, process transparency has a very important impact on motivation. The more scarce information becomes, the less employees trust each other (Formoso et al. 2002). A sense of disempowerment may follow, leading people to start worrying about making mistakes (Galsworth 1997).

In this sense, the amount of information displayed at the construction workplace has strong influence on the effectiveness of production planning and control (Formoso et al. 2002), resulting in cost reduction and better quality.

The aim of this paper is to propose practical recommendations for the application of transparency practices in the construction site, evaluating its effect. To do that, an exploratory survey was developed in three different industries in order to identify practices that increase transparency and with possible applications in construction sites. An empirical study was also developed in a commercial development construction site aiming to implement transparency practices initially based on Oliveira et al (2012) work and assess the contribution of transparency for the improvement of the production planning and control, cost estimating and quality requirements.

## VISUAL WORKPLACE

The Toyota Production System considers visual management as an essential practice in leaders and workers development (Liker and Convis 2012). Every metric that matters throughout the company, especially on shop floor, is presented visually for everyone who is involved in meeting the goal to see. For Liker and Convis (2012), a key reason for the dedication to visual management at Toyota is that it clarifies expectation, determines accountability for all the parties involved, and gives them the ability to track their progress and measure their self-development.

According to Galsworth (2005), the technologies of the visual workplace represent a comprehensive strategy for installing vital information as close to the point of use as possible. For that author, a visual workplace is a self-ordering, self-explaining, self-regulating and self-improving work environment, where what is supposed to happen does happen, on time, every time, day or night, because of visual solutions.

Visual management has different functions in an organization, such as transparency, discipline, continuous improvement, work simplification, job training, management by facts, creation of shared ownership, simplification and unification (Tezel *et al.* 2010). According to Galsworth (1997), visual communication should be precise, direct and at the same time simple. Furthermore, it should use clear words in context, this being particularly important in visual indicators, as this is visual tool demands interpretation. Graphics, photographic features and use of colors are important considerations for overall transparency.

The Toyota Production System uses a set of tools in order to improve their visual workplaces. A3 report is one of these tools, which has the purpose to produce in a single page, a "problem solving story" that summarizes the problem, its root causes and the countermeasures taken to solve the problem (Liker and Convis 2011). Another technology is the Floor Management Development System – FMDS, whose core idea is to link the daily production crew to their goals. There are spaces close to the workstation used for daily meetings, where leaders displayed graphics, charts, tables and information with color codes (Liker and Convis 2011). Kanban is another visual tool for managing and assuring just-in-time production. Basically, a Kanban is a simple and direct form of communication always located where it is needed (Ohno 1988).

Galsworth (2005) established ten doorways that help companies to achieve enterprise-wide visually. Each door is linked to a different group of employees and each group owns and opens a different doorway and develops a different category of visual functions. The ten doorways are: (1) visual order to associates, (2) visual standards to engineers and supervisors, (3) visual displays to planners and supervisors, (4) visual metrics and problem solving to executive, managers and supervisors, (5) visual controls and visual pull systems to material handlers, planners-engineers and supervisor, (6) visual guarantees to engineers quality technicians; (7) visual machine (maintenance); (8) visual lean office to support staff, (9) macro visual environment to special team and finally (10) exam-award process to multi-dept examiners.

In the construction industry Tezel *et al*. (2010) have published studies that list a number of visual management practices which can be used on construction sites with the aim of increasing transparency. These practices was based on Galsworth (2005) work as following (a) visual guarantee (poka-yokes), which outcomes reduce variability, (b) visual indicators, which give only information, common in construction in terms of safety signs, (c) visual signal, which calls for attention and expects people to react, and (d) visual controls, that limits response in terms of height, size, quantity, volume, weight, length and etc.

Based on Tezel *et al*. (2010), transparency practices, and other references, Oliveira et al. (2012) assessed the use of transparency practices on five construction sites in the city of Salvador, Bahia, Brazil through a check-list with thirty one transparency practices. The analysis of the results focus on whether these practices were providing the expected benefits related to organisation, productivity, and production planning and control.

According to Oliveira *et al* (2012), no great variation was found within the five sites. The number of practices implemented by the construction site that adopted the highest amount of visual management practices corresponded to eleven practices, only 35.5% of all practices analysed. However, when analysing the construction site

in the city of Fortaleza which was taken as a benchmark, a twenty transparency practices in use were identified, representing 64.5% of the total.

## RESEARCH METHOD

This research was performed through a case study strategy, divided into three stages: literature review, survey concerning transparency practices in other industries and an empirical study in a commercial building construction site.

Initially, the survey of transparency practices in other industries aimed to perform a benchmarking study on the topic, as well as identify possible practices to be applied in the context of construction sites. The study was developed in three different industries.

Company A is one of the most renowned hospitals in the city of Salvador and is a reference in various medical fields. In the hospital, the concern about keeping the environment clean and organized was evident and there were several visual devices, including PokaYokes. Company B is one of the largest automobile plants in Brazil and can be taken as a reference in the application of transparency through visual management in its production. Company C is a department store brand that operates throughout Brazil, involving 200 stores and 18,000 employees. This company is a national reference in the management of human resources and, they are used to applying transparency practices in order to improve the distribution of information and motivate the work team.

The data were collected through site visits followed by pictures taken, interviews with the production engineer of the factory, the hospital nurses and the store manager, as well as direct observation.

The empirical study was carried out in a commercial building with 61,000 m² of constructed area divided in two towers, one with 15 floors and slabs of  500 m² and the other with 24 floors and slabs of 800 m².

Initially a diagnostic for identifying the current transparency practices was conducted. For that, the checklist developed by Oliveira et al (2012), aforementioned, was applied in order to evaluate the transparency practices quantitatively and qualitatively. Also, structured interviews with the production staff were developed, involving two production managers, a building technician and six engineering trainees to assess the quality of the information displayed in the workplace.

The next step involved the selection of the transparency practices based on the results of the checklist applied, the literature review, the practices identified in the benchmarking study in other industries. Also it was considered improvements in practices which already existed in the study construction site and other practices that were created from the perception of the needs of the work by the author.

For the implementation, the practices were divided into groups of similarity such as visual displays, visual standards, visual metrics and visual controls due to the fact that this first stage of implementation focus on planners, managers and supervisor, according to Galsworth (2005) definition. Along the implementation, three production engineers and eight trainees were involved. The visual devices were designed by the main author of the paper, being implemented by the production staff.

The success of a construction project occurs when the work is performed without delay nor budget deviation and with the required quality. Based on these three pillars, the expected improvements on construction sites that were analysed in this work were

divided in three categories of visual management: exposure and control of planned goals, exposure and control of estimated costs and exposure and control of quality required, as presented in Table 1. For each category, four construct were analysed based on the following source of evidence: pictures taken in the field, check list, internal research, production staff interview, and direct and participant observation.

In order to analyse the impact (effectiveness) of each transparency practice, each construct were evaluated based on the construction manager's opinion. These data were collected in a one hour meeting with two senior production engineers and three senior trainees, where they were encouraged to evaluate if: (a) the practice had a significant impact, (b) the practice do not have an impact, but has the potential to have one, (c) the impact does not apply to this practice.

Table 1: Categories of Visual Management, Construct and Sources of Evidence

| Categories of Visual Management | Construct | Sources of Evidence |
|---|---|---|
| **Exposure and control of planned goals**: means to display information of what was planned and what was achieved, enabling the production staff to be able to judge their progress clearly. | Greater consistency in decision making | Pictures taken in the field; |
|  | Increase in employee participation | Check List; |
| **Exposure and control of estimated costs**: means to disclose how much it planned to invest in each service and compare the figures achieved demonstrating abnormalities and acting based on the data. | Increase in employee motivation | Internal research; Interview with production staff; |
| **Exposure and control of required quality:** means to show the quality desired by the company and facilitate their control in the products executed. | Quick understanding and response to problems | Direct and Participant observation. |

## BENCHMARKING STUDY IN OTHER INDUSTRIES

In company A, the visual management was widely used, the patients wore bracelets with different colors and codes that identified their needs. In every room there was a poster showing the steps to wash hands and sticking to the alcohol hand gel, there was one flashy warning that leads all visitors to disinfect their hands. Also as a kind of Andon (Figure 1), a remote control with emergency indicators that is close to the patient and he/she must press when he/she needs any nurse assistance was identified. This system was more advanced than the conventional one, which consists simply of a bell that warns the nurses of something. In the hospital, the emergency indicator was separated into three stages and each stage activated a light in the patient's bed and at the nursing center that could be green, yellow or red.

The Andon in Company B operates in two ways: manual and automatic. This happens automatically with a system that evaluates the status of the operation in accordance to the position of the car on the treadmill, for example, the system knows that six screws must be tightened, if the car passes the mid-section of that station and three screws have not been tightened, the system warns of it automatically and if the car arrives to the end of the workstation and the six screws are not tightened, the system stops the production line. Also the Andon can be activated for any worker at the plant floor to warn or even to stop the production line (manually). This system has received an upgrade with a large Digital Panel in each production line of about 3 x 2 meters, which displayed information that would come out of each workstation

automatically, providing information about which station came to a halt, why it is stopped, for how long, how many cars were produced on the day and what the goal of the day was.

An important practice observed in Company C was the Visual Management boards, which presented the evaluation of each employee carried out by internal coordinators, and the evaluation of the store outsourced by external auditors and clients' survey. In addition to the evaluating of employees, strategic indicators are also displayed (Figure 2).



Figure 1: Emergency Indicator (Company A) Figure 2: Visual Management Board

## EMPIRICAL STUDY IN A CONSTRUCTION SITE

Based on the check list, 13 of the 31 practices of transparency proposed by Oliveira et al. (2012) were identified, which represent 41.93%. Of these 13 practices, 12 were related to the use of transparency to organize the construction site and only one related to increased productivity. None of the practices implemented in the work were related to improvement planning.

From this analysis, it was decided that the focus would be on the implementation of practices related to production planning and control and productivity. Of the 17 practices of diagnosis not yet adopted, 7 were selected to be implemented. 3 practices were selected from the literature review, 7 by the perception of the researcher and 4 from the benchmarking study, totaling 20 practices implemented throughout the study (Table 2).
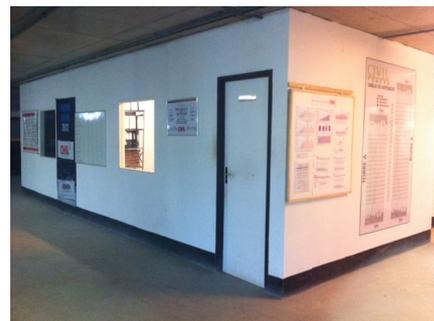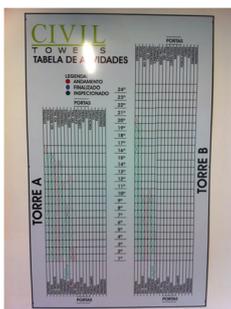


Figure 3: Activities Board          Figure 4: Office walls with visual management

After the implementation of the transparency practices according Table 2, an evaluation of their impacts on the production planning and control, cost estimating and quality sector was made through meetings and interviews with the production staff. Table 3 presents the matrix developed correlating the five selected impacts of transparency with twenty practices implemented.

Table 2: Origin and Description of the transparency practices implemented

| Categories | Transparency practices | Origin |
|---|---|---|
| **Exposure and control of planned goals** | 1- **Board displaying the long-term planning** through line of balance | Literature / Checklitst |
| | 2- **Board displaying** the **medium-term planning** and constraints | Literature |
| | 3- Dissemination of **short-term planning** for the leaders of work | Literature |
| | 4- **Sequence of the activities concerned** the facade's activities, plotted in A2 format. | Literature |
| | 5- **Board displaying indicators** of planning in a frame with 1.20 x 1.60 m. (PPC, and Deviation term productivity of critical tasks) | *Benchmarking* / Checklist |
| | 6- **Monthly printed Calendar** showing events and important milestones | Checklist |
| | 7- Board displaying **the 6 core items** that must be checked before the short-term planning (Labor, Material, Equipment, Design, Predecessor and Security) | Perception |
| **Exposure and control of estimated costs** | 8- **Kanban system** applied to mortar coating process, using *kanban* cards and Heyjunka box. The cards were used and compared to the planned budget, indentifying errors and material wastes, contributing to better control costs. | Checklist |
| | 9- **Visual management boards in the budget sector.** With plants of budgeted works, schedule and status of past activities. The visual management was applied in the office generating positive results. | *Benchmarking* |
| | 10- **Meeting** to monitor costs more transparently | Perception |
| | 11- **Research at the warehouse** The warehouse keeper had no time to feed the cost control system. He informed that he was overloaded by employees' orders. So, during 2 weeks, was evaluated how often and for which reason employees went to the warehouse. The results showed that the lack of planning of the workers led to an increase of non-added value activities (visits to the warehouse). | Perception |
| **Exposure and control of quality required** | 12- **Training** for workers using images and figures. | *Benchmarking* |
| | 13 – Board displaying **quality indicators** with traffic signs showing the level of attention to each result, green (ok), yellow (caution), red (actions need to be taken). | *Benchmarking* |
| | 14- **Knowledge Management Program** with the objective of retaining the knowledge generated in the company and forward democratically among employees. The program was created and presented. | Perception |
| | 15- Board displaying the Core Construction **Activities Schematic section** of towers with 20 activities on the X axis color-coded to represent the status of activities, red (in progress), blue (finished), green (finished and inspected). Through this board it was possible to control inspections, the lack of completed activity, presenting an overview of the progress of the work (Figure 3). | Perception |
| | 16- **Supplier assessment tables** | Checklist |
| | 17- Improvements in the **identification of the workplace (figure 4)** | Checklist |
| | 18- Cards displaying **company philosophy** and **safety procedures**. | Checklist |
| | 19- **Color-coded helmets** with additional written information. | Perception |
| | 20- **Satisfaction research of employees and suppliers.** Exhibition of organizational climate research done in the workplace. | *Benchmarking* |

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Table 3: Matrix of the Impacts of Transparency

| Evaluating the effectiveness of practices | | A | B | C | D | E |
|---|---|---|---|---|---|---|
| **Planning** | 1- Exposure of the long-term planning | | | P | | |
| | 2- Exposure of the medium-term planning | | | P | | |
| | 3- Dissemination of short-term planning | | | | | |
| | 4- Sequence of the activities concerned | | | | | |
| | 5- Board displaying indicators | | | | | |
| | 6- Monthly Printed Calendar | D.A. | P | P | D.A. | P |
| | 7- The 6 core items | P | | D.A. | | |
| **Cost Estimating** | 1- *Kanban* System | | | | | |
| | 2- Visual management boards in the budgets sector | | | | | |
| | 3- Meeting to monitor costs more transparently | | | | D.A. | D.A. |
| | 4- Research at the warehouse | | | P | | |
| **Quality** | 1- Training for workers using images and figures | D.A. | | | D.A. | D.A. |
| | 2- Quality indicators | | | | | D.A. |
| | 3- Knowledge Management Program | P | | P | D.A. | P |
| | 4- Activities Schematic section | | | | | P |
| | 5- Supplier assessment tables | | D.A. | | | D.A. |
| | 6 - Improvements in the identification of the workplace | D.A. | D.A. | D.A. | | D.A. |
| | 7- Cards displaying company philosophy and security procedures. | D.A. | D.A. | | D.A. | D.A. |
| | 8- Color-coded helmets | | D.A. | D.A. | | |
| | 9- Satisfaction research of employees and suppliers | | | | | D.A. |

| **Subtitles** | | | |
|---|---|---|---|
| A | Simplification and greater consistency in decision making | D.A | The impact does not apply to this practice. |
| B | Increased involvement of employees and management autonomy | P | The practice did not have an impact, but has the potential to have one. |
| C | Increased worker motivation | | The practice had a significant impact. |
| D | Rapid understanding and responding to problems | | |
| E | Greater efficiency in production scheduling | | |

Analyzing Table 3, it was noticed that there were some transparency practices related to quality that did not have the impacts studied, such as: improvements in the identification of the workplace, on displaying the company's philosophy and security procedures and training for workers. However, these practices are also important because they have other benefits when implemented. The practice "Improvements in the identification of the workplace" promotes greater organization and makes it easier to identify abnormalities. By contrast, the practice "Cards displaying company philosophy and security procedures" and "Training for workers using images and figures" are important to expose what is the standard of quality that the company expects of its employees.

Regarding transparency practices that have great potential to promote major impacts, "Monthly printed calendar" and "knowledge management program" were highlighted. The calendar was just being used with dates of birthdays and few meeting dates, but according to the respondents, they believe that if it were updated with other information related to production or client's visits, it could promote more positive results. The knowledge management program is still in development and going through a period of inclusion of data with the potential to promote more positive results from the use of stored data.

Analyzing the results in Figure 7, it was noticed that the vast majority of the transparency practices implemented achieved the expected impacts. Practices which did not generate impact or did not have the potential, actually not include these impacts as benefits of their implementation. It is concluded that the impacts proposed in the literature were actually achieved and brought many benefits for exhibition and control for planning, costs and quality of this new development.
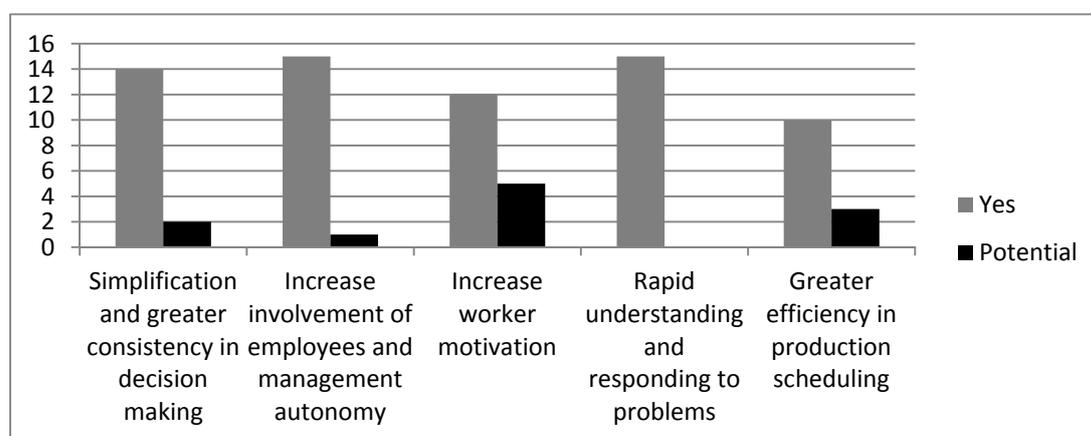


Figure 7: Number of transparency practices implemented X Impacts

## RECOMMENDATIONS FOR PRACTICAL APPLICATION OF TRANSPARENCY

From the literature review and the empirical study, it was possible to establish a set of recommendations for the application of the principle of transparency in construction sites. These recommendations were divided into two periods of application: the pre transparency period and post transparency period.

### PERIOD OF PRE-TRANSPARENCY

It is extremely important that before defining which data will be collected, the definition of what these data may answer and what actions could be taken from aiming to achieve the results is established. Data should be simple, didactic and should promote actions. The main recommendations for this period are:

- The principle of transparency requires a high availability of information, so a period of data collection is needed. These data need to be processed into information then analyzed and transformed into knowledge.

- The data collected can be divided into two types: the vital indicators and the exams (analogy with hospital indicators). The vital indicators are collected

regularly and are already part of the process, for example, time deviation, cost deviation, PPC, etc. The exams are the specific internal research used to find answers to specific problems and are not used regularly, for instance, search requests in the warehouse, verification points of mortar coating, organizational climate survey, etc.

• There are some displays of information that may generate some negative results on stakeholders such as performance evaluations. A meeting is necessary before any exposure in order to make those involved aware that exposure of such data does not aim to punish, but to discover the problems and solve them faster and thus achieve common goals.

• After data collection, plenty of time should be dedicated to creating the best way to display the information. There are three major failures that can happen at this point, which are:

1) People are used to printing tables that are made to be read on a computer at a distance of approximately 50 cm, so the font size is too small and the data are unattractive.

2) At the beginning of a period of transparency there is an enthusiasm for exhibiting too much information and often the excess of data becomes completely disorganized and goals cannot be achieved.

3) Too much data is collected, but it is not transformed into information nor knowledge. It is important to display analyzed information (knowledge).

• The news boards are important tools of visual management and can be divided into static and dynamic.

1) **Static Boards**: information that practically does not change and can be printed on a resistant material. Usually involve the identification of materials, flooring, employees, boards of company policies, procedure of activities and safety signs.

2) **Dynamic Boards**: dynamic information that changes periodically and needs to be designed to work in this way. It can be printed on A4 paper and updated at every data change. This solution is simple and despite not being so resistant it is ideal for boards which are made of Formica or glass so you can write on them with specific pens and erase it easily. Another solution is to use "post its" to display dynamic information, and also use monitors or televisions with information updated by computer. The dynamic information involves, for example, the indicators of performance, and short-term planning.

• f) Tips for better displays.

1) Do not make a mistake concerning the font size. A simple relation can be made: (h / d = H / D) (h height of the individual letter, d distance that an individual reader sees a text, H ideal height, D distance from the observer to the information). It is important to adopt up to 50 cm of the individual reader.

2) Use color in the displays, in order to draw attention. Remember that the traffic language is well-known worldwide and whenever possible, use it to

display the data. Green represents something that is approved or above target, yellow is used to draw attention to something that can get away from the standard, or is slightly below target but it is evolving, and red to draw full attention and demand immediate action.

3) Standardize information that will be displayed following an easily and quickly recognized visual standard. Charts should follow the same format.

4) Use of images; research with focus on facebook posts show that posts with images manage to attract 94% more likers (Socialbakers 2012). This research can be brought to construction, because the data exposed need to attract the attention of those involved and the use of images virtually doubles the power of attraction.

5) Number of words in static frames; advertising literature said that billboards should have a maximum of 8 words but with the increase of traffic jams it has become acceptable to use 11 words. You can bring this into construction. Assuming that there are few "traffic jams" in the works, apart from lunch queues, it is better to adopt the practice of 8 words at most in static frames that are just informative.

## PERIOD OF POST-TRANSPARENCY

After the period of information exposure it is extremely important to provide training to different levels of the workers regarding of how to use this information and what actions could be taken from it, aiming to create a systematic analysis of the information generated and standardize this procedure.

In the initial period updates of dynamic information should be required until it takes hold and the users feel the need to update it to facilitate the work itself. Two of transparency goals are to facilitate access to information and to highlight abnormalities, these two objectives generate the need for actions to be taken. Thus, practices that incorporate information to process and generate data need to be constantly reviewed to evaluate their usefulness and guarantee stability.

## CONCLUSION

This study looked into detail at one of the principles of lean construction defined by Koskela (1992), called "increase process transparency. This principle is often confused with visual management, however it is important to make clear that transparency is a principle and visual management is a set of devices which has increasing transparency as one of its objectives.

The Experience of Benchmarking was used to identify best practices in other industries that are already more advanced in the implementation of transparency in its processes. Some of these best practices have been applied in the case study and others were suggested for future applications. This experience also serves to inspire other researchers to widen the scope of their field of vision and seek answers to their problems in different fields and enriching their knowledge.

The application of the principle of transparency in a construction site made it possible to externalize difficulties and benefits that can only be noticed in practice from one application. Difficulties in updating dynamic boards, the use of indicators

that are not conclusive and the negative effects of displaying performance are examples of this difficulty. The benefits that were treated as variables of the case study and observed in a matrix of benefits are: greater consistency in decision making, increased involvement of employees, increased employee motivation, understanding and responding quickly to problems and more effective programming activities.

Through this study it was possible to perceive that increased transparency in a construction company cannot be imposed or applied abruptly, it should be a change in culture involving awareness training for staff to clarify that highlighting processes in a traditionally "silent" industry aims at continuous improvement and is not a form of punishment.

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