The Adoption of Building Information Modeling (BIM) in Construction Contracts in Syria

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Abstract

The primary objective of this study is to evaluate and propose modifications to the current construction contracting system in Syria to accommodate and fully leverage Building Information Modeling (BIM) technology. By identifying deficiencies and proposing a comprehensive contractual framework, the research aims to enhance project delivery efficiency and collaboration in public sector construction projects. This research employs a descriptive-analytical approach, utilizing case studies and interviews. The Syrian Petroleum Company's traditional contract served as the primary case study. Detailed content analysis was conducted on existing contract clauses, followed by bibliometric analysis of relevant literature to inform potential contractual modifications. Interviews with key stakeholders provided practical insights into current contractual practices and challenges. The study identified significant shortcomings in the current contracting system, which fails to address the needs of modern construction technologies like BIM. Key findings include discrepancies between contract quantities and actual project requirements, frequent delays necessitating contract extensions, and inequitable risk distribution. Additionally, the lack of clear dispute resolution mechanisms often leads to costly and time-consuming legal battles. The research concludes that substantial updates to the current contracting framework are imperative to integrate BIM effectively. Proposed modifications include incorporating a BIM Execution Plan (BEP), clearly defining digital model ownership and responsibilities, and establishing equitable risk management and dispute resolution protocols. Implementing these changes can significantly improve project outcomes, fostering transparency, collaboration, and efficiency in public sector construction projects in Syria.

Keywords: Building Information Modeling (BIM); Construction Contracts; Contract Modifications; Project Delivery; Risk Management; Dispute Resolution; BIM Execution Plan (BEP);Collaboration Construction Technology

1. Introduction

Construction projects today are marked by increasing complexity, demanding seamless collaboration among diverse stakeholders including architects, engineers, contractors, and owners to ensure successful project outcomes. Building Information Modeling (BIM) emerges as a pivotal tool, offering a collaborative platform where stakeholders integrate their expertise across design and construction phases. This integration enhances communication, minimizes errors and omissions, optimizes construction sequencing, and facilitates timely project delivery within budgetary constraints.[1]

Central to achieving these outcomes is the role of a well-crafted construction contract, which serves to clearly delineate the contractual obligations among parties, preempt disputes, and swiftly resolve any emerging conflicts. However, in Syria, the existing contracting framework governed by Law No. 51 of 2004 has demonstrated inadequacies in adapting to the rapid advancements within the construction industry, particularly in embracing BIM technology.[2]

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This research endeavors to evaluate Syria's current construction contracting system, highlighting its inherent deficiencies and its inability to effectively integrate BIM technology. The objective is to propose modifications that enhance the contractual framework, thereby enabling the full realization of BIM's benefits. By focusing on the execution phase of construction projects, this study seeks to bolster project delivery efficiency and foster enhanced collaboration among stakeholders.[3]

The scope of this research entails a comprehensive examination of prevailing contractual practices within Syria's public sector construction domain. Employing a descriptive-analytical approach, the study leverages case studies and interviews, with a specific emphasis on analyzing the traditional contract utilized by the Syrian Petroleum Company. Through this investigation, the research aims to pinpoint existing gaps and shortcomings, drawing insights from pertinent literature and stakeholder perspectives to inform the proposed enhancements to the contractual framework.[4]

It is important to acknowledge the study's limitations, notably its geographical focus on Syria and the specific case study of the Syrian Petroleum Company, which may not fully encapsulate the diversity of public sector construction projects. Nevertheless, the findings and recommendations put forth aim to furnish valuable insights that can potentially inform broader applications within the construction sector, emphasizing adaptability to contemporary technological advancements and fostering sustainable project delivery practices[5]

2. Literature Review

- **Building Information Modeling (BIM)**

Building Information Modeling (BIM) has revolutionized the architecture, engineering, and construction (AEC) industry by enabling digital representations of physical and functional characteristics of a facility. BIM integrates various data sources into a single model, fostering collaboration and improving project efficiency from conceptualization through maintenance.[6] Its adoption has grown globally due to its potential to enhance project coordination, reduce errors, and improve decision-making processes across the project lifecycle. BIM's benefits extend beyond design and construction phases, encompassing facilities management and operations. However, challenges such as interoperability issues and the need for standardized protocols continue to impact its widespread implementation.[7]

- **Contractual Frameworks in Construction**

Effective contractual frameworks are pivotal in defining relationships and responsibilities among project stakeholders in the construction industry.[8] Traditional contracts, such as lump-sum and cost-plus agreements, have evolved to accommodate the complexities introduced by technological advancements like BIM. The integration of BIM into contractual frameworks requires clear delineation of BIM-related responsibilities, data ownership, intellectual property rights, and protocols for model updates and exchanges. This evolution aims to mitigate risks, enhance project predictability, and foster collaboration among stakeholders throughout the project lifecycle.[9]

- **Challenges and Limitations of Current Contracting Practices**

Current contracting practices often fail to align with the dynamic requirements of BIM-enabled projects. Traditional contracts may lack provisions for digital deliverables, collaborative workflows, and data interoperability essential for effective BIM implementation.[10] Challenges include ambiguous scope definitions, inadequate risk allocation mechanisms, and contractual disputes arising from data discrepancies and intellectual property issues. Addressing these challenges requires adapting contractual frameworks to incorporate flexible terms that accommodate technological advancements and promote collaborative project environments.[11]

- **Proposed Enhancements to Contractual Frameworks for BIM Integration**

To maximize the benefits of BIM technology, modifications to existing contractual frameworks are essential. Proposed enhancements include developing BIM-specific contract templates that specify BIM uses, model management protocols, and data exchange requirements. Emphasis should be placed on defining clear roles and responsibilities for BIM stakeholders, establishing mechanisms for resolving BIM-related disputes, and ensuring compliance with industry standards and legal requirements.[12] By aligning contractual frameworks with BIM capabilities, stakeholders can enhance project efficiency, mitigate risks, and foster collaborative project environments conducive to successful project outcomes.[13]

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3. Methodology

This research employs a descriptive-analytical approach to investigate the current state of contracting practices within the Syrian government construction sector. The study focuses on identifying technical and legal deficiencies in existing contractual frameworks and proposes amendments necessary to safeguard intellectual and material interests for both contracting parties. The overarching goal is to develop an ideal contractual model aligned with the advancements achievable through Building Information Modeling (BIM) technology.[14]

- **Research Design and Approach**

The study adopts a descriptive-analytical methodology to comprehensively examine the current contractual landscape within government-owned companies, specifically targeting the Syrian Petroleum Company (SPC). This approach involves:

Case Study Analysis: A detailed exploration of SPC's existing contractual agreements will be conducted. This includes scrutinizing traditional contract templates to assess their compatibility with contemporary construction industry developments and BIM technology.

Identification of Weaknesses: Critical evaluation of identified weaknesses in current contractual practices, focusing on their implications for project execution efficiency and legal compliance.

Proposal Development: Formulation of a set of modifications and additions aimed at establishing a new contractual framework that integrates seamlessly with BIM environments. These proposals will address issues related to model management, data exchange protocols, and liability issues currently absent from the prevailing contractual system.[15]

- **Data Collection**

Theoretical Tools: Utilization of scholarly literature, articles, and relevant Arabic and international books that discuss engineering contracts and their adaptation to modern BIM technologies. These theoretical foundations will guide the analysis and proposal stages of the research.[13]

Practical Tools: Conducting structured interviews with key stakeholders at SPC, including project managers, technical department heads, and contract administrators. These interviews aim to gather comprehensive insights into current contractual practices, challenges faced, and perspectives on necessary adaptations to align with BIM requirements.[11]

4. Research Scope and Limitations

Geographical Boundaries: The study is geographically constrained to the Syrian Arab Republic, focusing specifically on construction contracts within the public sector, particularly within SPC.

- **Framework of the Research**

Having laid the groundwork by delving into the theoretical underpinnings of the research topic, the next critical phase involved implementing a practical study through targeted interviews with employees from the Syrian Petroleum Company. Specifically, the focus was on individuals holding key positions within the Contracting and Technical Directorates.[16]

5. Interviews, Analysis of Responses, Findings, and Recommendations

- **Study Tool:**

Interviews were selected as the primary methodological tool due to their ability to capture specific and nuanced information crucial for the study. Face-to-face interviews were conducted with a carefully chosen group of eight employees from the Syrian Petroleum Company. These interviews were structured to facilitate in-depth discussions and to extract insights based on the extensive professional expertise and practical experiences of the participants. To achieve the research objectives effectively, a variety of interview techniques were employed. Prior to commencing the interviews, an introductory session was conducted to clearly outline the research objectives and scope.[17]

- **Research Sample:**

The research sample comprised department heads from pivotal divisions within the Syrian Petroleum Company, including the Projects Department, Contracts Department, and engineers specializing in various fields within the Technical Directorate. Additionally, employees from the Contracts Department were also included in the

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sample.[18] This methodological approach was meticulously designed not only to explore theoretical concepts but also to glean practical insights from real-world contexts within the company. By engaging with this diverse group through structured interviews, the study aimed to derive valuable recommendations aimed at enhancing operational efficiency and effectiveness within the Syrian Petroleum Company. These findings are anticipated to contribute significantly to broader academic discussions concerning organizational management and strategies for improvement.[19]

The research sample consists of department heads in relevant departments at the Syrian Petroleum Company (Projects Department - Contracts Department) and engineers from various disciplines within the Technical Directorate, in addition to employees in the Contracts Department, as outlined in the following table:

Table 1: Specializations of experts in the interview

Nu	Position	Specialty	Experience
1	Head of Projects Department	Civil Engineer	30 years
2	Head of Electrical Division	Electrical Engineer	32 years
3	Head of Mechanical Division (Equipment)	Mechanical Engineer	24 years
4	Head of Mechanical Division	Mechanical Engineer	30 years
5	Staff in Projects Department	Civil Engineer	8 years
6	Staff in Projects Department	Electrical Engineer	30 years
7	Head of Contracts Department	Legal Specialist	24 years
8	Staff in Contracts Department	Legal Specialist	12 years

Table 2: Interview Questions in the interview

Group	Questions
General Questions about Position, Experience, and Educational Background:	• What is your current job position? • How many years have you been working at the Syrian Petroleum Company? • What is your educational background and what certifications do you hold?
Questions related to Evaluating Current Projects and Contractual Agreements:	• How familiar are you with the current contractual system used at the Syrian Petroleum Company? • How knowledgeable are you about the execution contracts used by the company? • What is your opinion on the contracts used in executing projects at the Syrian Petroleum Company? Are they comprehensive and integrated? • What are the main challenges you face during contract execution monitoring? • Is there alignment in quantities and prices with what is stated in the contract during execution? • Are projects delivered on time as per the contract? • Are project risks fairly distributed between the company and the executing contractor? • How are disputes regarding contract matters resolved? What impact does this have on projects in terms of time and cost?
Questions about Building Information Modeling (BIM) and its Integration into Current Contracting Systems:	• How familiar are you with Building Information Modeling (BIM)? (If not familiar, provide a brief explanation of BIM and its benefits) • Is it necessary to develop the current contracting system to align with BIM principles? • Can adopting Building Information Modeling in the current contracting system facilitate contract monitoring and thereby improve project execution performance?

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Table 3: Questions and results in the interview

Questions	Results
1. What is your level of knowledge of the current contractual system used in the Syrian company?	1- Excellent knowledge of all aspects of contracting 2- Very good 3- Very good 4- Good 5- Good 6- Moderate knowledge 7- Full knowledge 8- Excellent
2. What is your level of familiarity with the current contractual system used at the Syrian Petroleum Company?	1- Full awareness 2- Very good 3- Good 4- Good 5- Good 6- Average 7- Full knowledge (solid experience) 8- Excellent
3. What is your familiarity and understanding of the execution contracts used by the company?	1- There are some gaps in some materials and need for adjustments 2- Comprehensive and serves its purpose 3- Comprehensive and integrated 4- There are deficiencies and need additions 5- Not integrated and requires modifications 6- Not comprehensive and needs a review of many contract items 7- There are gaps in execution and require adjustments 8- There are deficiencies and shortages in many contract items
4. What is your opinion on the contracts used in executing projects at the Syrian Petroleum Company? Are they comprehensive and integrated?	1- None 2- No coordination during execution and monitoring 3- Material mismatch, delay in material supply, contractor penalties and re-advertisement 4- Change in some specifications 5- Price differences and price adjustment requests 6- Delay 7- Procrastination and delay 8- Delay in execution and price changes
5. What are the main challenges you face during contract execution monitoring?	Most answers agreed that there is always an increase in quantities (25%) and inconsistency in prices that often change Is there alignment in quantities and prices with
6. what is stated in the contract during execution?	All responses confirmed that there is a delay in project delivery, often extended by agreement between parties, and sometimes resorting to delay penalties
7. Are projects delivered on time as per the contract?	All answers agreed that the contractor is always responsible for risks (except force majeure reasons)
8. Are project risks fairly distributed between the company and the executing contractor?	1- Joint agreement minutes and if not adhered to, there are administrative issues 2- Legal Directorate is consulted for necessary actions 3- Administrative judiciary 4- Deprivation issues and execution at the contractor's expense 5- Friendly methods first, then legal action 6- Administrative judiciary 7- Friendly methods and agreement minutes, if failed, resort to legal action 8- Administrative judiciary
9. In case disputes arise regarding the contract, how are they resolved? And what is the impact of this on the executed projects in terms of time and cost?	1- Joint agreement minutes, and if not adhered to, there are administrative issues. 2- The legal directorate is consulted to take necessary actions. 3- Administrative judiciary. 4- Deprivation issues and execution at the contractor's expense. 5- Friendly methods first, then resort to legal action. 6- Administrative judiciary. 7- Friendly methods and agreement meetings; in case of failure, resort to legal action. 8- Administrative judiciary.
10. How familiar are you with Building Information Modeling (BIM)?	The responses varied from being uninformed or superficially informed to having moderate awareness
Is it necessary to develop the current contracting system to align with this environment?	1- Not necessary (development through traditional contracting methods only) 2- Necessary 3- Development is necessary as the current system is not suitable 4- Mandatory for improvement purposes 5- Definitely 6- With development and updates 7- Definitely 8- Definitely

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Will adopting Building Information Modeling (BIM) in the current contract system facilitate contract execution monitoring and consequently improve project execution performance?	All responses affirmed that adopting Building Information Modeling (BIM) will contribute to improving performance and enhancing execution.

The study's results reveal a spectrum of understanding and challenges within the Syrian Petroleum Company's contractual framework and project execution practices. Participants exhibited varying levels of knowledge and familiarity with the current contractual system, ranging from excellent to moderate, highlighting both strengths and areas needing improvement. Their opinions on execution contracts varied, citing gaps, integration issues, and challenges like delays and pricing discrepancies. Disputes and their resolution mechanisms were also discussed, with a consensus on the negative impact of disputes on project timelines and costs. Importantly, respondents recognized the potential benefits of integrating Building Information Modeling (BIM) into the current contracting system, foreseeing enhanced performance and execution efficiencies through its adoption.

6. Discussion

- **Discrepancies from previous studies indicate that:**

Discrepancies from previous studies indicate that there is considerable variability in the understanding and implementation of contractual systems and project execution practices within the Syrian Petroleum Company. Participants in this study demonstrated diverse levels of knowledge and familiarity with the current contractual system, highlighting strengths in some areas while identifying gaps and challenges in others. Their opinions on execution contracts underscored issues such as material mismatches, delays, and the impact of these factors on project timelines and costs. Dispute resolution mechanisms were also a point of concern, with recognition of their critical influence on project management and outcomes.[20]

- **Limitations by focusing on several key points, including:**

Defining the scope of the study presented challenges, particularly in synthesizing a comprehensive literature review. This specialization might have inadvertently excluded significant studies or methodologies crucial to understanding the broader context. Accessing relevant sources and resources posed another limitation, potentially hindering efforts to gather supporting articles or original studies. Moreover, constraints in time and effort allocated to the review may have limited its depth and currency, impacting the breadth of insights gained. Lastly, challenges in data analysis from selected studies could have compromised the review's conclusions in terms of accuracy and validity.

7. Conclusions

- **Summary of Key Findings:**

The study reveals significant variability in knowledge and understanding of the contractual system and execution practices within the Syrian Petroleum Company. While some participants demonstrated excellent or good knowledge levels, others showed moderate to limited familiarity, indicating potential gaps in training or communication within the organization. Views on execution contracts highlighted recurring challenges such as material mismatches and delays, impacting project timelines and costs. Dispute resolution mechanisms were acknowledged as critical, with implications for project management effectiveness.

- **Concluding Remarks:**

Addressing the identified gaps in knowledge and understanding of the contractual system is crucial for enhancing operational efficiency and reducing risks in project execution within the Syrian Petroleum Company. Efforts should focus on comprehensive training programs that ensure all stakeholders have a clear understanding of contractual obligations and execution procedures. Improving communication channels and implementing robust monitoring mechanisms are also essential to mitigate risks and enhance project delivery timelines. Future research could delve deeper into specific strategies for improving contract management practices in similar organizational contexts, aiming to optimize project outcomes and stakeholder satisfaction.

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References

[1] Saleh F, Elhendawi A, Darwish AS, Farrell P. A Framework for Leveraging the Incorporation of AI, BIM, and IoT to Achieve Smart Sustainable Cities. Journal of Intelligent Systems and Internet of Things. 2024;11(2):75-84.

[2] Elhendawi A, Omar H, Elbeltagi E, Smith A. Practical Approach for Paving the Way to Motivate BIM Non-Users to Adopt BIM. International Journal of BIM and Engineering Science. 2020;2(2).

[3] Saleh F, Elhendawi A, Darwish AS, Farrell P. An ICT-based Framework for Innovative Integration Between BIM and Lean Practices Obtaining Smart Sustainable Cities. Fusion: Practice and Applications. 2024;14(2):68-75.

[4] Shaban MH, Elhendawi A. Building Information Modeling in Syria: Obstacles and Requirements for Implementation. International Journal of BIM and Engineering Science. 2018;1(1):42-64.

[5] Elhendawi AIN. Methodology for BIM Implementation in KSA in AEC Industry [Master of Science MSc in Construction Project Management thesis]. Edinburgh Napier University, UK; 2018.

[6] Roumieh N, Ahmed S. Adopting Risk Management Professional Methodologies as an Effective Strategy to Protect Heritage Sites in Syria. International Journal of BIM and Engineering Science. 2022;5(1):61-72.

[7] Salami H, Alothman K. Engineering Training and Its Importance for Building Information Modelling. International Journal of BIM and Engineering Science. 2022;5(1):41-60.

[8] Elhendawi A, Smith A, Elbeltagi E. Methodology for BIM Implementation in the Kingdom of Saudi Arabia. International Journal of BIM and Engineering Science. 2019;2(1):01-20.

[9] Evans M, Farrell P, Elbeltagi E, Mashali A, Elhendawi A. Influence of Partnering Agreements Associated with BIM Adoption on Stakeholder's Behaviour in Construction Mega-Projects. International Journal of BIM and Engineering Science. 2020;3(1):01-20.

[10] Gibbs DJ, McAuley B, Smith R. BIM and Construction Contracts–CPC 2013's Approach. Proceedings of the Institution of Civil Engineers - Management, Procurement and Law. 2015;168(6):285-293.

[11] Abd Jamil AH, Fathi MS. Contractual Challenges for BIM-based Construction Projects: A Systematic Review. Built Environment Project and Asset Management. 2018;8(4):372-385.

[12] Arshad MF, Afzal F, Hashim MA, Khaqan S. Contractual Risks of Building Information Modeling: Toward a Standardized Legal Framework for Design-Bid-Build Projects. Journal of Construction Engineering and Management. 2019;145(4):04019010.

[13] Ahmed S, Dlask P, Selim O, Elhendawi A. BIM Performance Improvement Framework for Syrian AEC Companies. International Journal of BIM and Engineering Science. 2018;1(1):21-41.

[14] Kadi AJ, Bakar AR, Isa CR, Salman H, Dhafir SA. The Effect of Innovation Barriers on Construction Firms' Innovation Orientation. European Proceedings of Social and Behavioural Sciences. 2022;14:125-130.

[15] Kadi AJ, Dhafir SA, Bakar AR, Isa CR. A Conceptual Framework for the Factors Affecting the Innovation Orientation of Syrian Construction Firms and the Indirect Effect on the Tourism Industry. In: Handbook of Technology Application in Tourism in Asia. Cham: Springer International Publishing; 2022. p. 629-644.

[16] Mahdi MM, Mawlood DK. Challenges Facing the Implementation of Building Information Modeling (BIM) Techniques in Iraq. Zanco Journal of Pure and Applied Sciences. 2020;32(4):48-57.

[17] Elgendi AF, Elhendawi A, Youssef WMM, Darwish AS. The Vulnerability of the Construction Ergonomics to Covid-19 and Its Probability Impact in Combating the Virus. International Journal of BIM and Engineering Science. 2021;4(1):01-19.

[18] Teo Ai Lin E, Tzai Koon W, Sim YC, Soon CL. Framework for Productivity and Safety Enhancement System Using BIM in Singapore. Engineering, Construction and Architectural Management. 2017;24(6):1350-1371.

[19] Manderson A, Jefferies M, Brewer G. Building Information Modelling and Standardised Construction Contracts: A Content Analysis of the GC21 Contract. Construction Economics and Building. 2015;15(3):72-84.

[20] Shojaei A, Ketabi R, Hakak S, Hashemi S, Grobler K. An Implementation of Smart Contracts by Integrating BIM and Blockchain. In: Proceedings of the Future Technologies Conference (FTC) 2019: Volume 2. Cham: Springer International Publishing; 2020. p. 253-270.

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