

# Sustainability in the Execution of Works: a Case Study

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**Abstract-** The reduction of natural resources and pollution caused by construction is one of the factors responsible for the increased concern with the environment. As a result, more sustainable constructions have been implemented with the aim of reducing aggression to nature. Allied to this aspect, economic and social issues are also important and complete the tripod of sustainability. To build sustainably, it is necessary to plan the project effectively, from project to demolition. In this context, the work presented as an objective analysis of the execution of a work, in the aspect of sustainability. The activities, the materials, the tools used, the organization of the construction site and the waste management were observed. The results indicate that the concern with sustainability was not well used in the execution of the work, mainly with the residues generated by the construction. It is concluded that it is possible to carry out more sustainable works, but sustainability must be a priority in the civil construction projects in the country.

**Keywords-** Sustainability, Execution of Works, Construction Site

## I. INTRODUCTION

The consumption of natural resources on the planet has grown significantly in recent years, especially after the industrial revolution [1];[2]. However, to achieve the current quality of life, a high amount of nature's resources was used. According to [3], Brazil has increased the consumption of its natural resources by 65% over the past 50 years. The report also points to carbon emissions as a growing problem in the country.

Cement production is responsible for about 5% of carbon dioxide emissions among the activities responsible for this pollution on the planet. Cement is the main material used by civil construction and therefore contributes significantly to the increase of this pollution. In addition to CO<sub>2</sub> emissions, the industry also consumes other materials from the environment and generates many construction wastes[4].

However, the construction sector is extremely important for social development, as it promotes the realization of housing and public works, basic sanitation, transportation and infrastructure. It also contributes greatly to the economy, employing thousands of workers and moving considerable amounts of financial capital [5].

Faced with these important aspects related to the construction industry, there is a need to build in a sustainable way, guaranteeing the well-being of society, growing the economy and using less natural resources and, consequently, reducing environmental impacts. Civil construction has a high potential for the implementation of sustainable practices, which can become quite effective [6].

According to [7], the Brazilian construction industry is progressing in relation to its focus, aiming to produce works with greater durability, greater control, complying with standards and establishing a more effective system of technical control.

Research conducted by the Green Building Council Brazil, in 2010, ranked fifth among the countries with the highest number of works that meet sustainability requirements and are Green Building certified [8]. Due to the competitive advantages of products with environmental seals in the foreign market, the country invests in programs that certify environmental companies that are concerned with sustainability [9].

In addition to private enterprise, municipal governments can also contribute to the growth of sustainable buildings. Through city-planning laws and codes of works, financial incentives and public-private partnerships, municipalities have the possibility of encouraging companies to invest in sustainability in their works [10].

In this context, this work has as main objective to follow some activities in the execution of a public work, observing sustainable aspects employed in the construction of a basic health unit (BHU). The activities of the workers, the materials, the tools used, the organization of the construction site and the waste management were observed.

## II. METHODOLOGY

In order to reach the objective of the work, visits were made to the work, in the following stages of execution: infrastructure, superstructure, fences, roofs and linings and installations and finishing. The activities and materials involved in the execution of the construction on the issue of sustainability were observed and recorded through photos and notes. In this article, the most relevant aspects found in the research were highlighted, judging them as positive and negative for a sustainable construction site.

### III. STUDY OBJECT

The work studied in this work was carried out in a city in the interior of Paraíba, Brazil. It consisted of a Basic Health Unit, financed by the municipal government and the federal government, with a term stipulated in seven months of construction.

The unit has a total of 261.05 m<sup>2</sup> of built area. Most of this area was occupied by clinics, reception rooms, collective activity rooms, vaccination and curative rooms, drug storage sites, and material depots and circulation areas.

The unit was built with traditional reinforced concrete technology and ceramic block fence. The finish was composed of internal granilite floors, installed under a 7 cm thick concrete floor, exterior floor of 10 cm thick concrete blocks with 35 MPa and walls painted with acrylic latex paint (except kitchen and the cafeteria that have pottery). Figure 1 shows the finished construction.



Figure 1. Construction completed. Source: Author (2015).

### IV. SUSTAINABILITY IN CONSTRUCTION

Sustainable development has as its premise to use natural resources to meet current needs without hindering future generations from using these resources [11]. According to [12], traditional construction has a large and complex production chain, consumes a significant amount of natural resources that alter the environment and therefore needs to treat environmental factors as an integral part of the sector's projects.

Sustainability in construction needs to involve other parameters besides quality, cost and time, approaches to conventional construction. In order for the construction industry to fit the definition of the sustainability tripod, it must also be concerned with: quality of life and the built environment, resource consumption, CO<sub>2</sub> emissions and health, development sustainable development, biodiversity, social equity and cultural heritage [13].

According to [14], in order for civil construction to contribute to the reduction of environmental impacts and

climate change, and consequently to be sustainable, it needs to address three main points:

- Constructions attentive to the environment (reduction of resources).
- Sustainable constructions (related to preservation of the environment).
- Sustainable living (economic and social concern).

### V. SUSTAINABLE BUILDINGS

Sustainable construction is considered a constructive system capable of changing the neighborhood, meeting the needs of the enterprise, of the user, preserving the environment and reducing the use of natural resources, without harming future generations [15];[16].

According to [17], sustainable constructions consist of projects that address ecological, social and economic issues within society. The same author lists seven principles of sustainable construction proposed by the Conseil International du Bâtiment (CIB) in 1994:

- Reduce resource consumption.
- Reuse resources.
- Use recyclable resources.
- Protect nature.
- Eliminate toxic products.
- Economy based on the life cycle.
- Focus on quality.

The quality of the production process and the materials used in the project are responsible for the durability of the buildings. A building needs a high durability to be considered a sustainable building [17]. [18] states that the most important environment in a sustainable construction is the construction site, where it is the execution stage, since it is where the moment in which the principles of sustainability in civil construction are applied.

### VI. SUSTAINABLE CONSTRUCTION SITE

The construction site is where the main activities are concentrated in a construction project. It is in this environment where there is the largest capital investment of the whole project and where the workforce is most intense. Therefore, the site requires greater supervision and care in its implementation and maintenance of its activities [19].

In conventional construction, the release of fragmented materials, the generation of hazardous waste and the emission of vibration, noise and fragmented materials, are the main pollutants generated at the construction site [20];[21]. In the execution of the work, the material losses can occur in the receipt, in improperly stored blocks, in the transportation of the concrete, in the wrong dosing of the mortar and in the poor use of the plaster [22].

Safety is an important social aspect at the construction site. Civil construction presents itself as a problematic sector in this aspect, being responsible for a large number of accidents in construction sites, mainly due to the lack of use of individual and collective safety equipment [23].

A sustainable construction site requires practices and actions such as: environmental management project, responsible purchasing, community relations, occupational health and safety management, quality management project, loss and material reduction, solid waste management, land use and occupation, water consumption, energy consumption and transport, conservation of local flora and fauna, and employee education [18].

## VII. RESULTS AND DISCUSSIONS

After visits to different stages of the project, a high number of problems were found in the construction site and some positive points, considering the aspects analyzed in relation to sustainability.

### A. Negative points

There was no concern about the use of recyclable materials in the work. Despite not being foreseen in design, these materials, with performance compatible with their function, can be used instead of others, in order to minimize the environmental impact caused by the extraction of natural resources.

Some materials used in the work, prior to their application, such as forms, sand, gravel and blocks, were randomly positioned at the site, without complying with the storage specifications described in [24], unprotected and exposed to bad weather, compromising quality of the products, as shown in Figure 2. Also, no place of deposition of debris was determined according to the nature of the material.



Figure 2. Storage of materials. Source: Author (2015).

Figure 3 shows the deposition of construction waste without any segregation of the waste to a possible disposal for recycling or reuse, not having a suitable storage location, leaving the site disorganized and compromising the safety of the workers.



Figure 3. Construction Waste. Source: Author (2015).

The site, in all the visits, portrayed the lack of cleaning of the work. Workers were not concerned about keeping the environment clean and there were no instructions for cleaning (Figure 4).



Figure 4. Lack of cleaning. Source: Author (2015).

The disorganization in the finishing phase also drew attention, especially with the electrical equipment left in the circulation areas, which may cause accidents, as shown in Figure 5.



Figure 5. Lack of organization of construction. Source: Author (2015).



One striking problem encountered was the absence of a support unit that could adequately house an office, cafeteria and restrooms for the staff. The justification given by those responsible for the work, for this absence, was the availability of employees to use their residences to meet their needs, since the municipality is small and the displacement was facilitated and the time spent was considered small.

However, the biggest problem found in the work was found in safety. For the neighborhood, the work did not have sidewalks that protected people passing near the place, only an improvised fence to demarcate the construction area, as shown in Figure 6.



Figure 6. Marked construction area with fence. Source: Author (2015).

For workers, there was virtually no use of basic personal safety equipment such as gloves, boots and helmets. This problem is evident in Figure 7.



Figure 7. Construction Workers. Source: Author (2015).

### B. Positive points

At all stages of project execution, there was concern about the reduction of resources, due to the low availability of financial resources by the city and federal government. The materials were purchased and delivered in portions, according to the need of the execution step. For the same reason, when

possible, materials were also reused, such as forms and shoring, although they are made of wood, as shown in Fig. 8.



Figure 8. Shapes and shoring. Source: Author (2015).

Another important positive point was the concern, both on the part of the designers, as for the workers, with the nature around the work. The area chosen for construction of the unit was not significant amount of undergrowth and large trees, avoiding deforestation. Workers were careful with the designed plant area, illustrated in the layout of Figure 1, doing the cleaning and preparing the place for the gardener's work, without the need for instruction from his superiors.

The inspections in relation to the measurements in the work were also highlighted. The prosecutor responsible for the measurements showed up at all visits and it was possible to observe his performance. These activities lead to fewer errors due to poorly performed measures and, consequently, reduce rework and additional costs. Figure 9 shows some measurements of the prosecutor.



Figure 9. Conference of measures. Source: Author (2015).

## VIII. CONCLUSIONS

After the visits and the records, the activities in the execution of the work could be analyzed and presented. It was possible to point out positive and negative activities of the site,

considering the sustainable aspect. The problems found allow us to verify that the project was not designed as a sustainable construction.

Problems such as carelessness with materials, lack of cleaning and organization of the construction site can compromise the quality of the building. On the other hand, concern about the correct measures described in the project reduces the risk of errors and favors quality, reducing the likelihood of rework and unnecessary expenditure on materials, equipment and labor. This contrasts with the lack of well-developed and effective quality management.

The problem with security, the most worrying in this work, shows the lack of commitment to the social question. The risk of sequelae in accidents with construction workers who do not use safety equipment is high. You must comply with safety standards to avoid them. In addition, the neighborhood is also vulnerable, at risk of suffering damage due to such negligence.

The reduction of financial resources and the reuse of materials, indicated as positive factors, occurred to the detriment of the lack of capital to carry out the work. Therefore, it is assumed that the intention was not to make the work environmentally more sustainable with these strategies. However, the economic issue was a concern in this case, and can be considered a measure introduced in sustainable constructions.

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