How to Achieve Sustainable Building Design and Operation with Building Information Modeling

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☐ ABSTRACT ☐

The goal of the research is the combination of sustainable design strategies in BIM tools (Building Information Modeling). By integrating a BIM model into a sustainable planning strategy, specific sustainability trade-off analyzes can be carried out taking into account the actual building conditions and characteristics.

In terms of engineering and sustainability, BIM is a newer technology. Many of the tools that measure the impact of old or new sustainable design strategies are not directly available in a BIM model itself. Therefore, data must be exported to another application or imported from a data source. Research offers a new means of improving the quality of life for the Syrian community and a new tool to reduce the negative impact we as humans have on the environment.

Keywords: BIM – Sustainability - Green Building - Building Systems.

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كيفية تحقيق تصميم وتشغيل مستدام للمباني باستخدام نمذجة معلومات المباني

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□ ملخّص □

الهدف من البحث هو دمج استراتيجيات التصميم المستدام مع أدوات نمذجة معلومات البناء .(BIM) حيث يسمح هذا الدمج لنموذج BIM مع استراتيجية تصميم مستدامة إجراء تحليلات محددة للاستدامة، باستخدام ظروف وخصائص البناء الفعلية. بالنسبة إلى الهندسة والاستدامة، تعد BIM تقنية حديثة إلى حد ما. العديد من الأدوات المستخدمة لقياس تأثير استراتيجيات التصميم المستدامة، القديمة أو الجديدة، لا يمكن الوصول إليها مباشرة ضمن نموذج BIM نفسه، لذلك، يجب تصدير البيانات إلى تطبيق آخر أو استيرادها من مصدر بيانات.

يوفر البحث وسيلة جديدة لتحسين نوعية الحياة للمجتمع السوري، وأداة جديدة للحد من الآثار السلبية التي نتسبب بها نحن، على البشر وعلى البيئة.

الكلمات المفتاحية: الاستدامة– أنظمة البناء– BIM

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Introduction:

There are many reasons that construction prioritising sustainability now than in previous years, including the world's better understanding of climate change. For example, buildings in the United States consume the majority of electricity and natural gas, account for a significant portion of the country's water consumption, generate the majority of waste, and are responsible for more than a third of its greenhouse gas emissions (https://www.usgbc.org/), The construction industry also consumes approximately 40% of the world's raw materials (Hill and Bowen 2010), more than any industry other than food production. Efforts to reduce this number are changing the way buildings are designed, built, operated, and maintained. As designers, we have a code of ethics that includes our responsibility to pass on a cleaner and more sustainable world to the next generations and to protect their lives. However, we really need one essential thing, namely "*innovation*". *"Innovation is the foundation for sustaining life on Earth. We are at a critical point and the right innovations need to be incorporated into the environment of the future."*

A recent study into the sustainability of UK construction found that the built environment accounted for 45% of total UK carbon emissions (27% from domestic buildings and 18% from non-domestic) 72% of domestic emissions arise from space heating and the provision of hot water. 32% of landfill waste comes from the construction and demolition of buildings. 13% of products delivered to construction sites go directly to landfill without being used.

Looking at these statistics, it is no surprise that governmental authorities and institutes must ask us to make our projects more environmentally sustainable. This legislation and certifications come in various forms, such as Passive House standards.

Research Objectives and Scope:

The main objective of this research is to explore the suitability of BIM for sustainability analysis. These include Passive House and Virtual Environment. In addition to these is the development of a conceptual framework illustrating how designer can use BIM for sustainability analysis and evaluate the energy and environmental design rating of a building facility. The research scope is limited to residential building projects.

Methodology:

A two-step methodology is adopted for this study as follows:

1. Development of a conceptual framework to establish the relationship between BIM and Passive House rating processes..

2. Validation of the developed framework via a case study. Brief results of both steps are presented in the following sections.

What is Green Building?

With a wider range of ways of thinking and understanding about sustainability, the construction industry is also exploring the deeper meanings. The language in the construction industry remains relaxed and uses the terms green and sustainably interchangeable. When investigating criteria for sustainable design, several leading thinkers tested designs and wrote about the differences between green design and sustainable design. Two documents from the first decade of the 21st century address the difference. The first is "Building for Sustainability" ((2002) by BNIM Architects in close collaboration with Keen Engineering, Oppenheim Lewis, Hawley Peterson and Snyder Architects, and the Packard Foundation facility steering committee).

The second consists of two parts: "*The Sustainability Report*" and *"The Sustainability Matrix"*. This document was created to answer the question of how a decision tool can be developed to explain the impact of different levels of green on the proposed project. To answer the question, six solutions were developed, which are based on the same program and the same location and meet the required building regulations. The design has been changed to improve environmental sustainability. The solutions are organized in such a way that they meet the four different certification levels for environmentally friendly construction of the USGBC LEED rating system as well as a standard certification level and a certification level for sustainability that goes beyond LEED. The effects for each of the six solutions were quantified in the categories of building shape, energy, pollution and external costs for society, schedules (planning and construction) and short and long-term costs (planning and construction).
The design solution going beyond LEED was conceived as a living (green) building. In "*Building for Sustainability*", a "*green building*" is defined as "operationally no net annual impact on the environment. It provides its own energy and water, cleans its own waste and does not emit pollution".

Green Building Rating Systems (Sustainability Indicators):

It is important to note that measuring the sustainability of a building remains problematic. Numerous protocols are currently in use to assess sustainability, including, for example:

1)- The Global Reporting Initiative, which uses indicators for material use, energy consumption, water use, emissions and waste, and many other environmental and social issues to develop their ecological footprint sustainability reports (GRI 2006).

2)- Yale University's Office of Sustainability, which uses three main categories of sustainability metrics: (Yale Office of Sustainability 2005):

♦ Use of natural resources.

♦ Systems and processes, which includes procurement, waste management, land use, food, transportation, and building design.

♦ Culture, which includes social justice issues on campus.

3) - the EU's sustainable development strategy, which includes an extensive list of items for measuring sustainability (European Commission 2001).

4) - the World Economic Forum sustainability performance index, which deals with two main categories of indicators: (Esty et al. 2006):

♦ Reducing environmental stresses on human health.

♦ Protecting ecosystem vitality.

5) - the American Society for Testing and Materials (ASTM) framework for sustainable design of buildings (ASTM 2005).

Numerous certification and rating systems are available throughout the world for sustainable building, as well. In fact, there are over 34 green building rating systems or environmental assessment tools available to the marketplace, and the number is likely to grow. In my opinion, here are the six primary developing players in green building rating systems:

1) - Comprehensive Assessment System for Building Environmental Efficiency (CASBEE).

2) - SBTool (formerly known as GBTool).

3) - Building Research Establishment's Environmental Assessment Method (BREEAM).

4) - Green Globes U.S.

5) - LEED (Leadership in Energy and Environmental Design).

6) – Passive House (German System)

Each of these in some part was developed to promote environmentally responsible design, construction, and operating approaches as well as transform the built environment and marketplace, as we traditionally understand it. All of them offer some form of score so that the high-performance claims of projects can be compared openly, at least within each system.

1)- CASBEE:

CASBEE is the newest of the systems and was developed in 2001 for use in Japan through cooperation of academia, industry, and government under the Japan Sustainable Building Consortium (JSBC). The system has been developed for New Construction (NC), Existing Buildings (EB), Renovations (RN), Heat Islands (HI), and Urban Developments (UD).

CASBEE distinguishes itself from the others in that it is founded on a new principal of Building Environmental Efficiency (the BEE portion) as the major indicator of overall performance. The two parts to this principal are the **Building Environmental Loadings (L)**, which is defined as the impact of the building on the outside world beyond hypothetical project boundary, and **Building Environmental Quality and Performance (Q)**, which is defined as improvements for the building users within a hypothetical project boundary. Users are encouraged to think about the project boundary as the division between private and public property. It is represented by the system as the following equation:

$$BEE = \frac{\text{Building Environmental Quality and Performance (Q)}}{\text{Building Environmental Loadings (L)}}$$

Overall, 100 sub items are scored within the three major categories of Q and L.

Criteria for Q are developed from Indoor Environment, Quality of Service, and Outdoor Environment on Site issues. **Criteria for L** are developed from Energy, Resources and Materials, and Off-Site Environment issues. Each area is scored on a scale of 1 through 5, with 3 being average and 1 being the worst. Results from comparing the quality and the load reduction are plotted on the graph, and the better buildings will graph a scenario of high quality with the least environmental load. The final score of the project is put on a graph and graded C (poor) through B–, B+, A, and S (excellent).

2) - SBTool :(-sustainable building tool):

SBTool (http://greenbuilding.ca/iisbe/sbc2k8/sbc2k8-download_f.htm) is the current generation of GBTool, which was launched in 1998 as part of the Green Building Challenge (**GBC**), a program developed by Natural Resources Canada. In 2002, the International Initiative for a Sustainable Built Environment (**IISBE**) took over responsibility of running the GBC and has since renamed it to the Sustainable Building Challenge (**SBC**). Similar to CASBEE, SBTool is a framework tool for assessing buildings based on environmental performance. The overall framework has 116 parameters spread over seven main categories. Those categories are:

- Site Selection, Project Planning, and Development
- Energy and Resource Consumption
- Environmental Loadings
- Indoor Environmental Quality
- Service Quality
- Social and Economic Aspects
- Cultural and Perceptual Aspects

One of the unique claims to this system is that it is highly adaptable to local needs and conditions. This is intentional and explains why more than 20 countries around the world are able to participate in the SBC and the development of the SBTool. As part of the adaptability, building performance is related to nationally established baselines or benchmarks. The IISBE notes that the scoring is meaningless unless the national team has established the baseline values. In other words, it only becomes a rating tool for a region if the performance baselines are agreed to. In an attempt to have further flexibility, the IISBE also touts that the SBTool can be used for projects of all sizes, commercial or residential, as well as both new construction and renovation.

The tool comes in three parts. First is the tool for noting and weighting the appropriate standards for the region in the project. Second is a tool for the design team to describe all the project information. Last is the assessment form, which is based on information from the first two forms. At the current development stage, the IISBE recommends using the system for design assessments only.

3) - BREEAM:

BREEAM (http://www.breeam.org) has been most widely used in the United Kingdom and is the oldest of the five, getting its start in 1990. According to BREEAM, versions are updated regularly in line with UK Building Regulations. BREEAM assesses the performance of buildings in the following areas:

Management - Health and Well-Being –Energy –Transport –Water Material and Waste - Land Use and Ecology -Pollution

An officially trained assessor assesses the project to develop the overall rating for the project. A first assessment can be done at the end of the design stage, with the final assessment coming after occupancy. Becoming an assessor is open to all building professionals who are trained by the BREEAM quality assurance body called BRE.

Credits are awarded in each area according to performance and then added

Together through a combined weighting process. Finally, the building is rated on a scale of (Pass, **Good**, **Very Good**, **Excellent)**, and a certificate awarded to the project.

Although BREEAM was originally available in two types, one for office and one for homes, it is now available in a range of building types: offices, homes, industrial, multi residential, prisons, retail, and schools….

4) - Green Globes:

Green Globes (http://www.greenglobes.com) is one of the systems that grew out of BREEAM. Green Globes first appeared as an online version of BREEAM for existing buildings in Canada in 2000. In 2002, it was adapted for use in the design of new buildings, and then in 2004 it was converted to a U.S. version, which is distributed and run by the Green Building Initiative (GBI). Recently, GBI became accredited as an American National Standards Institute (ANSI) standards developer, and they are in the process of trying to establish Green Globes as an official ANSI standard.

The Green Globes tool itself is questionnaire based. To that end, teams are expected to answer questionnaires and review recommendations developed from their answers at each stage of the design process. The rating system is based on the construction document questionnaire. The point system includes up to 1,000 points across the system's seven main sections:

Project Management—Policies and Practices	**50** points
Site	**115** points
Energy	**360** points

Water	**100** points
Resources, Building Materials and Solid Waste	**100** points
Emissions and Effluents	**75** points
Indoor Environment	**200** points

The final Green Globes rating is expressed by a number of globes from one to four. The number of globes is based on the percentage of points successfully obtained:

1 Globe	**35–54** %
2 Globes	**55–69** %
3 Globes	**70–84** %
4 Globes	**85–100**%

A unique thing about Green Globes is the focus given to Lifecycle Assessment (**LCA**); the majority of the Resources points are LCA related.

According to GBI, "LCA considers materials over the course of their entire lives and takes into account a full range of environmental impact indicators—including embodied energy, solid waste, air and water pollution, and global warming potential."

An original goal behind the creation of the Green Globes system was to provide a simple, online, self-assessment tool. While this allows flexibility and cost savings compared to other rating systems, it can make the credibility of the assessment suspect.

To that end, Green Globes has recently developed a third-party verification system.

Verification is provided by a Green Globes trained licensed architect or engineer who has been approved by GBI. Precertification can be obtained after the construction document stage, with the final rating and ability to use the Green Globe certification coming after the Green Globes verifier reviews the completed project. Buildings that have been third-party verified for certification receive a plaque for display. Green Globes estimates the average total cost for all assessments to be $4,500 to $5,500.

Currently no organizations require Green Globes ratings for their buildings.

5) - <u>LEED</u>:

The USGBC introduced the LEED (http://www.usgbc.org) green building rating system in 1998 as LEED for New Construction (LEED-NC), making it the second oldest system of the five described here. The rating system has two key fundamental attributes.

First, it was developed with an open consensus–based process, with input from a broad range of building industry professionals and other experts, including the U.S. Department of Energy. Second and common to the other systems, using LEED is voluntary. A goal behind creating the LEED system was to establish a measurement standard for what is considered a *green* building, comparing them on an even playing field. At the time of creation, some U.S. practitioners were finding it difficult to decipher the claims of their competitors and building product manufacturers who also had started campaigns about how environmentally conscious their product or building was.

With its required third-party certification, LEED made it clear which buildings were high-performance green buildings and which ones were not. Under the LEED-NC system, buildings are judged via a 69-point credit system in five categories of environmental performance and one additional area for innovative strategies. The five major categories and credits available in each are:

- Sustainable Sites (14 points).
- Water Efficiency (5 points).
- Energy and Atmosphere (17 points).

- Materials and Resources (13 points).
- Indoor Environmental Quality (15 points).
- Innovation and Design (5 points).

In addition to the points, seven prerequisites must be met to participate in the program. These are considered the basics of a green building, such as construction pollution prevention, a recycling program, no smoking, no chlorofluorocarbon (CFC) refrigerants, basic building commissioning, minimum indoor air quality performance, and a baseline for energy performance. Up until June 26, 2007, once those seven prerequisites were met, the points attempted were left up to the team. It was at this time, in reaction to stakeholder cries for more progressive energy efficiency requirements, that the USGBC made achieving the first two Optimize Energy Performance points required as well.

To show credit achievement, the team must document in an online system per the LEED-NC Reference Guide how the project achieved each attempted credit. After the construction document phase, the team can submit design credits for a cursory review. Only after construction is complete can the team submit the project to the USGBC for certification. The total credits achieved in each category are added together for the final score to determine the level of certification awarded to the project. The four levels of certification are as follows:

LEED certified	26–32 points
LEED Silver	33–38 points
LEED Gold	39–51 points
LEED Platinum	52+ points

This clear, simple, verified system has been greeted with rapid adoption across the U.S. building design and construction industry. Originally developed for use in the United States, buildings have earned LEED in 13 other countries.

The USGBC has updated the LEED NC program three times since its inception, making the system more challenging and user friendly each time. In addition, the USGBC has developed specific versions of LEED for Core and Shell Development (CS), Commercial Interiors (CI), Existing Buildings (EB), Homes (H), Schools (S), and Retail (R). As of June 2007, there are over 900 certified buildings and almost 7,000 more that are registered to seek certification.

6) - Passive House

Passive House is the world‘s leading standard in energy efficient construction.( ) The Passive House Standard stands for quality, comfort and energy efficiency. It requires very little energy to achieve a comfortable temperature year round, making conventional heating and air conditioning systems obsolete. While delivering superior levels of comfort, the Passive House Standard also protects the building structure. As great as these rating systems are and have been for the industry, none of them are set up to produce or lead a team to a sustainable building—only a green one that is less bad than what we’ve seen over the past few decades.

Passive House requirements

For a building to be considered a Passive House, it must meet the following criteria:

1. The Space Heating Energy Demand is not to exceed 15 kWh per square meter of net living space (treated floor area) per year or 10 W per square meter peak demand.
2. In climates where active cooling is needed, the Space Cooling Energy Demand requirement roughly matches the heat demand requirements above, with an additional allowance for dehumidification.

3. The Renewable Primary Energy Demand (PER, according to PHI method), the total energy to be used for all domestic applications (heating, hot water and domestic electricity) must not exceed 60 kWh per square meter of treated floor area per year for Passive House Classic. .
4. In terms of Airtightness, a maximum of 0.6 air changes per hour at 50 Pascals pressure (ACH50), as verified with an onsite pressure test (in both pressurized and depressurized states).
5. Thermal comfort must be met for all living areas during winter as well as in summer, with not more than 10 % of the hours in a given year over 25 °C. For a complete overview of general quality, requirements

Passive House buildings are planned, optimised and verified with the Passive House Planning Package (PHPP).

All of the above criteria are achieved through intelligent design and implementation of the 5 Passive House principles: thermal bridge free design, superior windows, ventilation with heat recovery, quality insulation and airtight construction.

Building Information Modeling (BIM):

Building Information Modeling, or BIM, is defined as " a data-rich, object-oriented, intelligent and parametric digital representation of the facility, from which views and data appropriate to various users' needs can be extracted and analyzed to generate information that can be used to make decisions and improve the process of delivering the facility " (Eastman, Chuck,…. 2018). Therefore, BIM is an emerging tool in the design industry that is used to design and document a project, but is also used as a vehicle to enhance communication among all the project stakeholders. This tool has already begun changing how designers work with their consultants and with builders, but it also has the ability to help guide the industry in a more sustainable direction by allowing easier access to the tools necessary to quantify a greener design approach.

Sustainable BIM: Building Form:

Now we will acquire how to use some of sustainable design concepts with BIM models. We will look at some real-world applications and examples of design strategies and show how we can apply them using BIM's today technology. Therefore, we will discuss the following points: ***Building Orientation. - Building Massing. - Daylighting analysis***.

1) - <u>Building Orientation</u>:

Building orientation in sustainable design is defined as the way a building is placed on its site relative to the path of the sun. How a building addresses the sun and how the glazing openings are defined can have a large effect on the energy efficiency of the building systems and the comfort of the occupants. Because proper orientation sets up the building for optimization of solar-based passive strategies and sometimes wind based, it naturally creates lower energy solutions for lighting, heating, and cooling.

Building orientation is something that should happen in the beginning stages of the building design. At predesign, you should know the geospatial location of the project, where solar south is, and the direction of the prevailing breezes. Orientation is the foundation for keeping energy loads low, and it should not be deviated from in later phases. While proper orientation in and of itself normally creates a smaller single-digit percentage energy efficiency gain, it sets up the other strategies for greatest success.

Note that while we have focused on the energy efficiency and comfort aspects of correct orientation, there is an energy supply benefit too. To maximize the benefit of a solar hot-water system or photovoltaic electric system, the panels should face solar south.

In a hot climate, employ shading strategies to keep the building cool and eliminate direct sun penetration. The first step to this is orienting the building so that shading becomes easier to do, requiring fewer materials and less cost. In a cold climate, you would want to encourage sun penetration to reduce heating loads and absorb solar radiation. Again, facing the sun will set the project up for the easiest and most cost-effective solution. In either climate, you want to use daylight for your primary lighting source. Proper orientation has the following benefits:

- Allows the greatest opportunity to use natural daylight and less electric lighting systems.
- Allows for the most effective incorporation of electric lighting controls.
- Allows for less complicated external shading devices.
- Allows for integration of renewable energy systems like PV panels by having them facing solar south.

2) - Building Massing:

Second to proper orientation, proper building massing is key to a healthy, sustainable building. Proper massing allows good access to daylight for all the building occupants while still creating an efficient building envelope optimised for thermal efficiency and comfort. Building types have great flexibility when it comes to building mass, but within each specific type certain proportions have become acceptable or the norm—some for aesthetic reasons and others for efficiency of leasing. Office buildings, for example, come in many different shapes and sizes. Some are tall and skinny, some are short and wide, some are tall and wide, and others are short and skinny. It is important to understand the ideal situations based on building type and location so as you design, you can adapt the building form accordingly, with the knowledge that it is not always possible to fit the ideal massing condition. Factors like site restraints, economics, programmatic needs, and aesthetics can also be form-driving elements in design.

The primary reason for proper building massing is simple. By choosing the right mass for the building type and climate, you are reducing the building's overall energy needs. This then allows you to spend project funds on more efficient equipment, which makes purchasing on-site renewable systems more palatable.

1. Climate's impact on building mass affects the ability to use passive design strategies for heating, cooling, and lighting.

2. If a building is going to rely heavily on day lighting, it will likely have a narrow footprint, perhaps a large atrium to bring light down into the interior space, or it might have clerestories, or a shed roof optimized for either north or south light collection.

3. Passive heating suggests a narrow footprint with south-facing glazing to capture the solar radiation during the day.

4. Climate also affects building mass in the ability to collect rainwater. For a building in a climate where it rains little, you might want a larger roof to extend its rainwater collection capacity.

3) - Daylighting:

Daylighting is the use of natural light for primary interior illumination. This reduces your need for artificial light within the space, thus reducing internal heat gain and energy use. Natural light is the highest quality and most efficient light source available today—and the source is free. An effective day lighting design relies heavily on proper building orientation, massing topics we have already discussed. A fully integrated day lighting system can enhance the visual acuity, comfort, and beauty of a space while controlling external heat gain and glare.

The ability to use daylight in your design is directly related to climate and place. Certain climates have more sunny days than other climates. This is just a fact of nature.

The building's location and what makes up the immediate surroundings have an effect on your ability to use daylight in your design. If your project site is quite open, you could have great access. If you are in a dense urban area, the challenge will be greater. In other situations, your site might be oriented the wrong way, in which case you might be spending time and effort trying to "trick" the building into capturing daylight or working hard to create a solution for keeping unwanted glare out.

The most common goal related to day lighting design is the ratio of interior to exterior luminance or daylight factor. The project goal for percentage of daylight in a space will influence several things, such as: the type of glazing, the depth of the building, the percentage of glass on a façade, the size and location of the window apertures, location and material of shading devices, the layout of interior spaces, the interior materials and finishes, and so forth…

4) - Energy Modeling:

Understanding a building's energy needs is paramount to helping the project become more sustainable. According to the U.S. Energy Information Administration, buildings According to the U.S. Energy Information Administration, buildings electricity, making the United States the primary consumer of energy in the world and the built form the largest consumer as shown in the following figure:

- That gives us a large burden to build responsibly and think about our choices before we implement them.
- The energy needs of a building depend on a number of issues that are not simply related to leaving the lights on in a room that you are no longer using or turning down the heat or upping the air-conditioning. Many of the systems within a building revolve around the energy use.

For instance, if you increase the windows on the south façade, you allow in more natural light and lower your need for electric illumination. However, without proper sun shading, you are also letting in additional solar heat gain with those larger windows, thus increasing your need for more air-conditioning and potentially negating the energy savings from lighting.

In exploring the use of energy in a building, all energy-related issues must be taken into account, and this is why we use energy simulation. These computer-based models use climatic data coupled with building loads, such as:

♣ The heating, ventilation, and air-conditioning system (HVAC).
♣ Solar heat gain.
♣ The number of occupants and their activity levels.
♣ Sun shading devices.
♣ Daylight dimming.
♣ Lighting levels.

The energy model combines these factors to predict the building's energy demands to help size the building's HVAC system and parameters of other components properly so we are not using a system larger than what we need and so we can understand the impact of our design on the global environment. By keeping the energy model updated with the current design, we can begin to understand how building massing, building envelope, window locations, building orientation, and other parameters affect energy demands.

Reducing Energy Needs:

Following are some simple strategies that can help to reduce a building's overall energy need:

1. **Design for day lighting:** Orienting the building properly, optimizing shading strategies, and using daylight dimming controls to optimize the use of natural light within a space saves on the electrical demands of a building.
2. **Simulate energy performance during design:** Creating an energy model helps to predict the demands a building and it systems will have. By setting goals and iterating the design of the project, you can find reductions in the energy loads.

These savings can be found in three primary areas: (Lighting. - Heat/air- conditioning.-Power.)

3. **Commission the project:** Measure and verify that the systems chosen and installed in a facility are working properly and as efficiently as possible. Not only does this give owners confidence that they got what they paid for, it assures them that the components are running correctly and educates them on how to keep systems operating that way.
4. **Maintain equipment:** equipment must be maintained. Whether or not it is the most efficient equipment, equipment still needs regular care, such as cleaning, inspections, and part replacement, to extend its lifespan. Not taking proper care of equipment can lead to inefficiencies or even larger problems further down the road.

Using BIM for Energy Analysis:

For energy modeling to be successful, we first need a solid, well-built model. This does not mean we need all of the materials and details figured out, but we do have to establish some basic conditions. To ensure our model is correctly constructed to work with an energy modeling application, there are a few things that we need to ensure are within the model to get the proper results. Some of this might sound like common sense, but it is important to ensure that you have the following elements properly modeled or you can have adverse results:

- The model must have roofs and floors.
- Walls need to touch the roofs and floors.
- All areas within the analysis need to be bound by building geometry.

The energy analysis will not be accurate without all of the building elements in place.

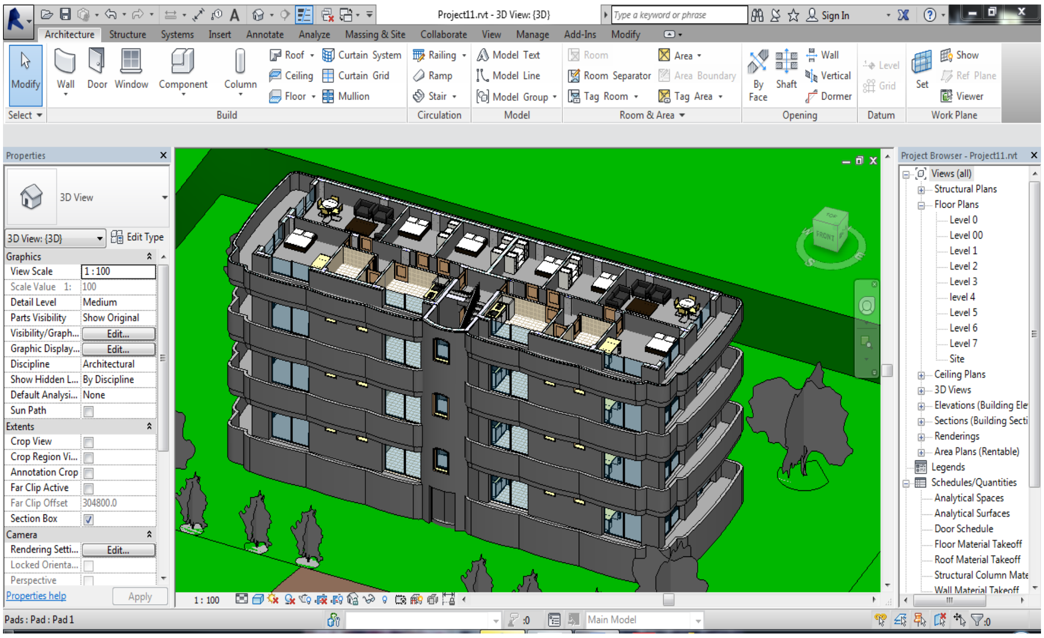
We need to capture a few key elements from the BIM model and transfer them to the energy analysis application: (Project location. - Building envelope. - Room volumes.)

Practical application on an apartment building in the city of Lattakia

Project Description

It consists of three floors, in addition to the ground .The floor, area is 275m2, and the floor height is 3.2m. The structure consists of rectangular columns with dimensions (25X 50) Cm, exterior walls with a thickness of 20 cm and the interior with a thickness of 10cm.The Slab are 25cm thick, with reinforcement ratio of 110 kg / m^3

The level of foundation at a depth of 1m from the level of the natural earth. The foundations are single foundations with dimensions (2 x 2.3) m and a thickness of 0.5m using C25 concrete (Figure 1)

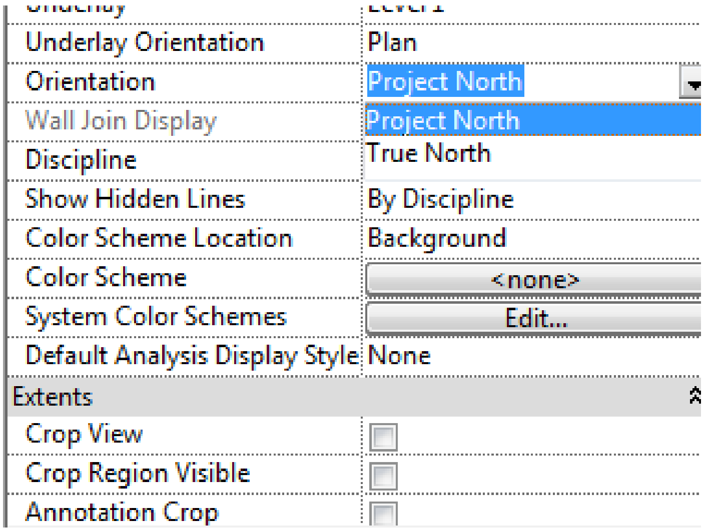


(Figure 1) 3D illustration of the Building

Application approach through Passive House Building Orientation Directing the building to the south of the sun, taking into account the declination deviation, considering that the building is located in the city of Lattakia, the deviation was calculated as it reached a value of 5 degrees on 27/2/2019.

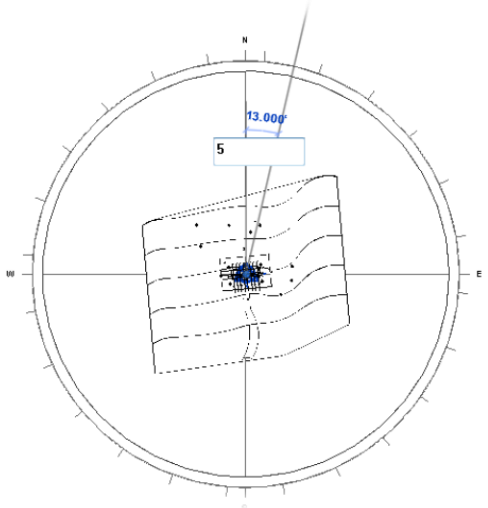
Lattitude	35^0 31' 16" N
Longitude	35^0 47' 31" E
Elevation	0.0 Km GPS
Declination	5^0 0' E changing by 0^0 5' per year
Uncertainty	0^0 19'

After knowing the value of the magnetic deflection, we go to the building's **Revit** and change the orientation of the building from the *manage* menu, we choose the *location* and specify the city in which the building will be built, then we choose orientation *true north:*



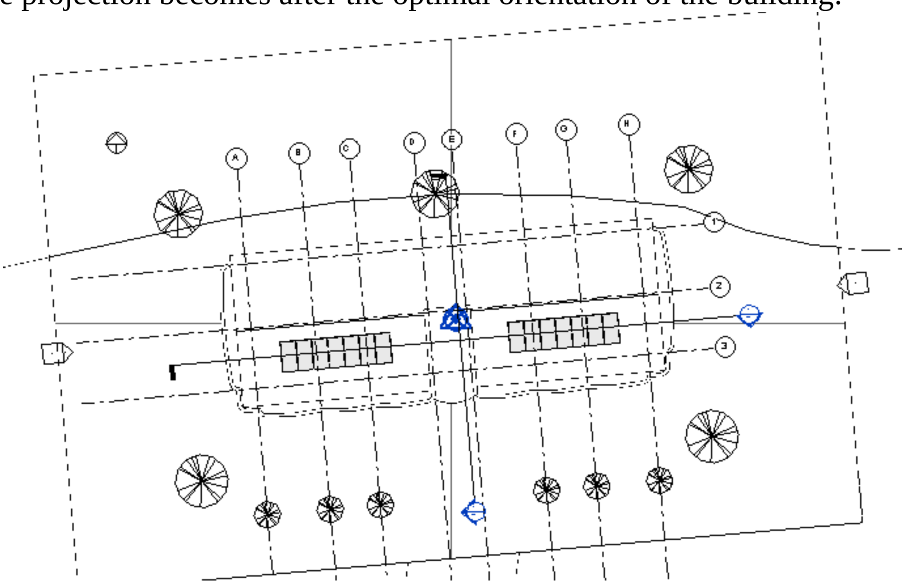
(Figure 2) Revit window

Then we determine the value of the angle that we want to rotate the project in the desired direction:



(Figure 3) Rotation of the Building

Finally, the projection becomes after the optimal orientation of the building:



(Figure 4) Orientation of the Building

The orientation of the building to the south is considered one of the most important factors affecting the performance of the building and its consumption of energy and heat. The sun's entry into the house is due to the sun's proximity to the earth's surface in the winter, and in the summer, it is far from the surface of the earth. Therefore, the sun's entry is very limited, and this process was clarified by doing a study of the sun's movement and its impact on the building, depending on To its location and the prevailing climate in that area. The Revit program from the option of *sun setting* provides this.

We will resort to using a passive house planning package PHPP, as the building planning depends on entering a number of data so that all matters related to the PH solutions are calculated, thus knowing the efficiency of the building and the extent to which it meets the required standards in order to be a sustainable building.

Verification

In this item, the following data will be entered:

- Building type
- Location and city
- Construction year
- The area to be studied
- The number of people occupying the space
- The total size of the building to check energy consumption
- The internal heat of the building
- Building materials used and their characteristics

As sustainable materials are used as possible, they possess good thermal properties that ensure adequate insulation of the building. Among the most important materials used in passive house: Polystyrene Foam.

Discussion and Conclusions:

BIM and sustainable design do not yet have the perfect marriage of integrated parts to make the solutions obvious and accessible. Yet we recognize the need within the design community to inspire better design through communication and knowledge management. This will greatly assist us in trying to get our carbon footprint to zero so that we can create healthier Syria and intact planet. In this paper, we discuss what still needs to be done to help better achieve these goals.

This exploratory study indicates that BIM can facilitate the very complex processes of sustainable design such as day lighting and solar access, evaluation of the building performance analysis software; it was found that Integrated Environmental Solutions Passive House software appears to be both the most versatile and powerful in terms of analysis capabilities.

The results produced from the software have not been directly validated. However, detailed study within the programs. This study was limited in scope from one example only; hence it may have overlooked several factors. The study is expected to be completed in the next research.

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