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CONVERTING CONVENTIONAL BUILDINGS INTO GREEN BUILDINGS USING BIM TECHNOLOGY

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Abstract

Through the uses of BIM (Building Information Modelling) Using the BIM methodology known as BIM 6D, we may acquire the building's energy model. The information contained in the digital model enables us to mimic the building's actual energy behavior and recommend strategies for improving the building's performance and making it more sustainable. BIM 6D simulation enables us to make judgments about building design and operation not only for new buildings but also for current building rehabilitation. Using BIM 6D allows for a full analysis of the energy impact of the aforementioned rehabilitation, as well as the suggestion of additional optimization options, resulting in higher quality and convenience in the use of the sustainable building. Our study topic is a residential building in Iraq with an area of 224 square meters that is being rehabilitated to obtain a reduction in energy consumption and to make it an environmentally friendly building After applying all possible improvement options, it was concluded that the reduction in energy consumption amounts to 50% of the current consumption of the building, and this percentage is considered very large and feasible. We were able to examine how a set of simulated optimization techniques performed in BIM 6D delivers energy savings of up to 50% overall and up to 28% just by modifying the building's heating and cooling system.

Keywords: Energy Management, BIM, sustainable buildings, BIM-6D, Energy Simulation.

BİM TEKNOLOJİSİYLE KONVANSİYONEL BİNALARIN YEŞİL BİNALARA DÖNÜŞTÜRÜLMESİ

Özet

BIM (Bina Bilgi Modellemesi) kullanımları aracılığıyla BIM 6D olarak bilinen BIM metodolojisini kullanarak binanın enerji modelini elde edebiliriz. Dijital modelde yer alan bilgiler, binanın gerçek enerji davranışını taklit etmemize ve binanın performansını iyileştirmek ve onu daha sürdürülebilir kılmak için stratejiler önermemize olanak tanır. BIM 6D simülasyonu, sadece yeni binalar için değil, aynı zamanda mevcut bina rehabilitasyonu için bina tasarımı ve işletimi hakkında karar vermemizi sağlar. BIM 6D'nin kullanılması, yukarıda bahsedilen rehabilitasyonun enerji etkisinin tam bir analizine ve ayrıca ek optimizasyon seçeneklerinin önerilmesine izin vererek, sürdürülebilir binanın kullanımında daha yüksek kalite ve kolaylık sağlar. Çalışma konumuz, Irak'ta enerji tüketimini azaltmak ve çevre dostu bir bina haline getirmek için rehabilite edilen 224 metrekarelik bir konut binasıdır. tüketim, binanın mevcut tüketiminin %50'sine tekabül etmektedir ve bu yüzde çok büyük ve uygulanabilir olarak kabul edilmektedir. BIM 6D'de gerçekleştirilen bir dizi simüle edilmiş optimizasyon tekniğinin, yalnızca binanın ısıtma ve soğutma sistemini değiştirerek toplamda %50'ye ve %28'e varan enerji tasarrufu sağladığını inceleyebildik.
Anahtar Kelimeler: makale, yazarlar için talimatlar, makale şablonu

1. Introduction

Green architecture preserves the environment and reduces the waste of energy and water. Building Information Modelling (BIM) has helped in the application of green architecture, We will also see in our research, that we were able, through building information modeling programs, to reach options for improving the performance of buildings when doing the rehabilitation of an existing building to get as close as possible to the requirements of sustainable buildings where we have studied a two-story private university building and rehabilitated it and studied the possibility of improving the performance of the building aft rehabilitation and saving energy use in it by nearly half of the previous consumption.

Construction has become increasingly "green" and is the norm in most new construction projects nowadays. Its many benefits. The principles of the green project are based on developing designs to be in line with the efficient use of natural resources, including the selection of appropriate materials and the reduction of waste and toxins Whereas, the term Green BIM is the sustainable practice related to maintaining the activities of the construction industry through the application of building information modeling techniques (Rajendran, Gambatese, and Behm 2009).

The digital revolution of the construction industry and built environment relies heavily on BIM methodology. As a key component of a sector's development and competitiveness strategy, BIM is widely recognized by governments and the general public alike across Europe and the rest of the globe. Several proactive steps are required to accomplish these economic, environmental, and social advantages by using BIM in the building, implementation, and operation of public goods sectors. Management of all project information created throughout the development of a project, from the basic planning phases, through conceptual design and alternative selection, to supplier procurement and advanced stages such as structural design and amenities.Furthermore, future development and maintenance of facilities in 4D, 5D, 6D, and 7D must be monitored, controlled, and managed. Table 1 below shows

In our study on the sixth dimension, table 1 below shows the dimensions in BIM

Table 1. BIM Dimensions

Dimension BIM	PROPERTIES
2D	Basic document
3D	3D dimension model
4D	Programming plan
5D	Cost control
6D	Sustainable and energy efficiency
7D	Facility management

1.1. Purpose of Study

Researchers in this study are looking into ways to use BIM models to simulate energy behavior and conduct energy analyses on a model that already exists for an existing building. This will allow researchers to examine how the building operates before beginning any possible renovations or rehabilitations. For this, the Building Energy Model (BEM), also known as BIM 6D, is used. After conducting an energy simulation and analyzing the building's present energy state, the objective is the investigation of feasible options to increase energy efficiency and sustainability, as well as investigate the possibilities of combining renewable energy and the use of natural light the other hand, through these advances in building sustainability. When it comes to the rehabilitation and modernization of a structure, having access to a decision-making approach might be beneficial. Finally, the goal is to examine the existing building's state using energy modeling about the standards necessary for daylighting in LEED certification for new structures.

2. BUILDING ENERGY MANAGEMENT

Buildings energy performance (BEMS) are control systems that monitor and control the electrical and mechanical equipment in buildings, such as lighting, ventilation, heating, and power systems. They are sometimes referred to as building management systems since they connect all of the building options back to a central computer to enable control over timings, humidity, temperatures, and other aspects. Cables Data is sent from the plant's control hubs, known as outstations, across the facility to a master station, which serves as the computer's central controller and allows building operators to administer and monitor the building. A building's profitability and operation may be improved while saving millions of dollars a year on energy costs by properly managing the building's energy systems. Modern energy management systems make it much simpler to keep tabs on how much energy is being used (EMS). When the system is controlled, the facility may utilize energy and equipment just when they are required. Many facilities save money by reducing energy use in sections that aren't in use all the time. A building's mechanical systems may be improved and the capacity to manage comfort and air quality throughout the building increased by minimizing needless usage of equipment via optimal controls. Maintaining a building's mechanical systems and lighting systems may be made easier with the help of energy-conserving devices(Aman, Simmhan, and Prasanna 2013).

2.1. Building Information Modeling

Building information modeling (BIM) is a sophisticated software modeling method that architects, designers, and contractors can use to aid in the design, operation, and construction of a building. Commercial construction is considered a sophisticated method that requires many people from many specialties: architectural engineers, business professionals, contractors, tradesmen, and building employees. Without BIM, each individual must work separately on the structure, and when they are gathered, they may discover that their goals are irreconcilable (Edirisinghe et al. 2017).

Occasionally problems aren't recognized until the construction process has already begun, resulting in costly setbacks and modification orders in the timeline. The building information model facilitates real-time collaboration among all parties involved in a construction project, resulting in significant gains in safety, cost, and efficiency. As a result, BIM is now one of the most influential building trends (Merschbrock and Erik Munkvold 2012).

2.1.1. Needing of BIM In construction

BIM in construction is a technology that enables all of the professionals who work on a building throughout its life to collaborate on a single project. BIM objects, or the components of a BIM model, are intelligent, geometric, and capable of storing data. An element may be changed in BIM software and the model will be updated accordingly. Consistent and coordinated modeling throughout the process enables the building phase to be a collaborative effort between engineers, architects/designers, construction managers, and stakeholders. Structure Information Modeling (BIM) is software that generates a realistic 3D model of a building. An attempt was made to produce a realistic model of a building using BIM software, however, unlike a simple sketch, this modeling is fully aware of the structure's characteristics(Bui, Merschbrock, and Munkvold 2016).

Building information modeling is quickly becoming one of the most essential building technique advancements because of its multiple advantages in terms of cost, efficiency, and safety. Problem discovery at an early stage: Conflicting components in a design process are identified at the systems. the system, preventing costly revisions throughout the construction process.

Improvements in Scheduling: Using an intelligent make model, related project elements can be more actively sequenced, increasing the likelihood of regular scheduling (Latiffi, Mohd, and Brahim 2015).

BIM can help with construction automation. Responsibilities that can be discovered by leaving software workers to focus on more specialized tasks Improved construction processes: Workflows are generated automatically using BIM software, and changes made during construction automatically update the processes for everyone above site .BIM can also improve worker safety by providing workers with real-time access to information about any task, resulting in increased awareness of danger and effort. These are just a few of the advantages that BIM delivers to construction, not to mention the gains in construction state integrity, environmental making, material consumption, force, and efficiency.BIM is employed throughout the development of a building project; thus, it can be beneficial to search for the full procedure from start to completion(Fargnoli and Lombardi 2020).

2.1.2. BIM Processes in construction

A building information model is used throughout the life of a construction project, from design to operation and construction. BIM increases the magnitude for every complex project at each class along the method. A cooperative team is put together early on in a BIM project. It agrees on the method and data structures to verify that the information obtained is coordinated, and it will be very helpful to individuals taking part in the building and procedure stages in the future. This initiation is accompanied by the inclusion of individuals who will take part in subsequent classes of the construction project or who will be able to significantly contribute in the future(Schoop 2005).

The program enters that level of construction, and the information developer is able to construct and plan that efficiently. Adjustments to that plan are critical, with such changes able to follow the right process in a validated and used transparent fashion. The project's construction is complete, and the use stage has begun; any information in just that can be used to activate the asset that was developed. Real-time asset performance data is modeled in such a way that specific components of the built magnificent sources have prepared digital data(Dastbaz, Gorse, and Moncaster 2017).

2.1.3. Trends of BIM in construction projects

The building information model is relevant at every stage of the construction process, including:

Design: Using a planners model, engineers may rapidly sketch out potential outcomes and spot problems(Pikas, Koskela, and Seppänen 2020).

The model of planning Referring contractors that can make educated estimations about timelines and costs that improve the building process (Politi 2018).

Construction: the models are always available, construction workers can clearly define duties, and they receive real-time updates on all changes (Benedetti, Dibisceglia, and Abdirad 2014).

When construction is completed, an elements manager gets access to the modeling, which is primarily an enhancement over as-built drawings, providing all of the systems and features of the building (Benedetti et al. 2014).

Several strange projects that exist today would not have been conceivable without BIM, which has pushed innovation in building processes, leading to cost-effective constructions with extraordinary designs. Despite these significant advancements in building processes, the difficult job of construction is still completed by individuals using heavy equipment. That looks forward to seeing persistent improvement in the sector as a result of the employment of strong software to strengthen the abilities of all workers who will eventually create construction potential (Rodrigues, Santos Baptista, and Pinto 2021).

2.1.4. 3D BIM

Using cutting-edge tools for reproducing developing digital models requires us to pay attention to the graphic aspect of our design while ensuring an accurate portrayal of that appearance aesthetic and the adherence to outstanding geometry of the elements that are represented. Problems that can be solved by planning classes do not just concern the model figuring as such, which is in a state of separation from the associated technical disciplines, but it also considers the interface of many strategy disciplines as a component of this technique. The necessity for activity control, often known as "model checking," can be described with two different processes. Checking the code, investigating the modeling's conformance to the plan, and adhering to the ethics requirements. clash detection, which is the proactive analysis of the model's capable geometric conflicts. the necessity for official verification of each correction's model (Cha and Kim 2020).

3. CASE STUDY

The architectural modeling of the case study adopted in the research is first implemented, and for this purpose, BIM REVIT was created When using software with this software, we also get the power model, which is done by Perform simulation and analysis later using REVIT plugin, INSIGHT 360. With this program, energy simulation is implemented in the cloud, using a reliable, industry-leading, large scale When performing an energy simulation, The INSIGHT 360 technology showed and interacted with the gathered information via graphs and performance charts directly in a virtual model, allowing researchers to investigate both the existing state of the building as well as potential future energy improvements.

3.1. Define Case Study

The building is a two-story residential house with a total area = of 224 square meters located in Iraq, Anbar. It is a traditional building in use in many regions of Iraq. The available options will be studied to improve the performance of the building in terms of energy use to be reflected in future residential complexes, especially since Iraq suffers from a shortage of Services for many years.

3.1.1. Building description

The house is located in Anbar, Iraq, with an area of 224 square meters a building with a long rectangular floor consisting of two floors built above the ground.

The concrete structure and the outer and inner fence walls are made of brick material, The ceilings of the building are also made of reinforced concrete.

3.1.2. Description of building facilities

The building is cooled using separate cooling units for each room on each floor. For water heating electric heaters are used for the lighting units in the building, most of them are fluorescent lamps.

3.1.3. BIM building definition for energy simulation

In this section, you must specify all of the data needed to run an energy simulation for the building using BIM software. Geometry, voids, and thermals are examples of data that must be defined. Initially, our building schemes were utilized to serve as a model for building architecture and BIM architecture utilizing REVIT software, including the envelope, climate, geographical position of the building, and operational features of the areas. Once the building's thermosphere, materials, and operation have been established in the architectural model, the professional properties of all areas are constructed to produce the power model to run the required simulation.

3.1.4. Building's architectural model

Figure 1 depicts the building's BIM architectural model, which is made up of spaces, windows, and doors.

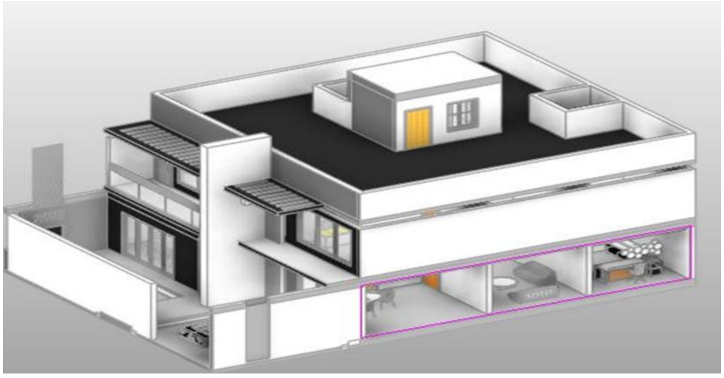

Figure 1. Building's Architectural Model

3.2. Discuss The Options Available

In this step, we will suggest options to improve the performance of the building and transform it from an ordinary building to an environmentally friendly building and analyze the results to reach the most available solutions.

3.2.1. HVAC System improvements for the building

This improvement is indicated when replacing the building's existing air conditioning systems
A new system is available within the improvement options in the program. The results will change after the application of the new system used for heating and cooling.

The power simulation (see figure 2) saw the most improvement:

a) Consumption: 198 kWh/ (m2 year)
b) Saving energy: 79 kWh / (m 2 years).

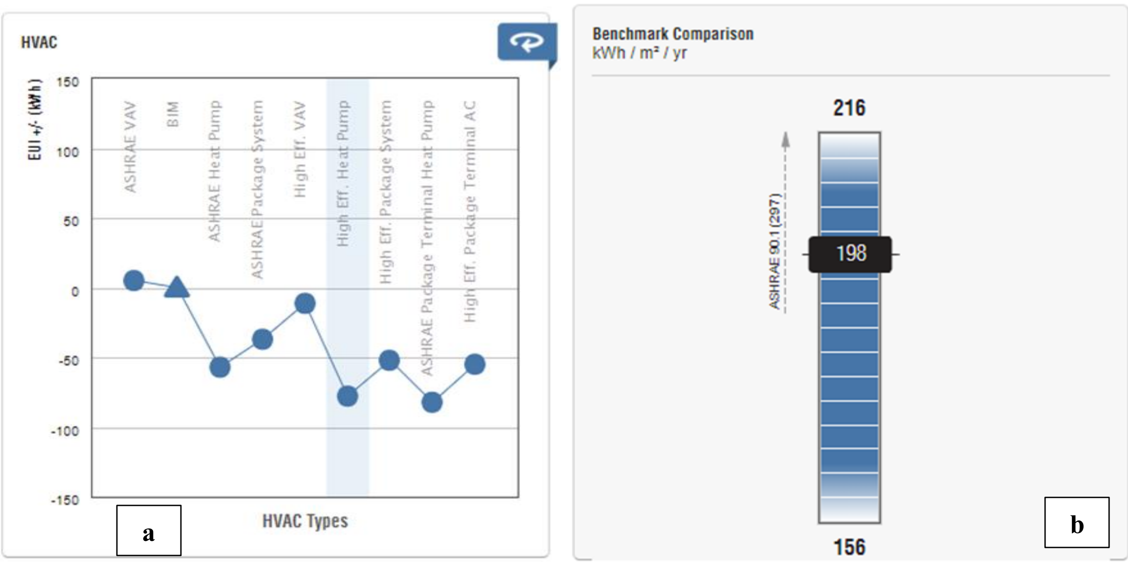

Figure 2. (a) INSIGHT 360 diagram with HVAC upgrade. (b) INSIGHT 360 platform result after implementing Improvement

3.2.2. Lighting System IMPROVEMENTS for the building

This type of improvement includes replacing existing fluorescent luminaires with others LED technology. The results that we obtained after applying this option of optimization in the energy simulation were (see figure 3):

1) Consumption: 254 kWh / (m2 year);
2) Saving energy : 23 kWh / (m2 years).

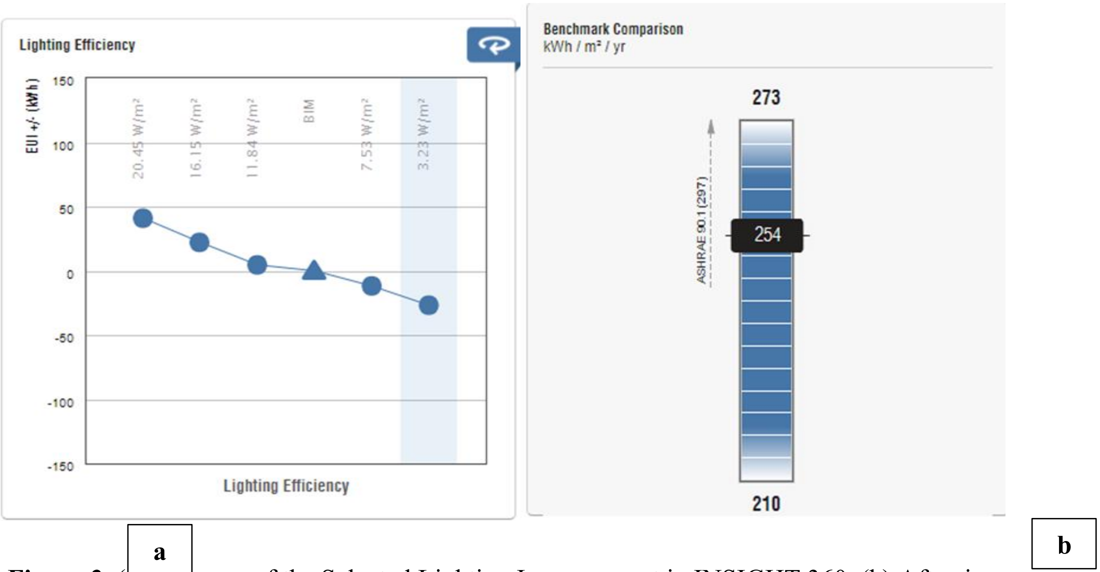

Figure 3. (a) Diagram of the Selected Lighting Improvement in INSIGHT 360. (b) After-improvement INSIGHT 360 platform result for the building.

3.2.3. Improvement of the quality of the holes in the building envelope (windows glass)

This type of improvement includes replacing existing single-glazed windows with low-emission windows, The results obtained after applying the optimization in the power simulation (see Fig. 4):

1) Consumption: 271 kWh / (m2 year).
2) Energy saving: 6 kWh / (m2 years).

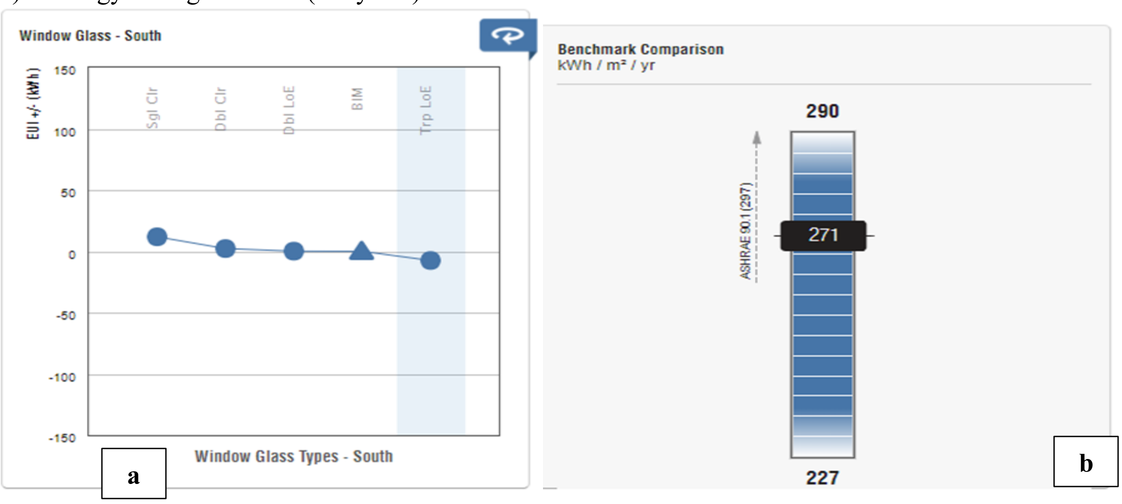

Figure 4. (a) Diagram of the Windows Glass Improvement Selected in INSIGHT 360. (b) Results Obtained on the INSIGHT 360 Platform after improvement.

3.2.4. Enhancement of the lighting control system

This type of improvement includes installing a sensor system to rationalize electricity consumption, The results obtained after applying this optimization in the power simulation were (see figure 5):

1) Consumption: 272 kWh / (m2 for a year).
2) Energy saving:5 kWh / (m2 years).

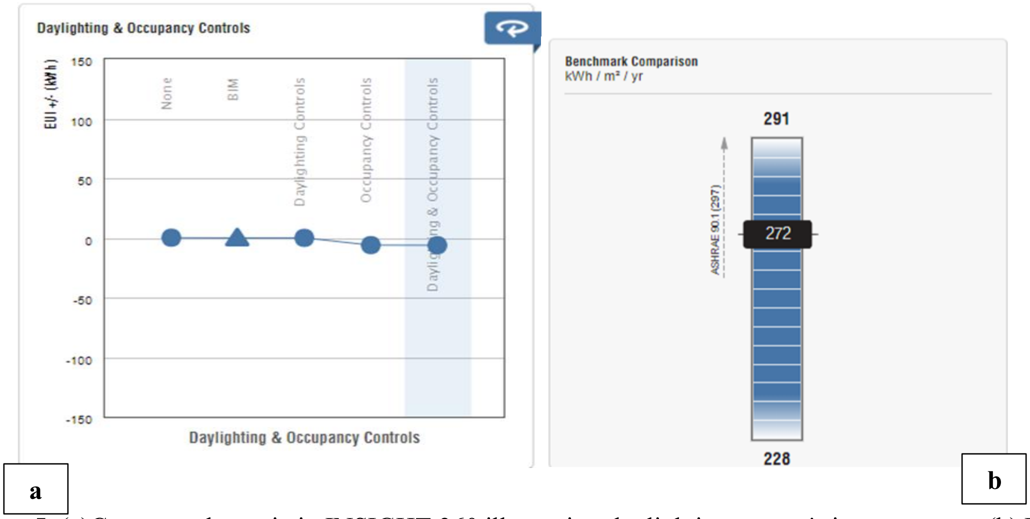

Figure 5. (a)Create a schematic in INSIGHT 360 illustrating the lighting system's improvement. (b) Post-improvement outcome on the INSIGHT 360 platform

3.2.5. Improvement of installed electrical power

This type of improvement includes the installation of equipment that is more efficient than existing ones located in the building, The results obtained after applying this optimization in the power simulation (see figure 6):

1) Consumption: 256 kWh / (m2 years).
2) Energy saving:21 kWh / (m2 years).

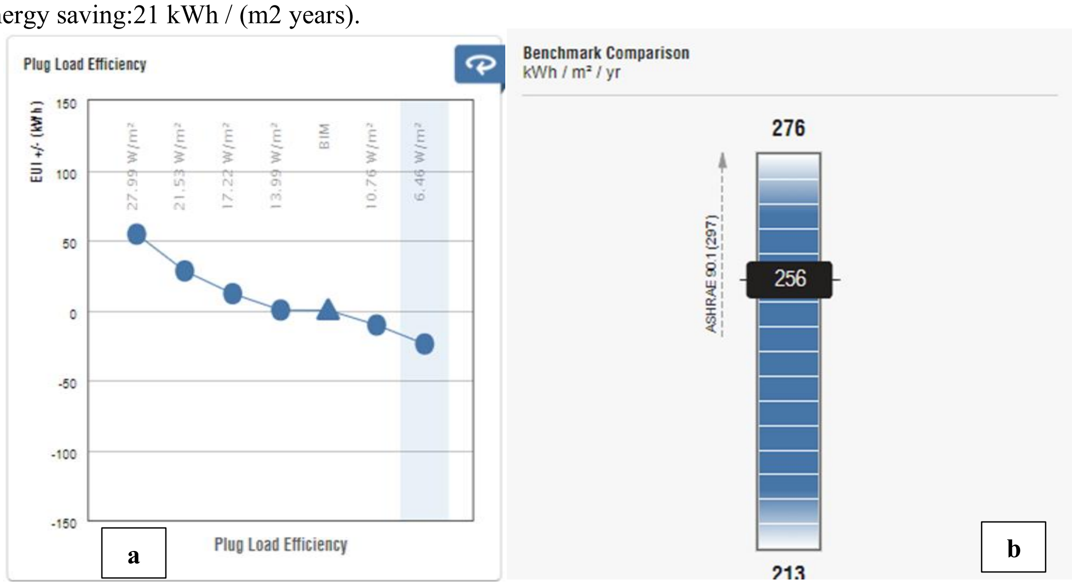

Figure 6. (a) Diagram demonstrating the increase in installed electrical power selected in INSIGHT 360. (b) The after-improvement result on the INSIGHT 360 platform

3.2.6. Improvement of wall construction

This type of improvement includes the installation of insulation layers that is more efficient than existing ones located in the building, The results obtained after applying this optimization in the power simulation (see figure 7):

1) Consumption: 256 kWh / (m2 years).

2) Energy saving:21 kWh / (m2 years).

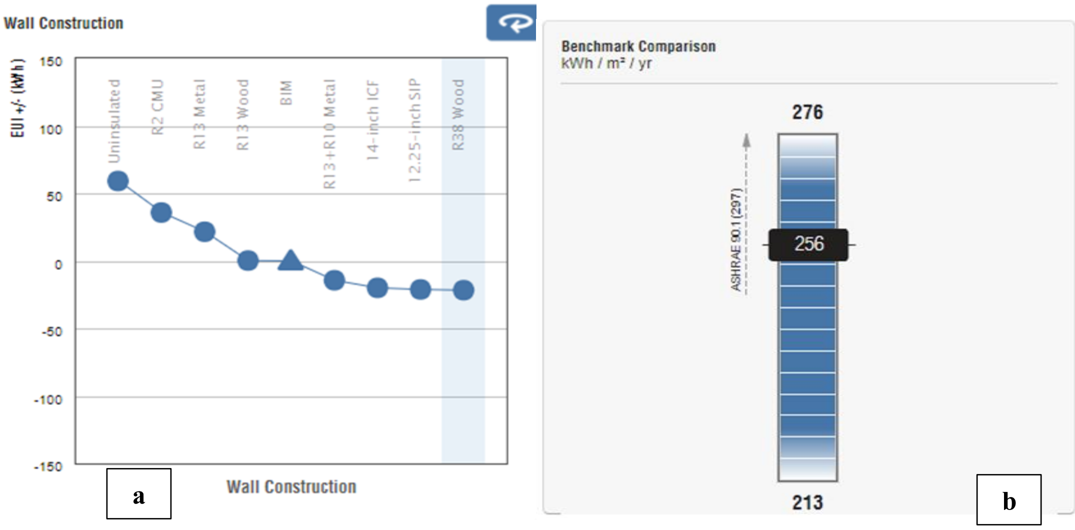

Figure 7. (a) Illustration of the improvement in installed wall insulation selected in INSIGHT 360. (b) The after-improvement result on the INSIGHT 360 platform

4. RESULTS AFTER APPLYING ALL SUGGESTED OPTIMIZATION OPTIONS

In this chapter, everything analyzed in the previous chapter is obtained to obtain Overall overall improvement in the application of all proposed measures. The results obtained after applying the general optimization in the power simulation were as shown in the figure after using all the optimization options proposed by the Insight platform. See figure 8 below;

1) Consumption on average: 138kWh / (m2 year).

2) The average amount of energy saved per square meter is 139 kWh / (m2 years).

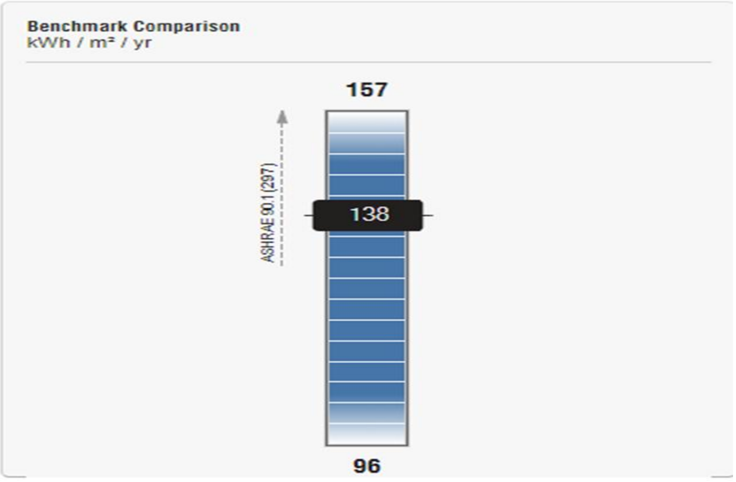

Figure 8. The Building After Improvement Result was Obtained on the INSIGHT 360 Platform.

The table below illustrates the quantity of energy stored for each proposed scenario, as well as the total energy savings, which reached 50% in the presence of the recommended changes. In short, we may graphically display the numerous studied scenarios, as shown in the table below. Energy modeling was used. This section displays a graph of the various enhancements. The options were analyzed in the energy simulation, and we can see that half of the total was saved. Improvement in energy management in the building compared to the baseline scenario.

Table 3: The Building's Results from the Different Scenarios ANALYZED

The name of the improvement	name of scenario	Building Consumption kWh/m2 year 277	Saving energy kWh/m2 year
HVAC system	HVAC	198	79
Lighting System	LED lighting	254	23
Holes in the Building Envelope (Windows Glass)	Windows glasses	271	6
Lighting control system	Daylighting	272	5
Electrical Power	Plug load	256	21
Wall insulation	Wall construction	256	21

Roof insulation		272	5
		138	139 =277-138

With the results shown, we can draw the conclusion that the BIM6D model allowed us to carry out a thorough analysis of the effects of building rehabilitation, compare the current state of the building with the future situation in terms of energy consumption, and determine whether energy rationalization was economically feasible. This will allow us to assess all of the improvements as a whole, allowing us to make more informed decisions. Alternatives that are more energy efficient, have a smaller environmental impact, and provide greater comfort to building users will be available.

5. CONCLUSION

When we apply the results and analyze them in this work, we can guess the proposed approach. During the research, we used a powerful tool for energy analysis and simulation of an existing building, because the methodology used allows for the analysis of energy management in structural buildings.

For a typical building's BIM 6D model. As a result of this study, we can simulate the essential methods for achieving more sustainable buildings in terms of rationalizing energy use in the building, and through the data resulting from the analysis process, we can evaluate the possibility of implementing the proposed options and the possibility of excluding other options that have a slight impact on reducing energy in the building.

Thus, we were able to determine that the proposed technique can become a useful decision-making tool and that these decisions can be considered while rehabilitating any building, whether it is residential, commercial, or service, where during the rehabilitation process, we can put insulating materials in the roof of the building for example.

In addition, it provides a tool to analyze the criteria used to evaluate the sustainability of buildings in tenders and contracts such as the rehabilitation of commercial and historical buildings, allowing us to know the economic feasibility when using certain materials that make the building more sustainable. Through the research, after applying all the proposed options for the rehabilitation of the building, we concluded that energy savings were achieved by 50% compared to the previous situation in the building, which is reflected in the life of the building, and that the saving of energy consumption in the building is reflected in a decrease in carbon dioxide emissions, which is one of The most important criteria for sustainable buildings. In addition to the economic feasibility that we will obtain due to the low energy consumption From what was previously shown, These proposed energy-saving techniques improve the building's sustainability. We noticed that the largest percentage of options to improve the performance of the building is due to the heating and cooling system used in the building and that other options are not of high impacts, such as the ratio of the window to the wall, as well as the type of glass used in the external walls of the building.

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