# A New Model of Productivity Management as an aid to Deadline Management

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## Abstract

Most problems involving owners and contractors are caused by failure in meeting completion deadlines in construction. The consequences of these delays are social stress and financial damages. Minimizing the causes of delay systematically and efficiently has always been a key demand in construction and, therefore, a theme of great interest to the Academia. In 2007, one of the biggest companies of the world (with investments higher than 200 billion dollars in the 2009-2014 period) took on this challenge. From a partnership with two Brazilian universities, a new model of productivity management was developed and effectively implemented to aid the deadline management in the construction works of this company. The purpose of this article is to present this management model, namely GEPOP, highlighting some of the achievements associated with its application. Presently, the model has been deployed in a significant number of construction sites of the company and it has promoted substantial changes in the relationship between owners and contractors regarding deadline management.

**Keywords: productivity, management, construction, delays, deadline**

## 1. Introduction

The delays in the conclusion of construction activities in Brazil have caused great concern. Losses from those delays both affect owners and contractors. Owners witness the postponement of their expected share of the results and, therefore, the reduction of the business attractiveness rates. Contractors witness the reduction of their profits, which affect their company's financial health and, in extreme cases, cause the fall of its market value.

When delays become a reality and financial losses are the immediate consequence, conflicts between owners and contractors may be staged in court. In these extreme cases, lawsuits are founded on the bad management of resources in construction sites. Then, a relevant question

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arises: why is such a problem not properly addressed in its origin, that is, in the construction site?

The answer seems to be in the manner how that management is performed. Today, construction management is distant from production. With the advent of subcontract (systematically practiced for more than 20 years), construction supervisors have become "contract supervisors". They do not focus on production, or production management anymore. They have become deadline managers, deadline "jugglers". In the Engineering, Procurement and Construction (EPC) contract model, the responsibility for meeting deadlines is delegated to Contractors. Owners are just supposed to demand the achievement of deadline goals. However, when deadlines are not achieved, it is a problem to know how to proceed: take a reactive or a proactive position.

As delays are systematic, another problem is to determine their cause. One usual justification for delays is the "insufficient resources" - either in quantitative or in qualitative terms. Another one is the labor poor qualification.

It is true that labor scarcity has consequences on productivity. In the past decade, there were lines of workers at the doors of Brazilian construction sites. The large supply allowed for selection, and the most qualified were chosen. Nowadays, the large demand favors a situation in which both well and poor qualified workers are employed. The reflex on productivity is certain. However, this is not the only cause of the deterioration of productivity. It is very easy and, at the same time, very irresponsible to follow this path.

Simply accepting that the amount of resources is insufficient - when instantaneous observations ("Activity Analysis" models) show low rates of labor occupied in direct work - does not seem to be the path to the mitigation of delays either.

The biggest Brazilian owner in terms of volume of construction works in the 2007-2014 period has reacted to the systematic delays in construction in different ways. In one of these approaches, initiated in 2007, it was proved that the delays of the construction activities are a direct consequence of the inefficiency in the use of resources. From this moment, a new approach for the mitigation of delays was conceived. In this perspective, the owner does not only demand the accomplishment of deadline goals, but also plays a direct and proactive role in production, favoring success with deadlines.

## 2. Objective

This work has the purpose of presenting a Model of Productivity Management capable of contributing to the mitigation of one of the main damages caused by the loss of labor efficiency: delays in construction activities.

# 3. Background

## 3.1 A scenario of incomplete information in Brazilian construction enterprises

Brazilian owners have revealed major advances in the management of costs and deadlines lately and a gradual change towards a culture of knowledge management. However, some barriers for an effective knowledge management must be considered: i) the insufficiency of databases; II) the lack of experienced professionals to consolidate the databases; III) the scarcity of available time from supervisors and foremen to collect data; IV) the inexistence of forums for the dissemination of good practices; v) the scarcity of available time for the dissemination of the lessons learned.

The analyses of the owners' management systems reveal that their management of knowledge is not solid yet. One aspect that stands out is the fact that feedback is still limited (information does not flow naturally). There is a general perception that supervisors could have a more decisive performance in the collection of productivity indices and, therefore, participate in a more decisive manner in the consolidation of the owners' planning.

Regarding the contractors' management system, there are no evidences that it operates with more complete information than that of the owners'. Therefore, the expectation of a more consistent planning from contractors is optimistic.

In fact, there are complaints between both owners and contractors. Some examples of the complaints frequently reported by owners are i) the inexistence of commitment with the owners' objectives; ii) the mobilization of management teams with inadequate abilities and competences; iii) the inexistence of a previous mobilization; iv) the lack of a robust planning before the beginning of the construction activities; vi) the inadequate preparation of cost-based schedules; vii) the inconsistent analysis of risks (i.e. the non consideration of risks to the planning by means of multiplying indices).

As the evidences above show, it is possible to understand why deadline and cost problems have become usual in the present Brazilian scenario. The lack of information creates space for the establishment of common sense (and some myths), such as i) safety requirements exert a major impact; ii) owners' requirements are very rigid; iii) contractors' costs are very high; iv) contractors are incompetent; v) contractors do not know how to plan.

Common sense reflects personal experiences; it does not represent the overall Brazilian reality. In practice, it works as a “cognitive shortcut”. Therefore, it is not enough to i) identify the factors influencing productivity; ii) evaluate the independent and joint impact of the influencing factors; iii) discriminate the actors responsible for the factors; iv) support management processes of continuous improvement.

Thus, a management model capable of providing a scenario of complete information, driven by the improvement of productivity is imperative if one considers i) treating the information as an organizational asset (source of competitive advantage) and ii) facing the loss of information as the loss of a financial resource (liability).

Productivity has been commonly associated with the contractors' inability, even though it is generally accepted that owners' actions can influence contractors' performance. Although sensitive to those actions, owners have no idea of the magnitude of their impact on productivity.

ARAUJO et al. (2012) argued that productivity has been usually treated by owners as a matter of increasing the amount of resources. If production is low, the main action to be taken is to increase the amount of resources. Such action can generate conflicts of interests between the actors involved, leading to: i) contractual dispute; ii) extra costs; iii) stress.

The pessimistic scenario presented in Figure 1 corroborates the value of information for companies. Silva (2005) argues that there is a natural tendency to measure the value of information by how much additional gain it brings. For this author, the broadest and most correct concept considers the opportunity cost – i.e. how much the lack of information would cost. In this sense, measuring the value of information is a process similar to those involved in insurance or advertisement – how much "not having it" costs. In this broader approach, information is treated as a resource, possessing cost and value, return rate, opportunity cost. Irrespective of the type of organization - private or public - administrators come from, they make their decisions of investment adopting the principle of the economic rationality: to get the most out of a certain amount of resources or to reduce this amount to achieve a certain result. For this analysis, opportune and quality information is crucial for an efficient administrative performance.

Moresi (2000) believes that the importance of information for organizations is universally accepted. Its management and use are directly related with the desired success. In many organizations, it is considered and used as a structuring factor and a management tool. Thus, an organization effective management requires an objective and precise perception of the values of information and of the information system.

The present authors, therefore, recognize i) the negative implications of the current scenarios of incomplete information in Brazil, worsened by technical, management and commercial significant difficulties during the implementation of new investment portfolios; ii) the existence of difficult scenarios for owners, considering an unknown set of factors to be conveniently evaluated and faced; iii) the value and the power of information. These authors see the Model of Productivity Management as a powerful tool to promote invaluable feedback in the enterprises.

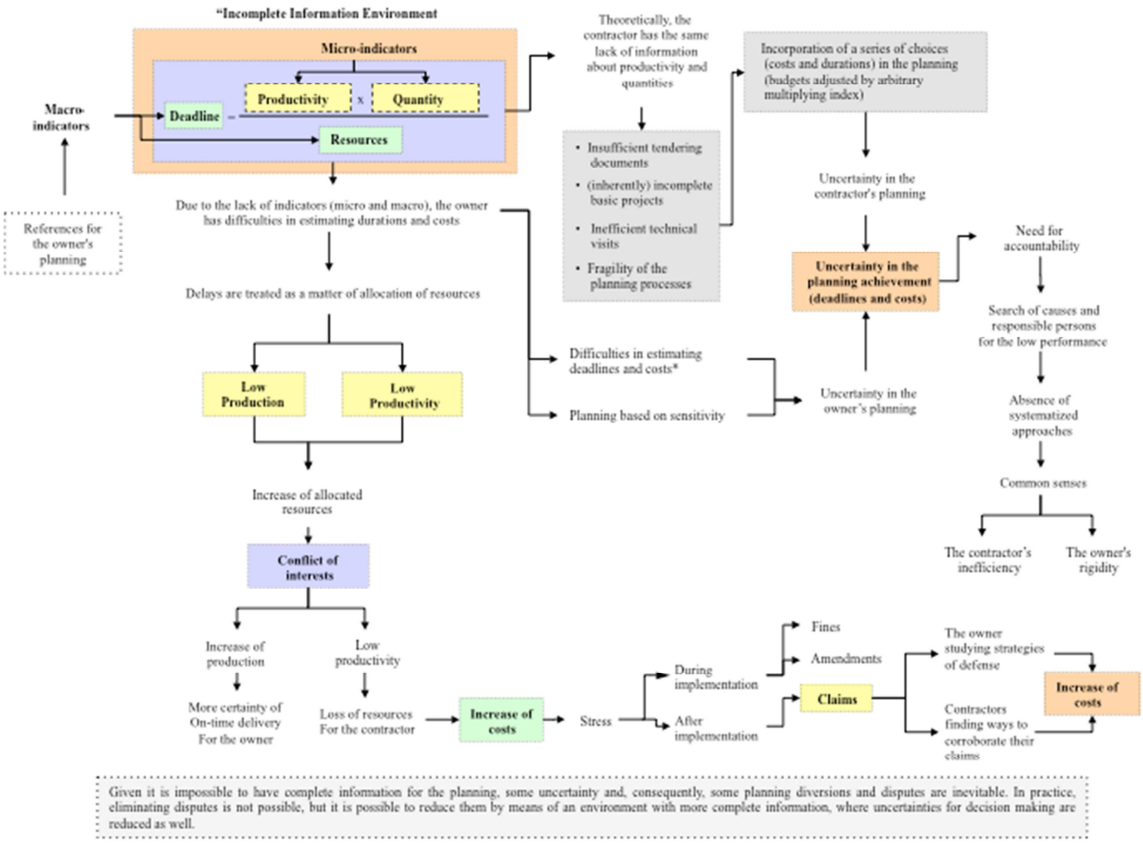


***Figure 1: Scenario of incomplete information***

## 3.2 Concern with the corroboration of claims

Recently published works about productivity loss in the construction sector reveal that discussions and reflections about this theme are almost exclusively turned to the contractors' and owners' concern with disputes. Owners desire to find ways and mechanisms to corroborate their claims, and contractors try to defend themselves, aiming at rejecting those claims.

Discussions about productivity losses, as a result, are reactive and usually promoted when construction activities are already finished. Disputes usually end up in court, with the parties justifying themselves before the judge, and their resolution address financial questions only.

The works reviewed (Thomas (1992); Dieterle and DeEstephanis (1992); Thomas and Napolitan (1994); Singh (2001); Swartzkoph (2004); Thomas (2009); Thomas (2010); Dieterle and Gaines (2011); Guevara (2012)) make evident the concern in systematizing the collection of productivity loss evidences in construction activities to justify future claims. The present authors believe that

the resolution of productivity losses must happen in the construction site, as soon as it is diagnosed.

## 4. Contextualizing the model of productivity management

THOMAS 2010 questioned why the loss of labor efficiency (LOE) damages is so difficult to recover. The reasons pointed by the author refer to the difficulties in justifying productivity losses. He presents and analyzes two broad categories of actions related to evidentiary justification that can be taken to improve contractors' chances of recovering LOE damages.

The above questioning led to the reflection on one previous question: why is loss of work efficiency not mitigated in its origin so that disputes in courts could be avoided? The answer to such a question was very simple: Why not?!!

Then, the development of a model of productivity management began. Its success would ease THOMAS' concerns and all the other previously cited authors'. And that is possible simply because it deals with productivity losses in an opportune place and moment: in the construction site, as soon as it is made evident.

The intended result with the application of the model is the mitigation of construction delays. The adopted path necessarily leads to the treatment of Loss of Labor Efficiency or loss of productivity, and the word treatment is especially important here. The model of productivity management does not aim at collecting evidences to justify losses of productivity for the future use of this information. The success of the model is exactly the mitigation of productivity losses at the moment it occurs.

Particularly for EPC contracts, the scenario of productivity loss is no different. They require extensive knowledge and expertise and, rationally, they should not demand owners' detailed supervision of the resources employed by contractors. However, the systematic delays have made owners review their supervision measures.

The first observations reveal idle resources and symptomatic delays. Productivity losses are usually justified by the observation in site of idle labor force or by the low rates of occupation in direct work, measured by the Activity Analysis.

Thus, from the observation of the primary justification (idleness) and of the significant evidence (construction delays), the largest Brazilian construction owner, in EPC contracts, started the development of a new model to treat productivity losses in partnership with two Brazilian universities - UERJ and UFRJ. This model was called Productivity Management Model - GEPOP.’

## 5. Model of Productivity Management: premises

The Productivity Management Model - GEPOP - considers the reestablishment of crucial information channels to the success of construction projects. Productivity management is based, therefore, in the collection, availability and use of information during construction.

The productivity improvement depends more and more on the capacity of production units to diagnose and combat their inefficiency at the exact moment it occurs. The faster information and knowledge are generated, made available and transmitted, the greater the benefits of their use. The units of production strategically supported by the Productivity Management Model start to count on scenarios of complete information, interrupting the undesired flow previously presented in Figure 1.

There is a major effort to produce better information to support the internal decision making in the production environment. The Model of Productivity Management brings tools (ARAUJO and SAMPAIO 2012) capable of offering information with a high level of detail (ARAUJO et al. 2012) and specific measurement of productivity, labor and other factors associated with productivity losses. The benefits are organized as follows:

1. identify, systematically and independently, the influence of the main actors interested in the productivity;

2. evaluate the impact of contractors' actions on productivity in a quantitative and qualitative manner;

3. contextualize the impressions, perceptions and common senses in light of the data collected in the construction sites;

4. corroborate or reject the impressions, perceptions and common senses;

5. stimulate the collection of productivity measures in owners' construction and assembly services;

6. motivate actions for continuous improvement from the main actors involved;

The Model of Productivity Management assumes that:

1. productivity is influenced by all the stakeholders involved, and the improvement of productivity requires coordinated actions, involving, necessarily, owners (client and engineering) and contractors;

2. the levels of adherence and commitment of stakeholders managers are directly proportional to the success in the critical analysis of the revealed productivity losses;

3. the reduction of uncertainty regarding deadlines and costs demand, in turn, a better knowledge management, allied to a competent management of risks in qualitative and quantitative terms;

4. the implementation of productivity management, founded on a database of productivity measures, constitutes a relevant part of this effort;

5. the validation of the information that will feed into the database must be made by a reputable and independent organization;

6. the quality of the information (evaluated by parameters as data consistency, veracity and reliability) is directly associated with the quality of the improvement actions;

7. it is essential that the information on productivity is made available all the time, allowing for a continuous monitoring of everything that happens in the construction site.

As a result, the potential benefits of the implementation of a Productivity Management Model as a structured program are:

1. support cost management processes;

2. support deadline management processes;

3. support risk management in the processes above;

4. increase the overall reliability of the planning process;

5. early identification of productivity losses;

6. mitigation of the impact of productivity losses;

7. increase the reliability of budgets;

8. mitigate the direct and indirect impacts of productivity losses, including contract disputes;

9. support internal processes of continuous improvement.

The adoption of the Productivity Management Model is not a guarantee of productivity improvement. However, the improvement of productivity will hardly be carried out without such a management model.

It is important to consider that the purpose of a productivity management model is to enable the control of productivity. The control of productivity will be possible from the analyses of the

information made available by the measurement systems. The improvement of productivity will happen through the beneficial cycle promoted by the systematic use of the information generated in this process.

Measuring productivity is the initial step of a Productivity Management Model. Perhaps, the fact that only this step is considered important explains the poor development of that type of model and, therefore, the absence of control mechanisms. Having the best system of productivity measurement is not enough. The effective and systematic control of productivity is equally important. To illustrate the importance of the use of the available information for control, some real cases will be discussed in the next session.

## 6. Model of Productivity Management: application

The application of the Model of Productivity Management is aimed at the improvement of productivity in the ongoing construction contracts. For that, the model enables a thorough analysis of productivity by means of the concept of “productivity stratification” (Araujo et al. 2012). The presentation of the U.R. in “fractions” enables the examination of productivity losses, as its exceeding factors are revealed, identified and quantified all at once.

At this point, it is necessary to analyze the productivity metrics, look deeply at the results for the different categories, compare them with the results obtained in other sites, evaluate daily metrics and the main occurrences and causes for productivity losses. This step should be taken by owners and contractors together. Then, actions should be defined and implemented in order to increase construction productivity, and good practices should be identified. That is the moment to involve all the stakeholders who work to the success of the project.

The Model was applied in three projects involving piping assembly and piping welding. They illustrate improvements and the specific actions behind those improvements.

The first success case of piping assembly is related to a large project in the Refinery of Rio de Janeiro. For this project, the construction productivity was evaluated in three different periods and the increase rates were 64% within three months and 22% two months later (Figure 2). To the first case, the owner gave a great contribution by adapting its safety requirements: improvement of conditions for measuring workers' blood pressure, with exams valid for three days. Workers received a stamp with the expiration of the exam. The gain provided by the Contractor was based on some actions, such as: i) improvement of the communication (all foreman have radio communicators, facilitating the tracking of work areas); ii) better distribution of tasks (distributed on the previous day); iii) reduction of the number of workers per foreman; iv) improvement of the logistics of construction sites (collective ladders instead of sailor ladders).

The second case (Figure 3) is related to another large project: the construction of the Petrochemical Units in Rio de Janeiro. In this case, there was a 60% increase in pile installation

within two months. The productivity program contributed to faster solutions, by promoting the adoption of some main actions: i) the replacement of equipment due to frequent failures; ii) the replacement of the concrete supplier due to frequent delays; iii) the strengthening of support activities (a bulldozer was dedicated to improve the working conditions on the ground).

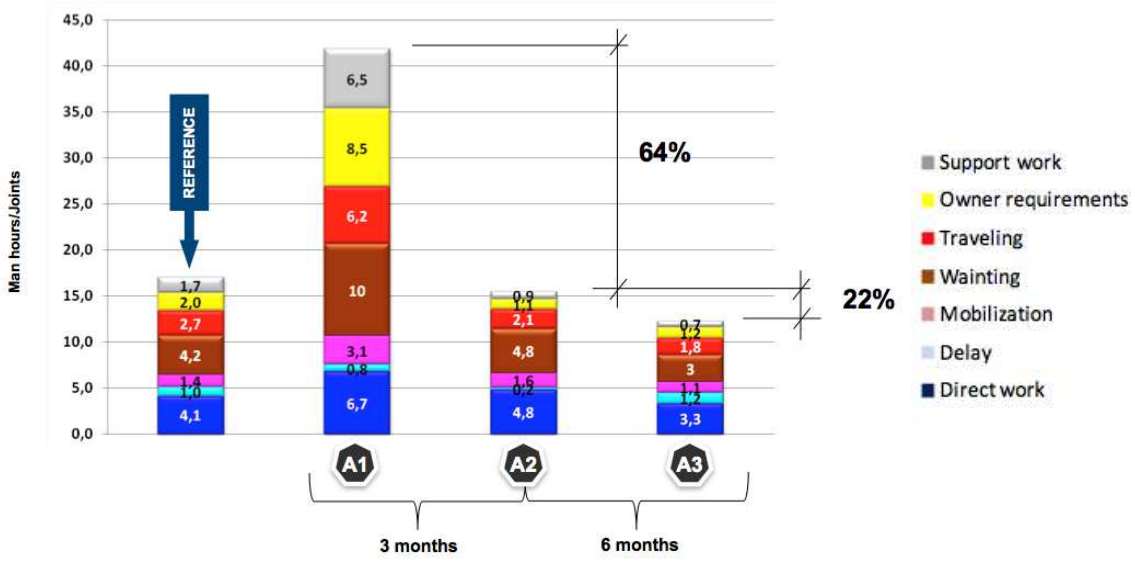


***Figure 2: Case 01***

The systematic monitoring of productivity, as evidenced in Figure 3, allows for comparisons of the construction phases in consecutive periods. This monitoring takes into account the performance in consecutive periods or internally determined references. This type of comparison promotes ACTING, which is a driver for the structuring of the management model. The diagnosis of a period presents points to be debated, demanded and treated. The diagnosis of the following period makes evident the effectiveness of the implemented actions. The repetition of this beneficial cycle is expected to promote a standard behavior of the productivity trend curve: downward. A behavior different from that must be investigated, justified, treated and combated. It must never be ignored.

The third success case (Figure 4), involving piping welding, is related to the Refinery of Campinas. It presented a 63% increase within four months. The main actions implemented in Campinas were i) integration of the teams (planning, production and quality control teams); ii) Improvement of the weekly schedule of activities; iii) definition and monitoring of weekly goals for welding and inspection of joints; iv) reduction of rework; v) implementation of a Weekly Management Productivity Meeting (one hour) with owner and contractor teams.

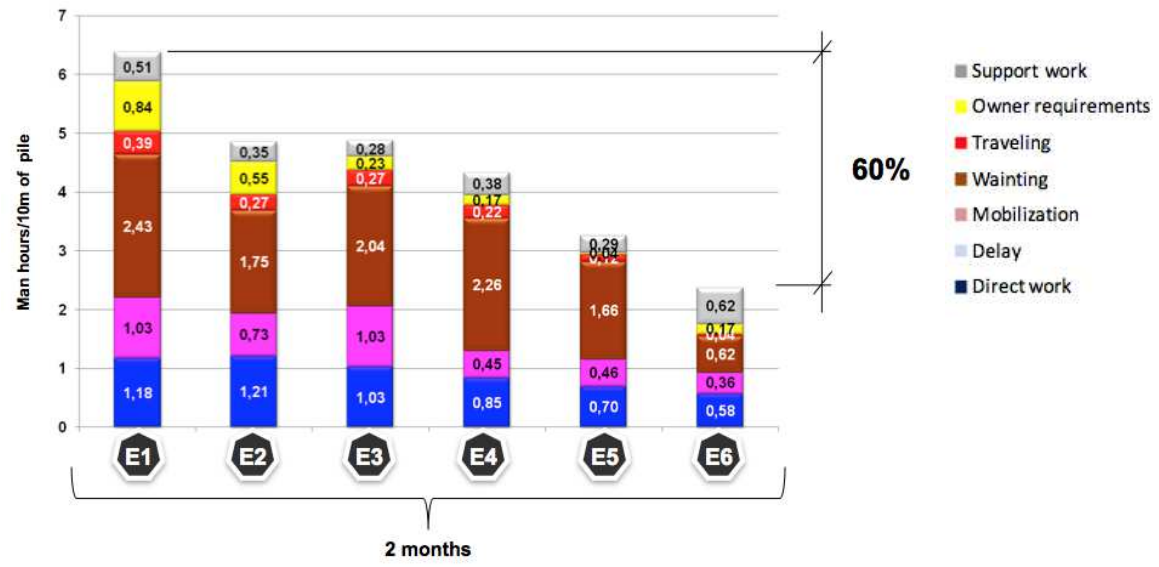


***Figure 3:*** **Case 02**

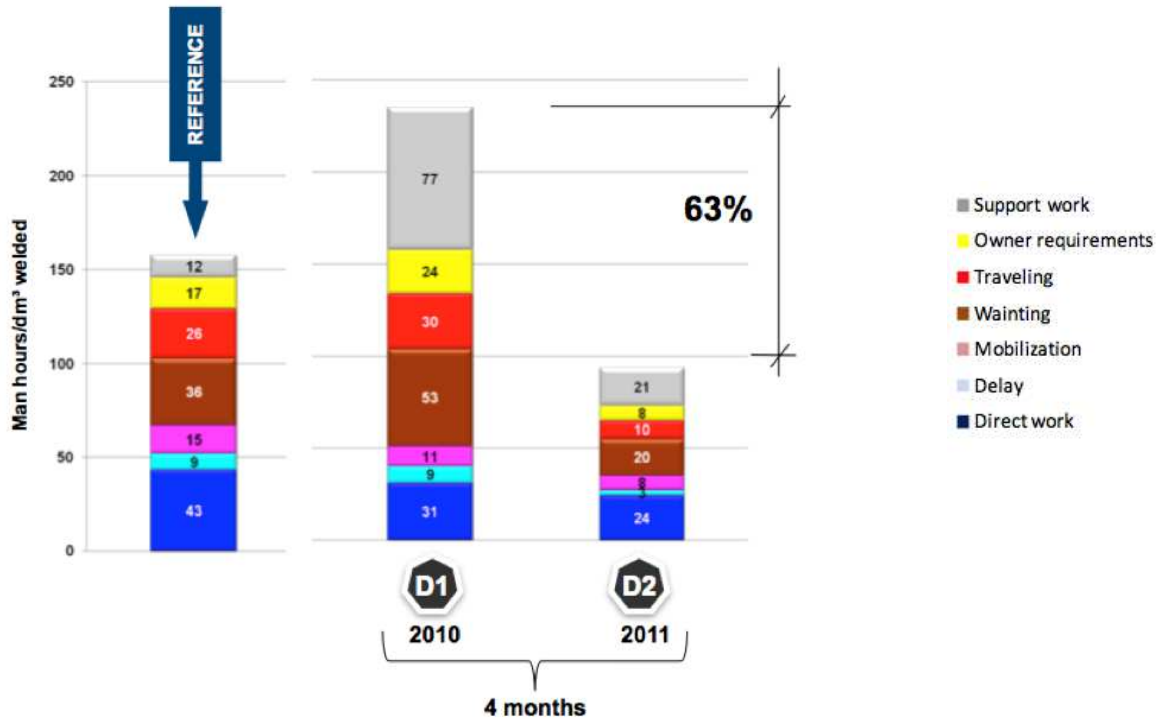


***Figure 4: Case 03***

In all the three cases the productivity was improved. And this was possible due to the vailability of information, which necessarily included the following actions: obtaining, making available and using the information during the construction activities in an effective manner.

## 7. Conclusions

The largest construction owner in Brazil faces productivity control in its EPC contracts as a crucial measure for the mitigation of delays in construction. The Productivity Management Model was conceived to support the management of deadlines in construction works. It considers the availability of information and the proactive use of this information during construction activities. Once productivity losses are estimated, it becomes easier to identify the factors that cause them.

The implementation of this Model enables the control of productivity losses. From the relationship between deadline management and productivity losses demonstrated by ARAUJO et al. 2012, it is possible to state that productivity control is essential to the management of deadlines.

However, some difficulties should be considered. The main difficulties detected in this research were i) lack of comparative references, particularly external metrics; ii) lack of access to the estimated and planned metrics; iii) inability to access the programming activities in order to check the commitment with the tasks that are being executed.

Conversely, the benefits obtained from the implementation of the Model and the effective use of the information available were i) recognize that both owners and contractors have to improve the planning process and optimize site logistics; ii) demonstrate that it is possible to implement improvements in ongoing projects and therefore increase their productivity; iii) actuate directly on the improvements, as soon as the productivity losses are identified and quantified; iv) collect metrics and establish references using comparison charts and starting an internal benchmarking process; v) identify and disseminate best practices that contribute to the increase of productivity.

The major benefits were i) disseminating the productivity culture in both owners and contractors organizations; ii) increasing profitability for contractors; iii) meeting project cost and time targets and, ultimately, the construction result.

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