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An overview of design tools applied in civil construction area at brazilian southeast region

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Abstract. The construction area in Brazil have different challenges to become more productive, efficient and sustainability. The objective is analyze the profile of projects offices at Brazil´s southeast region to determine the design tools used for project development and their characteristics in civil construction area. The strategy was a technical review about this issue in periodic papers and a survey, applied online, for project experts. The results shows that CAD – Computer Aided Design – tools still have more presence and BIM – Building Information Modeling – software is gaining space inside offices, but still have problems that need be resolved. Besides, inside the context, BIM tools have qualities aligned with actual demands that put it in evidence to resolve historical problems at civil construction context.

Keywords: CAD, BIM, Brazilian Southeast productivity, sustainability

1 Introduction

The civil construction industry in Brazil is one of the most important in the country under different aspects. The huge territorial extension combined with the poor infrastructure requires the direct application of the civil area resources. However, when compared to the other industry sectors, is still considered delayed because of the particularities of organization, work division, productive process and product characteristics.

The informatics tools have gained great importance in this scenario. As a direct replacement of the clipboard and handmade draws, the CAD tools - Computer Aided Design - mean a revolution in the design process, making it more productive and effective. Moreover, CAD-Based solutions favor the exchange of tools among the professionals what cover various technological areas such as aeronautics, mechanics and construction. However, the CAD model, specifically for buildings, presents bottlenecks which are difficult to overcome, and thus, the BIM tools - Building Information Modeling - emerge as an option to this problem.

BIM technology has appeared with a different concept. While CAD technology is based on vector information, BIM is based on parametric objects. In this case, it al-

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lows the designer to define a series of objects that make the process more interactive and rich, solving several problems before construction. Furthermore, BIM architecture uses the same file under different disciplines, such as facilities, structure, masonry, foundations, etc. As a result, the higher compatibility among the files improves significantly the project process. This technology has been deployed worldwide in order to adjust its parameters According to [1,2], the implementation of BIM systems requires the adjustment of variables that need to be carefully studied to obtain a better project performance.

In Brazil, BIM technology has been also gaining greater visibility. The Brazilian Army has applied such technology to improve the military projects. Moreover, the Foundation for the Education Development of Sao Paulo State – FDE - has been developing a database to make all its projects using BIM solutions. In addition, builders and developers are increasingly investing on the technology, seeking the benefit of the integration of the construction process and post-construction [3].

Despite the benefits, it is difficult to estimate the technology acceptation degree in the Brazilian building industry. In order to answer this question, the goal of this paper is to analyze the profile of the project offices in Brazilian Southeast, trying to find how kind of technology they are using and its features. The strategy to develop this work is based on a technical review focused on periodical papers as well as a survey that was applied online to experts in projects of the southeast region of Brazil.

2 Technical Review

2.1 – The production of projects and their importance – a national and international context

The concepts of project management and project production are very important and need be carefully studied. In general, many different professionals are involved in the production of buildings, and each one is responsible for a specific part of the process. The production of projects in Brazil is quite different when compared to other countries.

Current construction projects are becoming even more complex and requiring more labor time, especially as the amount of project data and active project participant increase [4,5]. Besides, both projects and management can be defined in a number of ways, but a reasonable view would be that projects are the creation or the extension of assets, and management is the conduct of controlling this activity. Project management can then be seen as the controlled direction of the use of resources in order to achieve this creative process [6].

The construction engineering process presents three stages: planning, design and execution [4]. Each stage is equally important, and carelessness during any stage can cause budget overruns, improper design and construction, and work delays. If the routine planned procedures can be simulated using a reliable data, construction costs can be reasonably estimated, thus providing feedback that can help to control the annual budget, increasing the resource allocation efficiency.

The concepts of [4,5] shows that the organization of the process is aligned to this different actors, that completes the idea of [6], whose definitions are the bases of the

controlling process. All this concepts are linked to effective tools, and informatics tools can be one answer for these questions.

Besides, the importance of the project in the building conception process is very important to avoid errors and minimize the costs and failures. In Brazil, some entrepreneurs understand that the project is a mere expense in the production system, and most of the projects start without all the projects finished [7,8]. According to [8], a largest investment in the project (in all steps) (fig. 1) could reduce the non-provided costs and also can aggregate more quality to the final product. Moreover, it permits a better financial management with reduction of the payments (non-provided mainly) during the process.

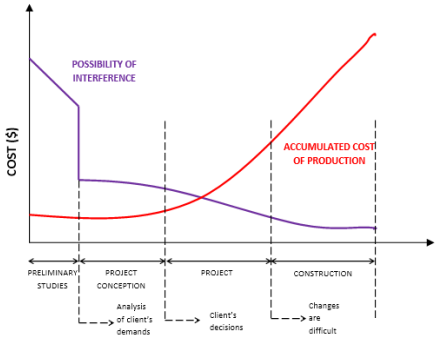

Fig. 1. Investment in Projects [8]

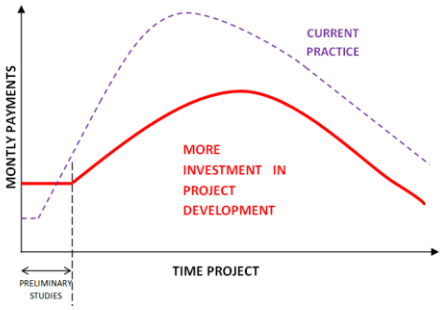

Fig 2. Costs and Monthly Payments [8]

2.2 – Informatics tools used in the project development

To define the most common tools used in the development of projects in the civil construction, it is necessary to study the importance of CAD and BIM tools for the project of buildings.

2.2.1 – CAD Tools

Early applications of computers to assist the stages of engineering began in 1950, when the Massachusetts Institute of Technology (MIT) started the discussion about Computer Aided Design – technology. CAD systems of that generation were limited to the description of two-dimensional geometric entities, creating and manipulating drawings in monochrome graphics terminals. Right now [9], CAD systems present several advantages:

- Ability to send and receive drawings electronically;
- Better management of drawings and information;
- Accuracy in sizing;
- Faster recovery, modification and update of drawings

During the 60s and 80s, the use of CAD systems was limited to large companies, such as aerospace and automotive due to the high costs, involving software, hardware and qualification level of the operators However, at the end of 90s, with the development of the Windows Operating System, there was a migration of the companies to

use Windows-Based tools. As a result, the costs reduced as well as the necessity of the highly skilled users [9].

For the project offices in Brazil, with the popularization of computers was responsible to the gradual migration of manual design processes (clipboard) to the computer and with the advent of the internet, the process became even more streamlined and integrated when compared to the previous stage. This fact has made the *.DWG interface the most popular of all CAD tools into nowadays [9].

2.2.2 – BIM Tools

According to [1] the definitions of BIM are broad and do not have a widely accepted definition. The initial concepts of BIM date back to the first attempts of optimization of information within the CAD platforms (fig. 3). This is a three-dimensional model enriched by additional intelligence (information associated with graphic or parameters). The basis of this technology consists of the graphical information of the model, which includes the construction of the geometric model, its physical characteristic, properties, names and functional peculiarities of the components.

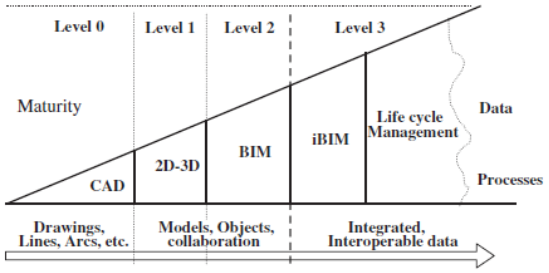

Fig 3. Costs and Monthly Payments [10]

BIM systems are adequate to support the simulation of a construction project in a virtual environment, with the advantage of using software, which means to perform several steps in advance of the construction process, allowing the necessary adjustments before the real work. The assembly instructions can be associated with BIM components. So the visual context of the specific location on the 3D model can assist the communication of such instructions.

The BIM tools involves modeling of information surrounding the production of a building by creating a digital model that integrates all the interfaces that make up a building, covering the entire life cycle of the building, which starts in the project, involves the implementation, use, rehabilitation and demolition.

According to [10], BIM systems have been gradually applied in the worldwide panorama of AEC – Architecture, Engineering and Construction- industries. However, there is no uniformity in the use of the tool. The low demand for BIM customers also becomes a major obstacle to the widespread use of the tool in Canada, with an absorption of 30%. Besides that, in the United States, the AEC market has a greater

use of the tool (50%) viewing the adoption of BIM as an excellent return on investment.

3 Case Study

In order to estimate a degree about the acceptation level of CAD and BIM software in the Brazilian Southeast Context, a survey was applied using a Survey Server (www.surveymonkey.com) to understand the particularities of the design process.

3.1 – Sampling

Twenty-three companies in the Southeast Region of São Paulo were interviewed, being formed by medium and large companies. The profile of the companies (fig. 4) shows that 20% are involved with Residential Building Construction, 42.5% with Commercial Building Construction, 16% with Infrastructural Projects of Roadwork and 22.5% with Infrastructural Projects in general. 40% of the respondents were small/individuals companies and 35% big ones (fig. 5).

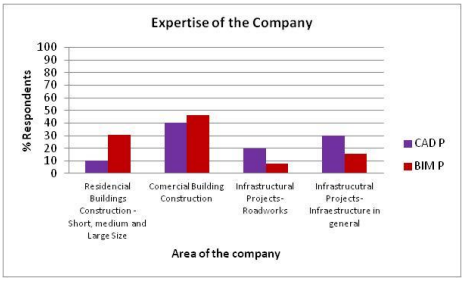

Fig. 4 - Expertise of the Company

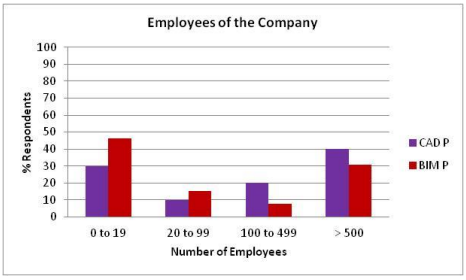

Fig. 5 – Size of the Company

3.2 – Time spent on project development

Analyzing the time spent on project development (fig. 6), is possible to see that BIM tools require more time in the project (52%) when compared with CAD tools (40%). This can be explained by the necessity that the BIM user needs to develop the projects. The project routine in CAD tools permit the omission of several information that cannot be omitted in BIM tools.

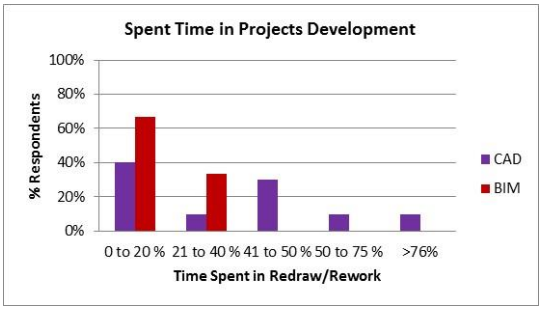

Fig. 6 – Spent time in Projects Development

3.3 – Labor Productivity Coefficients

To know the efficiency of the tools, the labor hour of each solution was compared as presented in fig. 7. This analysis shows that the users of BIM tools spent 50% more time in the development of the project due to the time needed to define all instances. The 4 most cited BIM software in the Brazil Southeast are Revit Architecture®, Revit Structure® and Revit MEP®, from Autodesk Corporation, with 27.5%, 25% and 25%, respectively. Vector Works is used only for 2.5 % of the users. Other specific software solutions were cited by 19% (fig. 8).

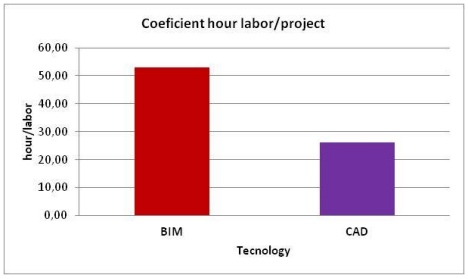

Fig. 7 – Labor/project

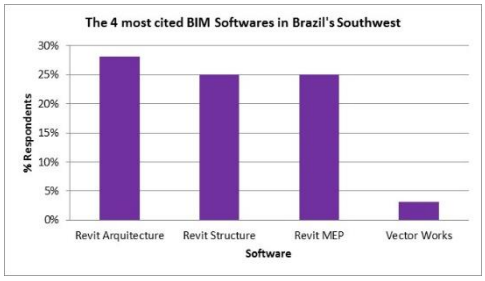

Fig. 8 – The most cited software

4 Discussion

The CAD and BIM tools have particularities that need to be analyzed before comparing both solutions. Nowadays, in Brazil, the construction market is familiarized with the routines and specifications of CAD tools, and the most part of the actors uses this technology proficiently. This characteristic can explain the differences between them.

In the project process, the customer needs different degrees of information, and at this point, CAD tools are more efficient because it needs less information to generate the final product. For BIM tools, is necessary to insert/define more information from the beginning of the project, what requires more time. On the other hand, for the next steps, BIM tools also require less information to continue the development of the projects, what could compensate this time lost at the beginning of the process.

5 Conclusions

Design processes in the civil construction area are very specific because they present some particularities that makes it different from another areas. CAD tools were the first tool applied in large-scale that transformed the project processes, while the BIM tools are considered the CAD evolution. In Brazil the offices are initiating the implementation of BIM tools, increasing the spent time of the users in order to use the tool in the correct way. Besides that, the construction market in Brazil is accustomed with less information projects, where a lot of details are resolved later. This practice increases the price of the products and, in a competitive market, is difficult to take gain.

The construction market in Brazil has grown in the past seven years and the challenge for the growing continuity is to become more efficient with a better quality product. To achieve this issue, is necessary to use more effective tools with the possibility to manage different variables and parameters. BIM tools present such characteristics and they permit the Brazilian offices to improve their projects.

6 Acknowledgment

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