Impact of BIM Implementation in Engineering Projects in Syria

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Abstract

Engineering projects are often exposed to problems during their design and implementation, due to the lack of availability and accuracy of sufficient information, the failure to set an accurate timetable and budget, and the lack of cooperation and coordination between team members. Therefore, a technology was found to help solve these problems, which is building information modeling. It is one of the most important developments in the field of engineering in general, and the second generation of model design tools is the result of decades of research and development. Through it, one or more virtual models were created to support the design process through all its stages, and it is a simulation of the reality of the real project. In our research, we will discuss the most important problems that engineers face when working on a project, the importance of applying this technology and the benefits it has on the project and its parties, a simplified explanation of it, its dimensions, the stages that the project goes through, and the most important problems that we face when applying it. Building quantities will be studied in the traditional way and compared with quantities calculated through building information modeling technology.

Keywords: Building information modeling; BIM; CAD

1. Introduction

The use of new methods and programs is one of the most crucial tools benefiting civil engineers, as they continually explore innovative approaches that achieve efficiency, safety, and coordination. Building Information Modeling (BIM) stands out for its ability to encompass all project-related information and link it across all disciplines, making the model comprehensive. Civil engineers can leverage BIM in various ways, such as having a constantly updatable model to accommodate any changes in design or general specifications while retaining all data. BIM excels in handling elements and visualizing components, ensuring a reduction in errors and, consequently, a decrease in design costs and improved productivity. Additionally, it facilitates better analysis of alternatives through simulation. [1] The delay of the projects and the excess cost have become a common feature due to the increasing complexity of the modern construction industry and its multiplicity Thus, the BIM system provides the opportunity to speed up processes that were usually executed sequentially. In addition, BIM allow us to perform some activities simultaneously or in parallel, e.g. synchronization of design processes with execution and execution with operation. BIM proves its capability to reduce project time and increasing profits. [2]

BIM application is challenging, but if it is adopted, it will have great benefits. Such benefits are especially notable in regard of productivity, for BIM facilitates creating elevations, sections, and visualization, in what helps in using the information in the construction, maintenance, infrastructure, and facilities. BIM application isn't about the effectiveness of the methodology or software applications only, but it's about changing the mechanism of thinking prevailing about projects modeling and building, and the way the elements of the building are defined with their information.[3]

Finally, insufficiently-detailed requirements can be of an adverse effect on the project performance, mainly for the complicated direct and indirect relationship with all the factors that might lead to a less-satisfying project performance [4].

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This research will help AEC project managers to enhance project schedule and cost performance, where AEC projects in Syria need such improvement due to the poor performance, especially during the economic crisis the country is going through. [5]

2. Literature Review:

The transition from the traditional method to the BIM concept requires dramatic changes in many disciplines such as software and hardware upgrade, changes in processes, and changing the organizational culture to reap BIM benefits. In the traditional methods, the considerable impact occurs in the construction documentation phases which in turn cause several issues to arise, delaying the project delivery and increasing the overall project cost. Many developed countries such as (USA, Canada, UK, Germany France Finland, Singapore, Norway, Denmark, South Korea Australia, Hong Kong, Netherlands) mandated BIM in their public AEC industry projects motivated by its benefits, while others adopted strategic plans for mandating BIM. However, almost all developing countries did not mandate BIM yet, but they are on the road too. UK has also achieved a steady increase in adoption from 31.0% in 2010 when UK announced BIM requirements to 39% in 2012 [6] and 54.0% in 2013 then actually mandated BIM in public sector in 2016 to level 2. [7]

The most significant barriers against BIM adoption as Lack of expertise, Lack of standardization, and protocols to mention but a few. And, most influential drivers from both adopters and non-adopters as the Availability of trained professionals to handle the tools, Proof of cost savings by its adoption, BIM Software affordability, and awareness of the technology among the industry stakeholders [8]

The advantages of BIM have been acknowledged by developed countries [9], Despite this recognition, the actual adoption of BIM has remained lower than expected [10]

BIM can be applied to several topics. Using BIM with partnering agreements improves stakeholder behavior in Construction Mega-Projects. enhancing stakeholder relationships reduces disputes, eliminates conflict of interest, and allows sharing of knowledge, healthy interaction between project stakeholders, and improving problem-solving techniques [11]

2.1. The concept of building information modelling technology:

Building Information Modeling (BIM) is a technology or methodology fundamentally based on integrating the processes of description and modeling with the structure of the building. It is an acronym for Building Information Modeling, which means designing a comprehensive model of the building that includes all its information and data. The term "model" here goes beyond the concept of merely constructing a three-dimensional shape. In BIM technology, a building model refers to a simulation and description of every process the building undergoes during its construction in reality.

Therefore, it encompasses constructing it as a three-dimensional 3D shape with its input table properties. It also involves perceiving it in terms of time or scheduling, known as 4D, as well as incorporating the cost factor, known as 5D. These factors go beyond being just a three-dimensional shape.[12]

In another definition, it is a simulated project mirroring a real-world project, encompassing a three-dimensional model representing the actual project with its components (walls, floors, ceilings, etc.). This model interconnects these elements with structural, mechanical, and plumbing elements, along with all specialties comprising the building. The documentation of this information allows for utilization in design, development, modification, analysis, quantity determination, material specifications, and drawing preparation. [13]

The ability of BIM to facilitate clash detection, coordination, and visualization of complex project components has been extensively explored, laying the foundation for its widespread adoption in the industry [14] [15]

BIM has emerged as a transformative technology in the construction industry, offering a digital representation of the physical and functional characteristics of a building [16-40]

2.2. Benefits of using BIM in the construction phase:

1. Encourages communication between the technical office and site engineers.
2. Enhances and strengthens the linkage between planning and the schedule.
3. Assists in visualizing the project in advance, sequentially according to the timeline.
4. Establishes limits on understanding the materials used in the building in terms of quantity and classification [41].
5. Improves the ability to clarify effective construction stages. [17]

2.3. Useful information for the contractor from BIM:

1. Detailed construction information, extracted from the model.
2. Equipment and temporary installations.

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3. Standard specifications for each element in the building, and these specifications must be present in the existing elements with the specification to issue a purchase order.
4. Clarity of design and execution through BIM, with the ease of adding new or changed data to building elements, leading to a clear view for the contractor and owner of sufficient information and timelines.[18]

2.4. The reality of Syrian Construction Industry:

The delay of the projects and the excess cost have become a common feature in this age due to the increasing complexity of the modern construction industry and its multiplicity. In recent years, several studies claimed that the main causes of delays and inefficient projects management in the AEC industry are: 1) Poor or weak design, 2) lack of integration within the design team themselves, and with execution team, 3) The absence of an integrated system to facilitate coordination between project parties as a result of the weakness of the contractual legal framework. [19]
The Architectural, engineering, and construction (AEC) industry projects in Syria struggled with myriad problems. However, Building Information Modelling (BIM) technology worldwide proves its capability to solve these issues, Syrian AEC companies are rarely using BIM. [20]
Despite the benefits of Building Information Modelling (BIM), the adoption level of BIM remains much lower than expected. [21]
The Construction sector in Syria is adversely far beyond other industries in terms of economic growth rate and technological advancements, in what makes AEC projects less committed to schedule, cost, and quality. [22]

2.5. Construction Project Delivery Systems:

Owner contracts primarily involve the party responsible for financing the project from start to finish. These contracts typically rely on the transfer of responsibility and risk from one team to another, creating individual behaviors and fostering competition among project team elements.

- Design-Bid-Build:

This method is linear, and usually, the execution team is not part of the planning process, leading to a lot of misunderstandings about the project's execution details.[23]

- Design-Build:

This approach aims to involve both the execution and design teams in a continuous collaborative process throughout all project stages. In this system, a Guaranteed Maximum Price (GMP) is adopted, and the project team strives to deliver the best value within the agreed-upon limit.[23]

- Design-Assist:

This method is derived from the Design-Build approach. In this system, the owner employs a primary contractor who, in turn, seeks assistance from a design team working from the planning stage of the project.[23]

2.6. Requirements for implementing the BIM system in Syria:

- Project Procurement or Resourcing System:

This encompasses all aspects related to preparing and securing project resources, including construction materials, labor, and other requirements throughout all project phases. It involves preparing contracts for subcontractors, suppliers, and other parties associated with the project to various degrees. The notion that the relationship between the main contractor and subcontractors or suppliers is purely private and does not affect the contractual obligations of the main contractor with the owner is a statement contrary to reality. Practical project experiences confirm that disputes among the main contractor, subcontractors, and suppliers adversely impact the project's time and cost.[24]

- Construction Industry Constraints or Contracting System in the Project Environment:

This includes design, construction, supervision, operation, and maintenance contracts, along with contractual requirements. Currently, Syria has only one administrative contract, which is used for all types of engineering contracts (design, execution, supervision, etc.). This contract does not consider the nature, content, project site, or subject matter of the contract.[24]

- Insurance System:

Current insurance systems in the project field do not cover crucial aspects, such as professional insurance for some project stakeholders like designers or supervisors. Project insurance, or what is known as engineering insurance, includes insurance for certain project workers and insurance for the executed works.[24]

- Necessity to Modify Design and Execution Standards:

Existing codes do not obligate the designer to follow a specific design method. Consequently, the designer may consider themselves not bound to adhere to a particular design method such as the BIM system.[25]

- Necessity to Follow a Specific Project Management Methodology:

It is essential to establish or adopt a specific methodology for project management from the conceptualization stage through operation and investment. Project management plays a role in every stage of its life cycle, requiring adjustments to the current contractual requirements in the construction contracts applied today.[25]

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2.7. BIM maturity levels:

Many researchers have tried to define maturity in different ways. According to [26] the definition of maturity was "the extent to which a process is defined, managed, measured, controlled, and effective.

BIM levels indicate the level of maturity for BIM implementation in a company. Moreover, BIM outcomes differ according to the level of BIM as there are four levels of BIM maturity [27] And excellent BIM performance at any BIM maturity level will guide companies or projects to advance their BIM implementation to the subsequent BIM maturity level [28]. In any case, the level of knowledge and adoption of BIM in the Syrian engineering companies is low and expected to rise in the next five years to the second level [29]

BIM Maturity Index developed by analyzing then integrating several models from different industries. Dr. Succar developed (BIm3) maturity matrix as a cognitive tool that integrates several components of the BIM framework for the purpose of performance measurement and improvement [30]

Measurement provides the basis for a company to assess its progress towards achieving planned goals helps identify areas of strength and weakness and decides on predictions for the future. [31]

there are four BIM maturity levels as follows:

- <u>Level 0 BIM:</u> referred to no collaboration, 2D CAD drafting, and use paper or electronic prints. The majority of the AEC industry is in this level. [32]
- <u>Level 1 BIM:</u> 3D CAD or Modelling 3D. Common Data Environment (CDE) such as electronic document management system (EDMS) should be implemented, to allow the exchange of the information between all the project players. [33]
- <u>Level 2 BIM:</u> featured by collaborative environments, and demand an information interchange process and harmonious between various systems and project stockholders.[33]
- <u>Level 3 BIM:</u> UK Government provides a Level 3 Strategic Plan which identified key features for this level as follows:

✓ international 'Open Data' standards.
✓ A new contractual framework.
✓ a unified cultural environment seeks to learn and share.
✓ Training the public sector clients.
✓ Driving local and global growth and jobs in BIM.[33]

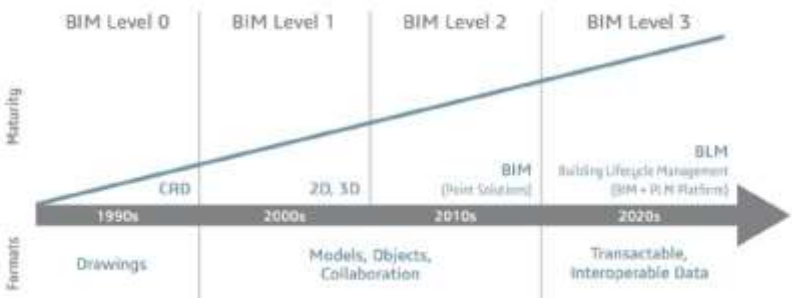

Figure 1: BIM maturity levels

2.8. Building life stages BIM _ BAM _ BOOM:

By utilizing this technology, we can facilitate collaboration and coordination among various engineering disciplines, identify early conflicts, and estimate the cost, time, and materials required to complete the project. It has brought about a significant transformation in the engineering sector across all its stages (design, execution, operation, and maintenance). The research aims to demonstrate that modeling is a technology that can be employed throughout the building's life cycle, starting from the initial design phase and continuing through its execution, operation, and maintenance. This is achieved by dividing the building's life cycle into three sections (BIM - BAM - BOOM)):

- BIM: The first stage, which is the design phase.
- BAM: The second stage, which is the execution phase.
- BOOM: The third stage, which is the operation and maintenance phase.

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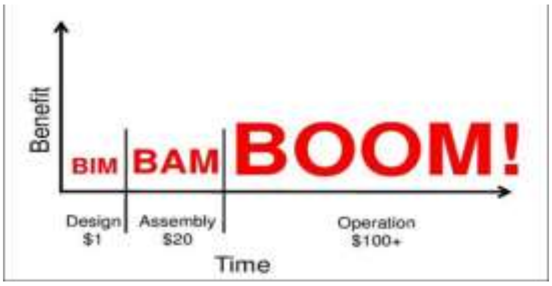

Figure 2: Building life stages

The ideal operating model for a building is not only a three-dimensional model, but rather it serves as a treasury of documents and data for the building during its life, a monitoring technology, an administrative warning and alert means for all its parts, and a tool for scheduling the maintenance and restoration work it needs during its occupancy period.[34]

2.9. Benefits of BIM Programs in Quantity Estimation:

Quantity estimation plays a crucial role throughout the project lifecycle, from project design and execution to delivery to the owner. It significantly impacts time, cost, and quality standards for project requirements. The impact of BIM programs on quantity estimation is as follows:

- During Project Study and Review:

In programs like Revit, where modeling and quantity estimation are conducted, the features for quantity estimation include:

- Visual verification ease, allowing precise identification and quantity assessment of specific elements.
- Direct modification of quantity schedules when the model changes, such as alterations to sections or materials.[35]

Additionally, Navisworks provides enhanced features:

- Full project quantity calculation based on item classification with a single click, taking only a few minutes, a crucial feature of the program.
- Creation of material, labor, and equipment lists during price analysis, understanding their impact on the cost of any item, aiding in discussions of various alternatives from an economic standpoint.
- Exporting quantity schedules to Excel for formatting. [35]

- During Project Execution:

The advantages of using Navisworks are highlighted:

- Any modification during project execution based on owner preferences can be directly reflected in the models, influencing quantity schedules that can be exported to Excel for financial summaries to subcontractors and owner claims.
- Improved financial control for the executing entity, as financial summaries are based on quantities derived from modified models, agreed upon by both parties, reducing disputes and accelerating the project's pace.
- Precision in organizing the supply chain by determining storage times for materials and planning new material orders from suppliers.[36]

2.10. The impact of BIM on design and contracting:

The impact of Building Information Modeling (BIM) is evident in both the design and construction fields, significantly contributing to the enhancement of project efficiency and quality. In the realm of design, BIM empowers engineers to bolster creative processes and improve design quality, thereby fostering the development of unique and innovative designs. Furthermore, it effortlessly facilitates the presentation of the model to the owner, providing a clearer and better understanding of the building during the design phase. This ease of presentation allows for modifications that align with the owner's preferences, presenting opportunities for adjustments and meeting specific owner requirements.

- Improve coordination and collaboration.
- Improve accuracy in design.
- Improve information management.
- Reduce costs and improve efficiency.
- Facilitating contracting processes.

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2.11. Types of engineering contracts in the BIM environment:

- **Lump Sum Contract:**

A fixed amount is predetermined for the project, and the contractor is responsible for managing costs and the schedule. It can be used in BIM projects if specifications and details are accurately defined early on.

- **Cost Plus Contract:**

Involves compensating the contractor for actual work costs plus an additional amount for profit. It can be used in BIM projects where it's challenging to determine costs in advance or in projects requiring frequent changes during execution.

- **Time and Materials Contract:**

The contractor is paid based on actual time, materials used, and labor costs. It can be used in BIM projects were defining the scope of work in advance is challenging.

- **Integrated Project Delivery (IPD):**

Collaboration among all stakeholders occurs early in the design and execution stages, jointly determining the project. IPD is suitable for BIM projects, encouraging complete collaboration and early involvement of all parties.

- **Public-Private Partnership (PPP):**

Involves collaboration between the private and public sectors to finance and execute the project. It can be used in BIM projects involving public-private partnerships.

- **FIDIC Contracts:**

FIDIC is a set of widely used standard contracts in the construction and engineering industry. Established by the International Federation of Consulting Engineers (FIDIC), these contracts provide a legal framework for contracting in construction and engineering projects. FIDIC contracts gain significance as globally recognized model contracts commonly used in the regulation of construction and contracting companies worldwide. The importance lies in:

❖ Establishing a contractual framework to overcome local and international construction issues.
❖ Achieving self-sufficiency principles for construction contracts.
❖ Recognition of FIDIC contracts by the World Bank and international lenders.

Although FIDIC contracts do not specifically address Building Information Modeling (BIM), they can be integrated with BIM principles to enhance project execution.[37]

There are several versions of FIDIC contracts, and the following are some of the main FIDIC contracts:

- FIDIC Master Contract (FIDIC Red Book):

This contract is used in traditional construction projects where the scope of work and responsibilities are precisely defined with prices and timelines specified. This contract can be integrated with BIM to improve project management and improve coordination between teams.

- 15.6.2 FIDIC Red Book contract:

The FIDIC Red Contract contains terms and conditions that define the relationship of the two parties in the construction project. It is used because it provides a comprehensive and globally recognized legal framework, enhances the balance of the relationship between owner and contractor, and provides effective dispute resolution mechanisms. It is a contractual model for the terms of the construction contract, and for the engineering works that the employer or his engineer representative undertakes (designing and preparing documents, regardless of the type of work included in the contract).[38]

- FIDIC Silver Book:

It is a contractual model for the terms of a turnkey project contract. It is suitable for projects established on a turnkey basis, such as development projects such as building electricity or water stations. The contractor bears full responsibility for the design and implementation of the project.[39]

- FIDIC Green Book contract:

It is used in design-only projects, where design is the primary responsibility of the architect or designer. It can be integrated with BIM to improve design processes and achieve consistent coordination.

2.12. Technical problems that may arise during BIM application:

❖ Lack of skills and training: Some personnel may not be qualified enough to understand and use BIM technology.
❖ Improper technique: Using BIM techniques or software that is not suitable for the needs of the project may result in the application being ineffective.

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❖ Data exchange and compatibility: Problems may arise in data exchange between different BIM applications, resulting in loss or incorrect conversion of information.
❖ Information Security: Security and intellectual property rights issues may raise concerns among different parties in a project.
❖ Technology Update: Irregular technology updates may lead to tool obsolescence and their non-compatibility with the latest software versions.
❖ Data inconsistencies: Data inconsistencies may occur between different models, affecting the accuracy and consistency of information.

3. A case study comparing project quantities calculation between the traditional method and using Revit:

This study aims to examine the impact of implementing Building Information Modeling (BIM) technology on project quantity estimation compared to traditional manual methods. The building chosen for analysis in this chapter serves as a practical example for evaluating and assessing the efficiency of BIM technology in material quantity calculations, presenting results in comparison with the conventional methods practiced in Syria.
The case study focuses on a commercial building consisting of a basement, ground floor, and first floor, with floor slabs having thicknesses of 22 and 28 cm. The ground floor area is 191.6 with a 22 cm thick slab and 367.6 with a 28 cm thick slab. The first-floor area is 191.6 with a 22 cm thick slab and 1622 with a 28 cm thick slab, as illustrated in Figure (8-1), showcasing the 22 cm thick slab. Quantities of materials used in constructing the floor slabs with different thicknesses will be measured, aiming to examine the accuracy and effectiveness of quantity calculations using BIM compared to traditional methods relying on manual calculations. Through this approach, we seek to shed light on the potential advantages and challenges of BIM technology in the field of project quantity estimation in engineering projects in Syria. This contributes to a better understanding of the positive impact that the use of this technology can achieve in the context of modern construction.

Table 1: Results tables comparison

Concrete (m3)			
difference	From Revit	From CAD	Type and location of works
0.02	*150.19*	*150.21*	Foundations
0	*95.63*	*95.63*	**pilings**
0.67	*827.51*	*828.18*	**Columns and Walls**
0.03	*454.13*	*454.16*	**Ground Floor ceiling**
0.09	*42.11*	*42.02*	
0	*218.66*	*218.66*	Level of half the ground floor
0	*233.44*	*223.44*	Level of half the first floor
0.01	*455.98*	*455.97*	**First Floor ceiling**
0	*42.15*	*42.15*	**Basement ceiling**
0.01	*102.92*	*102.93*	
0.02	*66.02*	*66.04*	Ground Floor ceiling joist
0	*20.80*	*20.80*	Level of half the ground floor joist
0	*3.96*	*3.96*	Basement joist

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This case study provides a valuable opportunity to explore the differences and improvements between quantity estimation processes using traditional manual methods and utilizing BIM technology in construction projects in Syria. Quantities of materials for building floor slabs with different thicknesses were analyzed and measured in the building, revealing clear discrepancies in accuracy and efficiency between the two methods. The differences in quantities between the two methods are attributed to errors resulting from calculations due to the lack of accuracy in drawings and details. Often, information in the manual method is less detailed than BIM, leading to oversight of some details that may arise during project execution. This can result in modifications to certain plans and their mismatch with other drawings, highlighting the communication gaps among project stakeholders. The experiment demonstrated that using BIM technology significantly facilitates the quantity estimation process compared to traditional methods. BIM showed higher accuracy in quantity and area estimates, contributing to a reduction in the time required for this process and overall efficiency improvement.

Steel (ton)				
difference	From Revit	From CAD	Type and location of works	
0.02	*4.30*	*4.32*	**F1**	**The isolated foundations**
0.05	*2.59*	*2.54*	**F2**	
0	*1.08*	*1.08*	**F3**	
0	*0.24*	*0.24*	**F4**	
0	*0.55*	*0.55*	**F5**	
0.36	*0.30*	*0.36*	**F6**	
0	*0.36*	*0.36*	**F7**	
1.3	*1.64*	*0.34*	**F8**	
0.04	*1.64*	*1.68*	**F9**	
0.02	*5.65*	*5.63*	**F10**	
0.01	*6.57*	*6.58*	**F11**	
0	*1.88*	*1.88*	**F13**	
0.33	*15.35*	*15.02*	**pile-cap**	
0.21	*4.60*	*4.39*	**S1**	**pilings**
0.33	*5.50*	*5.17*	**S2**	
0.36	*9.20*	*9.56*		
0.37	*79.00*	*49.96*	**Ground Floor ceiling**	
		4.62		
		24.05	**Level of half the ground floor**	
0.62	*25.20*	*24.58*	**Level of half the first floor**	
1.84	*52.00*	*50.16*	**First Floor ceiling**	
0.56	*15.40*	*4.64*	**Basement ceiling**	
		11.32		
6.4	*127.07*	*120.67*	**Columns and Walls**	

However, challenges facing the use of BIM in Syria cannot be ignored, such as the need for skill development and continuous training for engineering personnel on this technology. Additionally, there is a necessity to establish a legal and legislative framework that supports the use of BIM in engineering projects.

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4. Research Methodology:

The descriptive-analytical research methodology will be employed using a case study approach (quantitative study of a building using traditional methods and comparing the results with those from Revit), employing both structured interviews and online resources.

5. Results:

1. Using BIM technology enhances interaction and effective communication among all project stakeholders, helping improve coordination and avoid conflicts.
2. Building Information Modeling enables data analysis and early prediction of potential issues, reducing errors and the need for modifications in advanced stages.
3. Improving understanding of design and planning contributes to accelerating execution processes, leading to a reduction in the overall project completion time.
4. Avoiding conflicts and enhancing planning results in reducing the total project costs, whether through waste reduction or improving spending efficiency.
5. BIM usage ensures higher accuracy in design and execution, leading to an overall improvement in project quality.
6. Creating a three-dimensional model for the project makes maintenance and operation processes easier and more efficient.
7. BIM contributes to enhancing transparency across all project aspects, increasing understanding of all stakeholders in project details.
8. Using BIM contributes to improving project planning and management, enhancing the efficiency of time and resource utilization.
9. Implementing BIM promotes the adoption of technology in the construction sector in Syria, helping improve the overall industry performance.
10. BIM contributes to enhancing the experience of all project stakeholders, from the owner to the contractor, resulting in better satisfaction and more effective interaction.

6. Recommendations:

1. Providing training courses for engineers and specialists in the construction field to raise awareness about the benefits and techniques of BIM technology.
2. Establishing a legal and procedural framework that encourages the application of BIM technology in all construction projects in Syria.
3. Encouraging continuous interaction and collaboration among the owner, designer, contractor, and consultant through regular social sessions.
4. Providing incentives for construction companies to fully and effectively transition to using BIM technology.
5. Enhancing the availability of specialized human resources in BIM technology by encouraging universities and educational institutions to offer training programs.
6. Encouraging the collection and analysis of data resulting from the use of BIM technology to improve the overall performance of projects.
7. Contributing to the development of unified standards for the application of BIM technology in construction projects in Syria.
8. Supporting research and innovation in the field of BIM technology to improve and develop available tools and software.
9. Encouraging the establishment of collaborative models between various stakeholders to facilitate better information exchange.
10. Conducting periodic evaluations of the impact of BIM technology on construction projects in Syria and taking continuous improvement actions based on the results.

7. Conclusion:

During rapid technological advancement and the evolution of the engineering and project management fields, Building Information Modeling (BIM) has demonstrated an effective and pivotal impact on construction projects in Syria. Through our exploration of the concept of BIM, analysis of its maturity levels, and examination of the building life cycle from design and construction to operation and maintenance, along with a comparison between the traditional CAD system and modern BIM, we have arrived at robust conclusions regarding the significance of adopting BIM in the realm of engineering projects. Our analysis of the impact of BIM on enhancing project execution has revealed multiple benefits, ranging from improving accuracy in calculations and reducing errors to expediting implementation processes and enhancing managerial efficiency. The exploration of BIM's influence on design stages and types of engineering contracts has underscored radical changes in traditional methods, with a

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clear shift towards more integrated and efficient operational processes. The case study comparing the quantification of project elements between traditional methods and the use of Revit has highlighted significant differences in accuracy and the ease of modifications when employing BIM technology.

In conclusion, our findings emphasize the vital role of integrating BIM into engineering operations as a crucial step towards improving project performance and building a more effective and integrated future for the construction sector in Syria.

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