

BIM TECHNOLOGY STRATEGIES IN DESIGNING SUSTAINABLE CITIES

YOUSIF S. SAEED

College of Engineering, University of Kirkuk, Kirkuk- Iraq

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ABSTRACT

To prevent the serious environmental and economic damages resulting from the traditional state of the construction industry, global trend towards building sustainable cities is going on. Building Information Modeling (BIM) technology plays a prominent and effective role in achieving this trend in building called “smart” or “sustainable” cities in different phases of the construction starting from planning, design and, implementation phases and even also in managing after the occupation of the building. This paper highlights the importance of applying BIM technology in the field of sustainable cities by linking its tools to the construction industry by documenting these strategies and highlighting the effective role of the many applications of BIM technology in the planning, design, and implementation of sustainable green cities of high quality in conformity with the international standards adopted in the assessment of BIM. Also, it presents the state of the current obstacles that prevent the establishment of sustainable smart cities in Iraq, and take advantage of the applications of BIM technology to achieve this purpose, the main findings were concentrated on the most 10 obstacles facing application of BIM technology in Iraq and raising awareness and making decisions to start using BIM to save energy consumption, reduce the time and cost of projects, to keep pace with the modernity and great development in the field of construction technology, universities must be obliged to prepare qualified engineers to meet the requirements of the current technological reality in the construction industry, mandatory courses for preparing engineers working in the public and private sectors furthermore, companies and engineering departments in the government and private sector are encouraged to apply information modeling in the implementation of all construction projects in Iraq are the main contributions of this paper.

KEYWORDS: BIM technology, BIM tools, Construction industry, Current obstacles, international standards, Iraq, Sustainable cities.

1. INTRODUCTION

The emergence of many advanced modern technologies in the world of project management is essential to the mobility of a brighter and radically transformed future in the world of construction, BIM technology, which means the technique of modeling building information is one of the most important technologies used in engineering projects,

especially strategic and national projects around the world [1].

In tune with the global trend to achieve sustainability and creating smart cities were the main motivation for writing this research. To achieve an effective sustainable in the construction industry is one of the factors mitigating environmental change which have a real disaster in case of unsuccessful applying of different environmental solutions [2]. For

example, a country Arab Egypt heading towards establishment many cities, by standards schematic sustainable, and already several forms of towers sustainable smart buildings and feeding some cities with solar storage plants of different capacities have already been created [3]. The remarkable interaction of designers is required to support these remarkable initiatives and using BIM software BIM Create a methodology that will allow users to easily develop a system for application and evaluation to use them. Developed countries developed many vital projects that have been launched, applying the idea of sustainable cities and allocating a special budget to them, as in the United Arab Emirates and the United Kingdom. Saudi Arabia and Egypt [4].

2. METHODOLOGY

The research paper aims to develop a strategy for the design of sustainable cities using BIM, which is now important for improving project outcomes to include environmental consideration, human comfort, and public health, and to develop mechanisms of action in the implementation of any project and appropriate procedures to achieve its objectives and link it to specific time plans such as the State of Iraq Plan 2030, the International Plan for the Construction of Sustainable Zero. Buildings Zero Net and other plans and map studies contributed to the integration of the various disciplines related to the construction design, operation, and maintenance management, as well as to explain the reasons that hinder the application of the idea of sustainable cities in Iraq and ways to confront them by introducing many new solutions and ideas [4].

3. SUSTAINABLE OR ENVIRONMENTAL CITIES

3.1 Sustainable cities

Sustainable cities, are the fourth-generation cities, that all the countries of the developed world are headed for their full awareness of the energy crises, scarcity and the consequent problems of the future. It is a city designed with environmental requirements and standards, and was the first to record the word "environmental cities" by Richard, Berkeley in 1987 [3].

3.2 Environmental cities:

It means building cities for a healthy future, experts generally agree that sustainable development must meet the needs of the present without sacrificing the ability of future generations to meet their own needs. The ambiguity of this idea leads to a great deal of variation in terms of how cities implement their attempts to become sustainable. However, a sustainable city should be able to rely entirely on its natural resources, produce the least possible amount of pollution, use the land efficiently, use compost, either recycle it or convert waste into energy, and thus the city's overall contribution to climate change will be minimal if it joins such practices [4]. It is estimated that more than 50% of the world's population now lives in cities and urban areas, these large communities alike provide challenges and opportunities for environmental awareness developers to help achieve sustainable city goals, so the urban planning of urban projects must be taken into account with the characteristics of environmental sites, which contributes to its effective realization of BIM [4].

BIM provides the time and the special cost of a project and even gives a future vision of the projects suitable for the site, which helps planners to make the right decision, and to design sustainable cities must adhere to planning standards and requirements [5] which includes the followings: -

1. Sustainable structuring through the study and provision of infrastructure for the functioning of the city, with a commitment to the standards of achieving sustainable architecture and this

commitment includes all stages of construction such as: planning, construction, and restructuring, as well as managing environmental issues and resources, such as energy, water, and materials, and using energy more effectively, and more efficiently.

2. Land uses must be distributed in accordance with the environmental characteristics of the site.
3. Identify the appropriate and appropriate vacuum for the various types of development that exist or are expected to be present in the region so as to preserve the natural environment and the most environmentally sensitive places.
4. Securing the site and protecting it from potential natural disasters, especially floods, floods, fires, landings, and landslides in the proposed area.
5. The spatial distribution of land occupancy of residential blocks and their relationship with green and open areas as well as their relationship with pollution resulting from industrial sites on the site and from the road network and traffic on the site.
6. The city is a viable organism in the future without exceeding environmental standards for air, water, sanitation, and industrial waste pollution, so a continuous and continuous environmental assessment must be made to see if the project can move forward sustainability.

3.3 General principle of BIM

The BIM construction information model is one of the most important good developments in the fields of engineering different, using BIM is creating an accurate imaginary model of buildings; Using BIM software will not be limited to a single program, but must follow a mechanism of action consisting of several software, each of which plays a specific role during the design process starting from the stage, design conceptual phase which gives a preliminary picture that could be used in a number of software, including performance measurement software, the term could be defined by analyzing it in two parts [6]:

Modeling: a holographic representation of the information, there must be at least a three-dimensional model, and there must be useful information for the users of the model, and when the select element of the user must show its information, Construction: BIM specializes in buildings it is not generally as the technique of almost everything can be drawn into it, but is specialized. It is used during the process of design, implementation, operation and includes buildings, roads, and infrastructure projects [6].

BIM: An innovative methodology that helps improve communication and cooperation between stakeholders in the construction project, BIM implementation as a dynamic system helps to obtain a high-quality product and helps manage information during the life cycle of the project, not only during design and construction but also during operation and maintenance [6].

BIM Contributes achieving sustainable cities throughout permanent linking between BIM and sustainability because BIM achieves and documents the applicability of sustainability that meets the requirements of human beings at the moment without exceeding the reserves needed by future generations, and begins sustainable designs [6]. The philosophy that the definition of good planning or design automatically includes the characteristics that make up sustainability, including the selection of environmentally better sites, and optimal use of energy, which means that all design work carried out will meet specific performance standards, which is one of the most important contributions to sustainable city design, using BIM provides the ability to accept plug-ins that enable the designer to simulate energy consumption and natural lighting and provide the required database by green building certification bodies, BIM can also make it easy to allocate optimally and guide buildings to maximize renewable energy generation and reduce energy consumption [7].

3.4 Application of BIM in sustainable city design

When applying sustainable smart city technology, the term civil information modeling appears; its objective is to create and maintain infrastructure, by applying BIM technology during design and maintenance through municipalities, facility owners and public utilities to obtain infrastructure, road network and smart utility networks. The study by T. Nabil and A. Hussain [3] shows in Egypt for example began the entry of BIM as a new system, which imposed its control over national projects in order to achieve sustainable smart cities, but because the majority of companies still oppose the transformation and want to slow the old steps and the idea of applying BIM as a new idea when applied, according to the study [3] the BIM system faced the followings:

1. Lack of qualified competencies to apply BIM projects.
2. The need of companies for modern and advanced devices.
3. The majority of companies always look to make gains with minimal costs.
4. The unwillingness of the departments to accept the idea of the company moving to apply this system with many motives and illogical.
5. The misconception by the engineers about BIM as a system represented only by programs such as REVIT.

According to A. Abolsaud, Y., Cairo [2] BIM system has been used in some important projects in Egypt, as an experiment and has proved successful in many sewage projects, where BIM was applied in an integrated sewage project which consists of a wastewater treatment plant in western Alexandria in Egypt, in order to be suitable for irrigation and recycling to solve the form the Nile water crisis in Egypt, as well as

the establishment of lifting stations and the function of lifting stations is the collection of sewage in the region and pumping it to the treatment plant with hydraulic pumps, the application of the BIM has solved several problems, the most important of which are [2]:

- I. All observations were extracted in structural, architectural and electromechanical paintings and resolved the conflict between different civil disciplines prior to implementation.
- II. An inventory of concrete and rebar works has been made.
- III. Easy understanding of origin and how it works and then extracting implementation steps easier so that the treatment plants will not be complex in their implementation.

The strategy of noise and wind analysis as well as shadows and what can be expected to be used to exploit solar lighting, in order to take into account negative lighting, a planning model of the site, and an expected model of the movement of continuing elements to shade and give software simulation colors of lighting and shadows, that solar plants have been implemented in Egypt in some government buildings and main roads contributed to reducing the emission of carbon dioxide by more than 900 tons [2], and another set of solar power plants are being implemented for some cities. In the field of water recycling and utilization in the irrigation of green areas. The proposed strategy to design sustainable cities and to support the proposed strategy must link the stages of BIM use to design sustainable cities, where each tool used at each stage is importantly connected to the BIM model where attention must be paid to each stage because it is an essential part of its stages and requires time and time and stages follow as shown in Figure 1 [6].

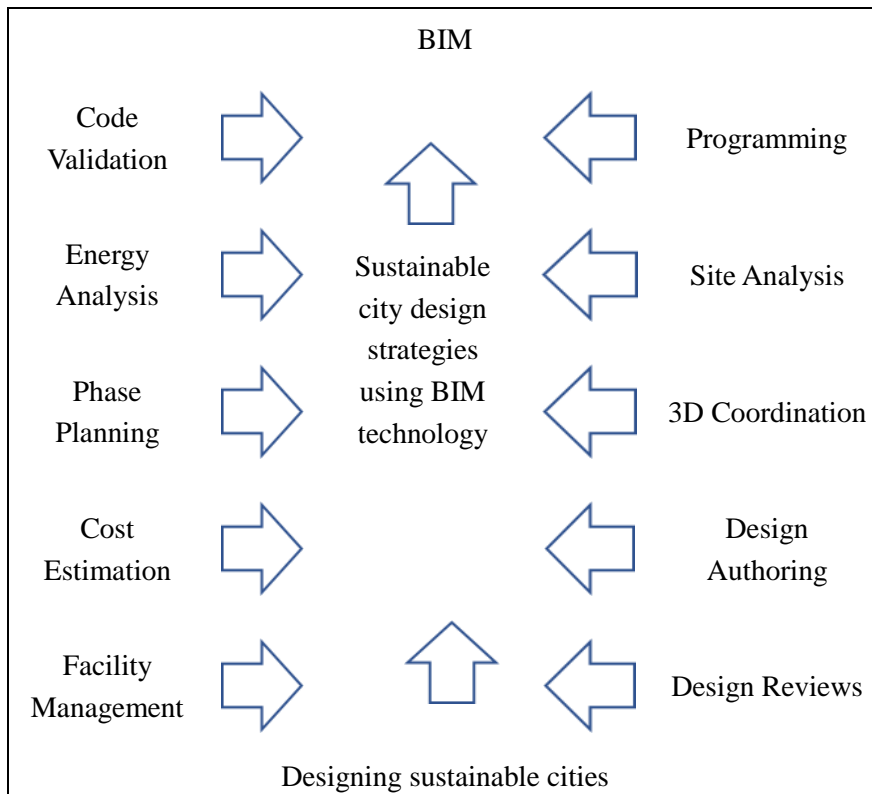


Fig.(1):- Suggested strategies for designing sustainable cities using BIM [6]

3.4.1 Programming:

These are tasks to maintain the flexibility of the project where all data and information about the city are entered from identifying the appropriate and appropriate vacuum for the various types of development that exist or are expected to be present in the area in order to preserve the natural environment, in order to contribute to the establishment of the infrastructure of the sustainable city, which must be studied for the functioning of the city, with a commitment to the standards of achieving sustainable architecture, and this commitment includes all stages of construction such as: Planning; Designing; Constructing; and Operating, as well as managing environmental issues and resources, such as energy, water and materials, more effective and efficient energy use [3].

3.4.2 Site Analysis:

Analysis and study of the general site, study by S. David, B. Victoria [7] of the surrounding areas and requirements of zoning and survey

data for land heights, study of maps and placements and study [7] surrounding the place help these studies to identify projects suitable for the site (residential - industrial - agricultural -recreational) and thus study the spatial distribution of land occupancy of blocks Residential and not in the green and open areas as well as not to be affected by pollution caused by industrial sites on the site and from the road network and traffic on the site.

3.4.3 Coordination:

Between disciplines across the third model or coordination 3D-the most important and first dimension in information modeling software, is the tasks of converting graphics from a dual to a dimension and adding information to the third-dimensional elements of the project and converting it from just drawing to information-saturated elements and coordinating between disciplines in solving conflicts between them in the elements of construction clash soft and clash Hard [8]. Features of information modeling software, connecting all the employees

to the project to each other in order to avoid any operational problems, business risks or occupational health and safety risks [8].

3.4.4 Design Authoring:

A process in which a third model is used only far away to develop the information on which it is based and the standards required for the development of the building, as it is the first step in the process of implementing design and how to link the third models far with the database of quantities of existing materials and methods and construction costs, and the delivery of a model containing the topography of the construction space and analysis of the surrounding environment and placements. BIM technology is the key to making cities more sustainable and intelligent, in addition to their importance in integrating individual information for each building more broadly with GIS information (technology designed to monitor, compile and analyze all types of geographic information and the results of these analyses represent real elements such as roads, land, levels, heights, trees, etc.) are monitored [9]. Through satellite aerial image technology that is associated with the coordinates of the place, coordinate z,y,x gives real information to the place has a spatial reference and is linked to 3D models and specifications to create an open base BIM that can be folded continuously and linked to the life cycle of the building or infrastructure or urban planning, and this information is processed by several specialized teams, hence BIM technology provides many long-term benefits as the buildings have not been isolated, and treated as individual units but are integrated and connected with city infrastructure data, roads, housing and utilities, heating, water, cooling, electricity grids, etc., this is called the link between building and city data with the term big data [9].

3.4.5 Reviews Design:

It sets the laws and standards of lighting, the design problems and the time by solving the problems in the project, compare the alternatives available in the design and resolve disputes between the parties of the local council officials [10]. Reviews the available alternatives in the form of building blocks and their trends in the building information model to compare them with the benefits and disadvantages of other forms to be deduced [9].

3.4.6 Validation Code:

The process of verifying the design implemented, in terms of conforming to the international standards and saving time, from visiting the site and complying with the laws in the aspects of design is by simulating time with modeling which is a tool connection. It is important to evaluate the project schedule with 4D technique to improve logistics and reduce the losses of raw materials, and from Goals. The main of these studies is to provide requirements necessary to secure the fire protection system, comprehensive design, project stages during Construction information modeling tools to link them correctly integrate each building's information with information GIS Geographic ecosystem, maintenance, daily operations, restoration, updates Business Electrical, mechanical and health MEP and introducing the effects of energy and weather on a model BIM. In addition, these studies should take into account the different types of buildings, and identify information that should always be kept up to date and thus greatly reduce the risk, BIM thus providing a more responsible way to design, build, operate, maintain roads, bridges, public transport systems and the ability to predict cost and to control projects business risk which represent by time and cost overruns [10].

3.4.7 Energy analysis 6D:

Based on building simulation as well as element software and study of electrical appliances in terms of energy efficiency and

knowledge of the project requirements of the energy used and be modeled from the information environment and be from the beginning of the design to also calculate thermal loads and sustainable design and multiple programs used to analyze the performance of the wild like Eco-Tec, Builder Design [10]. The beginning of the analysis process creates a clear picture of what will be measured and what aspects of the design need to be improved, this can help to understand these tools to be used, what to look forward to in the results of the analysis, and once the scorer and measurement tools required for performance analysis are highlighted, simulations that compare all different features can be worked on and gain a clearer view of the results of the analysis, taking into account the need for some approximate calculations to be prepared in advance to measure the logical extent of the analysis [11]. Analysis results, therefore, simulations are replicated in design stages and produce statistics that help guide the design strategy and the next steps, and to help maximize the benefit of results and improve design outputs, BIM tools provide comparison with industry standards such as ASHRAE 1.90 and 2030 Architecture and produce different scenarios to apply eleven consistent assumptions for several models to accurately compare results [11].

3.4.8 Phase planning:

Building Management Decisions, depends entirely on 4D the construction steps are known on the practical site that is two-way management direction and a standard model for increasing

efficiency in maintenance and operation of facilities and consists of available environmental equipment systems, computers and technical works of the company where it helps in financial decision-making and the extent to which information is exchanged between BIM programs, land, thermal simulation and building analysis, BIM application levels and services provided by long-BIM software [12]. Long-term planning of how to maintain the range database as it can be linked to BIM and monitor project movements in the traditional process of work, some information is lost every time information is transferred and delivered from one team to another and this leads to waste, and has BIM overcomes this through the centrality of information and the use of a unified code and the integration of building information, road information and transport information within the city model as BIM adds, the possibility of a **model of city services to avoid breaking water pipes, drainage, internet cables or gas during drilling** [12].

3.4.9 Cost Estimation

The development process from 4D to 5D determines the life cycle of the project Figure 2. Determining the cost of the materials, including the generation of materials and equipment used, which helps to reduce budget overruns and set prices and decrease changes, 6D could be used to achieve active safety management of the projects, 7D achieves A highly efficient designed model that achieves the integrated sustainable system [12],[13].

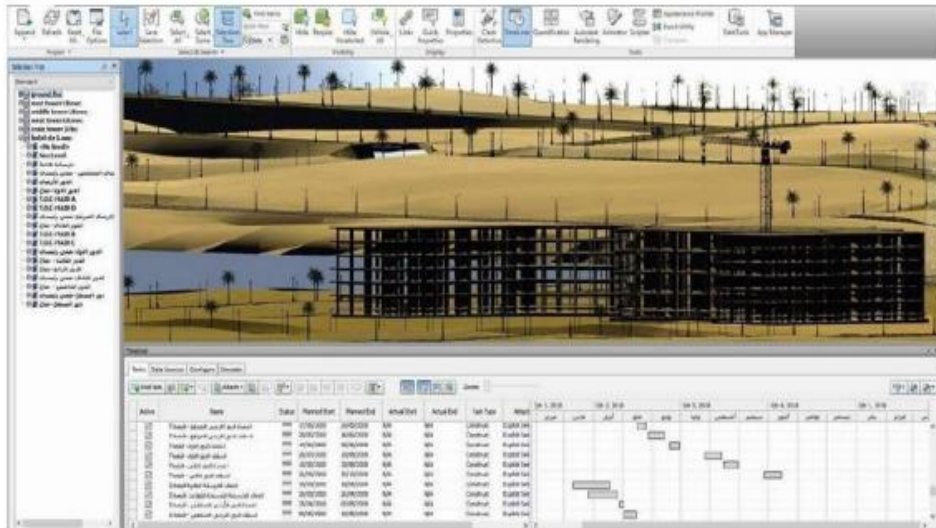


Fig.(2):- Ability to check the form after its integration and construction sequence (4D) and estimate the cost during the construction phase (5D) [12].

BIM was introduced as a new technology that can solve a lot of problems and document all project documents using 360 BIM formatting all graphics of the same discipline using Revit, cost estimate and schedule by Primavera P7 and Navisworks Figure3, coordination of all projects using Infra 360 and using this application solve a lot of problems [13]:

1. Organize drawings and documents using symbols.
2. Resolving cooperation between all

stakeholders in the project.

3. Solve all graphics problems without holding meetings and sending messages that have reduced lost time.

Use the WORKS INFRA 360 applications, which allows understanding of the process, and through visual simulations can compare the planned implementation with the actual part to coordinate projects in the virtual environment and verify errors [13].

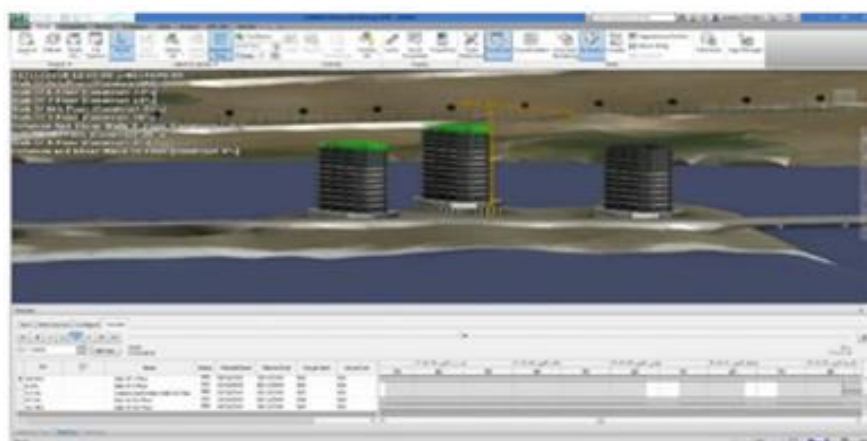


Fig.(3):- Construction of residential towers using BIM BIM software [13].

3.5 Barriers to the application of green buildings in Iraq:

Iraq has suffered from multiple obstacles that prevent the establishment of green buildings in Iraqi cities and prevent the development of the construction sector in line with technological advances in construction and building materials.

Through a questionnaire, [5] summarized the most important of these obstacles to the development of sustainable cities in Iraq, which are: Legal impediments; Technical constraints; Design constraints; Sustainable design constraints; Financial handicapped; The intellectual and functional cost; Construction and technological constraints; Strategic constraints; Sustainability constraints and Barriers to pious and legal appropriateness. Also N. Ismail and et.al.[5] proposed a number of logical solutions to all the aforementioned constraints to promote the building of sustainable cities in Iraq.

4. CONCLUSION

In this research paper, the importance of modeling construction information in the design, construction and management of sustainable cities within the cost and time allocated to the project, the quality and the required specifications, international standards are explained as well as the effective role of BIM in quality control, cost and time and referred to the State of Egypt as an example of the countries used information modeling in a number of its national projects, which facilitated for the designers, planners and implementers of the project to achieve its goals in controlling quality, cost and time.

The researcher reached a strategy to support the plan of the future state, which began in its modest steps in building sustainable cities through the use of BIM, linking design drawings to executive work and making a database from general studies to project and analysis of sites to management and take financial decisions and

technical support to produce a sophisticated intelligent model. To achieve prosperity and development in Iraq and promote bad service realities and overcome any obstacles we face in the design of sustainable cities, we recommend raising awareness and making serious decisions to advance the country for a more prosperous future and start using BIM through:

- 1.** To save energy consumption through environmental analysis using modern technologies of the thermal simulation software.

- 2.** Reduce the time and cost of projects by avoiding repeated administrative and operational errors in strategic projects by employing a BIM construction information modeling platform for cooperation and coordination between different employers (engineers, contractors, designers, and employers) in making the right decisions and integrating the various disciplines to detect early conflicts.

- 3.** To keep pace with the modernity and great development in the field of construction technology, universities must be obliged to prepare qualified engineers to meet the requirements of the current technological reality in the construction industry.

- 4.** Preparing engineers working in the public and private sectors by providing them with mandatory courses.

- 5.** Companies and engineering departments in the government and private sector are obliged to apply information modeling in the implementation of all construction projects in Iraq.

- 6.** The above-mentioned implementation is intended to provide technical and financial support, remove legal obstacles, encourage companies and government and private engineering departments, give preference to companies that apply and adopt the BIM system and make it a prerequisite for awarding contracts to contractors, which accelerates the mechanism of their application in all projects in Iraq within a maximum period of three years.

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