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Good sustainability practices applied in buildings using BIM technology

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ABSTRACT
The growing demand for more sustainable buildings, and the efficiency in the execution of civil construction projects give rise to the relevance to make proper use of technology in the increment of works. *Building Information Modeling* (BIM) creates and employs the compressed computational data of a building project, this parametric knowledge is common in the construction site for risk management, document formulation, performance anticipation, cost estimation, problem solving and ideation. The problem question of the work was: "How can civil construction companies apply strategies through the BIM tool to reduce environmental impacts in the construction of buildings?". The following general objective is to analyze the BIM tool applied to sustainability in the construction of buildings. This work was a literature review. To define the step-by-step of the work, Bryman's (2008) recommendation was used, which advises starting with the understanding of the theme, choice of information sources, data collection, data analysis, interpretation and proposal, and finally, result. Finally, it is worth noting that the use of BIM should not be related as a simple method of adopting a development model, but it is a multidisciplinary tool that aims to correlate and enhance complex sectors in the design of sustainable engineering projects.

Keywords: Design, Sustainability, Construction.

INTRODUCTION

With the increase in civil construction and consequently the increase of its environmental and social impact, the admission of adequate social responsibility measures has become an increasingly important factor within construction companies. (SAINTS; BERTULINO; PFEIFER, 2010).

Civil construction is one of the areas that makes the most use of natural resources and consequently this results in damage to the environment, and due to this fact it is essential to look for more intelligent and sustainable means such as BIM, thus helping to minimize these impacts on the environment (SANTOS; BERTULINO; PFEIFER, 2010).

Nowadays, companies want to be part of the social responsibility in which it has been widely discussed, and this proves that it is not only about building, but also about demanding social well-being and a better quality of life, the environment and culture (STEFANO *et al.*, 2003).

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Based on this, the growing demand for more sustainable buildings, efficiency in the execution of civil construction projects originate the relevance to make due use of technology in the increase of works. The simulations carried out in the virtual environment show potential in predicting problems and, consequently, in the conjecture of solutions, both environmental and work management (GOMES, LIMA, 2021).

The virtual coherence of data and the importance of projects are tricky in the personalization of projects, as they adapt a vast multiplicity of resolutions, systematizing the conditions of users, the impacts of the work and support decision-making in the face of setbacks. The studies and analyses of the multiple domains of the Engineering and Construction industry are indispensable for the creation, consignment of parameters and systems that support customs clearances, as occurs in projects that use BIM-type computational tools (MORORÓ *et al.*, 2016).

Building Information Modelling (BIM) creates and employs the compressed computational data of a building project, this parametric knowledge is usual in the construction site for risk management, document formulation, performance anticipation, estimation of cost, problem-solving, and ideation. BIM can also be emphasized as a modeling technology related to a set of processes that create, ponder and disseminate models for a work (construction of buildings and other civil engineering works), which performs the interpretation of engineering information and its interactions, in advance and without the precision of detailed drawings (LINO, 2012).

Due to what was previously mentioned, the present work aims to analyze BIM as a tool for the development of sustainability in the construction of buildings. Sustainability is currently a very important topic for society. In spite of the development of strategies in order to reduce the impacts caused to the environment, it is treated. In this sense, many companies seek to adopt sustainability as a relevant factor for the company. Not only to promote sustainability, but also to contribute to sustainable development, but for this it is necessary to create strategies that seek to reduce environmental impacts.

Civil construction causes several impacts, including waste and debris, and the environmental impacts motivated by the construction of a house, real estate speculation that can induce the construction of buildings in regions that were not urbanistically delineated to gain the number of people in a building, for example, thus causing some more negative impacts on cities (SANTOS; BERTULINO; PFEIFER, 2010).

Sustainable construction is the solution to achieving sustainable development. In this way, sustainability in construction is the satisfaction of the needs of the current population without compromising the future (MARTINS, 2018).

The work is justified by the fact that BIM represents a good tool in the fight against the impacts caused to the environment by the inappropriate use of natural and non-natural resources. Energy

efficiency is nothing more than a form of energy conservation, different from what economics are considered.

Energy saving aims to reduce consumption costs, while energy efficiency is a practice that, in addition to conserving energy, can be favorable for the environment.

The research to be developed below will have as a problem question: "How can civil construction companies apply strategies through the BIM tool to reduce environmental impacts in the construction of buildings?". The following general objective is to analyze the BIM tool applied to sustainability in the construction of buildings.

METHODOLOGY

In this chapter, the methodology used to carry out the research will be discussed. The methodological artifices of a research tend to explain what will be the activities developed to carry it out. That is, the type of research and method used will be qualified. According to Rodrigues (2007, p. 2), "scientific methodology is a set of approaches, techniques and processes used by science to formulate and solve problems of objective knowledge acquisition in a systematic manner".

In this work, a literature review will be made. To define the step-by-step of the work, Bryman's (2008) recommendation was used, which advises starting with the understanding of the theme, choice of information sources, data collection, data analysis, interpretation and proposal, and finally, result. According to Yin (2001), archival analysis is beneficial when one seeks to present the incidence or predominance of a phenomenon through statistical analyses.

The research will have an exploratory and descriptive character and to carry it out will be carried out readings of international and national articles and books. The sources were chosen due to their importance in the academic environment, writing, and for congruence in the theme idealized for the work, containing prominent information for the development of the result of this work.

To carry out the study, some criteria were determined for inclusion of the research, such as: addressing the concept and use of BIM and sustainable projects. The literature search and the selection of articles were carried out in May and June 2022, in the Google Scholar database, Scielo, considered the online resource with information related to civil engineering and corresponding areas, using keywords such as: "BIM", "engineering" and "sustainable". The works produced up to 2021 were taken into account, starting from the 2004 period.

RESULTS

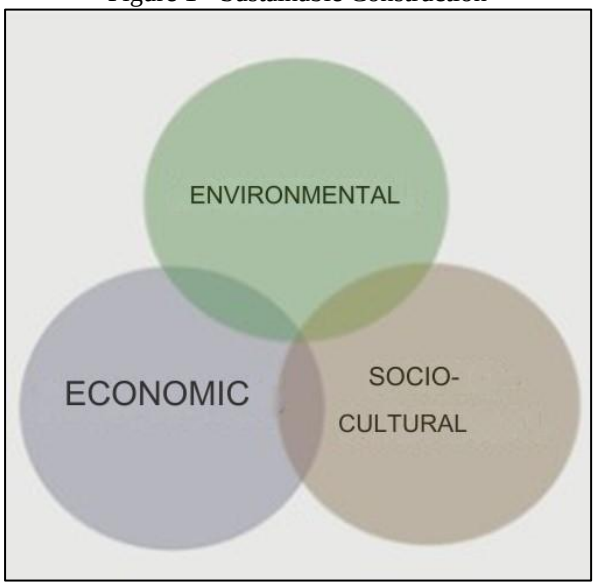
SUSTAINABILITY AND ITS DIMENSIONS

Sustainability aims to transform the environment into a better, more balanced place, thus improving people's quality of life and making the planet healthier and to distinguish itself in unequal dimensions or aspects, which, when included, proceed to sustainable development. According to Brundtland *et al.*, (1987, s.p.), sustainable development is what ensures that it will meet "the needs of the present without compromising the ability of future generations to also meet theirs...".

According to Carvalho (2009), in order to be considered sustainable development, it is necessary to be responsible with the amount of use of natural resources, that is, it is necessary to make only a rational use of the natural resources that are available to be used, so it can be understood that the sociocultural, political, aesthetic and other issues. The linkage and dependence between the dimensions of sustainability is what lead to sustainable construction, where sustainability is divided into 3 groups, which can also be called the three dimensions of sustainability: economic, environmental and sociocultural. It can be concluded that the way in which one builds, projects and acts in the improvement of a work influences the use of natural resources and the health of the population and the planet (CARVALHO, 2009).

According to Librelotto (2005), social extension as that which mentions social responsibility and management of people, the environmental dimension as that which is concerned with the precaution of ecosystems and the reduction of conflicts and damage to the environment, and economic extension that supports the financial response of investments to the patentees, the community and others related to the process.

Figure 1 - Sustainable Construction



Source: Adapted from Carvalho, 2009

BUILDING INFORMATION MODELING – BIM

Building Information Modeling (BIM) is an innovative method for expanding, developing and establishing construction projects. This method uses characteristic *software*, it adds to all important data to the construction such as: graphic documentation; construction materials; price and quantity evaluations; geometric parameters of objects, among others. In addition to having new ways of working and serving as an aid for the professionals involved in the project (BEZERRA *et al*., 2019).

The term BIM was born in the United States in 1970 (SANTOS; PINTO, 2019), and has as a concept to be activated in constructions that esteem interdisciplinary and/or multidisciplinary work (BEZERRA *et al*., 2019).

This program also serves as a tool for professionals and even clients related to the project/work. It evaluates and manages, correct means to implement in the building, always acting in the most correct way possible, following the rules, helping in the course and always seeking to preserve as much as possible the natural resources that are in the same place of the building, and as a result ends up cooperating to increase the life cycle of the buildings and mitigate the use of raw materials, damage and waste (SANTOS; PINTO, 2019), which can generate savings of up to 20% (CARVALHO; BRAGANZA; MATTHEW, 2017).

By making use of BIM, you also take advantage of its advantages, such as: having a better improvement in relation to the improvement of the quality in relation to the information obtained, lower cost in the realization of the project/work, adding the employees and the management of information, and as already mentioned above, when using BIM, it also ends up adding to the reduction of the use of natural resources and as a consequence results in collaboration for the sustainable increase of engineering works and projects and also results in a faster construction method, making the delivery of the project be ahead of schedule, or delivered on the scheduled day, without delays (ZHANG, et al. 2019).

The use of BIM adds to the increase of a better quality throughout the project, helping to minimize errors through the progress of efficiency, accuracy, evaluations and communications. As a result, there is better coordination between documents and the entire team, minimizing conflicts. All this progress is reflected in lower costs and shorter lead times (CHEN; LUO, 2014). According to Bessoni (2018), BIM and sustainability work well when implemented together, as it presents efficient proposals, helping to preserve the environment, aiming for a new way of life, a new general awareness of the impact of human development on the planet.

The most important contribution of BIM is in the acquisition of information to assist in the economy and costs of the works in general of a building. Regarding the company's economy towards the project, BIM technology does not provide any direct contribution, however indirectly it does, because it must be taken into account that its application, when implemented correctly, helps to reduce costs

indirectly, through other means, such as reducing the use of natural resources in excess and/or without need (CARVALHO, 2009)

BIM tools for feasibility studies extend to cost estimation and initial planning of projects that are still in the understanding or feasibility study phase. As a result, the tools support the decision-making moment in the early stages of the project, leading to a preliminary estimate of costs to start the work (BARISON, 2015).

Garcia (2014, p.184) also describes that "the usefulness of thinking about cost before going into daydreams of form when thinking about sustainability is also highlighted", clarifying that sustainability in its economic pillar is necessary for the acceptance of assertive formal decisions and for the search for sustainable construction (GARCIA, 2014).

BIM allows projects to be carried out faster and safer, causing less waste, since it generates accurate quantitative values, also helping in a reliable calculation to measure the duration of the work, and its correct equipment of use. These recommendations and the schedules that are proposed through this system help a lot in reducing the negative impact on the environment (GARCIA, 2014).

CONCLUSION

As time goes by, more civil engineers and architects are making use of computer modeling to improve the efficiency of projects and seek better solutions to common problems on construction sites. The analysis of the published works explains the progress of the practice in recent years, as a result of the entanglement of buildings and the growth of the civil construction area.

BIM is a technological means that has brought innovation to the market, where software is used to cover all the information necessary for the completion of a work. It brings with it numerous advantages and benefits, and it is worth noting that by making use of this tool, it will help to bring more collaboration on the part of the workers involved in the work, thus reducing the passage of incorrect information and intrigue within the team.

The result of this work also showed the relationship of the BIM tool with the sustainable environment, thus fulfilling the objective of the work, which was to analyze the BIM tool applied to sustainability in the construction of buildings.

However, in carrying out the research, the works found from the bibliographic survey emerge a development in the use of the BIM methodology and its various possibilities, especially when the objective is to design and put into practice sustainable works both with less environmental impact and in the sense of economy and operational management. It is worth noting that the use of BIM should not be related as a simple method of adopting a development model, but it is a multidisciplinary tool that aims to correlate and enhance complex sectors in the design of sustainable engineering projects.

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