

Research Title:

Assessing the Impact of Building Information Modeling (BIM) on
Engineering Project Management Efficiency: An Empirical Analysis of Time,
Cost, and Quality Performance.

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بسم الله الرحمن الرحيم

Research Proposal

Subject: Request for Approval of Master's Thesis Topic

To: Head of the Project Management Department - Midocean University

Dear Sir/Madam,

I hope this message finds you well.

I respectfully submit this request for approval of my proposed Master's thesis topic for the Master of Project Management program, entitled:

“Assessing the Impact of Building Information Modeling (BIM) on Engineering Project Management Efficiency: An Empirical Analysis of Time, Cost, and Quality Performance.”

This research aims to examine the impact of implementing Building Information Modeling (BIM) technologies on the performance of engineering projects, with a particular focus on key performance indicators such as time management, cost control, and quality improvement. In addition, the study seeks to evaluate the level of integration between BIM and contemporary project management methodologies, and to propose a practical framework to enhance the effective implementation of BIM in engineering projects.

I would greatly appreciate your kind approval of this research topic and your guidance in forwarding this request to the appropriate academic authorities to proceed with the necessary procedures.

Thank you very much for your time and consideration.

Please accept my sincere appreciation and respect.

Yours faithfully,

Mohammed Omer Ahmed Salih

University ID: 253001720

Date: 27 March 2026

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1. Research Title

Section	Details
Research Title	Assessing the Impact of Building Information Modeling on Engineering Project Management Efficiency: An Empirical Analysis of Time, Cost, and Quality Performance
Justification	The title clearly identifies the independent variable (BIM) and dependent variables (time, cost, quality). It is concise, specific, and aligned with academic research standards at MidOcean University.

2. Introduction

The construction industry is undergoing a significant transformation driven by rapid digital innovation and the emergence of Industry 4.0 technologies. These technologies, including automation, big data, cloud computing, and artificial intelligence, are reshaping traditional engineering practices and improving the efficiency of project delivery. However, despite these advancements, the construction sector continues to suffer from persistent inefficiencies, particularly in project management performance related to time, cost, and quality (McKinsey & Company, 2017).

Traditionally, engineering project management has been characterized by fragmented processes, lack of coordination among stakeholders, and inefficient information exchange. These issues frequently result in cost overruns, schedule delays, and quality deficiencies. According to Flyvbjerg (2014), large-scale construction projects often exceed their budgets by more than 20% and experience significant delays, which negatively impact project stakeholders and economic development. These inefficiencies highlight the urgent need for innovative tools and integrated approaches to improve project management practices.

In response to these challenges, the Architecture, Engineering, and Construction (AEC) industry has increasingly adopted digital solutions to enhance project performance. Among these solutions, **Building Information Modeling (BIM)** has emerged as one of the most influential technologies. BIM is defined as a digital representation of the physical and functional characteristics of a facility, serving as a shared knowledge resource for information throughout the project lifecycle (Eastman et al., 2011).

Unlike traditional two-dimensional (2D) design methods, BIM enables the integration of multidimensional project data into a single, collaborative platform. This includes:

- **3D Modeling (Design Visualization)**
- **4D Modeling (Time and Scheduling Integration)**
- **5D Modeling (Cost Estimation and Budgeting)**
- **6D Modeling (Lifecycle and Facility Management)**

This multidimensional capability allows project stakeholders to collaborate more effectively, improves visualization, and enhances decision-making processes (Azhar, 2011).

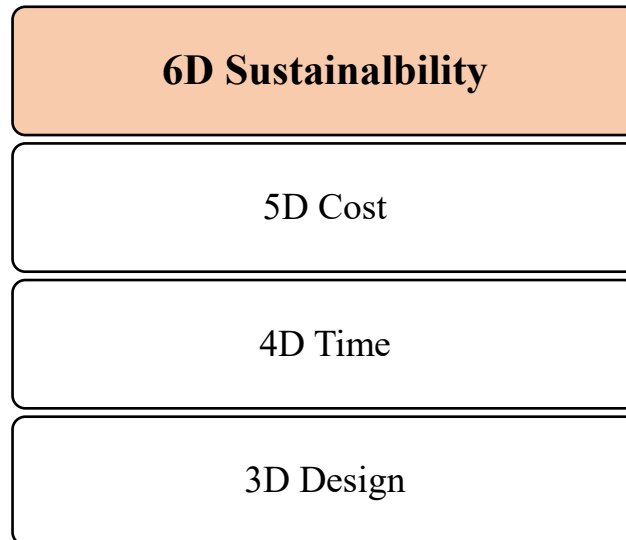


Figure 1.1: BIM Dimensions (3D–6D Model)

Source: Developed by the researcher

As illustrated in Figure 1.1, BIM evolves from a simple design tool into a comprehensive system that integrates time, cost, and lifecycle data. This integration enables project teams to simulate construction processes, optimize scheduling, and improve resource allocation.

Several studies have highlighted the benefits of BIM in improving project performance. Azhar (2011) found that BIM enhances visualization, reduces design conflicts, and minimizes rework, leading to improved cost efficiency. Similarly, Bryde et al. (2013) concluded that BIM implementation significantly improves communication among stakeholders and reduces project duration. These findings indicate that BIM has a direct impact on improving key performance indicators such as time, cost, and quality.

Moreover, BIM supports real-time collaboration and information sharing among project stakeholders. This reduces communication gaps and ensures that all parties have access to

accurate and up-to-date information. Additionally, BIM facilitates early conflict detection through clash detection tools, which identify design inconsistencies before construction begins. This proactive approach significantly reduces errors and improves overall project quality (Barlish & Sullivan, 2012).

Despite these advantages, BIM adoption remains limited and fragmented in many organizations. Several barriers hinder its effective implementation, including high initial costs, lack of skilled personnel, resistance to organizational change, and absence of standardized processes (Khosrowshahi & Arayici, 2012). Furthermore, many organizations use BIM primarily for visualization purposes rather than integrating it into project management processes, which limits its potential benefits.

In addition, there is a significant gap between the theoretical benefits of BIM and its practical application in real-world projects. While previous studies have extensively explored the technical aspects of BIM, fewer studies have provided empirical evidence linking BIM implementation to measurable improvements in project management efficiency. Most existing research focuses on individual performance aspects such as cost or time, rather than providing a comprehensive analysis of BIM's impact on multiple performance indicators simultaneously.

Therefore, this study aims to assess the impact of Building Information Modeling on engineering project management efficiency. Specifically, it examines how BIM influences key performance indicators, including project time, cost control, and quality outcomes. The study also seeks to identify the challenges associated with BIM implementation and propose a framework for enhancing its effective integration into project management practices.

3. Research Problem

The construction industry continues to face persistent challenges related to project delays, cost overruns, and quality deficiencies, despite the increasing availability of advanced technologies and digital solutions. These challenges indicate significant inefficiencies in traditional engineering project management practices.

Building Information Modeling (BIM) has emerged as a promising tool to enhance project performance through improved coordination, visualization, and information integration. However, its application within project management remains limited and inconsistent. In many cases, organizations utilize BIM primarily for design and visualization purposes, without fully integrating it into essential project management functions such as scheduling, cost control, and quality management.

Furthermore, although previous studies have highlighted the benefits of BIM, there is still a lack of comprehensive empirical evidence that clearly demonstrates its direct and integrated impact on key project performance indicators, particularly time, cost, and quality. Most existing research focuses on isolated aspects rather than providing a holistic evaluation of BIM's contribution to overall project management efficiency.

Main Research Question:

To what extent does Building Information Modeling (BIM) improve engineering project management efficiency?

Sub-Questions:

1. What is the impact of BIM on project time performance?
2. How does BIM affect cost estimation and cost control?
3. What role does BIM play in improving project quality?
4. What challenges limit effective BIM implementation?

Problem Statement:

Accordingly, the research problem is represented in the insufficient integration of BIM into engineering project management practices and the limited empirical understanding of its comprehensive impact on project efficiency, particularly in terms of time, cost, and quality performance.

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4. Importance and Objectives

First: Research Objectives

General Objective

To assess the impact of Building Information Modeling (BIM) on engineering project management efficiency, particularly in terms of time performance, cost control, and quality improvement.

Specific Objectives

1. To evaluate the impact of BIM implementation on project time performance and scheduling efficiency.
2. To analyze the role of BIM in improving cost estimation accuracy and cost control.
3. To examine the effect of BIM on enhancing project quality and reducing errors and rework.
4. To identify the key challenges affecting the effective implementation of BIM in engineering projects.
5. To propose a practical framework for integrating BIM into project management practices to improve overall efficiency.

- **Table 1: Research Objectives Classification**

Objective Type	Description
General Objective	Assess the overall impact of BIM on project management efficiency
Time Objective	Evaluate BIM's role in improving scheduling accuracy and reducing delays
Cost Objective	Analyze BIM's contribution to cost estimation and cost control
Quality Objective	Examine BIM's impact on improving quality and minimizing construction errors
Strategic Objective	Develop a framework for effective BIM integration in project management

Second: Importance

1. Academic Importance

- This study contributes to the existing literature on Building Information Modeling (BIM) and project management integration.
- It addresses a research gap by providing empirical evidence on the relationship between BIM implementation and key performance indicators (time, cost, and quality).
- The study may serve as a reference for future research in digital construction and project management.

2. Practical Importance

- The study provides useful insights for engineers, project managers, and decision-makers on improving project performance using BIM.
- It supports better planning, execution, and monitoring of engineering projects.
- It contributes to reducing project delays, controlling costs, and improving quality outcomes.

3. Strategic Importance

- The study supports digital transformation initiatives in the construction industry.
- It enhances organizational competitiveness through the adoption of advanced technologies.
- It aligns with global trends toward smart construction and sustainable project management practices.

5. Research Hypotheses

- H1: BIM implementation has a **significant positive effect** on project time performance
- H2: BIM implementation has a **significant positive effect** on cost control
- H3: BIM implementation has a **significant positive effect** on project quality
- H4: BIM implementation has a **significant impact on overall project management efficiency.**

These hypotheses reflect measurable relationships between variables.

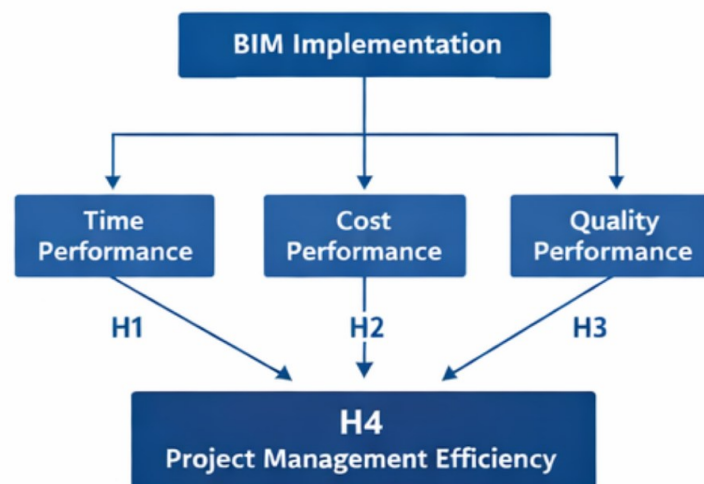


Figure 2.1: Research Model with Hypotheses

Source: Developed by the researcher

6. Literature Review

6.1 Project Management

Project management is a structured discipline that involves planning, executing, monitoring, and controlling project activities to achieve predefined objectives within constraints such as time, cost, and quality. According to the Project Management Institute (PMI, 2021), effective project management integrates multiple knowledge areas, including scope, schedule, cost, quality, risk, and stakeholder management.

In the construction industry, traditional project management approaches often suffer from fragmentation, poor coordination, and lack of real-time data integration. These limitations frequently result in project delays, budget overruns, and quality deficiencies. Therefore, there is an increasing need for advanced digital tools that can enhance coordination and improve decision-making processes.

6.2 BIM Concept

Building Information Modeling (BIM) is defined as a digital representation of the physical and functional characteristics of a facility, which serves as a shared knowledge resource for information throughout the entire project lifecycle (Eastman et al., 2011). BIM enables stakeholders, including architects, engineers, contractors, and project managers, to collaborate effectively by accessing and sharing accurate and real-time project data.

Unlike traditional two-dimensional (2D) design methods, BIM integrates multiple dimensions of project information into a unified digital environment. These dimensions include three-dimensional modeling (3D), time scheduling (4D), cost estimation (5D), and lifecycle management (6D). This integration enhances visualization, improves coordination among project participants, and supports better decision-making throughout all phases of a project (Azhar, 2011).

Furthermore, BIM facilitates early detection of design conflicts through clash detection tools, which help reduce errors and minimize rework during construction. As a result, BIM contributes to improved project efficiency, enhanced communication, and better overall

project outcomes. Due to these capabilities, BIM is increasingly recognized as a strategic tool for improving engineering project management performance.

6.3 BIM and Time Management

Time management is a critical component of engineering project management, as delays can significantly impact project costs, stakeholder satisfaction, and overall project success. Traditional scheduling methods often rely on separate tools and lack integration with design data, which can lead to inefficiencies, miscommunication, and delays during project execution.

Building Information Modeling (BIM) enhances project time management through the integration of scheduling information with three-dimensional models, commonly referred to as **4D BIM**. This integration allows project managers to visualize the sequence of construction activities over time, providing a dynamic representation of the project schedule (Eastman et al., 2011). By linking the project timeline with the digital model, stakeholders can better understand the construction process and identify potential scheduling conflicts before they occur.

One of the key advantages of BIM in time management is its ability to simulate construction scenarios and evaluate different scheduling alternatives. This enables project teams to optimize project timelines, allocate resources more efficiently, and reduce uncertainties. According to Azhar (2011), the use of BIM significantly improves planning accuracy and enhances coordination among project participants, which contributes to minimizing delays.

Furthermore, BIM facilitates real-time updates and improved communication among stakeholders. Changes in design or schedule can be instantly reflected in the model, allowing for better coordination and faster decision-making. This reduces the likelihood of errors and rework, which are common causes of project delays. Bryde et al. (2013) also found that BIM implementation contributes to reduced project duration by improving workflow efficiency and collaboration.

In addition, BIM supports proactive project control by enabling early identification of potential risks related to scheduling. Project managers can use BIM to monitor progress, compare planned versus actual timelines, and take corrective actions when necessary. As a result, BIM plays a significant role in enhancing project time performance and ensuring timely project completion.

6.4 BIM and Cost Management

Cost management is a fundamental aspect of engineering project management, as effective financial control is essential to ensure project success and profitability. Traditional cost estimation methods often rely on manual calculations and fragmented data, which can lead to inaccuracies, budget overruns, and inefficient resource allocation.

Building Information Modeling (BIM) enhances cost management through the integration of cost-related data with digital project models, commonly referred to as **5D BIM**. This approach allows project stakeholders to link cost information directly to design elements, enabling more accurate and dynamic cost estimation throughout the project lifecycle (Eastman et al., 2011). By associating quantities, materials, and construction activities with cost data, BIM provides a comprehensive and transparent view of project expenses.

One of the key advantages of BIM in cost management is its ability to generate automated quantity take-offs from the digital model. This reduces human error and improves the accuracy of cost estimates compared to traditional methods. According to Azhar (2011), BIM significantly enhances cost estimation accuracy and helps reduce unexpected expenses during project execution.

Furthermore, BIM enables real-time cost monitoring and financial control. Any changes in design or project scope are automatically reflected in the cost model, allowing project managers to assess financial implications immediately. This capability supports better decision-making and helps prevent cost overruns. Barlish and Sullivan (2012) found that BIM contributes to improved budget control and reduces rework, which is a major source of additional project costs.

In addition, BIM facilitates scenario analysis and cost optimization by allowing project teams to evaluate different design alternatives and their financial impacts. This helps

organizations select the most cost-effective solutions while maintaining project quality. As a result, BIM enhances financial planning, improves resource allocation, and increases overall cost efficiency in engineering projects.

6.5 BIM and Quality Management

Quality management is a critical component of engineering project management, as it ensures that project deliverables meet specified standards and client expectations. Poor quality in construction projects often results in defects, rework, increased costs, and delays, which negatively affect overall project performance. Traditional quality management approaches typically rely on manual inspections and fragmented information systems, which can limit their effectiveness in identifying and preventing errors.

Building Information Modeling (BIM) significantly enhances quality management by improving design accuracy, coordination, and information integration. One of the most important features of BIM is its ability to perform **clash detection**, which allows project teams to identify and resolve conflicts between different building components—such as structural, mechanical, and electrical systems—before construction begins (Eastman et al., 2011). This proactive approach reduces the likelihood of errors and minimizes the need for rework during later stages of the project.

In addition, BIM provides a centralized and shared digital platform that improves communication and collaboration among stakeholders. By ensuring that all project participants have access to accurate and up-to-date information, BIM reduces misunderstandings and enhances coordination, which are essential for maintaining high-quality standards. According to Azhar (2011), BIM contributes to improved project quality by reducing design inconsistencies and enhancing the overall reliability of project data.

Furthermore, BIM supports better documentation and traceability throughout the project lifecycle. Changes made to the design are automatically updated in the model, ensuring consistency across all project documents. This capability enhances quality control processes and enables project managers to monitor compliance with specifications more effectively. Barlish and Sullivan (2012) also found that BIM reduces errors and improves construction quality by facilitating better planning and coordination.

Moreover, BIM allows for the simulation and analysis of construction processes, which helps identify potential quality issues before they occur. This predictive capability enables project teams to take corrective actions early, thereby improving overall project outcomes. As a result, BIM plays a vital role in enhancing quality performance, reducing defects, and ensuring that engineering projects meet required standards.

6.6 Challenges of BIM Implementation

Despite the significant advantages of Building Information Modeling (BIM), its implementation in engineering projects is associated with several challenges that may limit its effectiveness and widespread adoption. These challenges are not only technical but also organizational and economic in nature.

One of the primary challenges of BIM implementation is the **high initial cost**. The adoption of BIM requires substantial investment in software, hardware, and training. Organizations must acquire advanced tools such as Revit and Navisworks, as well as upgrade their technological infrastructure to support BIM processes. According to Khosrowshahi and Arayici (2012), these high upfront costs can discourage small and medium-sized enterprises from adopting BIM, despite its long-term benefits.

Another major challenge is the **lack of expertise and skilled professionals**. Effective BIM implementation requires specialized knowledge and technical skills, including modeling, data management, and interdisciplinary coordination. However, many organizations face a shortage of trained personnel capable of utilizing BIM tools efficiently. This skills gap can lead to improper use of BIM technologies and limit their potential impact on project performance.

In addition, **resistance to organizational change** represents a significant barrier to BIM adoption. Many organizations are accustomed to traditional project management practices and may be reluctant to adopt new technologies that require changes in workflows, roles, and responsibilities. This resistance is often driven by uncertainty, lack of awareness, and fear of increased complexity. As a result, BIM implementation may face internal opposition, reducing its effectiveness.

Furthermore, the **lack of standardized procedures and interoperability issues** can hinder BIM implementation. Different stakeholders may use different software platforms, leading to compatibility problems and data exchange difficulties. This lack of standardization can affect collaboration and reduce the efficiency of BIM-based processes.

Overall, these challenges highlight the need for strategic planning, training, and organizational readiness to ensure the successful implementation of BIM. Addressing these barriers is essential to fully realize the benefits of BIM in improving project management efficiency.

6.7 Previous Studies

A considerable number of studies have examined the role of Building Information Modeling (BIM) in improving project performance within the construction and engineering sectors. These studies have primarily focused on the impact of BIM on key performance indicators such as time, cost, and quality, as well as its role in enhancing collaboration and coordination among project stakeholders.

Azhar (2011) conducted one of the most influential studies on BIM and highlighted its significant benefits in improving project visualization, coordination, and clash detection. The study found that BIM contributes to reducing design errors and minimizing rework, which leads to improved cost efficiency and better project timelines. However, Azhar also emphasized that BIM implementation requires organizational readiness and skilled personnel to achieve optimal results.

Similarly, Bryde, Broquetas, and Volm (2013) investigated the benefits of BIM in project management and concluded that BIM enhances communication among stakeholders and improves workflow efficiency. Their findings indicated that BIM implementation leads to reduced project duration and improved overall project performance. This study provided empirical evidence supporting the positive relationship between BIM adoption and project efficiency.

From a theoretical perspective, Eastman et al. (2011), in their well-known publication *BIM Handbook*, provided a comprehensive framework for understanding BIM and its

applications in the construction industry. The authors emphasized that BIM enables the integration of project data across multiple dimensions, improving decision-making and reducing conflicts during the design and construction phases.

Furthermore, Succar (2009) introduced a BIM maturity model that explains different levels of BIM adoption within organizations. The study demonstrated that organizations with higher levels of BIM maturity experience better project outcomes, including improved coordination, efficiency, and performance. This model is particularly useful in understanding how BIM implementation evolves and impacts project management practices.

In addition, Barlish and Sullivan (2012) conducted a case study-based analysis to evaluate the benefits of BIM in real-world projects. Their findings showed that BIM significantly reduces rework, improves scheduling accuracy, and enhances cost estimation. The study also highlighted the importance of integrating BIM into project workflows to maximize its benefits.

Despite these positive findings, several studies have identified challenges associated with BIM implementation. Khosrowshahi and Arayici (2012) pointed out that resistance to change, lack of expertise, and high implementation costs are major barriers that limit BIM adoption. These challenges indicate that successful BIM implementation requires not only technological investment but also organizational transformation.

Overall, previous studies consistently demonstrate that BIM has a positive impact on project performance. However, most research has focused on individual performance aspects such as cost reduction or time improvement, rather than providing a comprehensive analysis of BIM's combined effect on time, cost, and quality. This highlights the need for further research that examines BIM's integrated impact on project management efficiency.

Table 2: Summary of Previous Studies

Author	Year	Focus	Key Findings
Azhar	2011	BIM benefits	Reduced errors & rework
Bryde et al.	2013	Performance	Improved time & coordination
Succar	2009	BIM maturity	Better efficiency
Barlish & Sullivan	2012	Case studies	Cost & scheduling improvement

Table 3: BIM Impact on Performance

Dimension	Impact
Time	Faster completion
Cost	Reduced overruns
Quality	Improved accuracy

6.8 Research Gap

Although previous studies have extensively examined the benefits of Building Information Modeling (BIM) in the construction and engineering sectors, most of this research has focused on individual performance aspects such as cost reduction, time improvement, or quality enhancement in isolation. These studies provide valuable insights into specific advantages of BIM; however, they do not offer a comprehensive understanding of its combined impact on overall project management efficiency.

Furthermore, a significant limitation in the existing literature is the lack of empirical studies that analyze the integrated relationship between BIM implementation and key project performance indicators, particularly time, cost, and quality, within a unified framework. In many cases, BIM is studied from a technical or design perspective rather than as a strategic project management tool.

In addition, limited attention has been given to how BIM can be effectively integrated into traditional project management practices to enhance decision-making, coordination, and overall efficiency. This gap highlights the need for a more holistic and empirical investigation of BIM's role in improving engineering project management performance.

Therefore, this study aims to address this gap by providing a comprehensive analysis of the impact of BIM on project management efficiency, focusing on the combined influence of time, cost, and quality performance indicators.

7. Research Methodology

This study adopts a **quantitative research approach** to examine the impact of Building Information Modeling (BIM) on engineering project management efficiency. The quantitative approach is appropriate for this study as it allows for the measurement and analysis of relationships between variables, particularly the effect of BIM implementation on project performance indicators such as time, cost, and quality.

The research design is **descriptive-analytical**, as it aims to describe the current state of BIM implementation and analyze its influence on project outcomes. This design enables the researcher to identify patterns, test hypotheses, and draw meaningful conclusions based on statistical evidence.

Data Collection Method

Data will be collected using a **structured questionnaire** based on a Likert scale. The questionnaire will be designed to measure respondents' perceptions regarding the impact of BIM on time performance, cost control, and quality improvement. This method is widely used in quantitative research due to its ability to generate reliable and standardized data.

Population and Sample

The target population of this study includes **engineers, project managers, and BIM professionals** working in the construction and engineering sectors. A **random sampling**

technique will be used to ensure that the sample is representative of the population and to minimize selection bias.

Data Analysis Methods

The collected data will be analyzed using **Statistical Package for the Social Sciences (SPSS)** software. Several statistical techniques will be applied, including:

- **Descriptive statistics** to summarize the data
- **Regression analysis** to test the relationship between BIM implementation and project performance indicators
- **Reliability analysis (Cronbach's Alpha)** to assess the consistency and reliability of the questionnaire

These methods will enable accurate testing of the research hypotheses and ensure the validity of the results.

Research Variables

The study is based on the following variables:

- **Independent Variable:**
 - Building Information Modeling (BIM) implementation
- **Dependent Variables:**
 - Project time performance
 - Cost control and estimation
 - Project quality

The relationship between these variables will be examined to determine the overall impact of BIM on project management efficiency.

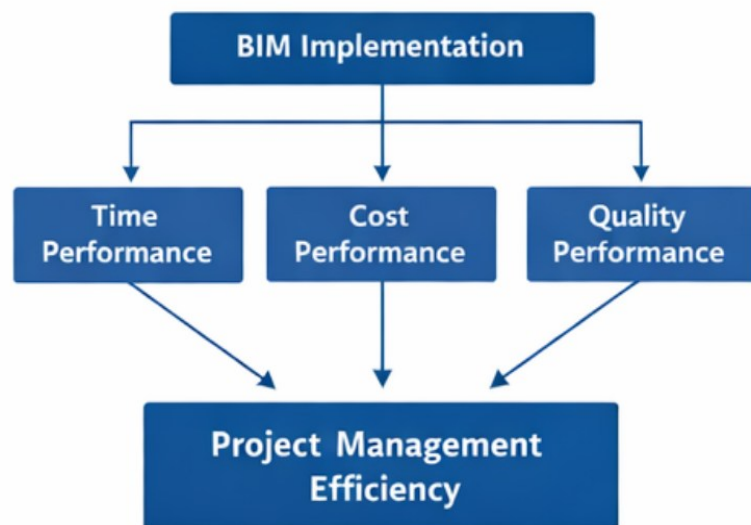


Figure 3.1: Conceptual Framework of the Study

Source: Developed by the researcher

Table 4: Variables

Type	Variable
Independent	BIM
Dependent	Time, Cost, Quality

8. Research Structure

The research is organized into five main chapters, each designed to address specific aspects of the study in a logical and systematic manner:

Chapter 1: Introduction

This chapter provides a comprehensive background of the study, highlighting the significance of digital transformation in the construction industry and the emergence of Building Information Modeling (BIM). It also presents the research problem, objectives, research questions, hypotheses, and the overall scope of the study.

Chapter 2: Literature Review

This chapter reviews relevant academic literature and previous studies related to project management and BIM. It discusses key concepts such as BIM dimensions, its impact on time, cost, and quality, and identifies gaps in existing research. The chapter also establishes the theoretical foundation of the study.

Chapter 3: Research Methodology

This chapter explains the research design and methodology adopted in the study. It describes the research approach, data collection methods, population and sample, research variables, and statistical tools used for analysis. It also discusses the validity and reliability of the research instrument.

Chapter 4: Data Analysis and Results

This chapter presents the analysis of the collected data using statistical techniques. It includes descriptive statistics, hypothesis testing, and regression analysis. The findings are interpreted to determine the relationship between BIM implementation and project performance indicators.

Chapter 5: Conclusion and Recommendations

This chapter summarizes the key findings of the study and discusses their implications for project management practices. It provides practical recommendations for improving BIM implementation and suggests directions for future research.

Figure 4.1: Research Structure Diagram (Table Format).

Chapter	Title	Content Description
Chapter 1	Introduction	Background, problem, objectives, hypotheses
Chapter 2	Literature Review	BIM concepts, previous studies, research gap
Chapter 3	Methodology	Research design, data collection, variables, analysis
Chapter 4	Data Analysis & Results	Statistical analysis and hypothesis testing
Chapter 5	Conclusion & Recommendations	Findings, implications, future research

9. Research Limits

- Spatial: Construction companies in Saudi Arabia
 - Temporal: Data collected during 2026
 - Objective: Focus on BIM impact on time, cost, and quality only These limitations ensure research feasibility.
-

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