University of Baghdad
College of Engineering
JOURNAL OF ENGINEERING

# Journal of Engineering

journal homepage: www.jcoeng.edu.iq

Volume 31 Number 11 November 2025

# The Role of Building Information Modeling (BIM) in Enhancing the Environmental and Economic Sustainability of Administrative Buildings in Iraq: The New Central Bank of Iraq as a Case Study

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## ABSTRACT

With the escalation of environmental challenges and financial constraints worldwide, and the development of the construction industry that has a wide impact on environmental and economic aspects, sustainable design has become increasingly important, especially in developing countries like Iraq. The construction industry has witnessed significant technological advancements in digital tools that enhance sustainability and maintain performance at all stages of project design, management, implementation, and operation. One of the most prominent of these technologies is Building Information Modeling (BIM). This research paper examines the direct role of BIM in enhancing environmental and economic sustainability in administrative building projects, focusing on the Iraqi context and the new Central Bank of Iraq project designed by the famous architect Zaha Hadid. The paper addresses the definition and dimensions of BIM, its development, and its applications in sustainable design. It presents a theoretical framework that explains the role of BIM in reducing emissions and improving resource efficiency, as well as financial and time management. It also addresses the most prominent challenges and opportunities that affect BIM adoption in Iraq, followed by an in-depth study of the environmental and economic strategies of BIM in the Central Bank of Iraq project. The study demonstrates the great potential of BIM in reducing costs, carbon footprint, and energy consumption, which enhances environmental and economic resilience in the long term. The research highlights practical lessons learned and develops a roadmap for the adoption and implementation of BIM on a comprehensive scale, with a special emphasis on administrative building projects.

**Keywords:** Sustainability, Environmental performance, Economic sustainability, Administrative building, Building information modeling (BIM), Central bank of Iraq.

## 1. INTRODUCTION

With the advent of the twenty-first century, an urgent need to adopt environmentally conscious and economically viable design practices has emerged. This duality

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Peer review under the responsibility of University of Baghdad.
https://doi.org/10.31026/j.eng.2025.11.08

Article received: 12/06/2025
Article revised: 05/08/2025
Article accepted: 13/08/2025
Article published: 01/11/2025

(environmental and economic) has become more prominent in developing countries facing significant environmental and economic challenges, including Iraq **(Hardisty, 2010)**. Office buildings consume large amounts of energy and demand substantial financial resources for their construction, operation, and maintenance **(Häkkinen and Nuutinen, 2007; Mahmood and Al-Alwan, 2023)**. These buildings are typically occupied for extended periods and exhibit high occupancy rates and resource consumption. The emergence of innovative digital tools and solutions in the construction industry has enabled more responsible approaches to planning, conflict resolution, error reduction, and the enhancement of long-term value **(Feige et al., 2013; Ashmawy et al., 2024)**. One of the most prominent digital technologies and systems in the modern construction industry is Building Information Modeling (BIM), an advanced technology described as a digital representation of the physical and functional characteristics of a building or project. BIM facilitates the management of the entire building lifecycle, facilitating data-driven decisions throughout the design, implementation, operation, maintenance, and even the end of the building's function in some projects. BIM overlaps and integrates with several digital tools in the field of environmental analysis and financial cost analysis tools, making it a digital platform for collaboration between all design stakeholders and promoting the principles of green design, financial responsibility, and smart management at every stage of the project **(Ingram, 2020)**.

In Iraq, environmental awareness has begun to grow; however, it is still largely limited to academic infrastructure projects and scientific communities. There is also a lack of knowledge about smart financial management practices that utilize digital and systematic approaches **(Hassan and Al-Kindy, 2023)**. BIM stands out as a model and an integrated digital platform through which many problems can be solved in various projects, most notably environmental and economic problems **(Alsaeedi et al., 2021)**. A starting point can be drawn from some projects that were designed and implemented using the latest digital technologies, most notably BIM, such as the new Central Bank of Iraq project, and consider it a model that can be used to adopt and implement BIM in other projects in the public and private sectors **(Mohammed and Hilal, 2024; Saaduldeen and Hilal, 2025)**. The current research paper explores ways to enhance sustainability through BIM within the Iraqi context, focusing on two main pillars of sustainability: the environmental aspect, which relates to strategic aspects specific to the country and the world as a whole, as well as the economic aspect, which represents an important factor, especially at a time when several economic challenges facing Iraq emerge.

The paper presents a theoretical framework exploring the relationship between BIM and both environmental and economic sustainability. It also discusses the challenges and opportunities related to BIM adoption in the Iraqi construction industry and assesses the role of BIM in a local case study. Finally, the research offers an analysis based on the findings and provides strategic recommendations for the future application of BIM and other digital technologies in Iraq. The research concludes that despite the recognized potential of BIM in advancing sustainability objectives, its application within Iraq remains limited and underexplored, particularly in administrative buildings. This gap reflects a broader issue in the local construction sector, thereby defining the research problem as “the absence of an integrated framework for leveraging Building Information Modeling (BIM) as a digital technology to achieve both environmental and economic sustainability in administrative buildings in Iraq”. The research assumes that utilizing BIM in the design and management of

administrative buildings can significantly enhance their environmental and economic sustainability.

Accordingly, the research raises the following questions:

- How can BIM contribute to reducing the environmental impact of administrative buildings?
- In what ways does BIM improve economic efficiency during the design, construction, and operation phases?
- What challenges and opportunities affect the adoption of BIM in the Iraqi construction sector?

## 2. THEORETICAL FRAMEWORK

### 2.1 Environmental Sustainability

In the construction industry, the concept of environmental sustainability refers to strategies and methods used to reduce negative environmental impacts through reduced emissions, reduced energy consumption, efficient design, optimal use of resources, and enhanced occupant comfort. The goal of environmental sustainability is to create buildings that blend in with the surrounding natural environment, improve indoor ventilation and lighting, and reduce demand for man-made energy sources **(Opoku et al., 2019; Al-Azzawi and Al-Alwan, 2025)**.

Key concepts include:

- Resource Efficiency: Optimal use of energy, water, and materials.
- Emissions Reduction: Significantly reduce carbon and greenhouse gas emissions **(Shareef and Al-Alwan, 2021)**.
- Occupant Comfort: Providing an indoor environment with visual, thermal, and acoustic quality **(Lima et al., 2021).**

The Role of BIM in Improving Environmental Sustainability

BIM supports the full consideration of environmental impacts by:

- 3D Modeling for Solar and Thermal Simulations: The 3D dimension in BIM involves creating a detailed digital representation of the building's geometry and spatial relationships. By evaluating building orientation and taking advantage of solar energy and daylight, smarter facades, air conditioning, and heating systems are designed.
- 4D Phasing for Waste Minimization: The 4D dimension adds the element of time (construction scheduling) to the BIM model, allowing for simulation and planning of construction activities. Organizing construction in a sequence that helps reduce construction waste, arranging logistics at the site, and preventing unnecessary energy use during the job.
- 6D Integration for Energy Modeling: The 6D dimension in BIM integrates sustainability and energy analysis data into the model, supporting the assessment of energy consumption and building performance. Adding energy information to the early stages of planning to review energy efficiency, HVAC performance, the amount of insulation, and the potential for using renewable energy.

The insights from these simulations lead to improvements in energy efficiency **(Latif and Shahin, 2023; Waqar et al., 2023; Pan et al., 2024**), more effective passive features, and help meet green building goals **(Wong and Zhou, 2015; Maltese et al., 2017; Alqalami et al., 2020)**, see **Table 1**

## 2.2 Economic Sustainability

When a building is economically sustainable, it delivers lasting savings on capital and current costs, remains stable during economic changes, and uses resources efficiently over its life. **(Zhou and Lowe, 2003)**. The important performance indicators are:

- Life-Cycle Cost (LCC): The total cost from the beginning of the building design work through implementation and operation until its demolition **(Figueiredo et al., 2021)**.
- Return on Investment (ROI): Comparing invested capital with expected financial gains.
- Budget Control in FM: Predictive ability to manage facilities budgets over decades **(Fregonara et al., 2016; Ribas and Cachim, 2019; Norouzi et al., 2021; Alaloul et al., 2022).**

The goal is not only to build a sustainable administrative building at an affordable cost, but it is also essential that the maintenance process is smooth and uncomplicated, and that the building is energy efficient in the long term, especially in an economy facing significant challenges, such as Iraq's **(Raheem and Fadhil, 2021; Kamil et al., 2024)**.

The BIM improves performance and economic outcomes by:

- 5D Cost Integration: The 5D dimension of BIM refers to the integration of cost data into the digital model, allowing stakeholders to track, forecast, and control costs throughout the project lifecycle. Communication with model components keeps total budgets updated as designs are developed. Thanks to full transparency in the process, overruns are limited, and design changes can be made cost-effectively.
- Clash Detection to Avoid Rework: Detecting system inconsistencies digitally before construction saves money, effort, and time, and there's no need to fix anything on-site.
- 7D Facilities Management for Operational Savings: The 7D dimension in BIM extends the model's utility into the operational phase, supporting facilities management by embedding asset data, maintenance schedules, and lifecycle information into the model . Because BIM models are used, the system features maintenance schedules, equipment details, and grant details, reducing the need for reactive and pricey repairs **(Ahmad and Thaheem, 2018; Aranda et al., 2020; Ingram, 2020; Xue et al., 2021; Sudarsan and Gavali, 2024)**, see **Table 1**

**Table 1**. Comparative Summary of Traditional vs. BIM-Enabled Project Outcomes (Environmental and Economic Aspects)

| Aspect | Traditional Projects | BIM-Enabled Projects |
|---|---|---|
| **Environmental Impact** | Higher energy consumption | Reduced energy consumption due to optimized design |
| | Increased carbon emissions | Lower carbon emissions via simulation and analysis |
| | Inefficient daylight and ventilation control | Improved daylighting and ventilation through modeling |
| | Limited water efficiency measures | Enhanced water use efficiency with integrated planning |
| **Economic Impact** | Unpredictable project costs | More accurate cost estimation and control |
| | Frequent budget overruns | Minimized budget overruns through real-time monitoring |
| | Delays due to conflict and poor coordination | Reduced delays via clash detection and coordination |
| | Higher long-term operation and maintenance costs | Optimized lifecycle costs and better resource planning |

## 3. THE CASE OF IRAQ: CHALLENGES AND OPPORTUNITIES OF ADOPTING BIM

### 3.1 Challenges

- Infrastructure and Technological Readiness

One of the most significant challenges and reasons hindering the implementation of BIM in Iraq is the lack of an advanced digital infrastructure. Compared to regions that have advanced, speedy internet, strong computers, and proper software licenses, there are many architectural and engineering companies in Iraq that lack proper IT infrastructure. In addition, using cloud platforms for real-time collaboration among various BIM teams is difficult since these platforms are not widely available. In many cases, they have the hardware but not the necessary staff to operate and manage it properly **(Mahdi and Mawlood, 2020).**

In addition, different BIM tools from Autodesk, such as Revit, Navisworks, and Green Building Studio, are not always available equally to everyone in the software ecosystem. Community practitioners are often dependent on outdated versions or illegal copies, so they lack the latest updates, features, and use of the cloud. If there is no dependable digital base, BIM reaches only a small part of its potential, which affects both how much and how well BIM is used **(Alsaeedi et al., 2021; Hassan and Al-Kindy, 2023).**

- Regulatory Framework and Standards

A further major obstacle is that no unified national policy for BIM exists. Compared to the UK and UAE, which have put strong BIM mandates and systems in place, Iraq has not yet introduced any necessary rules or unified standards for its construction to be digital. The fact that there is no official law for BIM makes how it is carried out, how data is handled, and how contracts are written **(Hassan and Al-Kindy, 2023; Kamil et al., 2024)**.

Furthermore, the systems for public procurement do not motivate the adoption of BIM. Since BIM deliverables are not usually mentioned in government tenders or construction guidelines, this keeps international and local firms from investing in BIM capacity. Because there is no unified way to use BIM, collaborating with project stakeholders is more difficult, as people may approach BIM differently.

- Organizational Culture and Skill Gaps

Adopting BIM is made harder by certain attitudes and the set ways work is managed in legacy institutions. A large number of professionals use 2D CAD drawings and work the same way as before. The idea that BIM is too hard to grasp, expensive, or time-consuming makes people slow to accept it **(Mahdi and Mawlood, 2020)**.

Moreover, very few people in Iraq are trained in BIM. So far, BIM has just started to be taught in most educational institutions, and the lessons may not cover detailed information. Because of this, most workers in the construction field did not have the chance to learn BIM, nor understand the digital models, and therefore resist using new tools in their work. All the challenges of adopting BIM in Iraq are directly reflected in the environmental and economic aspects, which are strongly linked to modern digital tools that help address these challenges. They represent an inseparable link. Environmental awareness, economic awareness, awareness of the need for digital transformation, and the adoption of the latest technologies available in the construction industry are all closely linked. Thereby, environmental and economic challenges can be addressed together with the challenges of adopting BIM **(Hassan and Al-Kindy, 2023; Kamil et al., 2024)**.

### 3.2 Opportunities: Government Initiatives, International Partnerships, and Capacity Building

Through concentrated policies and spending, Iraq has a chance to move directly to higher levels of BIM usage. Many factors show that things will improve in the future.

- Government Initiatives: The Ministry of Construction and Housing and the Central Bank of Iraq have been launching programs involving BIM in recent public projects. Such direction from leadership may lead to more widespread use of the technology.
- International Partnerships: Cooperation with top engineering and design firms from across the globe adds great value to Iraq. Foreign consultants make sure local teams learn and use the BIM methods that are applied globally.
- Capacity Building Programs: BIM training, workshops, and certifications are being offered now by international development agencies and academic organizations. As a result, such initiatives can narrow the skill gap, allowing a new group of people to step in as digitally savvy workers.

With the right support from digital and legal steps, Iraq can build a secure platform for introducing BIM into its construction market. The Central Bank of Iraq, which makes use of BIM at every stage, is an example of the results gained when innovation is built into how organizations work.

All of the above opportunities can be exploited by adopting a sustainable approach based on the integration of modern technology and sustainability visions. BIM stands out as a digital platform with a set of tools that are directly linked to sustainable methods in the environmental and economic aspects. BIM, in all its dimensions and levels, overlaps with the aspects of sustainability in all its foundations, especially from the environmental and economic perspectives **(Ahmed and Altaie, 2021; Hassan and Al-Kindy, 2023)**.

## 4. A CASE STUDY OF THE NEW CENTRAL BANK OF IRAQ

### 4.1 Project Overview and Objectives

The CBI headquarters is built on the banks of the Tigris River in Baghdad and is designed by Zaha Hadid to show the institution's main values: solidity, stability, and sustainability. These principles relate to the river's history, since this central waterway has played a major role in shaping Iraq from the past to the present. By its 170 meters height, and having an internal area of 90,000 $m^2$, the tower's form adjusts to the site by being narrow at the bottom, the middle part is widened for efficiency, and then thins again at the top. A large atrium inside the resort lets in plenty of natural light and links the interior space to the river, highlighting the place's cultural significance. The façade is defined by its structure, where open and closed elements give it a pattern made to look like river light on the water, and this style also gives the interior shade and light zones. It begins as the number of floors rises and the building gets sunnier and offers a better view. Moving up the building in vertical segments, the exoskeleton helps to connect the site and link the security features as well as various building sections. The building moves smoothly through all levels, joining both architecture and engineering. The architects mixed gardens and terraces with the urban surroundings, so the podium can be used and accessed by everyone nearby. The slender lines found on the tower turn into wide horizontal lines across the design site. All in all, the CBI is shaped to be compatible with its environment, helping its day-to-day operation and strengthening Iraq's position in the region **(Taqi and Jaafar, 2017)**, see **Fig. 2**

**Figure 1**. The external design of the Central Bank building and the two main parts of the base and the tower using BIM tools, taking into account the orientation and environmental conditions. **(Taqi and Jaafar, 2017)**.

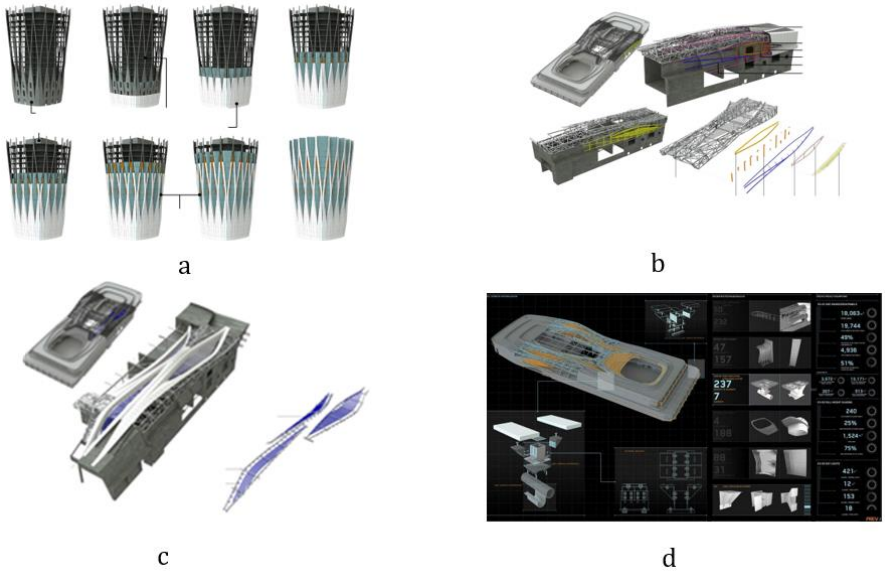


**Figure 2**. Utilization of BIM technology and tools to support environmental analysis and cost estimation: (a) details of the exterior concrete structure; (b) steel structure details for the building base; (c) cladding of the steel structure at the tower base; (d) building cladding details and connection methods **(Taqi and Jaafar, 2017)**.

The New Central Bank of Iraq is a turning point for the development of Iraq's modern administrative architecture. In Baghdad, the project demonstrates the country's drive for access to legal and economic reform, modernization, and durability. Both new technology and elements from Iraq's culture are part of the design, helping the tower show both its history and its hopes for the future **(Taqi and Jaafar, 2017)**.

The most important goals for the project are:

- Developing a solid, efficient, and sustainable central spot for financial activities in Iraq.
- Showing the government's effort to build smarter infrastructure and use new technology.
- Using Building Information Modeling (BIM) throughout all phases to ensure that the project is both environmentally and economically sustainable **(Mohammed and Hilal, 2024)**.

The project was designed and implemented using the latest digital technologies and modern management methods, relying on Building Information Modeling (BIM) as a digital platform connecting all project stakeholders. The project's experience can be leveraged to address the environmental and economic challenges facing projects in Iraq. Iraq's climate is characterized by extreme and harsh environmental conditions, especially during the summer, when temperatures are intense and the resulting challenges lie in providing clean energy, reducing the carbon footprint, and water consumption. Financing issues, financial waste, and project delivery delays are major challenges facing the construction industry in Iraq. The project can be used as a starting point for adopting and implementing BIM and promoting environmental and economic sustainability in construction projects in Iraq **(Saaduldeen and Hilal, 2025)**.

### 4.2 BIM Implementation Process

At the start of the Central Bank project, BIM was used as the main approach to make all project elements work together seamlessly. The project used the BIM process, and it took place in four main phases:

- Conceptual Modeling: The spatial studies and the initial mass were developed through various programs that work according to BIM technology, such as Autodesk Revit. These models were the basis that clarified the architectural idea, movement patterns, and other design details that were photographed in advance according to the studied patterns**(Taqi and Jaafar, 2017; Aldiwani and Shahin, 2023; Khaleel and Hilal, 2023)**.
- Detailed Design: The shared digital environment provided by BIM enabled cooperation between various architectural, construction, electrical, mechanical, sanitary, and facade companies. All of this was done through coordination meetings between the various specialties and accompanied by the use of the conflict detection program (Navisworks) that works according to BIM technology **(Taqi and Jaafar, 2017)**, see **Fig. 3**
- Simulation: Environmental, thermal, and daylight analysis tools and software were used to conduct comprehensive environmental simulations. These simulations influenced the design of the exterior facades, energy methods and strategies, and material specifications, see **Fig. 4**
- Documentation: Generating drawings automatically and using scheduling drafts reduced repetition and lowered the risk of errors. All the design data was combined with cost databases to produce 5D estimates **(Saaduldeen and Hilal, 2025)**.

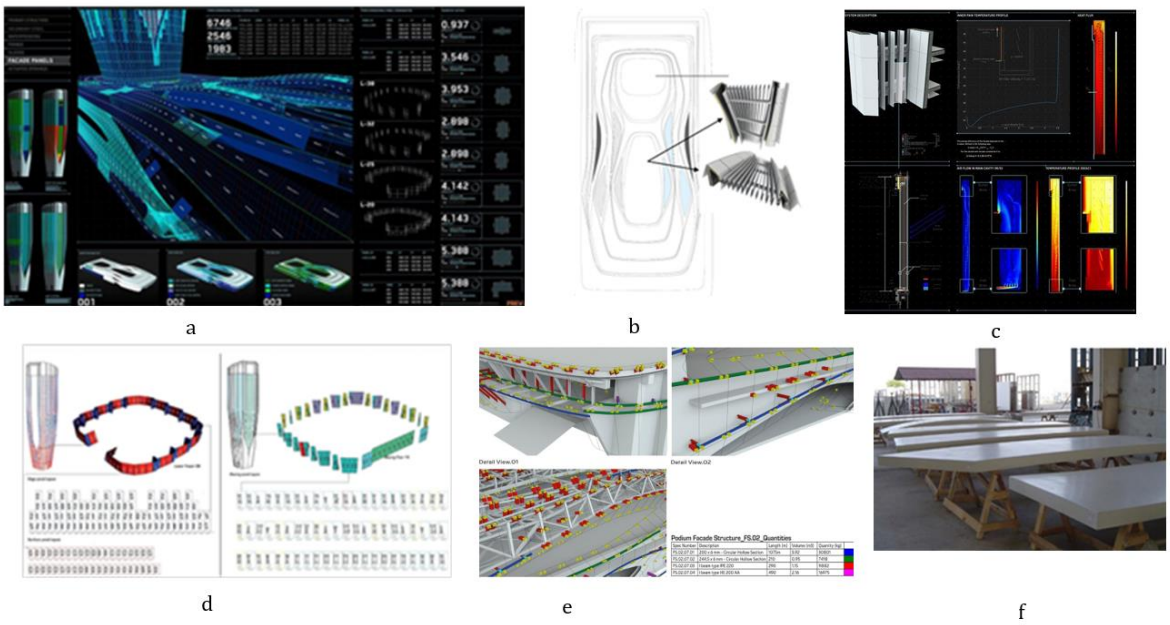

**Figure 3**. The use of digital tools within a BIM environment: (a) classification of the external structure cladding elements; (b) illustration of the building base cladding; (c) thermal analysis of a building section; (d) detailed numbering of each cladding element; (e) enlarged detail showing the precise design of the connecting elements for the external structure; (f) realistic images of the external cladding components with their respective dimensions **(Taqi and Jaafar, 2017)**.

### 4.3 Environmental and Economic Sustainability Strategies

The project's environmental objectives are achieved through a set of design strategies supported by BIM:

- Façade Optimization: The exterior of the building has two wall layers and adjustable shading. BIM made possible the study of orientation, glare, and lighting in the building.
- Energy Simulations: Ventilation and air conditioning systems were designed to precisely determine the required requirements using site climate data. Natural ventilation and solar gain reduction scenarios were tested in specialized digital virtual environments.
- Water Conservation: With the help of BIM, greywater recycling systems and rainwater harvesting networks were designed to fit seamlessly into the mechanical design package.

Because of these measures, the building's Energy Use Intensity (EUI) lessened, and passive environmental approaches were boosted, placing it foremost among green administrative buildings in Iraq.**(Ayead and Al-Tameemi, 2022; Al-Shammari et al., 2024; Mahmood and Hatem, 2024; Saaduldeen and Hilal, 2025)**.

The project leveraged BIM technologies to achieve cost efficiencies and long-term financial accountability through a combination of strategies and pre-calculations:

- 5D Cost Estimation: Each aspect of the model could be assigned to a budget database, so every time the design was updated, the budget was also updated at the same time.
- Value Engineering Workshops: BIM drawings were utilized at stakeholder sessions to select the best alternative designs that would not affect the project's efficiency.
- Life cycle maintenance planning: Under 7D BIM, the team grouped the FM aspects into a model that covered asset information, a schedule for maintenance, and data related to the lifecycle of each item**(Hardisty, 2010; Ribas and Cachim, 2019)**.

The approaches used by the team allowed them to select the proper investments initially and operate the building efficiently in the future, creating a model of economic sustainability for further Iraqi projects **(Khaleel and Hilal, 2023; Mohammed and Hilal, 2024)**.

## 5. RESULTS AND DISCUSSION

### 5.1 Environmental Performance Outcomes

As a result of using BIM in the Central Bank project, improvements in several areas of sustainability are to be achieved. Using advanced computer tools, the team found the ideal designs that helped the environment and preserved the building's style.

- Reduction in Energy Use Intensity (EUI): Thanks to 6D simulations of the exterior envelope, it is estimated that the building will provide significant energy savings compared to traditional administrative buildings in Iraq.
- Improved Daylighting and Occupant Comfort: The facade analysis resulted in the inclusion of flexible and responsive shading systems as well as material choices that enhance natural light without causing excessive glare or heat gain in the interior environment.
- Carbon Footprint Minimization: Using pre-simulations, materials with lower embodied carbon were selected, and machinery use was reduced. This is expected to significantly reduce the building's operational emissions.
- Water Conservation: Reducing drinking water consumption by supporting the design and simulation of an integrated plumbing system with Building Information Modeling (BIM) and incorporating graywater recycling and rainwater harvesting.

These achievements also demonstrate that Building Information Modeling (BIM) contributes to meeting green building certification standards, in addition to the environmental gains achieved **(Ayead and Al-Tameemi, 2022; Al-Shammari et al., 2024; Mahmood and Hatem, 2024)**.

### 5.2 Performance Outcomes

There are significant economic gains from using BIM in the Central Bank project, mainly because of strengthened cost management, better timeline planning, and efficient operating scheduling.

- Design and Construction Savings: Clash detection and 5D cost estimation helped reduce change orders, resulting in a reduction of the project´s cost by the same portion.
- Schedule Optimization: By using 4D phasing models, the right building sequence is used, and potential delays and lack of resources are prevented. The delays in costs due to schedule issues were much less than expected.
- Lifecycle Economic Efficiency: After linking 7D system data to asset management and how it was replaced, the facilities management team recorded a significant reduction in future operating expenses.
- Value-Based Decision-Making: Through visualization of different systems, stakeholders could meet their goals within their set budget without reducing the project's quality.

The research shows that BIM makes buildings more efficient and also increases their economic strength during the entire time they exist. **(Haron et al., 2017; Taha et al., 2020; Alsaeedi et al., 2021; Al-Shammari et al., 2024)**.

### 5.3 BIM's Integrated Impact

The project emphasizes that environmental and economic progress are closely linked, something that Building Information Modeling (BIM) can address with great flexibility. Using simulations, which require fewer costs and resources, reduces building operation costs. Similarly, increasing material efficiency helps reduce emissions and also reduces the amount that responsible authorities must spend on materials.

The data management system in BIM helps in making multiple upgrades to address cost, energy usage, and how people feel inside the building. With this knowledge, the team showed that applying sustainability methods helped reach goals for finances and the environment simultaneously **(Taqi and Jaafar, 2017; Khaleel and Hilal, 2023; Mohammed and Hilal, 2024; Saaduldeen and Hilal, 2025)**.

### 5.4 Lessons Learned and Best Practices

The lessons learned from the establishment of the Central Bank of Iraq are important for future Iraqi projects that utilize BIM to achieve sustainability. These lessons can be clarified as follows:

- Early BIM Integration is Crucial: To ensure better teamwork and a strong sustainability record in the project, it is essential to use Building Information Modeling (BIM) from the beginning of the design phase through implementation and operation.
- Multidisciplinary Collaboration is Essential: BIM-enabled environments enable immediate collaboration between all project stakeholders, including architects, engineers, cost consultants, and the implementing agency, eliminating barriers and improving and accelerating appropriate decision-making at all project stages.
- Training and Capacity Building are Non-Negotiable: The true benefits of BIM will only come to life if there are workers who are good with software, model according to standards, and understand how to measure a project's environmental impact.
- Data-Driven Decision-Making Reduces Risk: Thanks to simulation and modeling, decision-makers can see possible difficulties and assess responses well before they appear.

Information from working on this complex project in Iraq gives others a firm base to support wider use of BIM in public sector construction **(Alsaeedi et al., 2021; Ayead and Al-Tameemi, 2022; Al-Shammari et al., 2024)**.

All Building Information Modeling (BIM) related data used in this study were obtained with the proper authorization from the relevant authorities. The data were accessed exclusively for academic and research purposes in accordance with institutional ethical standards and data protection guidelines.

## 6. CONCLUSIONS

This research demonstrates that the adoption of Building Information Modeling (BIM) in the design and construction of administrative buildings can play a transformative role in advancing both environmental and economic sustainability within the Iraqi context. Through the comprehensive case study of the New Central Bank of Iraq, it was evident that BIM facilitated detailed simulations and data-driven analyses, enabling significant reductions in energy consumption, carbon emissions, and potable water usage. The integration of environmental strategies, such as façade optimization, energy modeling, and water conservation, through BIM led to notable improvements in the building's environmental performance and occupant comfort, supporting the achievement of green

building certification standards. Economically, BIM's capabilities in 5D cost estimation, clash detection, and lifecycle management contributed to effective budget control, minimized change orders, and improved project scheduling. These measures resulted in tangible cost savings during both the construction and operational phases, ensuring long-term economic sustainability. The ability of BIM to enable real-time collaboration among multidisciplinary teams, streamline decision-making, and maintain transparency further enhanced the overall project outcomes. Despite these demonstrated benefits, the study highlights that the widespread adoption of BIM in Iraq faces persistent challenges related to digital infrastructure, regulatory frameworks, and skill development. The experience of the Central Bank project emphasizes the critical importance of early BIM integration, multidisciplinary collaboration, and targeted capacity building in realizing the full potential of this technology. Ultimately, leveraging BIM offers a strategic pathway for Iraq's construction sector to overcome current environmental and economic challenges. The lessons learned from this pioneering project underscore the need for supportive policies, investment in education and training, and the development of national standards for BIM implementation. By institutionalizing BIM practices and aligning them with sustainability objectives, Iraq can make significant progress toward creating a modern, efficient, and environmentally responsible built environment.

## Credit of Author Contribution

Ali Q. F. Al-Jumaily: Writing – original draft, Validation, Software, Methodology. Hoda A. S. Al-Alwan: Reviewing & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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# دور نمذجة معلومات البناء (BIM) في تعزيز الاستدامة البيئية والاقتصادية للمباني الإدارية في العراق: مبنى البنك المركزي العراقي الجديد كدراسة حالة

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**الخلاصة**

مع تصاعد التحديات البيئية والقيود المالية عالميًا، وتطور صناعة البناء المؤثرة على الجوانب البيئية والاقتصادية، ازدادت أهمية التصميم المستدام، لا سيما في الدول النامية كالعراق. ونظرًا لأن المباني الإدارية تُعد مستهلكًا رئيسيًا للطاقة في مشاريع البنية التحتية الحكومية، فإن الحاجة الملحة لتبني نهج مستدام أصبحت أكثر وضوحاً. وقد شهد قطاع البناء تطورًا تكنولوجيًا ملحوظًا في الأدوات الرقمية التي تُعزز الأداء على مستويات التصميم والإدارة والتنفيذ والتشغيل للمشاريع. ومن أبرز هذه التقنيات نمذجة معلومات البناء (BIM)، وهي منصة رقمية تُشرك جميع أصحاب المصلحة المرتبطين بالمشاريع. تتناول هذه الورقة البحثية الدور المباشر لنمذجة معلومات البناء في تعزيز الاستدامة البيئية والاقتصادية في مشاريع المباني الإدارية، مع التركيز على السياق العراقي ومشروع البنك المركزي العراقي الجديد الذي صممته المهندسة المعمارية الشهيرة زها حديد. تتناول الورقة تعريف نمذجة معلومات البناء وأبعادها، وتطورها، وتطبيقاتها في التصميم المستدام. كما تُقدم إطارًا نظريًا يوضح دورها في تقليل الانبعاثات وتحسين كفاءة الموارد، بالإضافة إلى الإدارة المالية وإدارة الوقت. كما يتناول البحث أبرز التحديات والفرص التي تؤثر على تبني نمذجة معلومات البناء (BIM) في العراق، متبوعًا بدراسة معمقة للاستراتيجيات البيئية والاقتصادية لنمذجة معلومات البناء في مشروع البنك المركزي العراقي. وتُظهر الدراسة الإمكانات الكبيرة لنمذجة معلومات البناء في خفض التكاليف والبصمة الكربونية واستهلاك الطاقة، مما يعزز المرونة البيئية والاقتصادية على المدى الطويل. ويُسلّط البحث الضوء على الدروس العملية المستفادة، ويضع خارطة طريق لتبني وتطبيق نمذجة معلومات البناء في العراق على نطاق شامل، مع التركيز بشكل خاص على تعزيز الاستدامة البيئية والاقتصادية لمشاريع المباني الإدارية.

**الكلمات المفتاحية:** الاستدامة، الأداء البيئي، الاستدامة الاقتصادية، المباني الإدارية، نمذجة معلومات البناء (BIM)، البنك المركزي العراقي.