THE USE OF ANDON IN HIGH RISE BUILDING

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ABSTRACT

The Andon device is traditionally used in the manufacturing industry. This visual management tool shows the status of operations in an area and signalizes the occurrence of abnormalities. This research work takes the view that its application is connected to lean construction concepts, as its main function is to identify problems within the production line. It becomes possible to determine the origin of the production disturbances during the building process and not only at the end of it, in a way that the required measures can be taken to avoid the repetition of such problems. It is noticed also that the use of Andon improves the continuous flow of the activities and avoids rework. Moreover it provides operative crews and production managers the opportunity of learning. The application of this managerial tool has gained adepts in construction companies in the Brazilian northeast. The objective of this article is to show the steps for the application of this tool within the building construction environment. This work was developed through a case study in a multi-storey building construction and it encompasses hardware installation (both at the work place and management office), development of control charts, and the production problems analyzes. This study is concluded with the presentation of the results acquired with the use of this managerial tool. The number of work stoppages was reduced significantly, communication was greatly enhanced and transparency was enacted as production problems were readily reported, discussed and analysed.

KEY WORDS

Andon, lean construction, building control.

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INTRODUCTION

Toyota Production Systems represent a new production management paradigm, radically different from traditional western practices, putting in place simple and uncommon ideas to accomplish consistent elimination of wastes (Ohno, 1988). This paper takes the view that TPS might be kept as a different approach from what is labelled as Lean Production if it is accepted that it has two major axioms, as mentioned by Ghinato (2000). Those axioms are related to Just in Time and to Jidoka. A simplified representation of TPS is depicted in figure 1, where those axioms are represented as pillars, raising from foundations connected to concepts like variability reduction, heijunka, standardized work and kaizen.

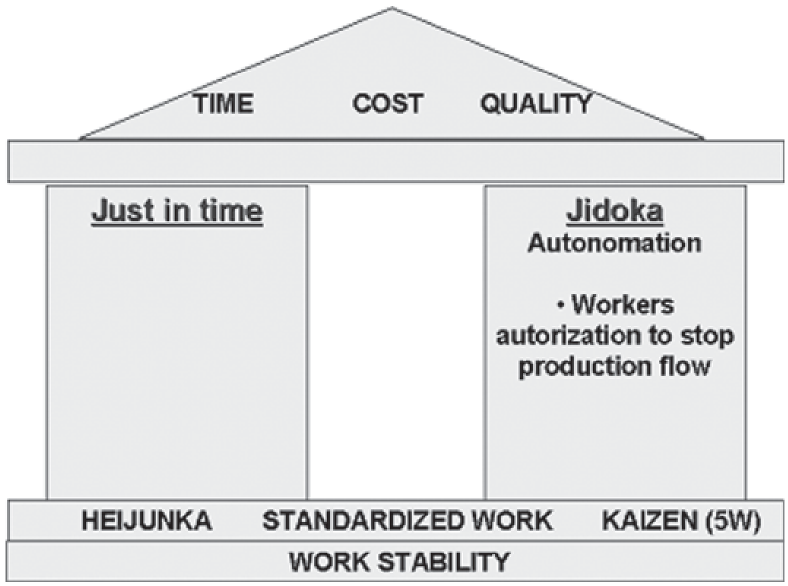

Figure 1 - Toyota Production System (adapted from Ghinato, 2000).

The fact that TPS finds a proper representation through the schematic drawing of a house points to the fact that the construction environment might be a natural field for its application, taking in consideration its main characteristics as high environmental variability, low work predefinition and pace of work dictated by labour force. Before further exploring this particular view on TPS as applied to the construction environment, it should be mentioned that this paper does not aim at discussing other Lean Production (and Lean Construction) views as proposed, for example, by Koskela (1992) and Womack (1992). This reductionist view on TPS was enough to put a number of preliminary steps that helped to achieve better performance in action according to the related experience.

Just in Time (JIT) was taken as the major driving mechanism of TPS due to its clear inventory cost reduction appeal. While pursuing a clear goal, difficulties might have been faced in operating the system due to the idiosyncratic nature of the work environment. In the manufacturing industry kanban auto regulating production ordering was a proper answer for the stabilized work flow. In the construction industry, a sophisticated suite of long, medium and short term planning was suggested, where buffering, negotiation between command and willingness to perform, imposition of artificial intermediary due dates throughout the construction process would help to stabilize work flow. A stabilized work flow would increase confidence on postponing action and use of resources, as suggested by JIT. According to most of reported lean construction experiences in the construction industry, site scheduling was taken as a substitute for JIT.

Ghinato (1996) embarked on a crusade to elevate JIDOKA (autonomation) to a higher standing in connection to TPS thinking. It is not enough to design the production system in order to foster JIT assembly. Additionally, scheduling will not take care of all possible production disturbances that might occur and a simple chain of command, like the one provided by kanban signalling, is not powerful enough to contravene external uncertain circumstances. Moreover, this takes the form of micro-management at the work place. Either hardware or people will help to manage work flow in order to guarantee that work does not stop or that problems remain unnoticed. In the manufacturing field most warnings, self correcting procedures and in-process quality checks are performed automatically by hardware. Automation is helped by a human touch, hence autonomation, an English translation for the Japanese word Jidoka.

In the construction sector, still heavily dependent on human resources to impose the rhythm of production, Jidoka means greater autonomy for the operatives to enforce a continuous and synchronized work flow. Operatives will detect possible disturbances and stoppages in the job processes under their responsibility and will activate internal or external support to overcome these problems. Jidoka becomes then, an attitude and empowerment to seek solutions to problems that are more easily perceived at work place by personnel with hands on experience.

METHOD OF WORK

This study was conducted in a medium size apartment building developed in Fortaleza, in the Brazilian northeast. This company used to participate in managerial development programs that lead to ISO 9000 Quality Assurance and Technology Innovation. The latter is accomplished through the INOVACON Building Technology Program sponsored by a group of building companies and CNPq - the Brazilian National Agency for Research and Development.

A number of studies report the background, objectives, major results and organizational structure of INOVACON (Maia, 2000; Brasileiro Netto et al., 2003; and Barros Neto et al., 2005). Particularly, the work by Barros Neto et al. (2005) covers recent lean construction development in 5 building companies belonging to INOVACON program: the research report given goes in greater depth on how a specific kind of andon system was implemented in one these 5 companies. Different types of andons will be found in the remaining 4 companies.

A 22-storey apartment building was in its final stage of execution when it was decided to implement the andon system as a first step in a new lean construction managerial approach. A systematic view on this approach would take into consideration better site scheduling (at long, medium and short term), cell organization of operatives, greater transparency and better flow of material supply to each work station. This research work describes only the benefits of applying visual signs to identify possible production disturbances.

ANDON HARDWARE AND OPERATION

Andon hardware and operation are described according to figure 2.

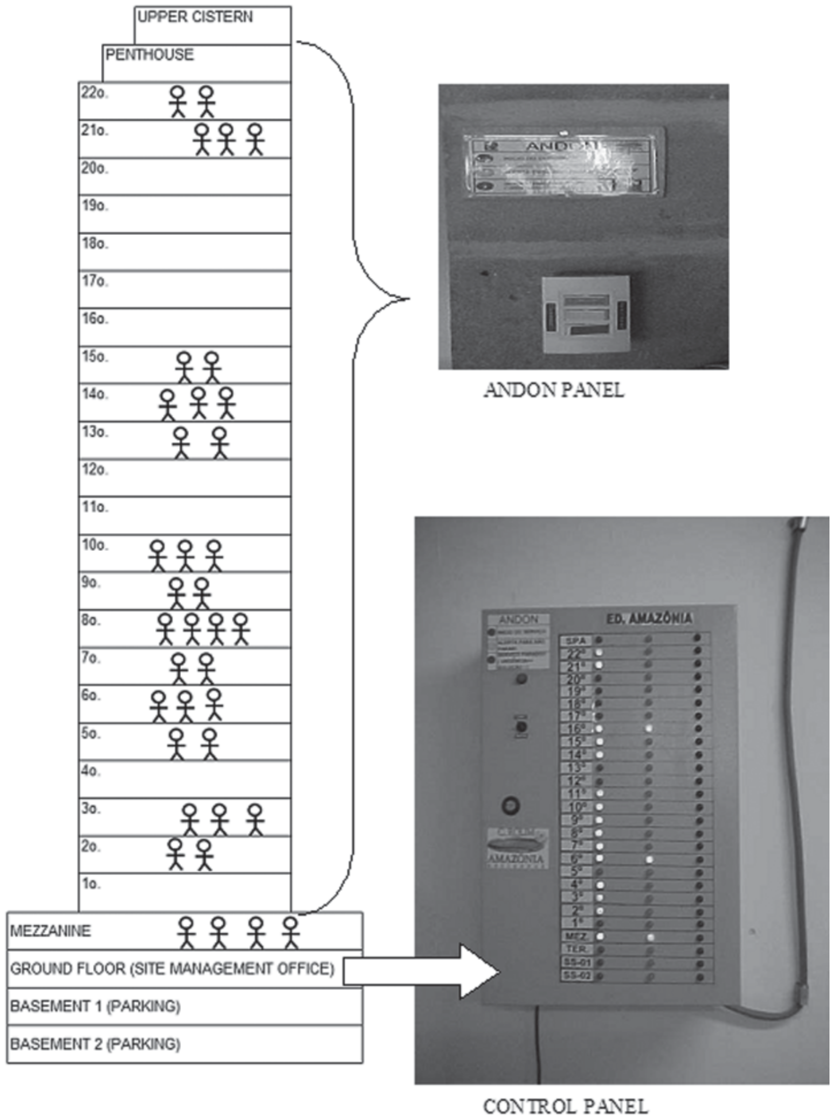

Figure 2: Andon hardware and operation.

Figure 2 might be better understood with following statements. Production was shielded by previously assuring that all materials, information, project details and labour force were in place to start production at each morning, at each working place. Working places were defined as each storey where a number of operations were gathered in a cell like production environment. When the gangs arrive at each workplace early in the morning, they press the andon panel green button at every storey.

A green light will turn on for every storey under execution at the control panel installed at the site management office. During the day gangs might anticipate the problems they would face within next hours, such as shortage of materials, lack of a more refined project detailing or unexpected difficulties with tools, equipment and labour skills. Based on this perception, gang's leader will press the yellow button and correspondingly a yellow light will turn on, calling management attention at the site office. Site personnel will get in touch by radio with operatives at that work station seeking how to best solve the problem.

A red button would be pressed when problems are being faced straight away at the work station. A red light will turn on at management office. This will work like an order to immediately get in touch with the gangs at the work place, eventually pay a visit there and redirect part of management effort on site to fix the problem. Conventionally it was established that half an hour would be expected as lead time between problem anticipation and work disturbance pressing the yellow button. Anything shorter than that or actual work stoppage will trigger a red light.

According to Brazilian safety regulations every high-rise construction should employ a personnel lift. The lift operator plays a central role in the andon system mechanism, as he is normally the first to visit the work place and go after the solution for the problems. This is the case when there is an unexpected lack of materials or tools. He will visit the site depot in order to bring himself those items to the gang facing those problems. He is also in charge of negotiating an urgent delivery of mortar mixes from the batching plant. As it can be seen in figure 3, mix production order is previously set by the mixer operator in a heijunka box, but this might be rearranged in the case of yellow or red lights emergency warnings.

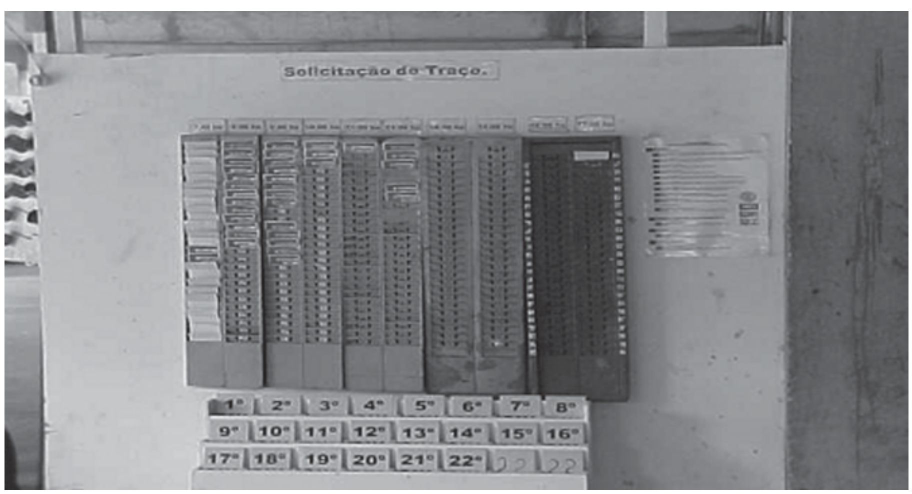

Figure 3 - Heijunka box for mortar batches delivery.

If the problem is not solved by expediting the delivery of materials and tools to the work place through the lift operator endeavour, a flow manager is called into action. The flow manager is a new administrative position on site that, apart from normal depot store keeping duties, has the responsibility of going after unavailable resources, even if this calls for leaving the building site and bringing resources from outside. If both lift operator and flow manager are unable to solve the problem, the site manager takes charge of the situation.

A key aspect of the system is a new organizational hierarchy on site. Gangs facing problems put orders to those in charge of finding a solution to avoid work stoppages on site. Whoever is activated to find the solution should diligently serve gangs in trouble. Ultimately, the whole site would get involved and redirect efforts to bring to normal every production flow.

Training is exercised in order to stress three main principles. First, the main objective is to avoid stoppages: management effort and operatives concern should go to great lengths to guarantee a continuous work flow; second, that a yellow button pressing is taken as a positive sign, while a red button demands explanations related to the reasons why problems were not previously anticipated; third that work preparation should be taken seriously in order to avoid both yellow and red lights.

ANDON STATISTICS

At the moment statistics are collected by hand and reported to site managers and to the main building work supervisor at main office. It is straightforward to collect them automatically, just by adding software to the control panel. It is interesting to note that this control panel at the site office became a dynamic testimony of production success. The number of work places being operated simultaneously not only comes to everyone's attention, but also the proportion of yellow and red lights that are on, and for how long they keep this status, is an indication of management activity.

Table 1 shows statistics for two months in 2005, comprising only red light warnings. Reasons for stoppages are categorized according to root problems. These root problems were unveiled after applying the 5 Why's technique. For example, training is a root cause that encompasses reasons for stoppages like worker inability, lack of proper instructions and even lack of understanding of adequate timing for yellow and red button pressing.

Table 1 - Summary of stoppages in production.

Summary of Stoppages in Production - June / July - 2005						
Reasons of Work Stoppages	**June**		**July**		**Total**	
	Quantity	%	Quantity	%	Quantity	%
Training	14	52%	8	53%	22	52%
System Capacity	4	15%	0	0%	4	10%
Planning	8	29%	7	47%	15	36%
Supplier Delay	1	4%	0	0%	1	2%
	27	100%	15	100%	42	100%

Capacity related problems are root causes connected to the unavailability of enough equipment to deal with peaks of production, mainly for material transportation. It is interesting to note that this problem was solved by the second month. Finally, planning problems are related to layout, unanticipated need for equipment maintenance and subcontractors coordination.

CONCLUDING REMARKS

The andon system was under operation only during two months by the time this paper was produced and so much cannot quantitatively be concluded. Notwithstanding it is interesting that the number of work stoppages was reduced significantly. This gives credit to the influence of andon at providing a better work flow management on site. Moreover, communication was greatly enhanced, due to the need to enforce the system and discussion about its proper operation. More important than that, the labour force gradually understood that a new balance of power was being introduced on site: labour demands in connection to production took precedence over other site management more bureaucratic functions like cost control and payroll. Confidence on the system grew as it was perceived that management was able to serve labour demands. Transparency was enacted as production problems were readily reported, discussed and analysed. Visual signs, like the control panel, graphical statistics and availability of andon buttons at every storey were a physical evocation that problems are not to be dealt with silently and without grasping everyone's attention.

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