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Emergence of Gemba Kaizen in Construction Industry

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ABSTRACT: Today, organizations worldwide from manufacturers, to hospitals, to banks, to software developers, to governments are making a difference by adopting kaizen philosophies, mind-sets, and methodologies. Even though the names of these strategies may change over the decades from continuous quality improvement and total quality management, to just-in-time and operational excellence, to six sigma and lean manufacturing, the most successful of these strategies are customer-focused, gemba-oriented, and kaizen-driven. Kaizen is one of the principles that support the Toyota Production System (TPS) as a philosophy. Thus, it is tried to use it in the field of Construction Industry (CI) because of its inherent characteristics of production. And hence a model was developed to aid the professional of the CI to systematically advance a kaizen project with the use of diagnostic tools and analysis of the production system. The research method is defined by three sequential steps governed by two research strategies: theoretical-conceptual - for the literature review and development of the model, and action-research - aiming the implementation of the model in a building site for housing production. As a result of the action-research strategy, using the model, nine problems as well as their roots and kaizen opportunities were identified and classified in the productive system. The systematization of the generation of kaizen opportunities for the CI contributes directly to the quality of the final products and to the reduction of costs of building sites, because it allows for continuous improvements of processes based on higher levels of value added with the reduction of the use of resources in the production system.

KEYWORDS*:* Kaizen driven; Construction industry; Toyota production system; Gemba oriented.

I. INTRODUCTION

The term “kaizen” was introduced in America in 1986 with the publication of Masaaki Imai’s book, Kaizen: The Key to Japan’s Competitive Success, which became widely used and accepted among industrial managers and companies that make use of this philosophy. Imai (2012) explains that in the Japanese language, kaizen means “continuous improvement” and that, in practice, it seeks to involve all the participants of the process that is being analyzed at a relatively low cost for the company. The continuous improvement of processes is one of the principles that govern the essence of the Toyota Production System (TPS). In this regard, Shingo (1987, 2010) presents a scientific model for the implementation of improvements in industrial processes, based on a series of questions and initiatives that encourage the identification, analysis and solution of problems, called the Scientific Thinking Mechanism (STM), which formed the basis for the development of the model. The STM is a flowchart comprising five main phases that encompass philosophies and techniques that lead to a final outcome, represented by the implementation of the proposed intervention. According to Berndtsson & Hansson (2000) and Brunet & New (2003), a kaizen (and the techniques for its development) can be adapted to fit the circumstances of each company or sector. Thus, this paper proposes the development of a model for kaizen opportunities regarding the context of traditional building sites. To this end, a flowchart was developed with the same essence as that of Shingo’s original model, but including significant changes involving the operationalization of the phases that make up the structure of the new adapted model. The modifications include the use of analytical techniques such as Value Stream Mapping (VSM) and Line of Balance (LOB), in addition to the systematization of the relationship of the problems identified with the workflow activities and with those relating to processes and operations. Another modification is the inclusion of the relationship between the formulation of the improvements and the principles of the TPS. Therefore, regarding the model, the outcome is a flowchart constituted by four macro-steps that contain tasks organized systematically, which lead the professional to the identification and classification of problems in the production system, going through the selection of the most appropriate improvement and its subsequent implementation.

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II. RESEARCH HYPOTHESIS AND OBJECTIVES

II.1 RESEARCH HYPOTHESIS

In view of the presented facts, the following research hypothesis is highlighted: the adoption of Lean concepts and tools must be made considering the whole, i.e., trying to understand the behavior and the consequences of the changes implemented in the building sites. This involves professionals, costs, equipment, techniques and technologies. Thus, for the proposition of changes it is necessary to identify and understand the problem, find its causes and, then, propose improvements for viability analysis in a systematic way to, finally, implement them.

II.2 RESEARCH OBJECTIVES

The main objective is to provide a model for guiding the systemized development of kaizen projects in production processes of the CI.

III. METHOD AND RESEARCH APPROACHES

In Chart 1, the steps that were completed for the development and completion of this paper can be found associated with the corresponding research approaches. Such approaches will be properly justified and conceptualized in this same chapter. In Chart 1 it is noted that the activities were separated in three sequential steps. The first is essentially conceptual and discusses important topics for the theoretical foundation of the flowchart and for the results related to its validation; for this reason, a bibliographic review was carried out using journals and books. The second step, being the main result and the contribution of this paper, involved the development of the model for the kaizen projects identified by the flowchart that will be detailed later. The last step is identified by the validation of the flowchart obtained from its application in a construction company with the participation of various professionals from one of the building sites of the company, in addition to the analysis of the results from this validation. This participation was fulfilled through meetings and data collection in the building site. This information and its processing in the flowchart will be detailed in the results section. With respect to the research approaches, Gil (2002) considers them as the most important procedure for designing a study, considering the data collection for each step. According to Berto & Nakano (2000), the research approaches seek to guide the investigation process, conditioning and systematizing the various activities that form the research such as the bibliographic review, data collection procedures, discussion and analysis of results, etc. Thus, regarding the objectives of each of the three steps, a research approach was associated. For the first and second stages, the theoretical-conceptual approach was adopted. Thesis considered an appropriate approach for these steps because, according to Berto & Nakano (2000), it is an approach that seeks to promote conceptual discussions from the bibliographic review, justifying the first step. In addition, the referred authors consider that this approach guides the research for the development of conceptual models that can be based on the perception and experiences of the researchers, which justifies this approach to the second step. For the third step, the action-research approach was adopted because this step is the validation of the proposed model. Action-research is, according to Coughlan & Coghlan (2002), an interactive approach that requires the participation of researchers and people who act on the place or institution in which the action-research is being applied. The authors show that this approach focuses on the development of research in the action and not on the action. Thus, the use of action-research is justified because there was the need to validate the proposed model for obtaining the results regarding its performance. This was done applying the flowchart in a real situation that counted with the participation of the researchers and several professionals of the collaborative enterprise.

IV. BASIC THEORETICAL REFERENCE

IV.1 Kaizen

Continuous improvement (kaizen) is one of the concepts that underpin the TPS. Authors like Alukal & Manos (2006), Martin & Osterling (2007), Doolen et al. (2008), Forbes & Ahmed (2011) consider that kaizen represents an action that promotes beneficial changes in a structure of continuous learning and improvement In the context of the CI, it can be considered that the kaizen concept is essentially the same as described in the previous paragraphs. However, the major obstacle in applying these concepts to construction are related to the environment in which kaizen events are usually practiced and described, i.e., in the manufacturing industry, which differ much from the CI. Deficiencies in the design process, and hence in the production, cause frequent and unexpected failures in construction. In a way, this promotes rushed decisions, which in most cases are based on the practical experience of managers and workers. This takes place

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without any kind of scientific systematization to ensure that the decision is the best one and that the problem will be effectively solved.

IV.2 The Scientific Thinking Mechanism – STM

In the context of integrated continuous improvement, as foundation of the TPS, Shingo (1987, 1990, 2010) proposes a scientific approach to identify problems, propose and develop improvements, and implement them in a systematic flow-oriented organization. Shingo (1987, 1990, 2010) shows the STM in a preliminary phase and four main phases, which will be identified and briefly analyzed in the following sections.

a) Preliminary Stage: In essence, Shingo (2010) structures the systematization of the STM starting with the Preliminary Stage, in which the author assumes that the process must be analyzed considering its division into groups of elements, so that the complexities of the process are reduced to manageable elements, in which the problems can be more easily identified;

b) Identification of the problem: Shingo (2010) believes that an improvement or the development of a kaizen should take place only after those involved have gained an in-depth understanding of the identified problem. Thus, according to the STM, the resolution of a problem involves three essential steps, namely: identify the problem, clarify the problem, and discover its cause. Thus, the first stage of the STM must provide the recognition of the problems and the consequent motivation to break paradigms, which suggests the beginning of the development for improvements;

c) Basic Approaches for Improvement: Shingo (1987, 1990, 2010) emphasizes that the professionals should: understand the facts with great level of detail, quantitatively instead of qualitatively; think in terms of categorical principles to understand the phenomenon, classifying it in such categories. Thus, this author affirms that companies must analyze the productive system from two approaches: procedural (to identify the course of changes on the object in question) and operational (to analyze the course of the changes in the responsible agent). Therefore the professionals should: focus on the objectives, recognize multiple proposals and search for objectives of greater complexity, leading to an understanding of the status-quo of the productive system;

Chart 1. Research method and used approaches.

Step	Activity	Research Approaches
1	Development of basic theoretical reference: kaizen; STM	Theoretical-Conceptual
2	Development of the model for kaizen projects	Theoretical-Conceptual
3	Validation of the model, data collection, elaboration of the LOB and VSM, meetings	Action-Research

d) Making plans for improvement: In this stage, the plans for improvements should be understood and developed from scientific and creative criteria developed by brainstorming methods. In this sense, Shingo cherishes four principles: do not criticize any idea, obey unusual ideas, generate the maximum amount possible of ideas and associate the ideas;

e) **Translating Plans into Reality:** The last stage of the STM promotes the use of proposals for improvements. Shingo (2010) draws attention to possible objections that can appear even during the implementation of the proposals. The author shows that such objections can be coherent in some cases. However, it is necessary that the professional learn to discern what can really be an impediment to changes.

V. THE PROPOSED MODEL

It is understood that the STM, under the operational point of view, is somewhat subjective. During the explanation of the stages, Shingo (1987, 1990, 2010) just focuses much more on the philosophy behind the steps than on the tools that should be used. Many of the solutions adopted and cited as examples in his works were designed on the basis of his own observations; this makes the implementation of the mechanism difficult to any professional. This becomes especially complicated for the use of the STM in the CI, for reasons already demonstrated. Thus, in an attempt to improve the operability of the STM for use in the CI, the characteristics of the model are presented below in Figure 1, regarding the elucidation from its four stages. The model aims to guide the professional, concerning the activities that should be performed, by inclusion of tools and questions of the yes or no type, avoiding ambiguities and errors during the process.

a) Stage I- Problem Identification: In the same way that the STM describes in its second stage, this step has as an objective the identification of the problems that are affecting the production on the perspective of the Lean Thinking. Thus, techniques such as the VSM and the LOB were inserted. The VSM is largely used in manufacturing to diagnose current situations and establish future states of improvement. The LOB technique gives, for example, a graphical view of the rhythms of production. However, in the context of the CI, it is suggested that the application of these tools should not be limited to the building site, but should be extended to the level of planning, since it is at this stage that the waste of resources can be avoided. According to this reasoning, the model provides an initial application of the techniques, based on the planning of the construction and on the strategies for implementing the project. For this, the first step is the execution of a diagnosis in the planning level, with the elaboration of VSM and LOB. The importance of the use of the VSM and LOB is highlighted because they are tools that help the professional to see what is happening with the production system, i.e., they can reveal the status quo of the system, as suggested by Shingo in their works. The

b) Stage II - Exploring the Problem: Stage 2, basically, consists in the classification of the problem identified with VSM and LOB. The categorization of the problem is important because, according to Shingo (2010), the science deals with the systematic classification of knowledge. This reasoning can be applied, according to the referred author, for fast and accurate resolution of problems aiming for the elimination of ambiguities. Thus, in Stage 2 the problem should be discussed by the coordinators and subsequently classified. It is mandatory to clarify that the development and implementation of the second stage depend on the level of integration of teams and the coordinators. In order to identify the root of the problem, it is necessary that the coordinators and other professionals hold frequent meetings as many times as necessary until they reach a consensus that the problem has been satisfactorily identified and classified. Therefore Finally, after knowing the reasons for the problems found in Stage 1 and classifying them, the direction in which to guide the improvements is defined. With this, Stage 3 starts.

c) **Stage 3 - Creating Improvement Proposals:** The beginning of the development of the proposals for the evolution of the production system should contemplate both the scientific approach and the creative approach (Shingo, 2010). The author considers that the improvements are originated from mental flexibility, with the precept that there are multiple paths to the same goal. In this way, the model has contemplated both science and creativity for the development of improvements. Like it is with the meetings among professionals in Stage 2, generating ideas will only be successful with integration of multidisciplinary teams. Thus, scientific and creative approaches should be examined at different times to enable everyone to contribute to the *kaizen*. It is considered that the first approach to be executed should the creative one so that, later, the generated ideas pass through the sieve of the scientific approach. For the development of a creative approach, it is considered that, as in the STM, the brainstorming is an appropriate technique for the free reasoning of the professionals. Once developed, the proposal must pass through two trials in Stage 3. The first is relatively simple and questions whether the proposal really solved the last “Why” of Stage 2. Obviously, if the proposal does not attend satisfactorily the resolution of the root of the problem, then new proposals should be generated. For this reason, it is necessary for the professionals to be in agreement and convinced that the root was really solved. The second trial depends on the knowledge and mastery of the professionals regarding the principles of the Lean Thinking. This sieve questions whether the idea generated is aligned with these principles.

d) Stage 4 - Implementation Viability: The purpose of this stage is to define the parameters that set up the implementation of improvements. For this reason, a VSM of the future state is drawn with the proposals for improvement, resulting from Stage 3. Once done, indicators (productivity, waste of resources etc.) should be defined, which will serve to describe the current state, control the process and determine whether the solution has brought the expected benefits. Then, the model guides the professional to the elaboration of the planning of proposals, in which some aspects should be defined, such as: activities to be carried out, the methodology to be used, responsibilities for the control and execution of activities and dates for verification and evaluation of the process. In sequence, the model

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provides the implementation of defined plans and the continuous control of the process to ensure that the improvements are understood and preserved over time.

VI. APPLYING THE PROPOSED MODEL:

Here, more details will be presented about the action-research and the results obtained with it. Concepts relating to the way the LOB and VSM should be elaborated will not be elucidated, since the concepts that determine its development were respected. These concepts can be found in works like Arditi et al. (2002) and Rother & Shook (2003) respectively.

6.1 Description of the project:

The project is characterized as a closed condominium, located in the city of Bangalore. The condominium will consist of 76 middle class houses with two decks, with a total of 120 m^2 of construction for each house. The houses were built in structural masonry concrete block and are composed of three bedrooms, living room, dining room, balcony, separate toilet and bathroom. The production unit (batch) was chosen as being a set of two houses because the company starts the units in this way, i.e. two houses per production team. For this article, 37 lots was the effective amount of units considered to be produced, seeing that houses 65 and 66 were completed and being used as office and show-room, respectively.

6.2 The action-research

Among the companies with which contact was kept for conducting the studies, it was decided the choice of building companies that had works (horizontal or vertical) with defined schedule, showing interest in the implementation of Lean concepts and disposition to collaborate with the required information for the research. Thus, in a first moment, the central office of the selected building site was visited in order to present the concepts related to *Lean Thinking*. In these meetings, one of the coordinators of the contracts of the company, the construction manager, trainee engineers and employees were present. The professionals, especially the coordinator and the manager, already presented a good knowledge of the principles of the philosophy; so the meetings were important to level the knowledge among the participants.

With the concepts and objectives common to all, the coordinator agreed to apply the developed model in the building site. Thus, Stage 1 of the flowchart was initiated which, basically, seeks to diagnose the production system. For this reason, data about the planning of the project was requested from the company; the long term schedule was provided.

With this information, the LOB of the initial plan was elaborated, to be demonstrated in the results. From the analysis of this initial plan, a series of essential information for the diagnostic process was obtained. In addition to the LOB, the current macro VSM was also developed concerning the activities of the execution of a batch. For the development of the current VSM, the dates of the beginning and of the end of the activities, the teams involved and the production planning and control scheme were requested. The latter was obtained from the interviews with the planning team, the coordinator and also with those in charge of the construction. On the basis of the VSM presented, the composition of the lead time (processing activities, workflow activities and operations flow) of the production unit was determined. It should be highlighted that, in addition to the data provided by the company, observations were made concerning the behavior of the building site. These comments were necessary to understand the dynamics of the work teams, transport, the waiting for part of the teams and the regularity and duration of inspections of services. This was done after 5 visits along 10 days. For collecting this information, the researchers observed the activities in the work site and recorded the information using stopwatches and a camera. With the analysis of the LOB and current VSM, together with the information collected in the own building site, problems were identified and understood, in consensus with the construction company, as being of strategic and operational order. This meeting was held in the office of the construction site and had as participants the construction team (counting with the coordinator of contracts, the construction foreman and the engineers in charge of quality control and planning) and the team of researchers. The main objective of the meeting was to present the problems found in the analysis of the initial planning and that which was executed (macro level) for their classification and for the discussion of possible sources of these problems. In that meeting, the macro diagnosis made was explained regarding the LOB and VSM results, in addition to the observation recorded in the visits to the building site. From this point on, the reasons for the problems

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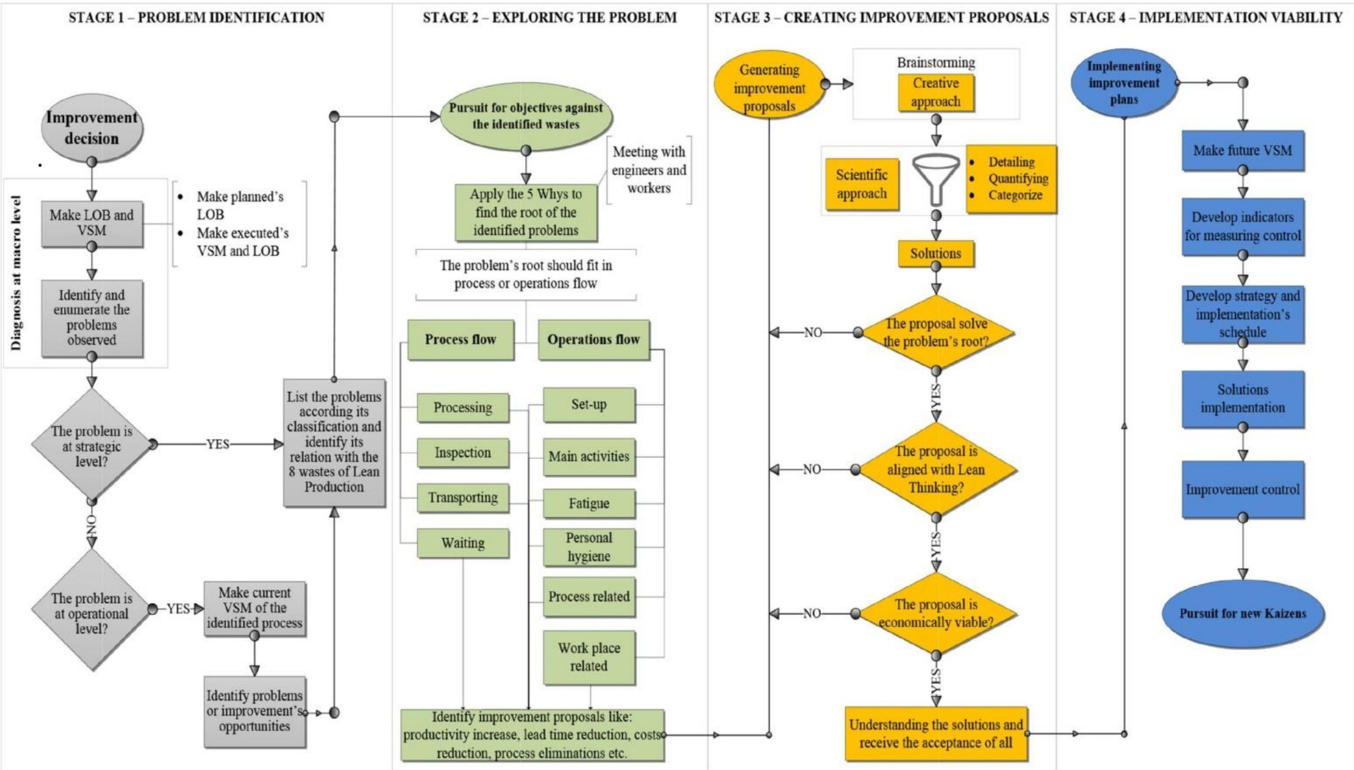
Figure 1. Flowchart of the proposed model.



were discussed aiming to find their origin, which soon would be classified and analyzed by all participants, to propose ways that would guide the final proposals for improvement. Stage 3 also had its development considering the meetings held in Stage 2, in which the opportunities for *kaizen* were proposed, passing by all sieves of the flowchart. Stage 4 was not implemented in the company during the development of the research, since it depended solely on the construction company. In this paper, only the presentation of *kaizens* originated from the model and considered possible to be implemented by the construction company are discussed.

6.3 Results

As shown, the processing of Stage 1 depends on the elaboration of the LOB and VSM for the analysis of the behavior of the production system, both for the planned production and for the performance of the production. Thus, as part of the results of the model, Figure 2 demonstrates the LOB that was elaborated from the initial planning of the company. It can be noted, analyzing Figure 2, that the strategy of execution of the work deserves a more rigorous planning, focused on the reduction of the transport of material, facilitation of access and on the movement of people and equipment, considering that, as the construction of the houses advances, the distance between the access points and the production areas also increase. According to the planning data, a production unit would be produced in 192 working days on average (approximately nine months), of which 36.9% are processing activities (PA), 62.5% are workflow activities (WA) and 0.65% are flow of operations (FO) for the internal customer (Table 1). These data are the result of the analysis of the times of services and of the long waits between these for each production unit.
This information propose, at the beginning, an unfavorable scenario for the project in the sense that only 36.9% of the total time invested to perform a unit is adding value to the product, while the rest of the time the unit is stored, waiting to be processed. This, indeed, is a problem which must be eliminated. It was observed, moreover, that the construction does not have a defined building site layout design, which connects the model of production with the conditions of the

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work space. The absence of this design is evidenced in the absence of flagged movement corridors, in the chosen sequencing of implementation, in the location of storage for mortar and grouting, among other aspects observed during the visits. Turning to another point it was noticed that, in several stages of planning, the activities have different rhythms, in part because there is not a structured plan indicating the amount and composition of the teams that will perform the services. This feature reduces the reliability of planning, hinders the synchronization of services, encourages the creation of idle times, waits and inventories (work in progress) and makes it difficult to control the production because of the the lack of a comparison standard. In the sequence of the proposed model, the LOB of what was being executed was developed as previously described; this is represented in Figure 3.

On the other hand, it was noticed that several teams were included in certain stages of labor to increase production. However, in some cases this had no continuity in subsequent activities, generating intermediate stocks of finished sub products. Continuing with the flowchart, the next step was the elaboration of the current macro VSM (Figure4).
Considering the VSM in Figure4, the composition of the lead time (processing activities-PA, workflow activities-WA and flow of operations-FO) of a batch was determined. Table 2 shows the time in hours and days for each of the components of the lead time and, additionally, shows its percentage.

These values were obtained from the average of the values presented in the 37 production units, both for workflow activities and for the activities which add value to the internal and final customer. From the Tables 1 and 2, it is possible to perceive differences in the composition of the lead time between the planned and what is being executed. However, as previously stated, these proposals were not implemented by the company during the research. Because of this, for Stage 4, the *kaizens* were only indicated, since the application of the improvements was in charge of the leaders of the construction company. Therefore, considering the identification of the purposes of improvement, the *kaizens* generated in Stage 4 were: to use the LOB and the VSM as tools to support the planning of the construction; to define the strategies of implementation throughout the development of the building site with its own design and the usage of tools such as the Spaghetti diagram in conjunction with the VSM; to improve the structure of material supplying with the use of *Kanbans*; to eliminate intermediate inventories (material and service), also with the use of *Kanbans*; to decrease the use of resources, especially of manpower, so that the cycle times of activities comes closer to the *tact* time.

VII. ANALYSIS AND CONSIDERATIONS

The proposed model represents a contribution to the process of systematic development of improvements in the building sites. This model is based both in theory and in practice. In regard to theoretical foundations, it is observed that its foundations are the STM of Shingo, which discusses the implementation of improvements from a concept that aims to develop teamwork, encourages the discussion of problems and solutions, links up scientific and creative approaches and, finally, prioritizes continuous, but durable along time (*kaizen*) improvements above the radical improvements (*kaikaku*). It is considered that the model deals with a flow-oriented structure, systematic and practical that will favor the identification of problems and their roots, the meeting of solutions and improvements and, finally, to the implementation of the proposals.

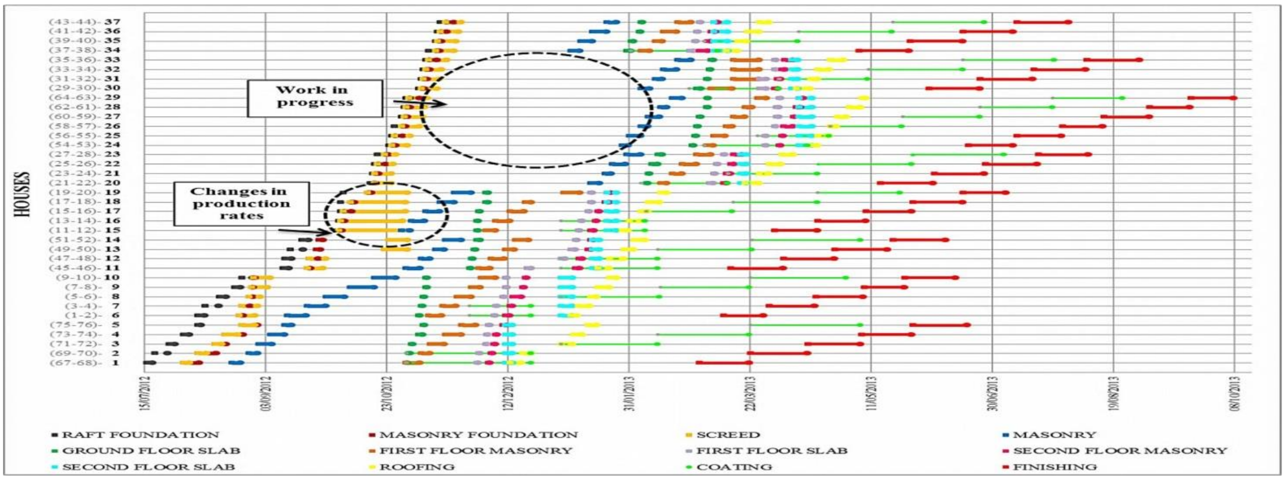

Figure 2. Planned Line of Balance.

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Analyzing the model in the light of action-research, it was observed that the techniques and the procedure adopted for the identification of problems were adequate for the work site analyzed and provided the identification and quantification of the waste of resources, as well as the situations in divergence with the *Lean* concepts and principles. On the other hand, Stage 2 provided the means to identify the real cause of the problems (origins) and not simply its consequences, enabling the proposition and implementation of more efficient future solutions that will resolve the problems definitely. In Stage 3, the advantages that produces the *brainstorming* between those in charge of the direction were evidenced allowing for the execution and control of the construction under the creative and scientific approaches. The sequence of questioning ensured the production of economically and technically feasible ideas, being aligned with the *Lean* philosophy and focused on the final resolution of the problems found. Some conclusions can be recorded with relation to the planning used by the company with the use of the model, such as: (a) the company does not have Stage 2 provided the means to identify the real cause of the problems (origins) and not simply its consequences, enabling the proposition and implementation of more efficient future solutions that will resolve the problems definitely. In Stage 3, the advantages that produces the *brainstorming* between those in charge of the direction were evidenced allowing for the execution and control of the construction under the creative and scientific approaches. The sequence of questioning ensured the production of economically and technically feasible ideas, being aligned with the *Lean* philosophy and focused on the final resolution of the problems found. Stage 2 provided the means to identify the real cause of the problems (origins) and not simply its consequences, enabling the proposition and implementation of more efficient future solutions that will resolve the problems definitely. In Stage 3, the advantages that produces the *brainstorming* between those in charge of the direction were evidenced allowing for the execution and control of the construction under the creative and scientific approaches. The sequence of questioning ensured the production of economically and technically feasible ideas, being aligned with the *Lean* philosophy and focused on the final resolution of the problems found.

Table 1. Composition of theoretical lead time - planning

Lead Time Composition	Time (Hours)	Time (Days)	Percentage Composition
Processing Activities (PA)	636.8	70.8	36.9%
Workflow Activities (WA)	1079	119.9	62.5%
Flow of Operations (FO)	12.00	1.3	0.6%
`Lead Time	**1728**	**4323**	**100%**

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Figure 3. Executed Line of Balance.

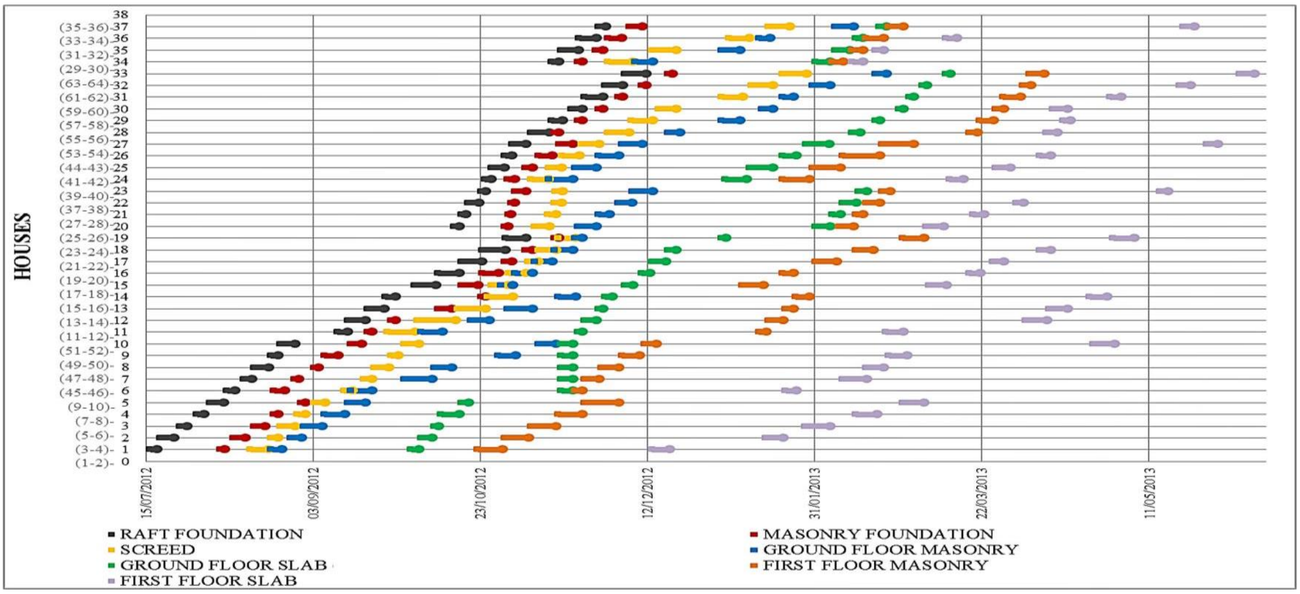

Figure 4. Value Stream Mapping of the executed work.

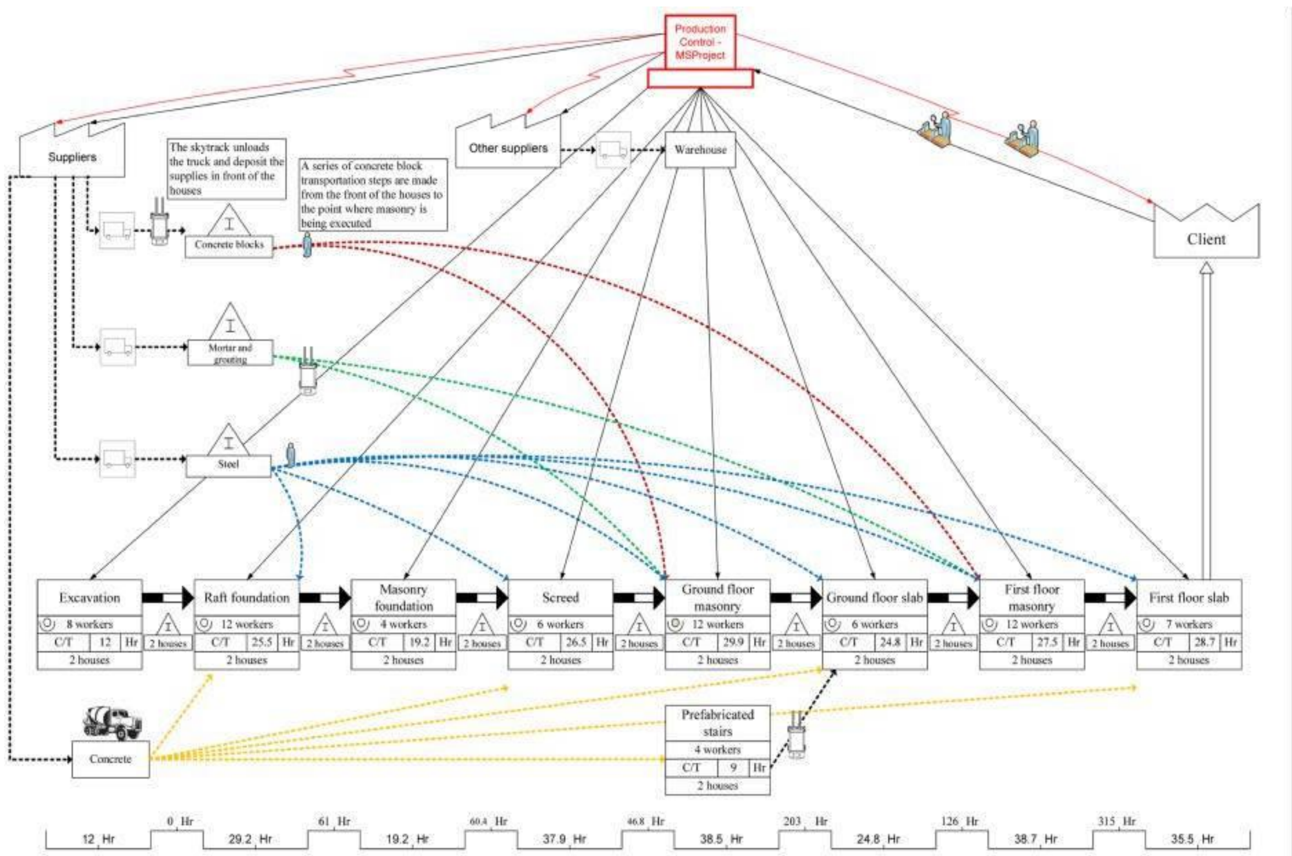

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Table 2. Composition of real lead time - executed

Lead Time Composition	Time (Hours)	Time (Days)	Percentage Composition
Processing Activities (PA)	223.9	24.9	21.3%
Workflow Activities (WA)	813.1	90.3	77.4%
Flow of Operations (FO)	13.3	1.5	1.3%
`Lead Time	**1050**	**116.7**	**100**

Chart 2. Problems, roots, classification and proposal for improvement.

No.	Problems	Root of the problem	Classification	Identify purpose of improvement
1	There was no site plan indicating the size and location of work areas, determining the sequence of execution and specifications for the roads for access and circulation of people and construction supplies.	Although the company's procedures include such a plan, it was not prepared for this particular construction site because it was overlooked at the beginning of the project.	Preparation and adjustment	Mechanisms should be created to ensure that the work does not start without putting in place certain input elements such as, in this case, the construction site plan.
2	The construction plan foresees high production lead times, including long intervals of idle time.	**1**. The planning activities lack defined parameters, such as teams involved, cycle times, processing times, etc. **2**. Techniques such as LOB are not used to synchronize activities and reduce the work in progress.	Idle time or wait time, specifically related to	Establish parameters for each activity (workers, cycle time, lead time, work elements) and use the LOB as the basis for detailed
3	There is no clear definition of the pace of production activities. Lack of	Planning is based on the concept of pushing production rather than on		

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	synchronization among processes.	pulling production.	processing, processing.	planning of the Gantt method, and link it with the bank's financing plan.
4	The execution strategy encourages the simultaneous opening of several work fronts. Forced production.	The bank financing scheme foresees the release of installments of the loan based on the advance of the construction work, sometimes leading to the opening of new work fronts in order to accelerate the pace.		
5	The planned work is not monitored as closely as it should be.	The root of this problem lies in the culture of construction in this country, where planning is seen as a necessary tool. However, the reality is that planning is often not followed due to uncertainties regarding factors such as labor and climate. This leads to fragmented and poorly controlled production.	Processing.	Transform planning into a reliable technique to serve as a model for controlling the execution of the construction project.
6	Changes in the pace of production (increase or decrease in the team sizes) without specific goals.	The workers, possibly due to the hiring scheme, display instability (inconstancy). This leads to uncertainties that are reflected in protectionist decisions that seek to take advantage of boom times in the demand for labor to produce more and to balance periods of decline.	Specifically related to processing.	Improve or change the labor hiring method.
7	The difference between cycle times and tact time reveals excessive labor available for the execution of some tasks.	The uncertainties that cause variations in the work market lead to the practice of incrementing the hiring of workers, whenever possible, to offset declining demand for labor.	Processing	

8	The material supply scheme still calls for moving materials by hand.	The Skytrack equipment has become the bottleneck in production, because it reduces the cycle time by placing the materials in front of the houses and thus requiring additional moving of materials by hand, which is much slower.	Transportation	The operational planning should consider the cycle time of skytrack equipment and link it with other activities.
9	Inspections cause increase lead times, since they are carried out within the main flow of the chain.	The frequent discoveries of execution errors and low quality have required increased control, resulting in stricter inspections that are more time consuming.	Inspection	Elimination or reduction of inspection time. This activity could also be carried out concomitantly so it does not affect the production lead time.

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