Evaluation Process for Building Information Modeling (BIM): CUB-e Certification

Processo de Avaliação para Building Information Modeling (BIM): Certificação CUB-e

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ABSTRACT

Building Information Modeling (BIM) is a topic of major relevance as the current Brazilian legislation, through BIM BR Strategy - a governmental plan establishing that such technology should be used in the execution of engineering works and services, forcing contractors to adapt to the new reality. In the Brazilian market, the difficulty in attesting the efficient use of BIM is linked to the lack of a certificate to guarantee the services provided by Architecture, Engineering, Construction and Operation (AECO) professionals. The purpose of this study is to create an evaluation model for certification (CUB-e), so that companies can attest the level of BIM in which they operate. For doing so, surveys and researches were carried out through interviews in technical visits to institutions that already operate in BIM, in order to obtain information on the current level of application of the technology in the job market.

Keywords: Building Information Modeling, Certification. Project Modeling, Civil Construction, Technology.

RESUMO

A Modelagem da Informação da Construção, do inglês Building Information Modeling (BIM) é tema de grande relevância, pois a legislação vigente no Brasil, através da Estratégia BIM BR, estabelece a utilização da tecnologia na execução de obras e serviços de engenharia, obrigando empreiteiras a se adequarem à nova realidade. No mercado brasileiro, a dificuldade para atestar o uso eficiente do BIM está ligada à inexistência de um certificado para garantir os serviços prestados pelos profissionais da Arquitetura, Engenharia, Construção e Operação (AECO). O objetivo do presente estudo é a criação do modelo de avaliação para certificação CUB-e, a fim de que as empresas atestem o nível de BIM em que atuam. Para isso, foram realizados levantamentos e pesquisas por meio de entrevistas em visitas técnicas a instituições que já atuam em BIM, a fim de se obter informações sobre o nível atual que se encontra a aplicação da ferramenta no mercado de trabalho.

Palavras-chave: Building Information Modeling, Certificação, Construção Civil, Modelagem de Projetos, Tecnologia.

1 INTRODUCTION

Building Information Modeling (BIM) has been gradually discussed in the conferences on AECO. The concept was developed to assist and integrate the various areas that make up a project from planning, identifying possible inconsistencies, until the end of the project's service life. The purpose of using BIM is to enable users to design and document all phases of the process, thereby saving time, money, reducing the number of project incompatibilities, and increasing productivity.

As BIM operates on a virtual database, any modification made to the model implies a change in all elements of the project. Thus, all participants involved in the project - engineers, contractors,
architects and owners - are able to share, discuss and coordinate the information contained in the project in a practical way. Therefore, it is possible to observe a production completely linked to the through virtual resources.

In view of the current growth scenario of BIM, some obstacles can make it difficult the evolution in the Brazilian market, such as the adaptation of equipment for the use of software, the lack of trained professionals, the incompatibility of files in the Industry Foundation Classes (IFC) format, and changes in the culture of professionals working in the civil construction sector.

Considering the current scenario of wide dissemination of BIM, there is a need to certify companies that use the technology. The certification process assesses whether a company or product meets certain predisposed parameters and requirements.

BIM is classified in dimensions (D), which centralize a specific type of information in the model. Those that have been studied are between 1D and 7D. Therefore, one way to estimate the level reached is to check how many dimensions the model can reach.

2 THEORETICAL REFERENCE
2.1 BUILDING INFORMATION MODELING

BIM creates a new concept of designing, managing, building, and projecting. If proceeded, it is possible to observe the contribution to the design and construction processes in a more integrated way, which generates a construction with higher and better quality with regard to costs and with shorter construction times (EASTMAN et al., 2011).

With BIM, one or more precise virtual models of a project - be it building, work of art or infrastructure - are built in a digital environment. These models support the project in its phases, allowing for better analysis and control of manual processes, in addition to the possibility of sharing information among all stakeholders to promote their value. When completed, these models comprise the geometry, data, properties, deadlines and construction costs, with the aim of promoting compatibility between the stages of the construction process, and the transmission of information without the need for highly detailed drawings (FREITAS, 2014; LINO et al., 2012).

BIM is classified, categorized and measured in stages and dimensions. The dimensions are characterized by sectorizing the different layers and work fronts, in order to define those responsible, and to facilitate the future exchange of information in real-time between each sector. A model can have a number “N” of dimensions depending on the context, however, it is commonly used only the 7 dimensions studied by Eastman et al. (2014) (Figure 1). The thinking through BIM allows a real
representation very similar to the projects that will be executed, which guarantees an understanding faithful to what will be found in practice.

Figure 1 - BIM dimensions studied

2.2 BIM DIMENSIONS

2.2.1 1D

According to the State Secretariat of Planning for the State of Santa Catarina (Brazil) (2018), the phases of a building project are understood as a flow in a technical process to obtain the proposed final project. Therefore, the first dimension of BIM refers to the pre-project of the work, composed of activities to collect documentation and juridical, technical, urban informations to define needs, restrictions and requirements. An initial architectural sketch is developed to verify physical, legal and economic viability, thus allowing risk analysis on the object to be carried out and a first conception of the final product.

In addition, 1D is also responsible for georeferencing, responsible for the exact geographical position of a property and its surroundings, making it easier to obtain consistent information on the transport of inputs during the construction phase. In view of this, georeferencing ensures the project benefits in decision making, providing resources within corporate communication and a better understanding of the environment (AZEVEDO et al., 2019).

2.2.2 2D

The most common representations of projects at AECO are 2D drawings. In this context, the use of CAD methodology is predominant (OLIVEIRA; MACIEL, 2019). AutoCAD 2D is dedicated to the development of lines, which generate drawings contemplating the realization of architectural, electrical, hydraulic and foundation projects, for example (COSTA et al., 2015).
The element created in the 2D representation is made up of lines, without characterization as to their properties. Thus, data such as volume, cost, color, geometry, density are not transmitted to the object contemplated in the two-dimensional plane. In the CAD system, the specified geometry is based on coordinates in order to obtain graphic elements. These are the representation of the walls, doors, slabs, beams, windows, among other construction elements (COELHO; NOVAES, 2008).

2.2.3 3D

According to Eastman et al. (2014) the definition of Building Information Modeling is the entire amount of information for a construction. The element created in the 2D representation is made up of lines, without characterization as to their properties. Thus, data such as volume, cost, color, geometry, density are not transmitted to the object contemplated in the two-dimensional plane. In the CAD system, the specified geometry is based on coordinates in order to obtain graphic elements. These are the representation of the walls, doors, slabs, beams, windows, among other construction elements.

In this methodology, elements are drawn that represent the final object, which is related to its inputs, dimensions, characteristics and weights. According to Andrade and Ruschel (2009), the parametric model is built from the item families, these include singularities that may be related to geometry, raw material, brand, density, color, etc. The development of three-dimensional (3D) models such as architectural, structural, electrical, hydraulic design allows to faithfully represent the elements that will be worked on in reality.

As the IFC is a data format that allows the exchange of information between the various BIM applications, the changes and information contained in the models made contain all the geometric and non-geometric elements that were designed. The data is stored in this file so that any member involved in the project can open the model and view it, provided they have compatible IFC software (BARRETO et al., 2020).

2.2.4 4D

The 4D dimension, according to Barbosa (2014) is linked to activity planning. In this dimension, it makes it possible and agile to visualize the various stages of construction of the work in any timeline of the process. Therefore, it is used as a source of visual construction planning, in addition to generating a new level of visualization and understanding of the processes on the part of those involved in the project (KYMMELL, 2008).
2.2.5 5D

According to Lino et al. (2012), this dimension has the advantage of greater cost control, in order to avoid spending beyond the budget, presentation of reports to the project owner and projection of scenarios. Dang and Tarar (2012) apply the cost factor to 5D when integrating spending and the project modelled in 3D. There is indication and monitoring of the costs of the proposal in the most varied construction stages. These are of great importance for the professionals involved in the construction, as they allow measuring the financial performance of the current construction situation.

2.2.6 6D

In the 6D, reviews are made at the beginning of the project to assess energy efficiency, energy consumption and carbon emission rates, contributing to sustainability and, consequently, to existing certifications, such as the LEED seal. It also allows measurement and verification during construction and better processes for choosing high-performance installations (SOUZA, 2015).

The term sustainability is associated with the impacts of the natural resources exploration, in order to avoid possible damage to future generations (CARVALHO, 2009). Dáros (2019) deals with the concept of sustainability involving four pillars: environmental, economic, social and cultural. The environmental involves the ability to reproduce and conserve natural resources; the economic includes the ability to generate income and work; the social includes the ability to generate well-being for human beings; and the cultural takes into account how people view their natural resources. Therefore, simplifying the management of the building will make the concepts of sustainability of a construction more efficient.

2.2.7 7D

The seventh dimension, according to Martins (2018) is related to the management and maintenance of the building after construction. The 7D model increases information aimed at preventive maintenance and project management. It includes equipment installation dates, guarantees, contacts of suppliers and manufacturers, documents describing the assets, installation manuals, functionality of the spaces created, among other activities in charge of the building manager. Therefore, it allows overcoming setbacks considered difficult, managing to easily manage the assets of the building.
2.3 CERTIFICATION PROCESS

ABNT (2014) characterizes certification as a process carried out by an independent entity, in which it assesses whether the chosen product complies with technical standards. Among the forms of quality assessment that already exist, the main:

- ISO 9.000, quality control management and assurance;
- ISO 14.000, environmental management;
- ISO/IEC 25.000, quality of systems and software;
- ISO/IEC 27.000, information technology;
- ISO 50.000, power management;
- LEED, sustainable aspects.

It is extremely important to assess whether the product or service meets any technical standard that sets out the minimum requirements to ensure compatibility and to start the certification process. It is essential to meet the requirements of the guidance standard, as well as having the necessary documentation to prove that the institution controls all information related to the object of certification (ABNT, 2014).

According to ABNT (2014), among the benefits of certification, there are:

- Enable quality to be the responsibility of the producer;
- Enable business development to constantly improve;
- Ensure that the service is efficient and effective;
- Organize and improve the display of your products to your consumers;
- Ensure that the requirements of the standard of the input, system or service are met.

2.4 ISO CERTIFICATION

The International Organization for Standardization (ISO) is an independent, non-governmental organization. The national body that represents Brazil before the ISO is ABNT. The National Institute of Metrology, Standardization and Industrial Quality (INMETRO) is the trusted institution in Brazil, linked to ABNT (ISO, 2019).

ISO standards are intended to create a global standardization of quality for products and services, combined to standardize the administrative functioning of the institution. The standards group forms a quality management system that applies to any company, regardless of size, whether it is public or private (MARIANI, 2006).
ISO develops a standard that provides specifications and requirements to be used consistently, in order to guarantee the quality of the inputs and services provided in their proper applications (ISO, 2019).

2.5 LEED

Currently in Brazil, one of the main certifications that shows the degree of commitment of buildings to the environment and social responsibility is the Leadership in Energy and Environmental Design (LEED) seal. The system was created internationally to certify and guide the buildings environmentally, by encouraging the transformation of projects, construction and operation of buildings. LEED has 4 typologies defined by GBC BRASIL (2019). They are defined according to the needs of each enterprise.

Each of the areas has prerequisites that characterize mandatory actions in all projects and require certification and credits, which are LEED recommendations, with a focus on performance. As the project fulfils the suggestions, it receives a score. Through the accumulated score, the level of the seal achieved is determined (Figure 2).

![Figure 2 - Levels of the LEED Seal](image)

Source: GBC BRASIL (2019).

3 METHODS AND TECHNIQUES

First, an exploratory bibliographic research was carried out about BIM and the existing certification processes. For the bibliographic reference, researches were used in Brazil and worldwide to understand the theme and search for the State of the Art in relation to BIM certification.

Then, technical visits were made to three companies that use BIM to design in AECO areas. The companies develop architectural, structural, earthmoving, hydro sanitary and electrical projects, among others. Such visits had the objective to know the practical process, the facilities and difficulties found for the insertion, use and performance of the technology.
In order to enable the evaluation of companies, a technical evaluation instrument was developed, in checklist format, with the purpose of identifying the level of BIM that companies use to design and execute, and up to what dimension this use is efficient, so that they can be certified according to the level of utilization and capacity for productive execution, which is sometimes not exercised due to lack of demand.

Finally, the BIM Use Certification methodology called CUB-e was developed, with different levels of certification: CUB-e Standard, CUB-e Silver, CUB-e Gold, CUB-e Platinum and CUB-e Diamond.

### 3.1 TECHNICAL VISITS

Technical visits were made to companies that work using BIM. In this way, it was possible to understand more about the concepts and application of BIM. In the first visit, as it was the first contact with BIM, it was possible to solve questions about the operation of the methodology in the company. It was shown that they use the technology until 3D modeling. Examples of architectural projects, foundations, plumbing, electrical and air conditioning were shown.

Initially, the concept of families was explained, which are groups of elements that have a set of common properties (parameters), with a graphic representation as an association. It was shown how to create a family and how to use the ones that are already available by the software. In sequence, the parameterization process of the created elements was shown. Such process refers to the definition of the parameters that will specify the geometric element that was created. The characteristics mentioned can be: product brand, material diameter, color, geometry, raw material, density, among others.

Another point to be highlighted was the efficiency of BIM modeling, compared to the CAD methodology. This efficiency is justified because the geometric elements are a real representation of what will be found in practice. With the 3D modeling carried out in Revit, it was shown how easy it is to modify the design, obtain views and make models compatible using Clash Detection being an easy way to find inconsistencies in the compatibility of projects.

In the second meeting, the company operates in carrying out projects and consultancy in the areas of infrastructure, hydraulic, earthworks and structural masonry paging. The institution works using 3D and 5D from BIM. As in the first visit, examples of BIM projects, family concepts and parameterization were shown. Due to the company's owner participating in the Brazilian Chamber of BIM MG, she also pointed out the importance of disseminating BIM in the academic field.
The third visit had a well-explained theoretical / practical direction. At this meeting, greater participation was possible due to the better understanding gained from previous visits and advanced research. Currently, the company uses BIM until the 5D. It was mentioned that, despite being able to apply it in their projects until 7D, they do not perform due to the low demand corresponding to the high cost for the contractor.

This visit also explained the concept of families, parameterization of objects, use of Clash Detection, differences between 2D design and parameterized modeling, among other particularities of BIM projects. Examples of projects already carried out and in the process of elaboration, with their respective characteristics, were shown. In order to better assimilate 3D, a tablet was made available, in which it was possible to view the projects in a 360º view.

The 6D and 7D, although they were never sold, were presented through a simulation covering all dimensions, in which the coordinator guarantees full knowledge for the realization, if necessary.

4 CUB-e CERTIFICATION

The proposed BIM certification model aims to certify builders and designers who works in the different dimensions of BIM and areas of applications at AECO, such as, for example, project elaboration and / or execution. Based on that, a checklist was prepared, so that through the analysis of the parameters proposed in each dimension, it is possible to determine the degree of use and efficiency of BIM, achieved by the members of AECO.

To that end, five different levels of certification were established, namely: CUB-e Standard, CUB-e Silver, CUB-e Gold, CUB-e Platinum, and CUB-e Diamond, with the purpose of differentiating the degree of use of BIM according to the use of dimensions. The assessment is made based on the fields of activity - elaboration and execution of architectural, hydraulic, electrical, air conditioning projects, among others - and even which dimensions they are capable of reaching, according to the demand and technical capacity.

4.1 TITLE AND LOGO

The name was defined as Certificado Digital de Utilização BIM (CUB-e). In addition to being the initials of the name (the letter "e" refers to the expression "digital") and reference to the word cube. The cube is a solid limited by polygons, so the name alludes to the three dimensions of the cartesian plane, which are characteristic of BIM projects.
When referring to the term “e” of the name CUB-e, he was assigned the words: everywhere, everything and everyone, otherwise digital. This relationship is due to the fact that BIM allows access to projects and their derivatives anywhere, due to the storage in the cloud, in addition to having a potential for application in several areas. Figure 3 illustrates the CUB-e logo.

Figure 3 - Logo

Source: Authors (2020).

4.2 CHECKLIST AND APP

In order to proceed with certification, a form was developed to assess AECO constituents. The checklist analysis is based on the software quality assessment models of ISO 9126 and ISO 14598, which are mapped in metrics between 0 and 1, where 0 is the worst result and 1 the best. From this the influence is defined according to the importance of the item. Thus, the weighted average is calculated in order to reach a score above 75% so that it is accepted (ALMEIDA, 2011).

The first page of the checklist collects company data, which are: company name, trade name, Brazilian National Register of Legal Entities (CNPJ), employee responsible for monitoring the appraiser, services provided, contact information, number of employees, address and type of company. In addition, it considers the appraiser responsible for the audit and the date of its execution.

On the following pages, each BIM dimension is evaluated separately and divided into items related to it. These parameters are evaluated in each service provided mentioned on the previous page, giving separate notes for each area of operation. For this, the analysis of the possible BIM dimensions to be executed begins, according to the services offered by the company.

The first dimension assesses the pre-project, the feasibility analysis - technical, financial and legal - soil analysis, georeferencing and whether the documentation was properly executed. For the work to start, it is essential that the documentation is in compliance with municipal, state and federal
laws, in order to avoid possible setbacks that can lead to delays in the execution schedule. Therefore, this item is mandatory, together with others, to guarantee the proposed certificate.

From 2D onwards, all dimensions improve the physical and processing characteristics of the equipment. The assessment is based on the ability of the hardware to support the modeling software, the fact that the licenses are duly acquired from the owners, the interoperability between the software, the qualification of the teams responsible for the projects and attesting to the legal guarantees of the enterprise, according to the standards.

In 2D and 3D, attention is paid to detail and executability, that is, if the projects were modeled in a consistent, practicable way, with the necessary details and in a way that does not cause doubts. In addition, the way the team is supervised, the analysis of the projects already completed, the parameterization of the elements in a detailed analysis of each specified item, as well as the compatibility between them, the composition of the As Built and descriptive information about the materials, equipment inserted in the project, their respective warranty terms and execution procedures, which prove the durability of the construction.

With regard to the 4D, executive schedules should be analyzed, both on a general scale (encompassing the construction systems ordered in stages of execution and guaranteeing the discrimination of all activities involved; control of the amount of labor used; materials to be installed, input and output inputs, among others), as well as in a more specific scenario (if the factors of each task are plausible and technically based, in order to avoid exaggerations and future undue expenses caused by the team's lack of preparation). In addition, verify the changes and schedule control, whether the physical performance of the construction site is periodically monitored, whether the stipulated deadlines are generally met, the justifications for any delays and the existence of action plans to supply them, in addition to evaluating the professional who conducts these functions and their technical capabilities.

In the 5D, a financial assessment is made regarding the macro and micro aspect of the enterprise in terms of budgeting. In the diagnosis of macro analysis, it is assessed whether all the services to be performed are included in the financial schedule and whether they are duly detailed, including expenses in relation to labor, equipment, inputs, among others. It also assesses whether, at the time of preparation, there was compatibility with the supply sectors, regarding the analysis and choice of more favorable proposals, and accounting, regarding the alignment of possible and estimated costs and expenses.
In the micro analysis, it is verified the budgeted values of each service and inputs in relation to market prices, in order to identify if there was an increase in values in budget items mistakenly and if the quantities are assertive in relation to the projected and planned.

For the 6D, there is a question of material losses, production and handling of tailings in a detailed way. They investigate the relevance given to these losses, if they count as one of the important and decisive factors in the choice of the terrain, the definition of equipment, components and construction elements.

Observe if the classification of waste is adequate, the planning for separating it and the proper functioning of the logistics in loco, as well as the subsequent destination to the appropriate locations; refine the sustainable input policies applied to both the project and the construction process, such as reverse logistics, the three “R’s” (Reduce, Reuse and Recycle) of sustainability and the implementation, or not, of actions that promote sustainability, energy efficiency and water reuse. When evaluating these measures applied to employees and local residents, the aim is to mitigate pollution in the air, noise and the environment, for example, with a view to their well being.

In the 7D, the building life cycle is predominantly examined, which is also used in macro and micro analyzes. The first is to inquire as to the correlation between the project and the life cycle, whether there is such a concern and whether it has been analyzed and considered since the pre-work, encompassing all stages of construction. The second, in detailing this cycle in relation to each system, if maintenance and eventual replacements already have deadlines and procedures foreseen, in addition to those responsible for these activities.

In addition, it verifies the documentation that formalizes and points out the responsibility for planning and execution, to which the client must resort in eventual adversities, technical reports that authenticate the characteristics and performance of the elements applied. Furthermore, it evaluates the communicability between the previous dimensions, how the process takes place and whether it is satisfactorily integrated and optimized.

In order to optimize the choice of the evaluated company's seal, an app was created to perform the form verification process, which is carried out in stages. First, the application imports all information from the standard form applied in the audit, which is the checklist. After that, the system makes the weighted average proposed in the third dimension, based on the importance initially assigned to it. The verification process starts in 3D because it is the first dimension intrinsic to BIM, that is, obligatory for it to be selected or use the modeling process. If the average reaches a score below 75%, the entire verification process is canceled and the company does not receive any stamp, since it hasn’t reached the minimum requirements.
If it is reached, the application starts to check the form in an increasing way. It makes the weighted average in the first and second dimensions individually, storing the average of each one. If the appraised does not propose to perform works of the first dimension, the answers are left blank and are not considered in the verification process.

After storing the weighted averages up to 3D, it is initially proposed to make an arithmetic mean between these values. Upon reaching a score above the 75% suggested in the arithmetic average, the company receives at least the Standard seal. To proceed, the same process is recommended initially. 4D is evaluated through the weighted average and when it reaches more than 75% the company receives the Silver seal. The process is repeated for all the following dimensions, with the 5D being the Gold seal, the 6D being the Platinum seal and the 7D being the Diamond seal.

In case the company does not reach more than 75% in each dimension, or obtains a score of 0 in any item judged initially to be mandatory, the verification process is finalized and the seal evaluates until the stage before the completion of the process.

At the end of the process, an ID code is generated, which automatically generates the Uniform Resource Locator (URL), from the company's exclusive page on the CUB-e website. The application does a process that can be done manually, however, it has several advantages, such as speed in the verification process, monitoring of the database that contains all the information of all companies already evaluated and the generation of the automatic URL of the page of each company that has been certified.

Figure 4 illustrates the application page and all stored information that will be available on the CUB-e website page for the evaluated company.
4.3 LEVELS

As the company complies with the specifications for the evaluated area of activity contained in the checklist, it receives a score. Through the score accumulated in each dimension, the level of certification achieved is determined. It was defined that the minimum to be met in each category is 75%, in relation to the totality of the items that are analyzed. The certificates are, in order of relevance: CUB-e Standard, CUB-e Silver, CUB-e Gold, CUB-e Platinum, CUB-e Diamond.

The scoring method primarily consists of defining importance for each item assessed, assigned according to the degree of relevance imposed arbitrarily by the group, for application of the dimensions, which may vary from one to three. Once the importance of each item is defined, they remain unchanged throughout the certification process. Some items are also mandatory, deemed essential for compliance with the process, that is, if any topic defined as mandatory does not appear at the time of the assessment, the score for that entire dimension must be zeroed.
Having defined this, during the audit process, the person responsible for the company's evaluation is responsible for granting scores from zero to ten for each item on the checklist. Therefore, it is necessary that he has full knowledge of the activities and processes to be evaluated. After the on-site assessment, the grades obtained are calculated and the categories reached are calculated using a weighted average, using the CUB-e app.

Thus, for the company to earn the seal in the area of activity designated for analysis, it must comply with the requirements contained in the checklist. To obtain the Standard certificate, the institution evaluated must reach an average greater than 75% in 2D and 3D, being evaluated in 1D only if it proposes to do so, as is the case of large construction companies. This dimension is not mandatory, as there are cases where designers are outsourced and have no need for such an analysis.

Therefore, the weighted average is calculated for each dimension separately and then the arithmetic average is calculated between the dimensions that were analyzed. It must be taken into account that the elements considered mandatory should always be filled with ten or zero. If the score is equal to zero, the analysis is immediately interrupted and the company will not be certified.

From now on the Silver certificate, the evaluated institution must comply with all the requirements of the immediately previous certification. If it reaches the minimum weighted average in the next dimension, it wins the next seal, and so on. It is important to pay attention to the fact that if a company does not reach a satisfactory average in a previous dimension, the next dimension is not even considered in the calculation.

To exemplify, an institution that achieves satisfactory performance in all dimensions by the fifth, does not achieve positive performance on the sixth and returns to repeat the high marks in the 7D, will only win the Gold certificate, because a bad evaluation in a previous dimension cancels the evaluations following. Therefore, a company will only receive the Diamond certificate, if it obtains satisfactory performance in all dimensions.

Five levels were created that represent the five levels to be reached (Figure 5), with the CUB-e Standard, CUB-e Silver, CUB-e Gold, CUB-e Platinum and CUB-e Diamond certificate. In the images, the term “your company” will be replaced by the name of the evaluated company.
4.4 SITE

The symbols inside the levels (Figure 5) are QR Codes (Quick Response Code). They are two-dimensional graphics in black and white cores that contain predefined information. The QR Code, when being tracked, through the cell phone camera or specific device, direct or to the potential customer to an exclusive page of the company that was certified by the tracked seal (www.selocube.com.br/yourcompany). This page will show the data of the certified company, such as: address, phone number, services provided that analyze and evaluate the category (Figure 6), or that is a good way to publicize your brand and that makes the pursuit for the certification attractive.
5 CONCLUSIONS

In view of the great growth in the use of BIM globally and with the decree that makes the use of BIM mandatory for public works projects from 2021, the Brazilian government seeks the development of civil construction and adaptation to the standards of the most developed countries in this field.

Brazilian Presidential Decree no. 10.306, on April 2, 2020, will also enforce companies to project public works in BIM, starting in 2021 and carry out in 2024 (BRASIL, 2020). This requires that they prove, through certification or appropriate documentation, that they perform BIM services with quality and within their obligations.

During the technical visits carried out, it was noted that there is a demand for the issuance of a certificate of performance in BIM, judging that when questioning employees about how they could prove that they practice BIM, the answer was obtained that they could only obtain this proof through a certificate of technical capacity.

Currently, the most efficient way to prove a technical capacity is through an audit. In this way, companies and designers who comply with all their obligations and maintain the quality of the services provided can request the assessment in order to obtain certification. To acquire a certificate
of technical capacity, it is enough to perform only one service. The certification process, on the other hand, takes into account the analysis of all the services already provided, the training of the entire team involved and even the quality of the hardware and software available for the process of executing the demands.

Several advantages of the certification process were noted, since it is possible to certify only one specific service, or all of them together and still separate the certification at different levels, since BIM has several dimensions and steps to be fulfilled. This is of great value as a large part of the potentials evaluated can perform services that cover only one dimension of BIM because they have difficulties in expanding their services to meet requirements from other dimensions.

The owners of the companies visited, when asked how the majority of BIM project demands are, claim that customers show interest only in a specific dimension, this being 3D or 4D. Such demand is justified by the higher initial cost, when compared to the others, however, if the potential client does a cost analysis and invests in the initial project phase, there’s return on the cost in the other stages of execution, due to the conjuncture of a well-planned project.

An important step was the creation of an evaluation model to certify the members of the AECO, in order to determine the level of use of BIM and the degree of efficiency that those evaluated can achieve. For the development of this model, the study carried out on the already existing and consolidated certifications in society was important, as well as the certificates issued by INMETRO, ISO certifications and GBC Brasil, of the LEED seal. In this way, it was possible to understand how the certification of companies in the market happens and how it could carry out an assessment to certify the institutions that use BIM.

From technical visits, it was possible to observe the situation in which the institution is inserted in the context of BIM, the advantages and disadvantages regarding its application, in addition to assimilating the characteristics of each level more cohesively. When carrying out the organization of the data obtained and the understanding of the aforementioned characteristics, a checklist was performed, to which it was possible to define which dimensions the evaluated individuals can reach and whether they do it correctly and efficiently.

From this, it is possible to affirm that the CUB-e seal is given to companies according to the requirements successfully achieved in each dimension. Therefore, when it is evaluated and when it reaches the necessary requirements, the institution can receive from the Standard seal to the Diamond seal, according to the degree of use.

The creation of different levels of certification is of paramount importance, given that it is possible to distinguish companies in terms of the level of use of BIM. On the website page for
certified companies, you can view the names of all certified companies and what level they reach in different areas of expertise. In this way, a space for appreciation and positive advertising is created for certified institutions. Therefore, it will be advantageous for companies to improve the use of technology, so that they gain a prominent position in the market. Another important aspect to note is the reliability that the company acquires in the face of the potential customer who may come to hire its functions, given that the certification process is based on technical parameters.

Regarding the job market and technical knowledge on the subject with professionals and students in the field, it is evident that the BIM concept is still associated only with 3D modeling.

Furthermore, although the owners understand BIM and its proposal for sharing data, most of them do not approve of sharing their private information collectively. As an example, we highlight the donation of used families and all the content involved in the projects, reporting that there is no interest, or limiting the dissemination only to public models already available.

Finally, with the mandatory use of BIM in Brazilian public works, the evaluation tool to prove the technical capacity of companies is a relevant topic. The certification process is fundamental to contributing with the implementation of technology in the country, besides disseminating what is proposed by BIM.

In addition by encouraging the implementation of BIM in companies, promoting them to reach higher levels until they reach the Diamond level and having a 75% requirement for the introduction of this process, certification contributes to the growth of sustainability within the scope of civil construction, since to reach better classifications the 6D must be satisfactorily applied.

The CUB-e was the certification created in order to meet the future demand to certify companies in an efficient manner. Thus, the creation of the evaluation model for certification contributes to the dissemination of BIM in Brazil, in line with the BIM BR Strategy and the Brazilian Federal Government decrees, due to the fact that companies have greater visibility and value in the market when acquiring certification.

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