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ADDIS ABABA UNIVERSITY
COLLEGE OF BUSINESS AND ECONOMICS
SCHOOL OF COMMERCE

Building Information Modelling (BIM) and Project Management (PM):
The Role of BIM for the Success of Building Construction Projects;
The Case of Ethiopian Engineering Investment Group (EEIG) Construction.

by

Hiwot Girma

A Project Work Submitted to Addis Ababa University College of Business and Economics
School of Commerce in Partial Fulfillment of the Requirements for the Degree of Master of
Arts in Project Management (MAPM).

June 2023

Addis Ababa, Ethiopia

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Advisor: Adane Atara (PhD)

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STATEMENT OF DECLARATION

I, Hiwot Girma, declare that this project work entitled “Building Information Modeling (BIM) and Project management: The Role of BIM for the Success of Building Construction Projects; *The Case of Ethiopian Engineering Investment Group (EEIG) Construction*” is outcome of my own effort and that all source of materials used for the study have been duly acknowledged. I have produced it independently except the guidance and suggestion of the research advisor. This study has not been submitted for any degree in this University or any other University. It is offered for the partial fulfillment of the degree of Master of Art in Project Management.

By: **Hiwot Girma**

Signature _____

Date: _____

Addis Ababa, Ethiopia

STATEMENT OF CERTIFICATION

This is to certify that Hiwot Girma has carried out this project work entitled: “Building Information Modeling (BIM) and Project management: The Role of BIM for the Success of Building Construction Projects; *The Case of Ethiopian Engineering Investment Group (EEIG) Construction*” under my supervision. This work is original in nature, and it is sufficient for submission as the partial fulfillment for the award degree in Master of Art in project management.

Advisor: **Adane Atara (PhD)**

Signature _____

Date: _____

ADDIS ABABA UNIVERSITY
COLLAGE OF BUSINESS AND ECONOMICS
SCHOOL OF COMMERCE
DEPARTMENT OF PROJECT MANAGEMENT

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ACKNOWLEDGEMENT

After my almighty God, my sincere gratitude goes to my advisor Dr. Adane A. for his invaluable guidance, support, and encouragement throughout the research process. His expertise and insights have been instrumental in shaping the direction and scope of this study.

I would also like to thank the staff and faculty of Addis Ababa University School of Commerce, for providing me with the resources and facilities necessary to carry out this research.

I am deeply grateful to Ethiopian Engineer Investment Group (EEIG) Construction company and staffs who generously gave their time and shared all the necessary data and information and for engaging in the survey by filling the questioners and answering the interviews. Their contributions have been essential in generating the data and findings of this study.

Finally, I would like to extend my heartfelt thanks to my family and friends for their unwavering support and encouragement throughout my academic journey. Their love and encouragement have been my constant source of motivation and inspiration.

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ACRONYMS/ABBREVIATIONS

BIM:	Building Information Modeling
PM:	Project Management
EEIG:	Ethiopian Engineering Investment Group
CSF:	Critical Success Factor
PMO:	Project Management Office
PMBOK:	Project Management Book of Knowledge
CAD:	Computer Aided Design
2D:	Two dimensions: x, y
3D :	Three dimensions x, y, Z
4D :	Four dimensional
5D :	Five dimensional
6D :	Six dimensional
7D:	Seven dimensional
MEP:	Mechanical, Electrical, Plumbing

ABSTRACT

Building Information Modelling (BIM) has been increasingly used in the construction industry as a tool for managing projects. The purpose of this study is to assess the role of building information modeling (BIM) for the success of building construction projects in the case of Ethiopian Engineering Investment Group (EEIG) Construction Company in Addis Ababa. The study adapted descriptive research with a mixed research design approach combining a questionnaire survey and interviews with key stakeholders involved in a recent construction project to describe the existing project management practice, the extent to which BIM is adapted, the impact of BIM on project success, and the challenges it faced during the implementation process. Using non-probabilistic purposive sampling, a sample of 45 relevant respondents was selected from the project team using the Census sampling method. The collected data are analyzed using SPSS using a descriptive statistical analysis. The study assesses the impacts of BIM on project success and the challenges the company faced while implementing BIM. The results of the study indicate that the use of BIM has a positive impact on project outcomes, such as improved project scheduling, cost estimation, better quality, and overall stakeholder satisfaction. However, the study also revealed some limitations of BIM, such as resistance to change, lack of standardization, lack of technology infrastructure, lack of trained personnel, and incompatibility with other stakeholders. Finally, the study recommends BIM adoption for building construction projects since it enhance the current project management practice in the case company of Ethiopian Engineering investment Group (EEIG) Construction. The findings of this research project have important implications for the construction industry, highlighting the potential benefits and challenges of using BIM in building construction projects.

Keywords: *Building Information Modelling (BIM), Project Management, Project Success, BIM Implementation, Building Construction Projects*

CHAPTER ONE

1 : INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The construction industry is a large economic sector that comprises a wide range of activities involving plans, design, construction, alteration, maintenance, repairs, and eventually demolishing of buildings, civil engineering works, mechanical and electrical engineering, and other similar works (Hillebrandt, 1984). In most developing nations, it contributes to 11% of the GDP and makes up 8–15% of the country's gross national product (Giang and Pheng, 2011).

In Ethiopia, the construction sector is a key factor in economic expansion and a major contributor to the country's economy (Giang and Pheng, 2011). Recently, the industry has shown tremendous growth. Recent studies by Zewdu and Aregaw (2015) showed that the contribution to GDP has increased to 5.6%. This fast-growing industry has become a lot more complicated and challenging to oversee. It holds different project participants, which are the key players of the project, including the client, consultant, contractor, subcontractor, project manager, supplier, manufacturer, and other stakeholders (Lutz & Gabrielsson, 2002). Proper communication and cooperation are needed among these stakeholders for the effectiveness of the work.

According to the triple constraints, the project's cost, time, and scope have an impact on the project's success. Even though the success of projects is determined by the participants, the completion of projects within these three constraints is thought of as one of the main success factors in the construction sector. However, the construction sector is having trouble completing the project within these constraints. Using management strategies helps to handle performance improvement possibilities in the construction industry.

Building Information Modelling (BIM) is a new tool introduced to the construction industry for a better design and construction process (Eastman, Teicholz, Sacks, & Liston, 2011). It is a collaborative tool that unifies design, construction, and management information into a single digital model. BIM gives project teams the ability to envision the building before construction starts, identify potential design problems, and make well-informed decisions that can raise the

project's quality while lowering costs and decreasing risks (Denis, F., & AIA Research Team, 2015). Additionally, BIM facilitates communication between all parties involved in a project, which can enhance project coordination and minimize disputes (Denis, F., & AIA Research Team, 2015).

BIM is linked to the building's entire life cycle. It can be applied at all stages of building and construction projects, including architectural and structural design works, cost estimation, property management, equipment management, etc. Its implementation has many benefits, including increasing quality, enhancing energy efficiency, supporting construction project management, lowering design errors, lead times, and lifecycle costs, as well as increasing efficiency and productivity in the design, construction, and operation of buildings (Denis, F., & AIA Research Team, 2015).

According to recent studies, the application of BIM significantly affects project management. BIM can be used as a tool to manage information, so it involves project management (Kerzner, 2009). Projects need proper management from inception to completion, and project management is a crucial instrument for the delivery of successful projects. Successful project management involves achieving the project's objectives while staying on schedule, on budget, and at the intended performance or technology level. It also involves making good use of the available resources in a way that the customer has approved (Kerzner, 2009).

Through BIM adoption, the entire building can be virtually built on a computer. Every component of the building, including the architectural, structural, and MEP systems that are going to be constructed on site, will be modelled first using computer-aided design software (Eastman, Teicholz, Sacks, & Liston, 2011). Using this approach helps the project manager integrate and manage the construction information collaboratively, find out clashes at an early stage of the construction, minimize waste and utilize the budgeted cost of the project, deliver projects on time by minimizing rework, and maximize the quality of the deliverables, which finally results in project success (Kerzner, 2009).

This study mainly focuses on analyzing the role of BIM as a project management tool. It discovers its impact and the best practice of advanced BIM integration into project management to explore the

extent to which BIM has contributed to the success of building construction projects in the case of Ethiopian Engineering Investment Group (EEIG) Construction Company.

1.2 BACKGROUND OF EEIG'S CONSTRUCTION COMPANY

The Ethiopian Engineering Investment Group (EEIG) is a 100% government-owned company holding three business units: consulting, construction, and investment. It is under a corporation called the Ethiopian Construction Design and Supervision Works Corporation (ECDSWCo). In 2015, three public enterprises called Ethiopian Water Works Design & Supervision Enterprise (WWDSE), Construction Design Share Company (CDSC), and Transport Construction Design & Share Company (TCDS) merged and formulated the current ECDSWCo company. In 2021, the second business unit, called the construction sector, is formulated. After a year, in 2022, the newly emerged business unit (construction) came up as an engineering and investment group with a new name and brand called EEIG (EEIG, 2020).

EEIG Construction, which is part of the EEIG Group, is one of the leading construction companies in Ethiopia. It is a Grade 1 construction firm active in the country. It's headquartered in Addis Ababa. It owns design-build capabilities and offers integrated construction solutions to clients. Currently, it has more than 200 employees (EEIG, 2020).

The company's primary goal is to foster an atmosphere that will support the growth of engineering businesses in Ethiopia. The engineering-related operations include designing and building infrastructure projects, developing energy projects, offering consulting services, and producing engineering goods. High-end complex construction projects, primarily high-rise commercial and residential buildings, real estate, infrastructure (roads, trains, and airports), water, and energy sectors are among EEIG Construction's major activities (EEIG, 2020).

The company's key priorities are the transfer of technology and building up local engineering expertise. It incorporates eco-friendly technologies and is dedicated to sustainable development. A group of seasoned experts work with EEIG and are dedicated to giving customers high-quality services. Engineers, architects, project managers, and experienced employees with the knowledge

to handle challenging engineering and construction projects make up the company's personnel. The business is committed to giving the residents training and employment possibilities (EEIG, 2020).

The organization offers project management, procurement, architectural, civil engineering, electrical engineering, mechanical engineering, and other services. It has completed various projects in different sectors, including infrastructure, industrial, commercial, and residential projects. Road, bridge, airport, and water supply system building are all included in the infrastructure projects undertaken by the company (EEIG, 2020).

EEIG has a relationship with many foreign companies, including the China Railway Engineering Corporation (CREC), which is involved in the planning and building of infrastructure projects. Additionally, the business participates in collaborative ventures with other Ethiopian businesses to build up Ethiopian engineering capabilities (EEIG, 2020).

Overall, Ethiopian Engineering Investment Group is a reputable company that offers extensive engineering and building services in Ethiopia. With its skilled team, attention to quality, and focus on sustainable development, EEIG is well-positioned to continue expanding and succeeding in the future (EEIG, 2020).

1.3 STATEMENT OF THE PROBLEM

The Ethiopian construction industry plays a significant role in the economic development of the country, and it's expected to keep expanding in the upcoming years. However, the industry is faced with numerous challenges during the design and construction stages, which include cost overruns, schedule delays, and quality issues that can lead to project failure (Zewdu and Aregaw, 2015).

One of the main factors affecting the project's performance and productivity is the multiplicity of stakeholders. There are numerous parties involved at various stages of the construction process which holds different disciplines, like the client, consultants, contractors, and other stakeholders (Lutz & Gabrielsson, 2002). The effectiveness of the work is reduced by a lack of collaboration and communication among these stakeholders.

According to the Addis Ababa Housing Agency, approximately 70% of Ethiopian construction projects are reportedly over budget and on schedule, out of which 55% are delayed due to incomplete drawings. The design's incompleteness can also add to the issue of incoherent and less integrated design and project management. Design changes, scope changes, shifts in the amount of work, poor initial estimation of cost, and completion time can also be listed as factors triggering the success of building construction projects.

When the duration of the project is extended, it will affect the client's and the contractor's scheduled completion dates, the budget of the project, and the quality of the design. Since the design is of poor quality, it should be changed during the exclusion period. This design change, which results in rework, has been one of the major factors in projects and contributes to both cost overruns and construction delays (Asmerom Taddese, 2016).

Traditionally, the design team, which includes the architect, structural engineer, mechanical, electrical, and plumbing (MEP), develops the designs separately and issues the drawings for construction. In this case, there might be less or no coordination of drawings at the design stage, so clashes might be detected at the construction stage after the construction has already started. Since the design is not developed centrally, there is a lack of relationship between the architectural and other engineering outputs. The drawings might not match up and need modifications, which results in rework. The client is the one who is responsible for paying for any modifications or poorly executed construction.

To address these issues, more advanced technology, known as **Building Information Modelling**, is introduced for effective collaboration among team members and improves the accuracy and efficiency of the work. BIM provides an integrated platform for better, faster design and construction delivery with a sufficient flow of information. It is also beneficial for stakeholder management. It helps stakeholders perform their individual tasks more efficiently and effectively, which improves project management and ensures project success.

Even though BIM has been in use for more than 20 years, its application in Ethiopia is still at a lower level. Most of the design and construction companies in our country don't implement BIM in their design and construction phases. There is a lack of understanding of the role of BIM as a

project management tool and its impact on the success of building construction projects in Ethiopia. This research project seeks to address this gap in knowledge by investigating the role of BIM as a project management tool and its impact on project success by taking Ethiopian Engineering Investment Groups (EEIG) Construction Company as a case study.

1.4 RESEARCH QUESTION

This study intends to answer the following research questions in detail based on the problem statement stated above:

1. What are the existing building construction project management practices?
2. What is the extent of BIM implementation in the case of EEIG Construction company?
3. What are the impacts of BIM applications for the success of building construction projects?
4. What are the major challenges of BIM implementation in the construction sector?

1.5 OBJECTIVE OF THE STUDY

The study objectives are presented as follows:

1.5.1 GENERAL OBJECTIVE OF THE STUDY

The main objective of this study is to assess the role of building information modelling (BIM) in the success of building construction projects.

1.5.2 SPECIFIC OBJECTIVE OF THE STUDY

As a result of the main objective above, the study will be undertaken by considering the following specific objectives:

- To identify the current project management practices of a selected building construction company in Addis Ababa (EEIG Construction).
- To identify the extent to which BIM is being implemented at EEIG Construction Company.
- To identify the application of BIM for the success of building construction projects.
- To identify the major challenges that have affected BIM utilization at EEIG Construction Company.

1.6 SIGNIFICANCE OF THE STUDY

This research will have a practical significance in various ways.

The aim of this study was to identify the role of building information modelling (BIM) on the success of building construction projects in Ethiopian Engineering Investment Group (EEIG) Construction Company as a case study. So, the study's findings and results can be used as a guideline for all project teams to establish the best practice in BIM implementation as a project management tool for the success of projects under EEIG supervision.

The study's findings will also help raise awareness of the benefits of BIM in building construction projects and their role in project success, the challenges of the BIM implementation process, and the strategies that can be used to overcome the challenges.

It will also have an academic contribution by giving an input for further studies. Since BIM is a new technology that came to the construction industry in very recent years, there is a lack of further previous research in the area. So, this research will inspire interested scholars to carry out additional research on the topic.

1.7 SCOPE OF THE STUDY

This study aimed to identify the Role of BIM as a Project management tool in a selected building construction firm in Addis Ababa. It includes a case study of BIM implementation in Ethiopian Engineering Investment Group (EEIG) Construction Company.

The theoretical and geographical scope of the research is limited to one level I construction company in Addis Ababa. It investigates the Role of Building Information Modeling for the success of building construction projects in terms of time, cost, quality, and stakeholders' satisfaction. It also identifies the challenges it faced in projects which are under EEIG Construction Company and the strategies which are used to overcome those challenges.

1.8 LIMITATION OF THE STUDY

One of the limitations of this research project is that it only investigates the role of BIM for the success of building construction projects in the case of one construction company. The study's findings and conclusions may not be applicable to all types of construction projects or all geographical areas, even though they may offer insightful information about the advantages and difficulties of adopting BIM for building projects. The findings may not be generalizable to other companies or contexts.

The other limitation is data unavailability. Since BIM adoption in the construction sector is still relatively new, there is a lack of BIM data that can be analyzed.

1.9 ORGANIZATION OF THE STUDY

This research project was organized into five chapters. The first chapter includes an introduction section reflecting on the background of the study, background of the organization, problem statement, research question, research objective, significance of the research, scope and limitations of the study, organization of the study and definition of terms. Chapter two includes the review of related literatures. It holds an introduction section, theoretical and empirical literature review. The third chapter deals with the methodology of the research. It includes the methods of data collection, the research design and approach, the source of data collection, the methods and procedures of data collection, the methods of data analysis, the research instrument, validity and reliability, and the ethical consideration section. The fourth chapter is all about data presentation, analysis, and interpretation. The collected data were analyzed and interpreted in this chapter. The last chapter includes a summary, a conclusion, and recommendations on the findings of the study. References and an appendix, including the questioner, were also included in the paper.

1.10 DEFINITION OF TERMS (OPERATIONAL MEANING)

Building Information Modelling (BIM) is a collaborative digital process that enables the creation and management of a shared 3D model of a building project that includes all relevant information about its design, construction, and operation throughout its entire lifecycle (Eastman, Teicholz, Sacks, & Liston, 2011).

Project: a temporary endeavor that is designed to achieve a unique objective with a defined scope, timeline, and budget (Project Management Institute, 2017).

Project management is defined as the application of knowledge, skills, tools, and techniques to plan, execute, monitor, and control a project from start to finish to achieve its objectives within the constraints of time, cost, scope, and quality (Project Management Institute, 2017).

Project success is the achievement of project objectives within the constraints of time, cost, scope, and quality while meeting or exceeding the expectations of project stakeholders (Shenhar & Dvir, 2007).

CHAPTER TWO

2 : REVIEW OF RELATED LITERATURES

2.1 INTRODUCTION

In this chapter, existing literature related to building information modelling and project management were reviewed. It consists of an overview of previous works that are related to the subject matter that serves as the crucial context for this study's objectives. It contains both a theoretical review and an empirical review.

2.2 THEORETICAL REVIEW

2.2.1 PROJECT AND PROJECT MANAGEMENT

Multiple researchers defined projects and project management. Since the project is multidisciplinary, it has various meanings from different perspectives. Every discipline has its own definition, depending on their area of study and profession.

According to PMI (2017), a project is a temporary endeavor undertaken to create a unique product, service, or result. Association for Project Management (2019) also defined project as a temporary endeavor that is started to accomplish predetermined goals that can be expressed in terms of outputs, outcomes, or advantages. In this study, the PMI's definition of project is used as an operational meaning.

For an organization, project failures often lead to financial losses, including significant losses in opportunity, competition, productivity, and employee morale (Williams, 2005). It therefore requires different organizational structures and managerial abilities. For a project to be completed properly and effectively, project management is a crucial tool. But the depth of project management practice affects how successful a project is (Kerzner,2013).

The Project Management Institute (2013: P5) defines project management as the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements.

Kerzner (2013, pp. 4) defines project management as "the planning, organizing, directing, and controlling of company resources for a relatively short period that has been established to complete specific objectives and goals."

For this study, the definition by Yirga (2017) will be used as an operational meaning. It states that project management is about achieving time, cost, and quality targets within the context of overall strategic and tactical client requirements by using project resources (Yirga,2017).

Project management is essential to the accomplishment of construction projects. It entails planning, organizing, and controlling resources to accomplish the specific objectives of a project. The process of project management involves creating a project plan that specifies the project's goals and objectives, the tasks that must be completed to reach those goals, the resources required, the budget, and the projected completion date. Along with tight controls to stay on the "critical path," or to make sure the plan is being managed as planned, it also entails putting the project plan into action (PMI, 2017).

Project management is the dynamic process of using relevant organizational resources in a controlled and structured way to achieve a well-defined goal identified as a need. It includes initiation, planning, implementation, monitoring and controlling, and finally the closeout phases (PMI, 2017).

2.2.2 CONSTRUCTION PROJECT MANAGEMENT

Construction project management is a process of planning, coordinating, and controlling resources to accomplish certain goals and objectives in the construction sector (Walker, 2015). It entails overseeing construction projects at every stage, including design, procurement, construction, and commissioning. It is an important component of construction projects since it ensures that they are finished on schedule, within budget, and to the desired quality standards (Walker, 2015).

2.2.2.1 THE CONSTRUCTION PROJECT PROCESS

The construction project process has four phases, which include the initiation phase, the design phase, the construction phase, and the closure phase (NE, 2011).

Figure 2-1: The four sequential phases: initiation, design, construction, and closure phase.



Source: (Zetterman,2011)

INITIATION PHASE

The initiation phase is the first phase before the project is started. In this phase, the client selects a project manager to plan and manage the project, and the client makes decisions about the building's look, standard, quality, and environmental criteria by accepting or rejecting proposals from the project manager (Nordstrand, 2008).

A pre-study is necessary before initiating a construction project to investigate and analyze prerequisites, specify the need for premises, and evaluate financial consequences (Nordstrand, 2008). The project team should consist of the client, persons with technical and economic skills, and representatives from the end-users. The pre-study should include an investigation and analysis of topography and geotechnical characteristics, specifying the need for premises, and evaluating financial consequences (Nordstrand, 2008). The pre-study is complete, and the client has decided to proceed with the construction project, requiring more detailed investigation and cost calculations (Nordstrand, 2008).

The initiation phase results in a program that includes a project description, activity description, premises program, technical program, site investigation, geotechnical study, outline drawings, environmental program, quality program, time plan, spreadsheet program, and more. It can also be used as a basis for the procurement of the contractor, the architect competition, and the design phase (Nordstrand, 2008).

DESIGN PHASE

The design phase involves preparing a construction that meets the client's needs and requirements, which is presented in construction documents that include drawings, specifications, descriptions,

lists, a time plan, a geotechnical report, and technical calculations that will be used by the contractor (Nordstrand, 2008).

It has three phases: the schematic phase, the preliminary design phase, and the final design phase. The schematic phase is the first phase of design in which conceptual designs will be produced. The preliminary design phase is the design development phase, and the last phase, which is the final design phase, is the construction documents preparation phase, where detailed designs and shop drawings will be prepared for the construction purpose.

The design team is composed of architects, structural engineers, MEP designers, and the project manager. The project manager may engage a planning manager to organize and plan the design work on major projects. To prevent clashes between components used in building and installation, these stakeholders should maintain a close relationship and open lines of communication throughout the whole design process. (Nordstrand, 2008).

All the information required to create a building in accordance with the specifications and needs of the customer should be included in the construction documents (Nordstrand, 2008). These documents should serve as a foundation for the contractor to generate cost calculations in connection with the tendering process. The project manager should review the schedule and budget and create operating and maintenance guidelines for the building's ongoing management and maintenance. These guidelines are handed to the customer in connection with the closure phase (Nordstrand, 2008).

CONSTRUCTION PHASE

The primary stakeholder in the construction phase is the contractor, who oversees gathering and managing resources as well as planning and carrying out the construction to satisfy the client's expectations (Nordstrand, 2008).

The contractor must organize and plan the building's construction before beginning any work. This is crucial for effective construction phase execution, which entails meeting project criteria for time, cost, and quality. Control over the project's execution during the construction phase should be ensured by these plans and the project budget (Nordstrand, 2008).

The contractor must obtain both human and material resources to carry out the construction job. They must be procured in the proper quantity, supplied on schedule, and placed in the proper position on the construction site. Re-planning is often necessary due to unanticipated risks and occurrences (Nordstrand, 2008).

CLOSURE PHASE

The project is completed when the final inspection is approved and the warranty period begins, allowing it to be handed over to the client (Nordstrand, 2008).

The handover process involves construction and installation contractors, quality managers, client representatives, designers, suppliers, and inspectors (Nordstrand, 2008). Activities such as inspections and quality documents must be performed to achieve formal acceptance. A final inspection is executed to determine if the building meets all requirements or if there are errors that need to be corrected. To minimize errors, the contractor and client can decide to perform several inspections during the construction phase (Nordstrand, 2008).

The building committee will approve the building for use if the client has fulfilled its commitments and any adjustments are implemented (Nordstrand, 2008). Following the completion of a project, representatives from the involved parties may come together for a seminar to analyze and discuss lessons that can be learned for subsequent projects. This strategy is frequently used in projects where cooperation or partnering is used (Nordstrand, 2008).

2.2.3 BUILDING CONSTRUCTION PROJECT MANAGEMENT PRACTICES:

Building construction project management techniques are a collection of processes, guidelines, and tools that are used to organize, control, and carry out projects (Abdul-Malak, M. A., & Hammad, A., 2016). The successful completion of projects in a complex and dynamic construction environment depends on employing efficient project management techniques. These techniques are necessary to guarantee that construction projects are finished within budget, on schedule, and to the necessary quality standards (Kerzner, H., 2017). There are various project management

practices utilized in building construction projects, which include project planning, project scheduling, project budgeting, risk management, and quality management.

Project planning is an essential project management practice involving project scope, goals, and deliverables. It also includes creating a thorough project plan that details the activities, deadlines, and resources needed to finish the project (Kerzner, 2017). Construction organizations can identify risks, assign resources, and set a deadline for completing projects with the help of project planning (Kerzner, 2017). Construction organizations may reduce project delays, increase project quality, and control costs by using effective project planning.

Project scheduling is another crucial aspect of project management. It involves the creation of a timeframe for the project's completion (Liu et al. ,2018). This entails developing a project schedule that specifies each task's beginning and ending dates, as well as its critical path and resource limitations. According to Liu et al. (2018), project scheduling aids construction organizations in managing project dependencies, allocating resources, and identifying project milestones. Construction companies can minimize project risks, shorten project delays, and increase project efficiency with the use of effective project scheduling.

Project budgeting includes estimates of the costs of each project activity as well as the resources needed to fulfil it. Construction organizations may control expenses, manage cash flow, and guarantee that a project is completed under budget by using project budgeting (Chua et al., 2019). Construction organizations can eliminate waste, maximize resource use, and increase project profitability through effective project budgeting.

The other project management practice is risk management. It involves identifying, assessing, and mitigating risks that could have an impact on the project's success (Odeh & Battaineh, 2014). Construction organizations may determine potential project risks with the use of project risk management and create backup plans to deal with them. Construction organizations can reduce project delays, keep costs under control, and raise project quality with effective risk management (Odeh & Battaineh, 2014).

Quality management refers to the techniques, practices, and processes used to guarantee that a project satisfies or exceeds the necessary standards of quality (Akintoye and MacLeod, 1997). it

helps to reduce errors, rework, and delays all of which can result in cost overruns and schedule delays by reducing these three factors. It involves making sure of the project complies with the relevant quality standards and that the required level of quality assurance and quality control mechanisms are in place are part of this.

Effective quality management can assist construction organizations in increasing project efficiency, lowering project risks, and raising customer satisfaction (PMI, 2017). Akintoye and MacLeod (1997) state that the development of quality policies and procedures, identification of quality requirements, establishment of quality standards, application of quality control measures, and monitoring and evaluation of quality performance are just a few of the activities involved in quality management in the construction industry.

As they aid in ensuring that the project is finished on schedule, within budget, and in accordance with the necessary quality standards, these activities are essential to the success of construction projects.

Construction firms can identify project stakeholders with the use of stakeholder management, which also helps them evaluate their needs and create plans for managing expectations. Effective stakeholder management can aid construction organizations in enhancing stakeholder satisfaction, reducing project risks, and improving project communication, claim Pinto and Slevin (2018).

2.2.4 BUILDING INFORMATION MODELING (BIM) AND PROJECT MANAGEMENT

2.2.4.1 WHAT IS BIM

Building Information Modelling (BIM) is a software simulation technique that optimizes building design, construction, and operation through the collection, analysis, and management of digital information (Eastman et al., 2011). It is the process of creating and using digital models of buildings for use in design, construction, and operation (Azhar et al., 2012). Design, construction, and facilities management can all be integrated as part of a building project using BIM technology, making the process more productive and collaborative (Eastman et al., 2011).

BIM originated in the 1960s, when computer-aided design (CAD) software was developed. The use of building information modelling (BIM) has increased in the building sector over the past ten years (Eastman et al., 2011). CAD software is thought to have been the inspiration behind BIM (Fischer & Kunz, 2004). Though, according to Eastman et al. (2011), the 1990s saw the development of the modern BIM idea,

The National Institute of Standards and Technology (NIST) of the United States started working on the creation of a standard for the interchange of building data in the early 1990s (Eastman et al., 2011). As a result, the Industry Foundation Classes (IFC) data model was created, which was intended to facilitate the transfer of data between various software programs used in the construction sector (Fischer & Kunz, 2004). With the advent of software tools that made it possible to create three-dimensional models of buildings, the concept of BIM was further refined in the late 1990s and early 2000s (Eastman et al., 2011). This made it possible to integrate several building project components, such as design, construction, and facilities management, leading to a more productive and cooperative process (Eastman et al., 2011).

BIM has developed and grown in popularity since it was first used in the building sector. A growing number of governments and organizations throughout the world have required the use of BIM in building construction projects in recent years (Azhar et al., 2012).

BIM is comprised of numerous interconnected models and databases. It speeds up information processing by reducing tedious, repetitive activities. It can be processed with the help of people. People gather data and input it into the model. Then BIM does the rest of the work (Autodesk,2011)

2.2.4.2 BIM AS A PROJECT MANAGEMENT TOOL

BIM improves project management by giving real-time updates on the project's status (Liu et al., 2018). It gives project managers the ability to model various scenarios and examine building performance, which improves decision-making and lowers costs. Project managers can track the development of their work, identify possible problems, and base their decisions on precise information using BIM (Abdul-Rahman & Wang, 2014).

BIM combines the 3D model with parametric design, coordination, communication, and visualization (Eastman, Teicholz, Sacks, & Liston, 2011). BIM improves stakeholder engagement and communication, minimizes errors and rework, and facilitates better decision-making and cost control (Azhar et al., 2012). It offers a collaborative platform for working together and sharing information across all project stakeholders, including architects, engineers, contractors, and owners (Chen, Lu, and Zhang, 2019).

BIM has been successfully used in numerous building construction projects and has been widely adopted in the construction sector (Chen, Lu, and Zhang, 2019). Construction projects, including residential, commercial, and industrial structures, among other types of buildings, have all benefited from the successful implementation of BIM (Wong & Wong, 2018).

2.2.4.3 ELEMENTS OF BIM

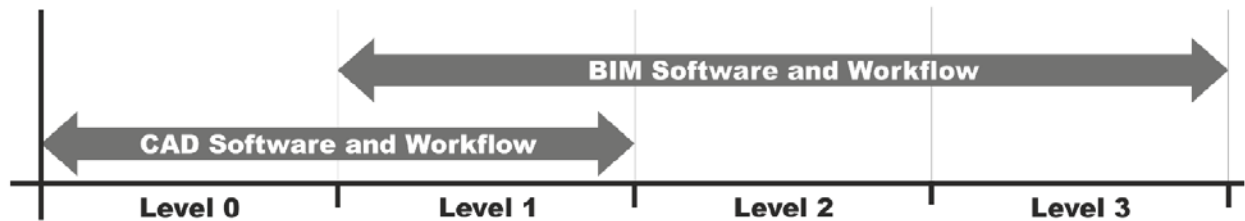
The five elements of BIM are process, policy, people, information, and technology. These elements should be integrated into BIM.

1. **Process** refers to specific sets of tasks that have a beginning and an end. It has a clear, recognizable demonstration of the inputs and outputs at each level (BIM Academy 2021).
2. **Policy:** refer to the benchmarks that guide the preparation of decisions. Guidelines are established by policies to reduce disagreements between the parties (BIM Academy 2021).
3. **People** are the most important element in BIM. Successful BIM can result from effective management of people (BIM Academy, 2021).
4. **Information:** Information comes in two different forms: models and documents. Models are digital data that depict, replicate, or simplify an item, such as a structure, bridge, road, etc. They are kept in a file format and may be shared, transferred, and used to help make decisions about developing infrastructure and other things. Documents are the electronic equivalent of papers, sketches, prints, photos, and videos (BIM Academy 2021).
5. **Technology:** the tools needed to control the many phases of the building information modelling process, including the software and hardware (BIM Academy 2021).

2.2.4.4 BIM LEVELS

The multilevel BIM approach, which has been adapted by the UK government, is widely used worldwide. It is used to describe the maturity of BIM implementation in a project or organization. It illustrates a progression from conventional working practices to fully collaborative work. The following are the four commonly recognized levels of BIM:

Figure 2-2 BIM Levels



Source: (BIM Academy 2017)

BIM Level 0 – CAD

According to McFadden et al. (2019), Level 0 is "unconnected" and "disconnected," and it commonly leads to errors and double-dipping. It exhibits the features of digital documents like PDF and has a clear source, disorganized process papers, etc. At this level, there is no collaboration taking place, and BIM is not being used. The project team mostly creates design and construction documentation using 2D CAD software (McFadden et al.,2019).

Currently, Level 0 operations are being carried out by the majority of the global construction sector, which follows the traditional approach. The design, construction, and handover of the facility are handled by Level 0 under a conventional contract (McFadden et al.,2019).

BIM Level 1 – Organized CAD

A 3D computer model design is used in Level 1 BIM implementation (Smith, J., 2018). It is a phenomenon that can be characterized by separate sources, planned collaboration, an unintegrated environment, and electronic documents (Yeh, I. C., & Wu, C. H., 2019). At this level, 2D CAD is widely used, while some 3D BIM technologies are used for specific tasks such as clash detection. However, paper or digital 2D formats continue to be the primary means of exchanging information (Yeh, I. C., & Wu, C. H., 2019). It still operates within the parameters of a conventional legal

contract. The naming of files, drawings, and other data is governed by this organization, as are the collaboration process and quality assurance. The use of Level 1 BIM increases efficiency and lowers mistake rates in the building process (Garca-Alcaraz et al. 2017).

BIM Level 2 – Collaborative Building Information Modeling

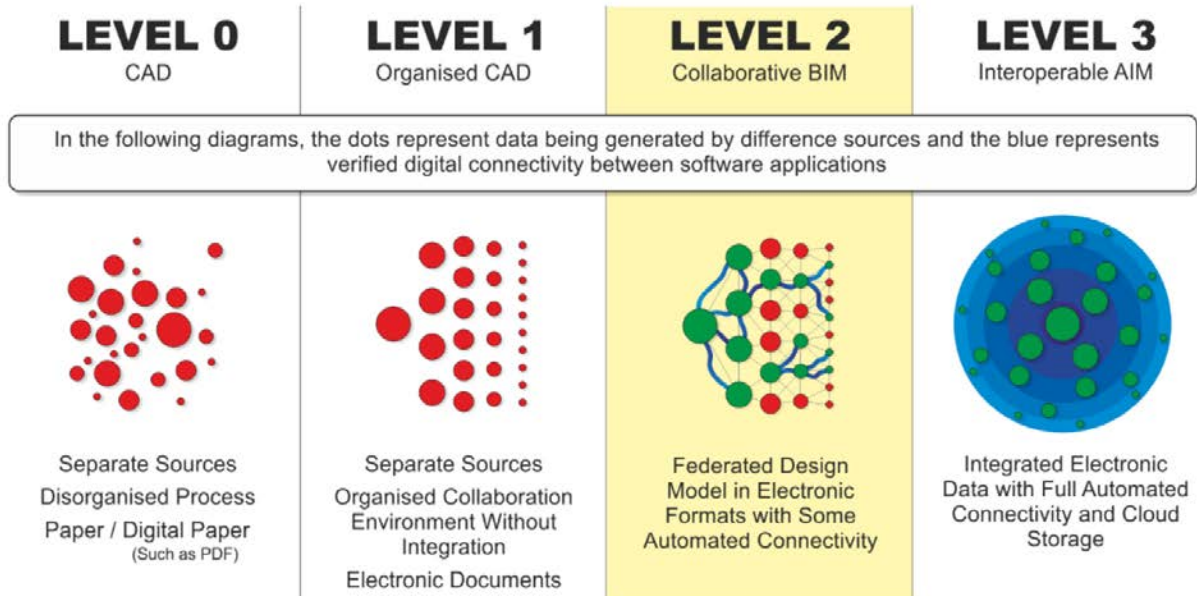
BIM implementation at this level is more advanced and involves cross-disciplinary cooperation. It is characterized by a federated design model in electronic format with some automated connectivity (Smith, J., 2018). Level 2 expands the organizational base with an evolutionary step into the digital transfer of data models between various parties. At this stage, the project team adopts a collaborative BIM strategy, with representatives from several disciplines collaborating on a single, shared 3D BIM model. Using standardized data standards and protocols, information is shared electronically (Smith, J., 2018). The data must be checked before being transferred, whether it is done digitally in native formats or through an interoperability language. Implementing Level 2 BIM fosters effective data sharing and increased collaboration among various parties (Kabir et al. 2016).

BIM Level 3 – Interoperable Asset Information Modeling

Implementing BIM at this level entails a completely integrated design and construction process from beginning to end (Kabir et al. 2016). In Level 3, real-time information access is made possible using cloud-based models and information systems. The use of Level 3 BIM guarantees that all parties participating in the construction project have access to real-time information, which enhances the decision-making process (Kabir et al. 2016).

BIM levels are not always linear and might change based on the unique demands and requirements of the project or organization (Kabir et al. 2016). Furthermore, rather than being taken as a necessary requirement for BIM deployment, the levels should be seen as guidance.

Figure 2-3 BIM Levels



Source: (BIM Academy 2017)

2.2.4.5 TECHNICAL ASPECTS OF BIM

Building Information Modelling (BIM) is a multi-disciplinary, intricate process that incorporates several technological elements (Eastman et al., 2008). The technical aspects of BIM describe the functions of BIM with respect to BIM levels. Among the most important BIM technical components are:

3D modeling: To produce and maintain the digital representation of a building, BIM mainly utilizes 3D modeling software. These models, which are used to replicate the building's design, construction, and use, are often constructed by architects, engineers, and other construction specialists (Eastman et al., 2008).

Visualization: BIM software enables stakeholders to construct virtual flyovers and walkthroughs of the design as well as 3D models of the building. This enables improved communication and comprehension of the structure's functionality (Eastman et al., 2008).

Collaboration: BIM is a collaborative process that necessitates tight collaboration between various parties and disciplines. Collaboration capabilities built into BIM software enable numerous users to work on the same model at once and track updates (Eastman et al., 2008).

Clash Detection: By using clash controls, different disciplines' building information models are combined and verified for geometrical design errors. When models from many disciplines are combined, points where they overlap are found and can be fixed. Additionally, visual mistakes that can result in subpar aesthetics can be found and fixed (Eastman et al., 2008).

Construction Sequencing: Construction schedules and sequences can be created using BIM software in detail, which can help streamline the process and reduce delays (Eastman, Teicholz, Sacks, & Liston, 2011). This allows for early identification of planning mistakes and optimization of logistical issues. Different alternative methods of carrying out the building can be simulated and compared to one another to find the most beneficial solution (Eastman et al., 2008).

Cost Estimation: The elements of a 3D design can be connected to price lists for various materials using cost estimation, often known as 5D (Eastman et al., 2008). Price lists can also contain labor and equipment expenses for more precise cost predictions. Price lists are mostly based on volumetric material costs. This makes it possible to estimate costs accurately at any stage of the design process and fosters an awareness of the financial effects of design choices. Therefore, materials and construction methods can be assessed from an economic standpoint (Eastman et al., 2008).

Data management: Design files, timelines, budgets, and other project data can all be stored and managed centrally using BIM software (Arayici, Coates, Koskela, Kagioglou, & Usher, 2011).

Environmental Analysis: Tools for analyzing several characteristics of the building, such as energy efficiency, structural soundness, and construction sequencing, are included in BIM software. Energy analysis enables the production of buildings that consume less energy during their lifecycle (Eastman et al., 2008).

2.2.4.6 DIMENSIONS OF BIM

BIM models can be created and applied at any or all the BIM levels, depending on the requirements of the project and the stakeholders involved. The level of complexity and detail of the BIM model are commonly expressed in terms of various dimensions. These dimensions are not mutually exclusive. The following are some of the most common BIM dimensions:

3D BIM: This is also called the physical dimensions of BIM (Eastman, Teicholz, Sacks, & Liston, 2011). It is the most frequent dimension that speaks of the 3D modelling of the systems and parts of a building. During the design phase, the 3D visualization aids stakeholders in visualizing the building design and its components, allowing them to foresee any conflicts and clashes (Eastman, Teicholz, Sacks, & Liston, 2011).

4D BIM: According to a recent study by Kymmell & Teizer (2010), 4D enables the development of a scheduling system that is connected to the 3D model in order to simulate and visualize building processes. BIM software's time-based simulations allow project stakeholders to simulate and visualize the construction process, spot potential conflicts or delays, and optimize the project schedule by including scheduling and project management data into the 3D BIM model. Construction activities are planned, scheduled, and monitored using 4D BIM (Kymmell & Teizer, 2010).

5D BIM: This BIM dimension adds cost. According to Arayici et al. (2011), 5D BIM entails developing a database that is connected to the 3D and 4D models and contains data on the price of building components. It's used in cost estimation, budgeting, and cost control. The financial ramifications of a building design or construction project are addressed by the cost dimension of BIM. BIM software enables stakeholders to analyze several design options and select the most cost-effective one by producing precise cost estimates. It contains cost data on building components and materials, allowing project stakeholders to forecast and monitor project expenses over the course of the project (Arayici et al., 2011).

6D BIM: it is also called the environmental dimension of BIM (Eastman et al., 2011). It is used for life cycle analysis, energy analysis, and sustainable design. It entails developing a database that is connected to the 3D, 4D, and 5D models and provides data on the effects of building components

on the environment (Wang, Lu, & Chen, 2018). It is a typical BIM factor that addresses the environmental impact of construction activities (Eastman et al., 2011). This includes the BIM model sustainability factor, including information on the environmental performance of building materials and parts, such as life cycle analysis, carbon footprint, and energy efficiency. Stakeholders may be able to find sustainable construction options and lessen the building's carbon footprint with the aid of the analysis (Eastman et al., 2011).

7D BIM: This covers the seventh facility management dimension (Eastman et al., 2011). According to Chen et al. (2019), 7D BIM entails developing a database that is connected to the 3D, 4D, 5D, and 6D models and contains details about how to operate and maintain building components. It is also related to the collaboration and communication between various project stakeholders (Eastman et al., 2011). During the construction phase, BIM offers a platform for cooperation and communication that allows stakeholders to share information and minimize misunderstandings. It provides information on managing assets and inventories as well as the upkeep, repair, and replacement of building systems and components (Eastman et al., 2011).

2.2.4.7 THE BENEFITS OF BIM AS A PROJECT MANAGEMENT TOOL

Building information modelling (BIM) is the digital representation of a building's structural and functional details. Due to its many advantages, BIM has been widely used in the construction industry. The sections show some of the benefits of BIM in building construction projects.

Better Collaboration and Communication: BIM facilitates collaboration and communication between project stakeholders. According to Azhar, Khalfan, Maqsood, and Ahmed (2012), who also note that this is true for the entire building life cycle, BIM enables real-time information exchange and streamlines communication between various building systems.

According to Arayici et al. (2011), BIM enables information sharing across project stakeholders, such as contractors, architects, and engineers. As everyone is using the same information, this can aid in improving communication and teamwork. This can help to guarantee that everyone is working towards the same goal and lower the likelihood of mistakes and misunderstandings (Arayici et al., 2011).

Enhanced Visualization: Project managers can use BIM to visualize the construction process and identify potential problems before work is started. As a result, project risks can be decreased, design errors can be avoided, and project estimates can be more accurate (Eastman, 2009).

Reduced Errors and Rework: By identifying and resolving conflicts between various building systems within the design process, BIM decreases errors and rework (Chen, Lu, & Wang, 2019). Stakeholders can find and fix design flaws before the beginning of construction, which reduces both time and cost.

Enhanced Productivity and Efficiency: According to Eastman, Teicholz, Sacks, and Liston (2011), BIM increases productivity and efficiency by optimizing repetitive tasks and minimizing human labor. By simplifying stakeholder contact and granting real-time access to project data, BIM further streamlines project management (Eastman, Teicholz, Sacks, and Liston, 2011).

Cost Control: By giving precise and current information about building components and their costs, BIM enhances cost control (Arayici et al., 2011). During the design process, BIM allows stakeholders to correctly estimate expenses and discover cost-saving possibilities. It also helps in enabling construction crews to spot possible problems early on and fix them before they become expensive difficulties. To improve cost estimation, BIM also makes it possible to create precise quantity takeoffs (Khemlani, 2011).

Improving Project Quality: BIM technology enables thorough examination and analysis of construction details, allowing project managers to ensure that construction meets quality standards. Contractors can monitor changes and spot potential issues during construction, and design teams can develop and test designs to reduce errors and enhance quality control. (Eastman, 2009).

Improving Project Scheduling: claim that BIM enables the production of a 3D model that contains all pertinent details about the building, such as its size, components, and equipment (Kim et al., 2017). Due to its ability to provide a more thorough understanding of the construction process, this information can be utilized to develop a more precise schedule. Delays and cost overruns may be less likely because of this (Kim et al., 2017).

Sustainable Design: BIM enables stakeholders to analyze and optimize building performance to reduce energy consumption, carbon emissions, and environmental impact. (Wang, Lu, & Chen, 2018).

2.2.4.8 BIM ADAPTION

Building Information Modeling (BIM) is a tool that is becoming well-liked in the building sector, and it has been adopted in many nations worldwide. The use of BIM on a construction project leads to a more integrated design and construction process, a better building, and a shorter project length and cost (Eastman, Teicholz, Sacks, & Liston, 2011).

2.2.4.8.1 BIM ADAPTION IN VARIOUS STAGES OF CONSTRUCTION

The construction stage has three phases: the pre-construction phase (the planning stage), the construction phase, and the post-construction stage. BIM can be implemented at all stages of construction. The entire procedure should be broken down into steps in order to make BIM adaptation more effective (Kaner, 2008).

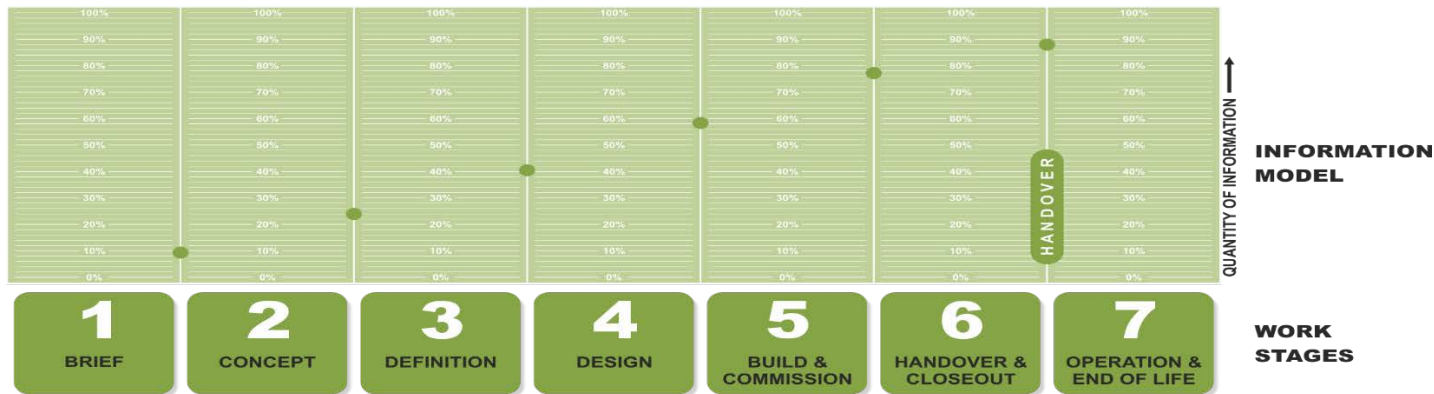
First, BIM can be used in the planning stage of a project to enhance design and planning. Arayici et al. (2011) claim that BIM can be utilized to enhance the design and planning process by enabling different project stakeholders to coordinate and share information in one central location. As a result, design and planning can be more accurate because all parties involved are using the same data. Eastman et al. (2011) also stated that BIM can be used to produce a digital representation of a building, which can be used to model construction scenarios and discover potential problems before work starts. Since possible problems can be found early on before construction is started and fixed easily, the design and planning process can be improved.

Secondly, BIM can be implemented at the construction stage. At this stage, it helps to increase quality and productivity throughout the construction phase. BIM is used to simulate building scenarios and find potential problems before construction starts (Kim et al., 2017). The quality of the construction can be raised as a result since possible faults can be found early on and fixed cheaply. BIM can also be used to automate some processes, like quantity takeoffs, which can increase productivity and save time. Succar (2009) claims that BIM may be used to generate accurate cost predictions, ensuring that projects stay within budget. Project managers can discover

probable cost overruns before they cause serious problems by using BIM to track project expenses in real-time.

Finally In the post-construction phase, BIM can be implemented to enhance operation and maintenance. To handle these tasks, Chen et al. (2012) claim that BIM can be utilized to establish a digital record of the building. As all pertinent data is kept in one centralized place, this can aid in increasing the efficiency of operations and maintenance. According to Azhar et al. (2012), BIM can also be used to find possible safety concerns and create safety measures. This may serve to lower the possibility of injuries and accidents on construction sites, which could assist in increasing the project's general level of safety.

Figure 2-4 BIM Adaption in various stages of construction



Source: (BIM Academy 2017)

2.2.4.8.2 BIM ADAPTION WORLDWIDE

BIM adoption is increasing globally, with many nations requiring its use on government-funded projects. Several nations are creating policies and measures to promote its use in the building sector. As more construction companies and governments come to understand its advantages, BIM usage is anticipated to increase over the next few years. Following are a few examples of BIM adaptation in various parts of the world:

In the USA, BIM is widely used in the construction industry. The US government has promoted the use of BIM through programs like the National BIM Standard and the BIM Guide Series of the General Services Administration. According to several surveys, the number of large

construction firms embracing BIM as a common practice is rising in the United States (Eastman, Teicholz, Sacks, & Liston, 2011).

BIM usage has also grown in Europe, where numerous nations have created rules and programs to promote its use. Since 2016, the UK government has required that BIM Level 2 be used on all public sector construction projects (HM Government, 2011). The desire to increase productivity and lower costs in the building industry has been the driving force behind the introduction of BIM in Europe (Khemlani, 2017).

In Asia, BIM usage has been rising quickly, especially in nations like China, Japan, and Singapore. Through programs like the National Building Information Modelling Standard (NBIMS) and the National Engineering Construction Standard (NECS), the Chinese government has promoted the implementation of BIM (Lu & Li, 2017). By 2020, the Chinese government wants BIM to be used in 50% of all construction projects. According to the government, all public-sector projects in Singapore must use BIM as of 2013 (Building and Construction Authority, 2013).

BIM use has also been rising throughout the Middle East, especially in nations like the United Arab Emirates. The government of the United Arab Emirates has required the use of BIM on all significant construction projects. To increase the effectiveness and productivity of the construction sector, the Dubai Municipality has started a BIM effort (Dubai Municipality, 2014).

In Australia and New Zealand, BIM usage is on the rise among major construction companies. On all government-funded construction projects, the New Zealand government has also adopted BIM (Eastman, Teicholz, Sacks, & Liston, 2011).

2.2.4.8.3 THE ADAPTION OF BIM IN AFRICA

BIM adaptation in Africa is still in its early stages, but the technology is growing slowly. Governments in the area are starting programmes to encourage BIM usage, especially in the public sector, and numerous large construction companies are starting to use the technology. Some African colleges have begun to offer BIM courses (Aigbavboa & Thwala, 2016). Here are some instances of BIM adaptation in various African regions:

In South Africa, BIM usage is rising, especially in the infrastructure and commercial sectors. The South African government has started several measures to encourage the use of BIM, and the technology is already being used by many sizable construction companies there (Aigbavboa & Thwala, 2016).

In Nigeria, BIM adoption is still in its infancy, but the technology is starting to catch on. Initiatives have been started by the Nigerian government to encourage BIM use, notably in the public sector (Odeyinka & Yusif, 2018).

Although BIM adoption is still in its infancy in Kenya, the technology is starting to gain ground. According to a study done in Kenya, a lack of understanding among stakeholders and a lack of trained labor are the reasons for the poor adoption of BIM in the nation (Mugambi, 2018). However, the Kenyan government has begun to promote the use of BIM in the construction sector after realizing the potential advantages of the technology (Mugambi, 2018).

In Egypt, several construction enterprises use BIM technology, where adoption is rather strong compared to other African nations. According to a study done in Egypt, the government's backing for the technology and the availability of skilled workers are responsible for the country's high adoption of BIM (Makki & El-Rasas, 2019). In order to promote the use of BIM in the construction sector, the Egyptian government has created policies and initiatives, including the creation of BIM standards and guidelines (Makki & El-Rasas, 2019).

Ghana is still in the early phases of BIM adoption, but the technology is starting to catch on. To encourage BIM use, particularly in the public sector, the Ghanaian government has started several programmes. According to a study done in Ghana, the poor adoption of BIM in that nation is a result of a lack of knowledge, a lack of experienced labor, and the expensive cost of putting the technology into use (Owusu-Manu, Badu, & Edwards, 2018).

2.2.4.8.4 THE ADAPTION OF BIM IN ETHIOPIA

On the use of building information modelling (BIM) in Ethiopia, there is not much information accessible. However, according to certain sources, BIM is in its early stages of development but is gradually becoming more popular in the nation's building sector.

According to a study by Girma et al. (2018), only 8% of the 50 construction companies in Ethiopia utilized BIM on their projects. This is because of the lack of understanding and knowledge of BIM among stakeholders in the construction sector, the high cost of BIM software and hardware, the lack of awareness, and the scarcity of professionals with the necessary training (Girma et al., 2018).

To increase BIM awareness among the nation's construction experts, the Ethiopian Construction Technology and Management Experts Association (ECTMPA) organized a workshop on the subject in 2018. The event gave an overview of BIM, covered its potential advantages, and emphasized the necessity of adopting it in Ethiopia (Biruk et al., 2019).

BIM has also been introduced into the curriculum for the architectural and construction management programmers at the Ethiopian Institute of Architecture, Building Construction, and City Development (EiABC). In 2018, EIABC introduced a BIM training course for architects, engineers, and contractors. For participants to employ BIM in their projects, the program seeks to equip them with the information and skills necessary (Biruk et al., 2019).

Ethiopia also has several private businesses and institutions, such as the Ethiopian Construction Professionals Association (ECPA), that provide BIM training and consulting services. ECPA has held several workshops and seminars to raise awareness among its members about BIM (Biruk et al., 2019). This is a constructive move towards encouraging the use of BIM among Ethiopia's aspiring construction professionals.

The government of Ethiopia is also supporting BIM adaptation in the country. It is aware of how BIM can boost the effectiveness and standard of building projects carried out in the nation. A BIM task force was established by the Ethiopian Ministry of Construction in 2017 to advance the adoption and application of BIM in the construction sector. The task force has created a draught BIM policy and regulation framework, which stakeholders are now reviewing (Biruk et al., 2019).

While BIM adoption in Ethiopia is still in its early stages, there are encouraging signs that the nation's construction industry is beginning to cautiously embrace it. In the upcoming years, it will be interesting to see how BIM evolves and expands in Ethiopia.

2.2.4.9 BIM TOOLS

BIM tools allow all project stakeholders to view and exchange information in real-time, and they are intended to promote the collaborative character of contemporary building projects (Eastman et al., 2011).

According to Eastman et al. (2011), BIM tools are classified into four subcategories. Modelling tools, analysis tools, collaboration tools, and management tools are the four subcategories of BIM software tools. Building components like walls, floors, and roofs are virtually modeled using modeling software employing 3D geometric objects. The performance of the building's HVAC system, lighting, and structural analysis are just a few of the components that may be simulated and studied using analysis tools. While management tools are used to handle project information such as schedules, budgets, and resources, collaboration tools are used to promote communication and collaboration among project stakeholders (Eastman et al., 2011).

Some BIM software includes Autodesk BIM 360, which is a cloud-based software that provides a variety of capabilities for project managers (Eastman et al., 2011). Revit is also another BIM application that provides tools for organizing project data and workflows and allows project managers to design intricate 3D models of buildings. Graphisoft ARCHICAD was the first CAD product on a personal computer able to create 2D and 3D geometry, as well as the first commercial BIM product for personal computers. It provides 3D models of buildings and manages project data, procedures, and real-time collaboration with stakeholders. Trimble is a BIM software. Connect is a cloud-based BIM application that offers tools for managing project data, papers, and procedures and enables project managers to collaborate and coordinate with stakeholders in real-time. Bentley AECOSIM Building Designer is a cloud-based BIM application that enables project managers to manage project data and workflows, develop 3D models of buildings, and interact in real-time with stakeholders (Eastman et al., 2011).

These tools vary in functionality, user interface, and cost, and it is important for project stakeholders to thoroughly consider their alternatives and select the tools that best suit their unique requirements and work processes. Eastman et al. (2011) stated that Revit was the best-known and market leader for BIM implementation in architecture.

2.2.5 TRADITIONAL PROJECT MANAGEMENT (TPM) vs PROJECT MANAGEMENT USING BIM (PMBIM)

Traditional project management (TPM) has long been the accepted method for overseeing building construction projects (Banihashemi & Haratian, 2017). In this management process, an organized approach to project planning is used, and activities are divided into more digestible chunks. To monitor the progress of a project, project managers use tools like Gantt charts, critical path analysis, and other project management software (Banihashemi & Haratian, 2017). With the advent of building information modelling (BIM), project management has been transformed (Eastman et al., 2011).

Project management using BIM (PMBIM) is a more integrated and collaborative approach to managing building construction projects (Eastman et al., 2011). To improve collaboration and communication among project stakeholders, such as architects, engineers, contractors, and owners, Banihashemi and Haratian (2017) state that PMBIM is used in conjunction with BIM technology. As a result, building projects are successfully completed within budget and on schedule. This improves the efficiency and effectiveness of the project management process. BIM minimizes errors and rework and facilitates improved decision-making and cost control (Liu et al., 2018). It also gives real-time information on the project's development.

One of the key differences between TPM and PMBIM is the level of communication and collaboration among project stakeholders (Banihashemi & Haratian, 2017). According to Liu et al. (2018), stakeholders in TPM frequently work alone with little communication and teamwork. This may result in misunderstandings, mistakes, and schedule delays for the project. In contrast, PMBIM encourages stakeholder communication and collaboration throughout the project's lifetime, leading to a more integrated and effective process (Banihashemi & Haratian, 2017).

The amount of precision and detail used in project planning and design is another major difference between TPM and PMBIM (Liu et al., 2018). TPM frequently uses manual processes and two-dimensional drawings for collaboration and communication (Banihashemi & Haratian, 2017). Due to mistakes and rework during construction, there may be delays and cost overruns. A detailed and accurate three-dimensional model of the building can be created using PMBIM, which can then be

utilized for design, construction, and facilities management (Eastman et al., 2011). As a result, there are fewer mistakes and reworks, and the project management process is more effective and efficient.

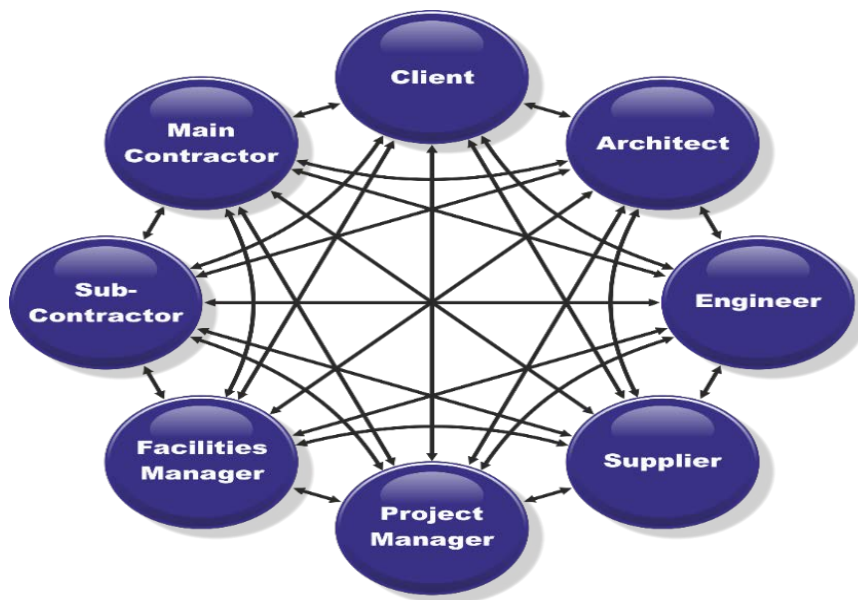
Communication in conventional project management is frequently hierarchical, with data flowing from the top down. In contrast, integrated project management places a strong emphasis on teamwork and communication while making all project information accessible to all stakeholders. All stakeholders have access to the same information when using BIM in an integrated project management strategy, which can promote improved collaboration and communication (Banihashemi and Haratian, 2017).

Quality checks are carried out at various stages of the project under traditional project management, which frequently separates quality control from project management. In contrast, integrated project management places a strong emphasis on ongoing quality control with project-wide quality checks. All stakeholders have access to the same data when using BIM in an integrated project management strategy, which can result in improved quality control and a more cooperative approach to quality assurance (Banihashemi & Haratian, 2017).

Risk management in conventional project management is frequently a reactive process, with hazards being recognized and managed as they materialize. In contrast, integrated project management places a strong emphasis on proactive risk management, where hazards are recognized and dealt with before they become serious problems. Because all parties involved have access to the same information when utilizing BIM in an integrated project management strategy, risks can be identified and mitigated before they turn into major issues (Banihashemi & Haratian, 2017).

Decision-making is frequently centralized in traditional project management, with the project manager making most of the decisions. The focus of integrated project management, in contrast, is on team members' collaboration in decentralized decision-making. All stakeholders have access to the same data when utilizing BIM in an integrated project management strategy, which can promote improved decision-making and a more cooperative method of problem-solving (Banihashemi & Haratian, 2017).

Figure 2-5 Traditional Approach



Source: (BIM Academy 2017)

2.2.5.1 COMMON DATA ENVIRONMENT (CDE)

A Common Data Environment (CDE) is a collaborative platform that enables the sharing of information and data among different stakeholders involved in a construction project (Akintoye and Fitzgerald, 2000).

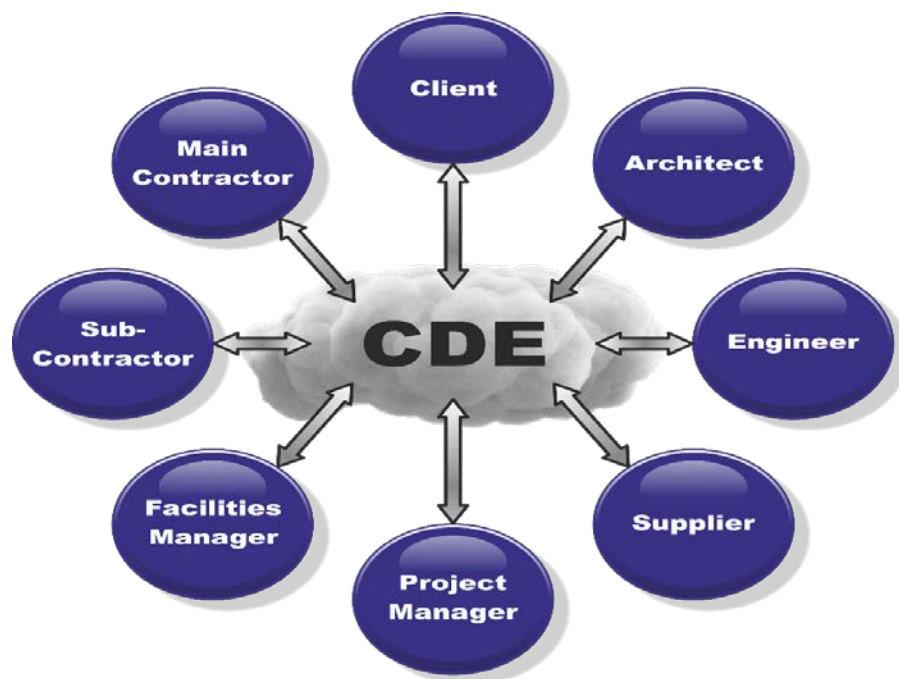
CDE is used to keep project data in a centralized location. It can be server-based or cloud-based. The CDE facilitates the systematic gathering, management, and distribution of all essential project papers among the multidisciplinary groups (Akintoye and Fitzgerald, 2000). A project server, an extranet, a file-based retrieval system, or any other suitable file repository or toolset may all be referred to as CDEs.

For construction projects, the use of CDEs can have a variety of advantages, such as better collaboration and communication, more effective decision-making, increased project efficiency, and better administration of project information (Akintoye and Fitzgerald, 2000).

CDE helps to increase project efficiency. According to Kiziltas et al. (2013), the use of CDEs can aid in the reduction of project delays by enabling stakeholders to quickly make informed decisions by giving them real-time access to project information.

CDEs are also helpful for maintaining project information. According to Aranda-Mena et al. (2009), CDE stores all project data in a systematic manner, making it simpler to manage and access. By doing so, it lowers the possibility of information loss and guarantees that all interested parties have access to the most recent data.

Figure 2-6 Common Data Approach



Source: VP (2017)

2.2.5.2 CHALLENGES OF BIM IMPLEMENTATION

Building information modelling (BIM) software can have a big impact on building construction projects, but it is not without its difficulties. To guarantee that the BIM software implementation is effective, project managers need to be aware of these problems and take action to address them.

One of the major drawbacks of BIM implementation is the lack of standardization. It can be difficult to transmit information among project stakeholders since different software vendors frequently utilize different file formats (Ugwu et al., 2015). Collaboration issues, time and effort wasted switching between software programs, and inconsistent data are all potential consequences of this.

The other challenge is resistance to change. The adoption of BIM necessitates a substantial change in the conventional method of managing building projects. According to Ruiz-Garcia et al. (2018), the implementation of BIM changes the responsibilities of stakeholders and necessitates a fresh approach to project delivery. The culture of the construction business, which is sometimes resistant to change, may find it difficult to accept this big change.

The high initial cost is also one of BIM's drawbacks. BIM software implementation and employee training might be expensive, particularly for small and medium-sized businesses (Eastman et al., 2011). This could prevent the use of BIM, especially in areas where building costs are already high.

Limited Technical Knowledge: Project stakeholders must have a specific level of technical knowledge to successfully apply BIM. To manage and deploy BIM, many businesses and people might not have the essential abilities (Hore et al., 2014). The lack of coordination or errors caused by this skills gap may cause the project to be delayed or fail altogether.

The requirement for specialized knowledge and training is yet another BIM drawback. Gu et al. (2016) suggest that specialized knowledge and skills may not be easily accessible in the construction industry for the successful adoption of BIM. This may restrict the use of BIM, especially in areas where small and medium-sized businesses dominate the construction sector.

Data Management: The management of the massive amounts of data produced by BIM software can be difficult. A system must be in place for project managers to manage, share, and store data among various stakeholders (Eastman et al., 2011).

Integration with existing tools and systems: It can be difficult to integrate BIM software with already-in-use tools and systems, especially if they weren't made to function with BIM software.

Legal and Contractual Issues: BIM software use may lead to contractual and legal complications. The right legal contracts must be in place to manage responsibility, intellectual property, and data ownership, according to project managers (Eastman et al., 2011).

2.2.5.3 BIM AND PROJECT SUCCESS

2.2.5.3.1 PROJECT SUCCESS

The definition of project success or failure is complex and dependent on various stakeholders' points of view. A set of accepted criteria must be specified for the assessment of projects to have a common understanding of the subject matter.

Many researchers define project success in terms of dimensions such as time, cost, quality, scope, stakeholder satisfaction, etc. (Bodicha 2015; Morteza & Kamyar 2009; Sudhakar 2016; PMI 2017). The project success criteria adopted the so-called Iron Triangle of 'Time, Cost, and Quality' as the set of principles for evaluating the success of a project (Wysocki, 2014).

Kerzner (2009) defined project success as the completion of a project within the allocated time period, within the budgeted cost, at the proper performance or specification level, with acceptance by the customer or user, with minimum or mutually agreed upon scope changes, without disturbing the main workflow of the organization, and without changing the corporate culture.

The triple constraints defined project success as the achievement of project objectives within the constraints of time, cost, and quality. The success of building construction projects is influenced by a variety of elements, even though the triple constraint framework is still useful for doing so.

Effective project management techniques are essential for meeting stakeholder expectations and project objectives (Kerzner,2009). Effective project management techniques can increase customer satisfaction, lower costs, and improve project performance. Planning, organizing, and controlling resources are all parts of effective project management techniques that help projects reach their goals. Planning projects, reducing risks, controlling costs, maintaining schedules, and managing quality are some of these techniques (Kerzner, 2009).

When a project meets its specified goals to the satisfaction of all stakeholders, it is deemed successful. In other words, if the client, end-user, project manager, project team, and developer all feel that their expectations were met or exceeded, the project must be considered successful. (Nicholas, 2004)

To summarize the above literature review, important indicators for measuring project success were identified and selected. In this study, project success will be considered from the standpoint of meeting the project objective, delivering the project within the specified time, completing the project within the budgeted cost, meeting the required quality, and meeting the stakeholders' satisfaction.

2.2.5.4 BIM FOR THE SUCCESS OF BUILDING CONSTRUCTION PROJECTS

Several academics and researchers assess factors that contribute to project success criteria. In the construction sector, the success of a project is influenced by a variety of factors, including the use of building information modelling (BIM). It has been discovered that the use of BIM improves project success in building construction projects.

According to Xu et al. (2018), the use of BIM can enhance project performance by lowering mistakes, enhancing stakeholder communication and collaboration, and facilitating improved decision-making. As a result, there will be fewer delays and cost overruns, and the project will be completed with higher quality (Xu et al. (2018),

BIM enables better project planning and management, which contributes to project success. According to Lee and Kim (2015), building information modelling (BIM) can be utilized to

develop accurate and complete three-dimensional representations of the model. This can enhance project success by facilitating better project management, lowering the likelihood of mistakes and rework, and enhancing the standard of the final product.

Integration of many project stakeholders is another way that BIM may help a project succeed. BIM can be utilized to bring together various project stakeholders into one collaborative platform (Arayici et al., 2011). By fostering improved stakeholder engagement and communication, lowering the likelihood of mistakes and rework, and fostering better decision-making, this can contribute to project success.

2.3 EMPIRICAL LITERATURE REVIEW

In this empirical review, the researcher has found that, since BIM is a new technology that has been adapted in the construction industry very recently, there is not much research in this field of knowledge. The result of the study will be presented as follows:

A study of recent empirical studies on the role of BIM in building construction projects shows that BIM has a positive impact on the success of projects in terms of cost, time, and quality. For instance, a study by Abdelhamid and Nguyen (2019), found that the utilization of BIM boosts project success in terms of time, cost, and quality. It also improves project coordination, lowers errors and rework. Like this, Shahi et al. (2019), discovered that BIM technologies enhance information management, collaboration, and communication, which results in better project outcomes and success. Furthermore, it was discovered that BIM improves project performance through better visualization, simulation, and coordination in a study by Ibrahim and Waly (2020).

A study by Yan et al. (2019) investigates the role of BIM in enhancing project scheduling and cost control in building projects. The study examined the usage of BIM in a high-rise residential building project in China using a case study approach. The results showed that using BIM considerably enhanced the project schedule and decreased project costs. According to the study's findings, effective BIM utilization can increase the success of construction projects.

According to research by Arayici et al. (2011), the use of BIM in a residential building project reduced construction time and costs by 7% and 30%, respectively. The usage of BIM in a

commercial building project, according to a study by Giel et al. (2017), led to a 20% decrease in construction time and a 10% reduction in construction expenses.

Guo et al.'s (2017) investigation on the effect of BIM on construction project quality was part of yet another empirical study. 105 Chinese construction experts participated in the study, and data were gathered using surveys. The results showed that the project's design, construction, operation, and maintenance stages all had higher quality due to the use of BIM. According to the study's findings, BIM can improve the quality of building construction projects.

Several studies show that BIM has a positive impact on stakeholders' engagement. Stakeholders, including architects, engineers, contractors, and customers, can benefit from BIM. A study by Adair et al. (2019) used a case study approach to investigate the use of BIM in a public infrastructure project in Ireland. The results showed that BIM facilitated improved collaboration and communication among project stakeholders, leading to improved project outcomes. The study concluded that BIM could play an essential role in improving collaboration on projects. This empirical literature review explores the role of BIM in improving construction project outcomes, including design, construction, and facility management.

In accordance with Akintoye and Goulding (2015), the use of BIM enhances interdisciplinary communication and collaboration in the design phase. The precision of 3D digital models is improved by BIM technology, enabling greater visualization during the design phase. In the end, this results in a decrease in design modification requests, a decrease in design faults, and enhanced project efficiency.

In the construction phase, BIM increases productivity, lowers costs, boosts safety, and improves work quality throughout the construction phase. In their study, Zhang et al. (2018) discovered that BIM technology increased job quality by lowering construction errors and enabling early dispute detection, which reduced rework.

In the phase of facility management, BIM technology also enhances building maintenance and operations. According to Guo et al. (2019), BIM technology offers better facility management by generating thorough and accurate digital models based on actual data. This lowers operational

expenses and the chance of a system failure while enabling facilities managers to simply monitor and maintain the building.

2.4 RESEARCH GAP

Several research gaps were identified while investigating the literature review. The research has identified that Ethiopian building construction industries started implementing BIM quite late, so there is a lack of research on BIM implementation in the local context. Further studies should be done on BIM utilization in developing countries like Ethiopia, where BIM adaptation is still in its infancy.

Another research gap is that there is a lack of empirical studies specifically looking at how BIM implementation at Ethiopian Engineering Investment Group (EEIG) Construction Company affects project success. Doing this research and identifying the potential benefits and challenges of BIM implementation will have a greater impact on identifying the best practices and lessons learned from past experience, which will help to adapt the most effective and efficient approach to BIM implementation. It also helps motivate other construction companies to start utilizing BIM for the success of their projects and to stay competitive in the industry. This has an advantage for the overall construction industry. When other companies start using this technology, the whole industry will grow. Although BIM's benefits for construction projects are widely proven in the literature, more research is needed to ascertain how well BIM functions in the specific circumstances of EEIG Construction Company.

The other gap that the researcher identified was a lack of research on the relationship between BIM and project success. Even though studies have been done on the role of BIM in building construction projects and it has been identified that BIM has the potential to increase the effectiveness and quality of construction projects, not much is known about how it affects their likelihood of success. A survey that examines the application of BIM in projects completed by EEIG Construction Company and its role in project success in terms of cost, schedule, quality, and stakeholder satisfaction can be conducted to fill this research gap.

This research will contribute to the body of knowledge and provide a starting point for future academics and legislators.

CHAPTER THREE

3 : RESEARCH METHODOLOGY

The research methodology refers to the systematic plan or approach used to arrange the inquiry process and collect data to resolve the research issue at hand (Creswell, 2014). To obtain the answers to his or her research questions, a researcher needs to go through this practical stage in the research process (Bryman, 2016)

3.1 RESEARCH APPROACH

Depending on the research topic, the type of research approach will be qualitative, quantitative, or both (Creswell & Creswell, 2018, p. 4). The main emphasis of the qualitative approach is on collecting verbal data that derives its meaning from the perspective of the participants involved (Holme & Solange, 1997). The methods employed in qualitative research to collect relevant data may include field observations, analysis of business documents, and other techniques. Quantitative data, in contrast, is expressed in numerical values and measurements. In qualitative research, a small sample size may be used to gather a significant amount of data (Holme & Solange, 1997).

In this study, mixed types of quantitative and qualitative approaches were used. Creswell (2014) suggests that using a combination of two distinct research methodologies can enhance understanding of a subject or issue, and this approach to research has gained acceptance and popularity in recent times.

3.2 RESEARCH DESIGN

Research design involves identifying the most precise and reliable information about the features of an individual, organization, or group under study (Bryman and Bell, 2011). The descriptive research design is determined to be the most suitable research design for this study because the goal of this study is to identify the role of building information modeling (BIM) in the success of building construction projects. It determines the current status of BIM regarding project success. It helps to describe the benefits of BIM, challenges of BIM implementation in building construction projects and the strategies which are used to overcome the challenges systematically.

In this assessment Descriptive Research design was used. Descriptive research design was used to describe the current statuses of BIM and Project Success. It helps to describe the problem, phenomenon, or a situation systematically.

3.3 RESEARCH POPULATION AND SAMPLING

Cooper and Schindler (2014) define the "target population" as the complete set of individuals or items that the research intends to use as a basis for its findings. Ethiopian Engineering Investment Group (EEIG) construction team and executive-level people who are thought to be actively associated with BIM and project management activities were included in the population sample for this study. Purposive sampling was used to choose the architects, engineers, BIM managers, project coordinators, and senior members of the EEIG Construction who are currently participating in the implementation of BIM as a project management tool for building construction projects.

After confirming that they were thoroughly knowledgeable about BIM and project management, an interview session was arranged with the selected higher management official which includes the BIM Manager, section managers, and projects coordinator. The appropriate parties were sent a questionnaire electronically, which was chosen as the most effective and valid method for obtaining rich information and selecting suitable samples for the study.

SAMPLING DESIGN

To collect the necessary data from the target population, since N is below 100 a census sampling technique was employed to sample the entire population, as stated by Israel (2009). The census technique involves creating a comprehensive list of all items in the population, and it enables researchers to gather information from every individual in the program, which is one of its advantages.

SAMPLE SIZE

For the BIM implementation project team at EEIG Construction Company, the population size (N) was determined to be 56. Using the census method, the entire population (56) was taken to be the sample size of the study.

3.4 TYPES OF DATA AND MATERIAL

For this research, primary data sources, which include questionnaires, interviews, and case studies were used as the research's primary data sources. The chosen organization's management, employees, and professionals were subjected to interviews and questioning.

Interviews were used to gather qualitative data from the primary source; higher-level professionals who are directly related, like BIM managers, section managers, and project coordinators, were questioned.

Questionnaires were created and administered to the chosen company being studied. Managers and staff members from different departments were requested to complete the questionnaires anonymously. The researcher distributed the questionnaires via email using a Google Form. Once completed, the questionnaires were readily available on Google Forms, and the data was easily extractable. An Excel and SPSS program was employed to record and organize the data, which was then analyzed to meet the research objectives.

Case studies: two projects, one from projects that has implemented BIM and other that has used the conventional method of project management, were selected for study in order to compare one another and identify their contribution to project success in terms meeting the project's cost, quality, time and stakeholders' satisfaction it incurred.

3.5 DATA ANALYSIS METHOD

After the data collection process, diverse analysis methods were utilized based on the nature of the gathered data. A descriptive statistics using frequency, percentage, mean and standard deviation were applied to analyze the data, and the findings which were interpreted using both quantitative and qualitative techniques.

The ideas and perspectives obtained from the interviews were analyzed through descriptive narratives. The survey data was analyzed using the Statistical Package for the Social Sciences (SPSS). The findings were discussed and analyzed using a descriptive research design, which involved using statistical tools like bar graphs, tables, and summary data.

3.6 RESEARCH INSTRUMENT

The research instruments that were used in this study were questionnaires, interviews, and case studies of two projects under EEIG construction company.

The questionnaires were prepared based on the fundamental ideas included in the literature review. A total of 21 questionnaires were distributed to members of the project team. The questionnaires were structured into five sections. The first section dealt with general information, such as year of work experience and job role. The second section contained questions related to project management practices. The third section focused on the existing project management process and BIM implementation, assessing the extent to which BIM was utilized within the company. The fourth section examined the impact of BIM on project success. Finally, the fifth section evaluated the challenges and barriers encountered during the BIM implementation process and suggested methods to enhance BIM implementation practices within the company.

MEAN SCORE RANKING

The mean scores reflect the average rating of the respondents on the Likert scale when the ratings are converted into a continuous index and categorized into distinct groups.

Table 3-1- Mean Score Ranking

Likert Scale	Likert Ranking	Mean Score Category
1	Strongly Disagree	1.0-1.49
2	Disagree	1.5-2.49
3	Neutral	2.5-3.49
4	Agree	3.5-4.49
5	Strongly Agree	4.5-5.0

Source: (Moohammad, 2014)

3.7 VALIDITY AND RELIABILITY

Validity: Hair et al. (2014) define validity as the degree to which a measure accurately reflects its intended purpose. To ensure validity, it is essential to have a clear understanding of what is being measured and to make it as precise and accurate as possible. To enhance the reliability of the final conclusions, the data collection tools were designed in a straightforward manner that respondents

can easily understand. Additionally, subject matter experts were consulted, and their feedback were incorporated. The questionnaire was slightly modified to make it suitable for online data collection. Before data collection, the questionnaire was reviewed by the research advisor and senior BIM experts to assess its content validity and ethicality.

Reliability: According to Sekaran (2003), the reliability of a measure indicates how consistently and reliably the instrument measures the concept and helps to assess the quality of the measure. The ideal sample population should have the relevant knowledge, experience, and authority to provide efficient and accurate responses to the questions related to the subject matter. The questionnaire was designed based on academic literature, and the questions and answers were developed after a comprehensive review of the relevant literature and previous research. Additionally, reliability test using Cronbach’s alpha were used to test the internal consistency and reliability of sets of items within the survey. From table 3.2 the Cronbach’s alpha coefficient for the BIM implementation ranges from 0.732 to 0.92. The instrument's Cronbach's alpha value must be at least 0.70 for the measurement to be considered reliable. All the numbers are greater than 0.7, proving the reliability of the measurements.

Table 3-2-Reliability Statistics

	BIM Implementation	No of items	Cronbach’s alpha
1	General Project Management Practice	6	0.863
2	Impacts of BIM for project success	4	0.732
3	Benefits of BIM	10	0.92
4	Challenges of BIM	7	0.91
5	Measures to improve BIM utilization	6	0.888

(Source: Researcher’s own work, 2023)

3.8 ETHICAL CONSIDERATION

Saunders et al. (2016) define research ethics as the moral values that regulate your behavior concerning the rights of people who are affected by or become the subject of your research.

The research was carried out in an ethically and morally acceptable manner. The participants' consent was obtained before collecting any information, and the data were not shared with anyone

who is not part of the study. The benefits of the research were clearly explained to the participants to ensure their rights are protected. To meet ethical obligations, the research followed appropriate citation rules, use honest data collection and analysis methods, kept data confidential, obtained consent from the case organization and staff, and maintain the anonymity of respondents if they agree to it.

CHAPTER FOUR

4 : RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter includes data analysis and interpretation of the findings from the survey data collected from interviews and questionnaires given to EEIG Construction personnel engaged in the BIM implementation under the company's supervision.

To create the complete data necessary for the study, the obtained data must first be rearranged and coded. Using SPSS software, statistical processes are utilized to analyse the data collected from the questionnaires in line with the research's main goal. To describe and explain the findings, descriptive statistics like mean, frequency, standard deviation, and percentage were used.

In the first section, the respondents' demographic profile is covered. Then the current project management practices in the company were analyzed based on the criteria described in the methodology. By following the research question, the analysis of the study was conducted sequentially. The extent to which BIM is implemented, the role of BIM for project success, the challenges of BIM implementation, and measures to overcome the challenges were analyzed and interpreted in this chapter.

4.2 SOCIO-DEMOGRAPHIC VARIABLES

Data for this research was collected through questionnaires and interviews. The questionnaires were created using Google Forms and shared with 56 individuals involved in BIM implementation at EEIG Construction Company. Out of the 56 questionnaires distributed, 45 were completed, resulting in a response rate of 80.4%. According to Mugenda (2003), response rates above 70% are considered very good for further analysis.

The demographic data of the respondents collected for this study are gender, educational level, department, profession, and total years of work experience.

4.2.1 RESPONDENTS PROFILE

The questioner is prepared by targeting the project team members in the company who are engaged in BIM implementation, including the planning team, the design team, and the execution team (the commercial and QS/QC teams).

Based on an interview guideline, five interviewees a BIM manager (1), a project coordinator (1), and line managers (3) were questioned.

Table 4-1-Department of the Respondents

Commercial	Frequency	Percent	Valid Percent	Cumulative Percent
Design	12	26.7	26.7	26.7
Planning	25	55.6	55.6	82.2
QA/QC	4	8.9	8.9	91.1
Total	4	8.9	8.9	100.0
	45	100.0	100.0	

(Source: Researcher's own work, 2023)

The table 4.1 presented above indicates that the majority of respondents (55.6%) were from the Design Department, with job titles such as BIM Manager, Design Team Leader, Project Coordinators, BIM modeler Architects, Structural Engineers, Electrical Engineers, Mechanical Engineers, and Sanitary Engineers. The remaining respondents were from the commercial department (26.7%), the planning department (8.9%), and the QA/QC department (8.9%). The Commercial Department included roles such as Tender & Estimation Engineer, Quantity Surveyor, Cost Engineer, and Database Engineer (12 respondents), while planning and QA/QC Department each had 4 respondents.

Table 4-2-Respondents Role in the Company

Position	Frequency	Percent	Valid Percent	Cumulative Percent
Architect	10	22.2	17.8	17.8
BIM Manager and Project Coordinator	2	4.4	6.7	24.4
Cost Engineer	3	6.7	6.7	31.1
Database Engineer	2	4.4	2.2	33.3
Tender and Estimation Engineer	3	6.7	2.2	35.6
Electrical Engineer	2	4.4	2.2	37.8
Line manager	2	4.4	6.7	75.6
Mechanical Engineer	2	4.4	2.2	77.8
Planning Engineer	4	8.9	2.2	80.0
QA/QC Engineer	4	8.9	2.2	82.2
Quantity Surveyor	2	4.4	2.2	84.4
Sanitary Engineer	2	4.4	4.4	88.9
Structural Engineer	3	6.7	2.2	91.1
Team Leader	4	8.9	8.9	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

In terms of their professional roles, 4.4% (2) of the respondents were line managers, 4.4% (4) were team leaders, 4.4% (2) were BIM managers and project coordinators, 22.2% (10) were architects, 6.7% were structural engineers, 4.4% (2) were electrical engineers, 4.4% (2) were sanitarian engineers, and 4.4% (2) were mechanical engineers. Additionally, 6.7% (3) were tender estimators, 4.4% (2) were quantity surveyors, 4.4% (2) were database engineers, 8.9% (4) were QA/QC engineers, and 8.9% (4) were planning engineers.

As the results indicate, the majority of the respondents were architects, who had more professional experience with BIM compared to other job titles.

Table 4-3-Respondents Educational-Level

	Frequency	Percent	Valid Percent	Cumulative Percent
BSC Degree	37	82.2	82.2	82.2
MSC/MBA Degree	8	17.8	17.8	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

The analysis results for the educational level of the respondents are presented in Table 4.4. The table indicates that the majority of the respondents (37 individuals or 82.2%) held a first degree,

while a smaller proportion (8 individuals or 17.8%) held a postgraduate degree (master's degree). It is noteworthy that none of the respondents had less than a bachelor's degree, which suggests that all of the respondents possessed at least a first degree in their respective study areas. This finding is significant as it suggests that the respondents had the requisite knowledge and background to provide informed responses to the study's subject matter.

Table 4-4- Respondents Total Year of Experience in the Construction Sector

	Frequency	Percent	Valid Percent	Cumulative Percent
< 1 year	6	13.3	13.3	13.3
1-5 years	21	46.7	46.7	68.9
6-10 years	9	20.0	20.0	100.0
11-15 years	5	11.1	11.1	80.0
>15 years	4	8.9	8.9	22.2
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

Analysis of the respondents' work experience in the construction industry revealed that 13.3% (6) of them had less than one year of experience, 46.7% (21) had between one and five years, 20% (9) had between six and ten years, 11.1% (5) had between eleven and fifteen years, and 8.9% (4) had more than fifteen years. (See above Table 4.4).

The majority of the respondents had between two and five years of work experience in the construction business, indicating that they have enough experience in the field to have an understanding of the subject matter.

4.3 GENERAL PROJECT MANAGEMENT PRACTICE IN THE COMPANY

Table 4-5 Type of Project Management Practice in the Company

	Frequency	Percent	Valid Percent	Cumulative Percent
Integrated Project Management	12	26.7	26.7	26.7
Integrated Project Management using BIM	32	71.1	71.1	97.8
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

Table 4.5 shows the current project management practice at EEIG Construction Company. The participants were asked to choose the current project management practice in the company. The survey result shows that 71.1% (32) of the respondents agreed that they are using an integrated project management approach using BIM to manage projects, and 26.7% (12) of the respondents said they are using the integrated project management approach without BIM.

As this result shows, the majority of the project team agreed that they are utilizes BIM in their projects, and BIM is widely implemented in the organization.

Table 4-6 Project Management System in the Company

	Mean	Std. Deviation
The company has a time management system.	4.13	.757
The company has a cost management system.	4.33	.707
The company has a quality management system.	4.33	.707
The company has a waste management system.	3.47	.869
The company has a Risk management system.	3.69	.996
The company has a stakeholder management system.	4.00	.674
Composite Mean Score	3.9926	.61129

(Source: Researcher's own work, 2023)

According to Table 4.6, the project management system in the company has an average composite score of 3.99 out of 5. This indicates that the majority of the respondents agree that the organization has a good project management system. The cost and quality management systems received the highest mean score of 4.33, followed by the time management system and stakeholder management system with mean scores of 4.13 and 4.0, respectively. The risk management system received a mean score of 3.69, indicating agreement among participants. The waste management system received the lowest mean score of 3.47, which suggests that the participants were neutral about this aspect of the company's project management system.

The interview results confirmed the survey findings that the company has time, cost, quality, risk, and stakeholder management systems in place. Additionally, the interviewee mentioned that the

company is currently utilizing Building Information Management (BIM) technology as a project management tool.

4.4 BIM AND PROJECT MANAGEMENT

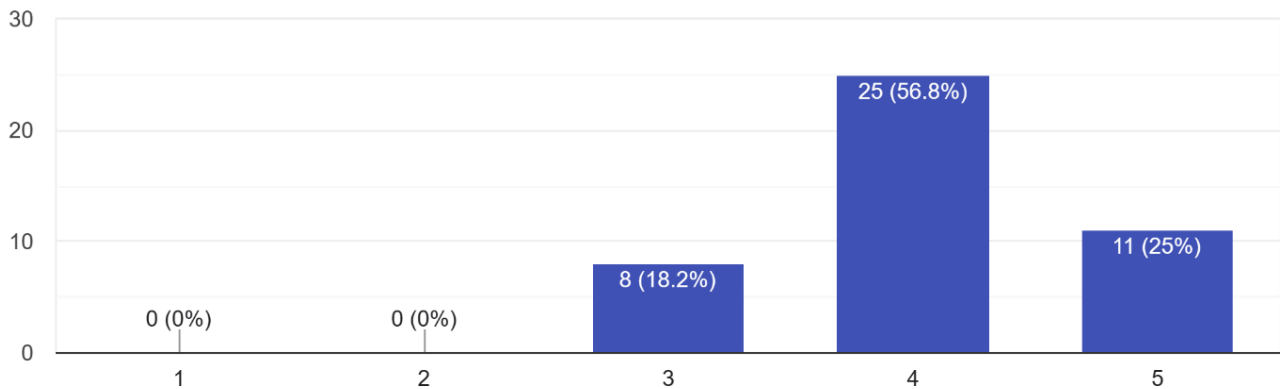
Table 4-7 The Extent of BIM Implementation in the Company

	Frequency	Percent	Valid Percent	Cumulative Percent
None	9	20	18.2	18.2
Agree	25	55.6	56.8	75.0
Strongly Agree	11	24.4	25.0	100.0
Total	44	97.8	100.0	100
Total	45	100.0		

Source: Researcher’s own work, 2023)

The respondents were asked their opinion on the extent of BIM implementation in the company. 55.6% (25) of the respondents agreed, and 24.4% (11) strongly agreed that BIM is widely being implemented in the company. but 20% (9 respondents) were uncertain about it. So as the result shows, the majority of the respondents agreed that BIM is widely implemented in EEIG construction.

Figure 4-1 Level of BIM Implementation



(Source: Researcher’s own work, 2023)

Table 4-8 BIM Utilization Stage

	Frequency	Percent	Valid Percent	Cumulative Percent
Design Stage	40	88.9	88.9	95.6
Planning Stage	5	11.1	4.4	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

The survey asked respondents about their use of BIM during different stages of the construction process. The results indicate that only a small proportion, 11.1% (5 individuals), implement BIM during the project planning phase. The majority of respondents, 88.9% (40 individuals), reported using BIM during the design phase. However, there were no reported instances of BIM implementation during the construction or operation stages of a project. This suggests that BIM is predominantly being used during the preconstruction phase at EEIG Construction Company.

The interview results confirmed that BIM is currently only being used during the preconstruction stage. However, the company has plans to expand the use of the technology to the construction stage in the future.

Table 4-9 Levels of BIM Implementation in the company

	Frequency	Percent	Valid Percent	Cumulative Percent
BIM Level 1 (Organized CAD)	4	8.9	8.9	11.1
BIM Level 2 (Collaborative BIM)	39	86.7	86.7	97.8
BIM Level 3 (Interoperable Asset Information Modeling)	1	2.2	2.2	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

The respondents were asked at which BIM level the company cooperates. 86.7% (39) of respondents answered that they use BIM Level 2, which is collaborative BIM. 8.9% of respondents used BIM Level 1 or organized cad, and 2.2% of respondents answered BIM Level 3.

As the result shows, most of the respondents use BIM Level 2 in their projects, so the researcher concluded that BIM Level 2 is widely being implemented in the company. BIM Level 2 can enhance stakeholder collaboration and communication, reduce mistakes, and rework, and improve productivity. (RICS, 2015)

Table 4-10 Extent of BIM Utilization in the Project

	Frequency	Percent	Valid Percent	Cumulative Percent
3D Modeling (3D Visualization and Clash Detection)	36	80.0	80.0	80.0
4D Modeling (Time estimation)	3	6.7	6.7	86.7
5D Modeling (Cost Estimation)	6	13.3	13.3	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

The survey asked respondents to indicate their level of agreement with the utilization of BIM at the organization. Based on the results, 80% (36 individuals) agreed with the use of BIM for 3D modeling and visualization. A small proportion, 6.7% (3 individuals), reported using BIM for 4D modeling or time estimation, while 13.3% of respondents reported using BIM for 5D modeling or cost estimation. None of the respondents reported using 6D or 7D BIM. The table indicates that the majority of respondents reported using BIM for 3D modeling and clash detection

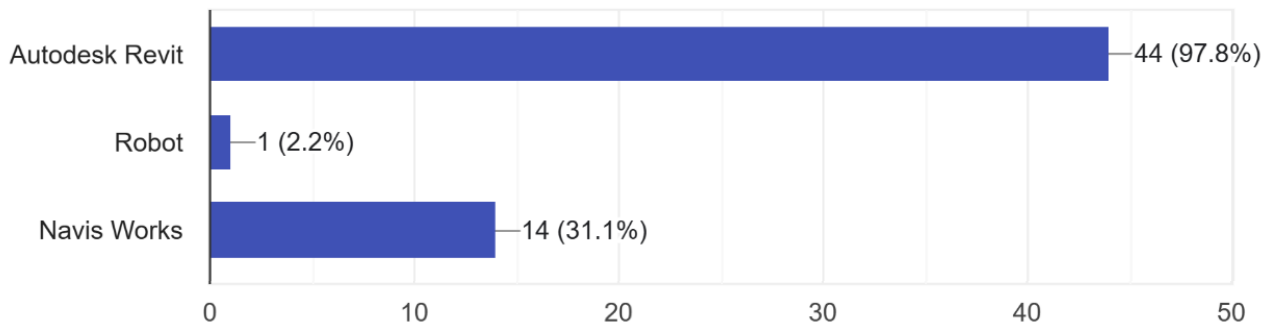
According to the interview with BIM managers, 3D BIM technology is widely used in the company. but 4D and 5D modelling are at a very early age, The 3D BIM is mainly implemented in the design department for 3D modelling and clash detection purposes. During the design phase, the 3D visualization aids stakeholders in visualizing the building design and its components, allowing them to foresee any conflicts and clashes (Eastman, Teicholz, Sacks, & Liston, 2011).

Every discipline in the design department, including the architect, structural engineer, electrical engineer, mechanical engineer, and sanitation engineer, works collaboratively with the help of 3D

BIM. The files are saved on the central server system so that any stakeholder can have access to the model. After the model is finished, the commercial department (the cost estimation engineer and the quantity surveyor) uses this model to do the cost estimation, determine the unit rate, do quantity takeoff, and the BOQ.

According to the Commercial Manager, 3D BIM is also used to check the actual measurement and the progress measurement of the works. By using the 3D model of the project, the progress payment can also be determined. 3D BIM is also used in the planning department to determine the timeline of the project, do sequential scheduling, and assign resources (manpower, material, and equipment) to the project. The planning team uses both the 3D model and the cost estimation file to do their work. According to the interview, the company planned to start implementing 4D and 5D BIM in its projects by the coming year. Majority of the employees have already taken training courses, and they are practicing the technology by using pilot projects for a better outcome.

Figure 4-2 BIM Tools



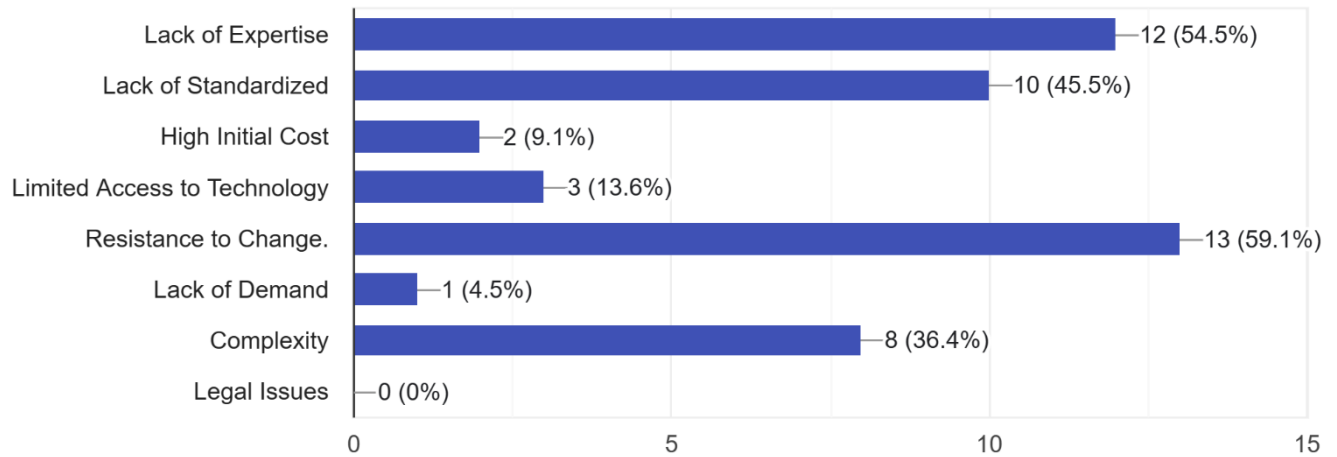
(Source: Researcher’s own work, 2023)

As we can see from the above diagram, Autodesk Revit is the most widely used software in the company. 97.8% (44) of the respondents confirmed that they use Revit as a BIM tool. 31.1% (14) of respondents stated they use Navis Work. Only 2.2% (1 respondent) confirmed that they use robot software in the company.

Conversely, the interview results revealed that the design team frequently employs Autodesk Revit software to model their projects. Revit is a well-known and leading software for BIM

implementation in architecture (Eastman et al., 2011). While Robot is considered the top BIM tool for structural engineers, the survey results indicated that it is not commonly utilized within the company. Navis Works, on the other hand, is used to identify clashes in the model.

Figure 4-3 BIM Tools



(Source: Researcher's own work, 2023)

Respondents were asked to specify their reasons for not implementing BIM in their projects. As the result shows, the top four reasons stated by the majority of the respondents were: resistance to change (59.1%), lack of expertise (54.5%), lack of standardization (36.4%), and software complexity (36.4%). Other reasons, like high initial costs, limited access to technology, and a lack of demand, were not specified by the majority of the respondents.

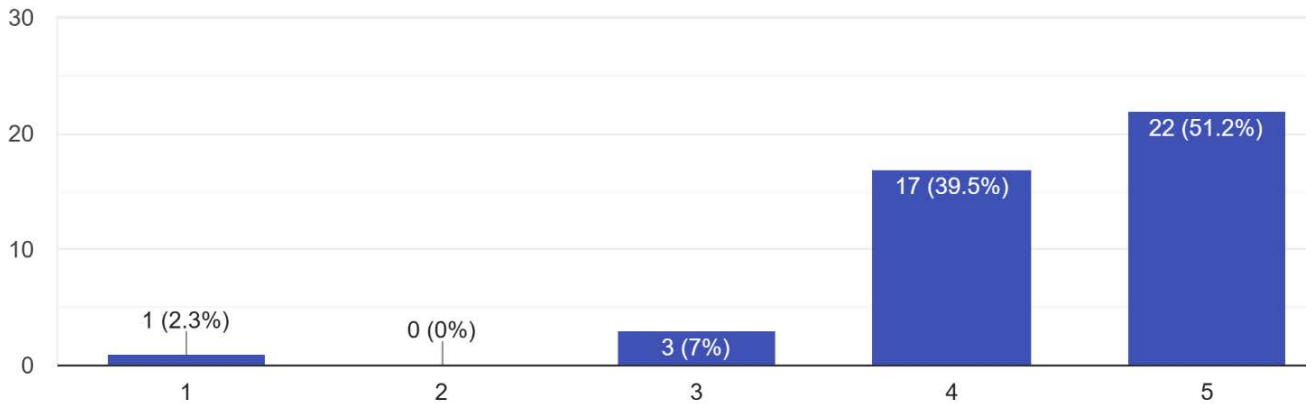
Figure 4.3 shows the majority (59.1%) of non-BIM user respondents stated they do use BIM technology because of Resistance to change.

4.5 BIM AND PROJECT SUCCESS

The success of a project has been determined to be significantly impacted by BIM (Chen and Lu, 2016). BIM can enhance project performance by lowering project costs, enhancing project schedule performance, enhancing project quality, and enhancing stakeholder satisfaction (Arayici

et al.,2011). In this section, the researcher aims to evaluate the extent to which BIM influenced the overall success of the project at EEIG Construction Company.

Figure 4-4 Impact of BIM for Project Success



(Source: Researcher's own work, 2023)

The initial inquiry aimed to determine the level of agreement among respondents regarding the efficacy of BIM in achieving successful construction project outcomes. Survey results indicated that 51.2% (22) of respondents strongly agreed and 39.5% agreed that BIM is effective in ensuring successful project delivery at EEIG Construction Company. A small percentage of respondents, 7% (3), were unsure, while only 2.3% (1 respondent) disagreed with BIM having an impact on project success.

In summary, the findings suggest that the majority of the surveyed participants acknowledged the benefits of BIM in facilitating successful building construction projects.

Table 4-11 Impact of BIM fir Project Success

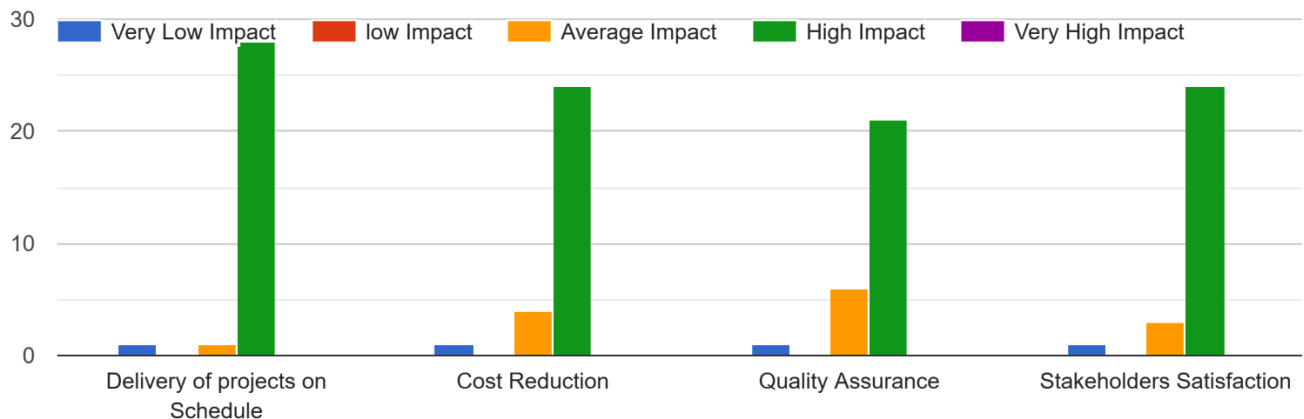
Success Criteria	Mean	Std. Deviation
Delivery of projects on Schedule	4.49	.549
Cost Reduction	4.13	.726
Quality Assurance	4.09	.701
Stakeholders Satisfaction	4.33	.905
Composite Mean Score	4.261	.47660

(Source: Researcher's own work, 2023)

On the next question, the respondents were asked to rate their level of agreement on the Impact of BIM on the success of projects in terms of delivery of the project on schedule, cost reduction, quality assurance, and stakeholder satisfaction.

Table 4.11 displays the outcomes of the study, which indicate that BIM has a substantial influence on the success of project delivery, as evidenced by its composite mean score of 4.261 out of 5. The impact of BIM is most notable in terms of delivering projects on schedule, cost reduction, quality assurance, and stakeholder satisfaction. The results demonstrate that the highest mean score of 4.49 is for delivering the project on schedule, followed by stakeholder satisfaction with a mean score of 4.33. Cost reduction and quality assurance come in third and fourth with mean scores of 4.13 and 4.09, respectively. Thus, BIM implementation has a greater contribution to the delivery of projects on schedule than the other success factors.

Figure 4-5 BIM Tools



(Source: Researcher's own work, 2023)

4.5.1 THE BENEFITS OF BIM AS PROJECT MANAGEMENT TOOL

The construction industry has extensively adopted BIM due to its numerous advantages. This section aims to determine if EEIG Construction Company has also benefited from the implementation of BIM in its projects. The researcher identified the potential benefits of BIM from the literature review and asked respondents to rate their level of agreement on a Likert scale (ranging from strongly disagree to strongly agree).

Table 4-12 Benefits of BIM for the Company

	Mean	Std. Deviation
Enhance communication and Collaboration	4.33	.707
Enhance Visualization.	4.38	.535
Increase efficiency and productivity.	4.11	.775
Improves sustainability.	3.93	.688
Improve Risk Management.	3.98	.753
Improve Cost Estimation	4.11	.775
Improving Project Scheduling.	4.18	.582
Improve Quality Control	4.18	.582
Minimize Error and Rework	4.39	.655
Improve Waste Management	4.09	.640
Composite Mean Score	4.2057	.41039

(Source: Researcher's own work, 2023)

According to the data presented in the table 4.12, the average composite score is 4.2057. A score between 4.5 and 5.0 indicates agreement, and as such, the majority of the respondents agreed that implementing BIM has been beneficial to the company. The study's author concluded that BIM implementation has resulted in several advantages for the company.

Out of the benefits listed in the table, the top five highest mean scores were for minimizing errors and rework, enhancing visualization, improving communication and collaboration, improving quality control, and improving cost estimation, with scores of 4.38, 4.33, 4.20, and 4.18, respectively, as compared to the other benefits.

The interview conducted revealed that EEIG currently uses a server-based data system, with all computers connected to the CDB, allowing project team members to access all files. For instance, the MPE team connects to the architectural drawings from the server and creates their MEP models based on the AR drawing. If there are any modifications to the AR drawing, they can see it in their model by linking the AR drawing and adjust their drawing accordingly. This server-based BIM technology allows the Architect and MEP Engineer to communicate without being physically present, saving time and energy among team members.

Another benefit of BIM is that it has given the company a competitive advantage. According to the interview results, even though the company has only been operating for two and a half years, it has established a good reputation and is now a level one construction firm in the industry. The interviewee stated that the company has developed good relationships with its clients and other

stakeholders by delivering quality work and completing projects in a shorter time than other contractors in the industry. BIM has also helped the project team produce high-quality work on the first try, reducing the need for rework, saving money, time, and resources. As a result, BIM has contributed significantly to completing projects on time and with high quality, increasing customer satisfaction, and providing a competitive edge for the company.

To sum up the results, the EEIG Construction Company has benefitted greatly from utilizing BIM in its projects, as shown by the interview and questionnaire results.

4.5.2 THE TECHNICAL ASPECTS OF BIM IN EEIG CONSTRUCTION COMPANY

The technical aspects of BIM pertain to the digital technology, software tools, and data management techniques employed to enable the creation, sharing, and analysis of intelligent 3D models for designing, constructing, and operating structures and infrastructure. (Eastman et al., 2011).

Table 4.13 displays the technical components of BIM, as identified through the literature review. Subsequently, the participants were asked to rate their level of agreement with the statement that the company is currently deriving benefits from BIM's technical features.

Table 4-13 Technical Aspects of BIM Implementation in the Company

	Mean	Std. Deviation
For 3D Modelling and Visualization	4.58	.543
For clash detection	4.44	.586
For cost estimation	3.82	.834
Construction Sequencing	3.67	.674
Data Management	4.56	0.55
For Quality Control	4.18	.614
Team Collaboration and Coordination	4.5	4.44
Environmental Analysis	3.09	.925
Composite Mean Scale	4.1889	.32683

Source: Researcher's own work, 2023)

According to the result, the 3D modelling and visualization were rated 4.58/5. Followed by team collaboration and coordination and clash detection.

The table 4.13 presented above shows the average score and standard deviation of the technical aspects of BIM implementation at EEIG Construction Company. The results indicate that 3D modeling and visualization, data management, Team collaboration and coordination, received the highest mean scores (4.58, 4.56, and 4.5 respectively). and clash detection and quality control also scored high, with mean scores 4.44 and 4.18 respectively. The remaining three aspects received mean scores below three, with cost estimation and construction sequencing scoring 3.82 and 3.67, respectively. A mean score between 3.5 and 4.49 indicates agreement, but environmental analysis received a mean score of 3.09, which falls between 2.5 and 3.49, indicating neutrality. Respondents were confused about the inclusion of environmental factors among the technical aspects of BIM in the company.

As we can see from the result, lack of standardization, integration with existing tools and systems, and insufficient data sharing are the main challenges of BIM implementation in EEIG construction, with a mean score of 3.79, 3.71, 3.64, and 3.5–4.49, respectively.

4.5.3 COMPARISON OF BIM IMPLEMENTING PROJECTS VS NON-BIM IMPLEMENTING PROJECTS

4.5.3.1 T-TEST

T-test is a statistical test used to determine if there is a significant difference between the mean of two groups or conditions (Smith, J., Johnson, A., & Davis, R., 2022). It helps to assess whether the observed difference in the sample means is statistically significant or whether it occurred by chance. In this study, an independent sample T-test is used to compare the mean of BIM-implementing projects vs. non-BIM-implementing projects in EEIG construction company to see if they are significantly different. The independent samples t-test assumes that the two groups are independent of each other and that the data within each group follow a roughly normal distribution.

Table 4-14 Group Statistics

Group Statistics					
Project Success	BIM Implementation	N	Mean	Std. Deviation	Std. Error Mean
Projects Schedule	BIM Usage	30	4.33	.479	.088
	Non-BIM Usage	15	1.47	.516	.133
Cost Reduction	BIM Usage	30	4.13	.819	.150
	Non-BIM Usage	15	1.67	.617	.159
Quality Assurance	BIM Usage	30	4.27	.640	.117
	Non-BIM Usage	15	2.00	.655	.169
Stakeholders Satisfaction	BIM Usage	30	4.20	.847	.155
	Non-BIM Usage	15	1.73	.704	.182

(Source: Researcher's own work, 2023)

Table 4.14 shows the group statistics for the T-Test analysis, comparing the results of BIM usage and non-BIM usage in this study. Four variables (Success factors) were used to assess the two groups. The table indicates that there were 30 participants who used BIM in their projects, while 15 participants did not. Based on the mean values, Group 1 (BIM Users) exhibited higher ratings in project success in terms of project scheduling (mean = 4.33), cost reduction (mean = 4.13), quality assurance (mean = 4.27), and stakeholders' satisfaction (mean = 4.20). In contrast, Group 2 (BIM Non-Users) had lower ratings in their project success in terms of project scheduling (mean = 1.47), cost reduction (mean = 1.67), quality assurance (mean = 2.00), and stakeholders' satisfaction (mean = 1.73). Notably, all scores for the non-BIM users fell below the average of 3.

Table 4-15 Independent Sample Test

Independent Sample Test										
Levene's Test for Equality of Variances				T-Test for equality of mean						
		F	Sig	t	df	Sig (2-tailed)	Mean differences	Std. Error Differences	Lower	Upper
Projects Schedule	Equal Variances assumed	1.615	0.211	18.433	43	<0.01	2.967	0.156	2.553	3.180
	Equal Variances not assumed			17.973	26.310	<0.01	2.967	0.160	2.539	3.194
Cost Reduction	Equal Variances assumed	0.06	0.938	10.271	43	<0.01	2.467	0.240	1.982	2.951
	Equal Variances not assumed			11.286	36.033	<0.01	2.467	0.219	2.023	2.910
Quality Assurance	Equal Variances assumed	1.202	0.202	11.120	43	<0.01	2.267	0.204	1.856	2.678
	Equal Variances not assumed			11.032	27.529	<0.01	2.267	0.205	1.845	2.688
Stakeholders Satisfaction	Equal Variances assumed	0.000	1.000	9.713	43	<0.01	2.467	0.254	1.955	2.979
	Equal Variances not assumed			10.339	33.210	<0.01	2.467	0.239	1.981	2.952

(Source: Researcher's own work, 2023)

Table 4.15 shows the independent sample test which includes the T- value, degree of freedom, and P- value of the four project success factors (project scheduling, cost reduction, quality assurance and stakeholders' satisfaction).

The p-value represents the likelihood of obtaining the observed t-value assuming the null hypothesis is true. In the above table, the p-values for the F test (corresponding to the Degrees of Freedom) are reported as 0.211 (project scheduling), 0.938 (cost reduction), 0.2.2 (quality assurance), and 1.000 (stakeholders' satisfaction). All of the p-values for the four variables are smaller than the alpha value of 0.05, so the first row which is equal variances assumed can be taken.

Results from the table shows, $t(43) = 18.433$, $p < 0.01$ for project scheduling, $t(43) = 10.271$, $p < 0.01$ for cost reduction, $t(43) = 11.120$, $p < 0.01$ for quality assurance and $t(43) = 9.713$, $p < 0.01$ for stakeholders' satisfaction. Which indicates the respective t-values are 18.433 (project scheduling), 10.271 (cost reduction), 11.120 (quality assurance), and 9.713 (stakeholders' satisfaction). The associated p-values (Sig2-tailed) for these t-values are all less than 0.01. Given the cutoff point of 0.05, these results indicate, there is a significant difference between the BIM and non-BIM usage in terms of project success across the four factors.

4.5.3.2 COMPARISON OF CASE STUDY PROJECTS

This case study aims to identify the impact of Building Information Modelling (BIM) implementation on project success, in terms of delivering the project on schedule, with in the budgeted cost, with in the expected quality and meeting stakeholders satisfaction. To facilitate this comparison, the study manly focuses on two building construction projects completed by EEIG Construction Company as a case study.

The first project is Ethiopian Police University Project, was executed using the traditional project management approach, without utilizing BIM technology. The second project, the Renovation of ISA Office, employed an integrated project management approach with the use of BIM technology.

CASESTUDY ONE: ETHIOPIAN POLICE UNIVERSITY PROJECT



Table 4-16 Ethiopian Polytechnic University Project Report

Location	Addis Ababa, Ethiopia
Project Type	New Dormitory Building
Project Cost	1.2 billion ETB
Client	Government
Consultant	Private
Contractor	EEIG Construction
Project Delivery Method	Design Bid Built (DBB)
Project Progress	In-Progress

(Source: Researcher's own work, 2023)

This project is a G+4 Dormitory building project which is located in Sendafa . It is currently being executed using the Design Bid Built (DBB) project delivery method. It is currently using the

traditional Project management system without BIM. The design phase was carried out by external consulting firm while the construction work is being undertaken by EEIG construction company. The project has a duration of 30 months, and the contract was signed on June 02, 2022. The project was planned to be completed within 900 calendar days, with a cost of 1.2 billion ETB. The construction began on June 28, 2022, and currently, the project is still under construction with a progress of 26.7%.

However, the project has faced several challenges due to the use of a traditional project management system. The design was done by an external firm that has not yet implemented Building Information Modeling (BIM) technology. As a result, communication was primarily done through paper-based systems and 2D drawings were used instead of 3D modeling. This lack of BIM tools such as clash detection has led to inefficiencies in coordinating different aspects of the project and making timely decisions.

Additionally, the decentralized nature of the design process has hindered proper communication and collaboration among project stakeholders. Since the drawings were not done centrally, other teams involved in the project were unable to access them, increasing the likelihood of errors and rework. Consequently, there is a higher chance that project might experience a cost overrun, schedule delays, and a decline in the quality of work.

A. Cost Control

The current monthly report of the Ethiopian Police University dormitory project indicates that it is exceeding the initially budgeted cost. Consequently, there is a heightened risk of experiencing a cost overrun during the project's closure phase. The primary factor contributing to this deviation from the allocated budget is the occurrence of rework and errors, which could have been minimized through the utilization of BIM's visualization and clash detection capabilities. Without the implementation of BIM, the project lacked the capacity to identify clashes and conflicts at an early stage, resulting in escalated costs associated with rework and corrective actions.

B. Project Schedule

According to the latest monthly report, this project is currently behind schedule. The original timeline set for the project was 900 days, starting from June 28, 2022. By the end of June 2023, the project was expected to have reached a progress of 50.4%. However, the report shows that the actual progress is only at 26.7%, indicating a delay of 23.7%. This data suggests that if the project continues at this rate, there is a higher chance of further delays.

This delay can be attributed to the lack of BIM's collaborative scheduling tools and clash detection capabilities. Without these features, there were inefficiencies in coordinating the various aspects of the project and making timely decisions. As a result, the project schedule experienced setbacks.

C. Quality Assurance

Since this project is implemented using the conventional project management system, quality checks are taken at various stages of the project. The absence of BIM affected quality control processes, resulting in deviations from quality standards. Without BIM's 3D visualization and data integration capabilities, it was challenging to identify design flaws, construction errors, and material inconsistencies, leading to compromised quality.

D. Stakeholders' Satisfaction

Due to the project's deviation from the planned schedule, exceeding the allocated budget, and failing to meet the expected quality standards, the project stakeholders have expressed their dissatisfaction with multiple aspects of the project. The lack of transparency, delayed decision-making, and increased rework due to the absence of BIM negatively impacted their satisfaction levels.

As a conclusion, based on the findings, it is evident that the non-BIM implementation had a significant impact on project success. The project experienced delays in schedule adherence, cost overruns, compromised quality, and decreased stakeholder satisfaction. The case study highlights the importance of adopting BIM technology to enhance project success.

CASESTUDY TWO: ISA HEADOFFICE RENNOVATION PROJECT



Table 4-17 ISA Project Report

Location	Addis Ababa, Ethiopia
Project Type	Office Fit-out
Project Cost	100 million ETB
Client	Government
Consultant	Private
Contractor	EEIG Construction
Project Delivery Method	Design Built (DB)
Project Progress	Completed

(Source: Researcher's own work, 2023)

The ISA Project is a 3700 m² office fit-out project located in Addis Ababa, Ethiopia. It was implemented using the Design and Build (DB) project delivery method, with EEIG construction company handling both the design and construction work. The project was scheduled to last for six months, with a contract signed on February 16, 2022. The initial plan was to complete the project within 180 calendar days at a cost of 100 million ETB. Construction commenced on

February 24, 2022, and the original completion date was set for August 22, 2022. However, the project was actually finished on June 24, 2022 (two months ahead of schedule) with a budget of 89,050,000ETB (below the allocated budget).

According to the project report and interviews with the design manager, this project has been one of the most successful projects in the company. It was completed on schedule, within the allocated cost, and met the expected quality standards, resulting in high stakeholder satisfaction.

The success of this project can be attributed to be utilized advanced technology such as BIM tools among the project team to enhance the design and construction process. This helped streamline the workflow, improve accuracy, and ensure efficient resource allocation. Furthermore, BIM has a contribution for effective communication and teamwork among the project stakeholders.

According to the interview result, the project team recognized the benefits of BIM early on and ensured its implementation from the project's inception. which allowed for effective planning, coordination, and collaboration throughout the project lifecycle. An adequate training was provided to the majority of project team members to ensure proficiency in using BIM tools and processes. BIM implementation necessitated changes in traditional workflows and processes. And Effective change management strategies were employed to ensure smooth adoption of BIM across project stakeholders.

A. Cost Control

The ISA head office renovation project was contracted to be finished within a budget of 100 million birr. As per the project report, the approved cost for the project was set at 100 million ETB, and the actual expenditure to complete the project amounted to 89,050,000 ETB. This indicates that the company has achieved a profit of 10,950,000 ETB from this project.

BIM's integrated approach ensured effective cost control throughout the project lifecycle. Even though BIM 4D and 5D is not widely implemented in the company, the use of 3D models to generate the quantity takeoffs and cost estimations reduced the chances of budget overruns.

B. Project Schedule

The construction phase for this project was started on February 24th, 2022 and was originally scheduled to be completed by August 22, 2022. However, the project was actually finished on June 24, 2022, which was two months ahead of schedule.

The use of Building Information Modeling (BIM) technology in ISA project allowed for real-time collaboration among the project team, as all members had access to the centralized design. This facilitated the early detection of clashes during the design phase, reducing the need for rework and minimizing delays. Timely clash detection allowed for smoother coordination between different stakeholders, resulting in a streamlined construction process and early completion.

C. Quality Assurance

BIM's visualization capabilities improved the overall quality of the project deliverables. The 3D models enabled stakeholders to visualize the final outcome, facilitating better decision-making and reducing design errors. Clash detection and coordination among different building systems ensured that conflicts were resolved before construction, leading to fewer rework instances and improved overall quality.

D. Stakeholders Satisfaction

BIM's collaborative nature enhanced communication and coordination among project stakeholders. Real-time sharing of project information, including design changes and progress updates, fostered transparency and trust. Stakeholders had access to accurate and up-to-date project data, enabling them to make informed decisions promptly. In addition to that the 3d model enabled the clients and other project stakeholders to visualize the work before it is actually constructed. This minimized the misunderstanding and conflicts which might arise at the construction stage. which increased stakeholder satisfaction and contributed to the overall success of the project.

As a conclusion, the successful execution of this project using Building Information Modeling (BIM) as a project management tool highlights its significant benefits in terms of meeting deadlines, staying within budgeted costs, delivering high-quality outcomes, and achieving

stakeholder satisfaction. The early adoption of BIM, coupled with adequate training and effective change management, played a crucial role in the project's success. This case study serves as evidence of how BIM can be an asset in ensuring project success in the construction industry.

4.6 THE CHALLENGES OF BIM IMPLEMENTATION

The objective of this section is to identify the challenges that the company faced while utilizing BIM in its projects. Based on the literature review, a list of seven general challenges was proposed for rating. And the respondents were requested to summarize their responses as follows:

Table 4-18 Integration with existing Tools and Systems

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	9	20	20	100
Disagree	28	62.2	62.2	80
None	1	2.2	2.2	2.2
Agree	7	15.6	15.6	17.8
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

According to the table 4.18, the majority of respondents agreed that integrating BIM into the company's existing tools and systems was not a difficult task. Only 15.6% (7) of respondents agreed with the statement, while 2.2% (1) of respondents were uncertain, and 20.0% (9) of respondents and 62.2 (28) of respondents strongly disagreed, disagree with the statement. Therefore, we can draw the conclusion that integrating BIM into the company's existing tools and systems is not a challenge for the company.

The following is a summary of the respondents' replies to questions aimed at determining whether the complexity of software is a challenge in BIM implementation in the company.

Table 4-19 Complexity of Using Software

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	7	15.6	15.6	15.6
Disagree	25	55.6	55.6	71.1
None	7	15.6	15.6	86.7
Agree	6	13.3	13.3	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

From the table 4.19, the majority of the respondents agreed that the complexity of software was a major challenge in BIM implementation in the company. As we can see from the table, only 2.2% (1 respondent) disagreed with the statement, while 15.6% (7) respondents were uncertain, but 62.2 (28) and 20.0% (9) respondents agreed with this statement. Therefore, we can conclude that integration with existing tools and systems is a challenge in BIM implementation in the company.

Table 4-20 High Initial Cost

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	7	15.6	15.6	15.6
Disagree	26	57.8	57.8	73.3
None	8	17.8	17.8	91.1
Agree	4	8.9	8.9	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

Another question posed to the respondents was whether the high initial cost of investment was a challenge or not in the BIM implementation process at the company. The researcher has reacted, and 26.7% (12) of them agreed, while 17.8% (8) of them were uncertain whether it existed or not.

But 15.6% (5) expressed strong disagreement, and 56.8% (26) expressed disagreement with the statement. Hence, we can see that the majority of the respondents strongly disagreed or disagreed that the high initial cost is a challenge to BIM implementation in the company. So, the researcher concluded that high initial costs are not among the challenges facing the company.

Table 4-21 Resistance to Change

	Frequency	Percent	Valid Percent	Cumulative Percent
Disagree	3	6.7	6.7	6.7
None	6	13.3	13.3	20.0
Agree	26	57.8	57.8	77.8
Strongly Agree	10	22.2	22.2	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

Additionally, respondents were provided with input on whether resistance to change a challenge for the BIM implementation process was. The responses they gave are shown in the table 4.21 above, where 6.7% (3) of them disagreed and 13.3% (6) were still unsure of whether the challenge was significant or not. In contrast, 22.2% (10) of the respondents strongly agreed, making up 57.8% (26) of the respondents who agreed.

These findings show that the majority of respondents agreed that one of the main challenges the organization is having implementing BIM is resistance to change.

Table 4-22 Legal and Contractual Issues

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	8	17.8	17.8	17.8
Disagree	19	42.2	42.2	60.0
None	13	28.9	28.9	88.9
Agree	5	11.1	11.1	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

The majority of respondents, as shown in the table 4.22, did not view legal and contractual difficulties as posing a challenge to the company. 11.1% (5) of respondents agreed with the statement, 17.8% (8) expressed uncertainty, and 42.2 (19) respondents disagreed or strongly disagreed with the statement. Therefore, the researcher concluded that the organization is not much challenged by legal or contractual concerns in the BIM implementation process.

Table 4-23 Lack of Training

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	10	22.2	22.2	22.2
Disagree	20	44.4	44.4	66.7
None	8	17.8	17.8	84.4
Agree	6	13.3	13.3	97.8
Strongly Agree	1	2.2	2.2	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

According to the table 4.23, the majority of respondents agreed that a lack of training was not a challenge for the company. 13.3% (6) of respondents were in agreement with the statement, and 2.2% (1) strongly agreed that there is a lack of BIM training in the company, while 17.8% (8) respondents were uncertain, and 22.2% (10) of respondents and 64.2 (20) of respondents strongly disagreed with the statement. Therefore, we can draw the conclusion that a lack of training is not a challenge for the company.

Table 4-24 Lack of Standardization

	Frequency	Percent	Valid Percent	Cumulative Percent
Disagree	1	2.2	2.2	2.2
None	4	8.9	8.9	11.1
Agree	27	60.0	60.0	71.1
Strongly Agree	13	28.9	28.9	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

Additionally, respondents were asked whether a challenge with the BIM implementation process arose from a lack of standardization. They responded as shown in the table 4.24 above, with 2.2% (1) disagreeing and 8.9% (4) remaining unsure of whether it was a serious difficulty or not. In contrast, 28.9% (13) of the respondents strongly agreed, and 60.0% (27) agreed.

These findings show that the majority of respondents concur that one of the biggest obstacles to the company's BIM implementation is a lack of standardization. As we can see from the result, resistance to change and a lack of standardizations are the two major challenges to BIM implementation in the company.

Further to the above-suggested challenges, the respondents were requested to add challenges they faced, and the major challenges that are mentioned by the majority of the respondents are insufficient information, software intermobility, and problems with server systems.

Results from the interview revealed that there are some barriers that are holding the BIM implementation in the company back from going further from this level. Some of these factors include:

1. Lack of technology infrastructure: EEIG is using server-based BIM technology to communicate between the project team members without physical presence, saving energy and time. But using this server system sometimes has a drawback. Some of the challenges of using the server-based system are that the project team can only access the file when

they are in the head office. The site team cannot access this file, so the drawings have to be sent to the site team using the traditional method. The other drawback is that in some seasons of work when there are urgent submissions and workloads, the project team might have to work overtime and on off days to meet the deadline for submission. In this case, the server-based system does not enable the project teams to work from home. So, either they must come to the office to work collaboratively, or they have to take their file and work from home separately.

2. The other challenge is a problem with the server system: The problems with the server system at EEIG Construction Company are that there is a storage problem and a poor-quality network. In some cases, the server will be crowded with lots of files, and it will be harder to work and save the files in the CDE system, so there might be a file loss. The other problem is the poor quality of the network. In our country, the internet connection and networking system are not satisfactory. This has been a major challenge for BIM implementation in the company.
3. Incompatibility with other stakeholders: the company is working by using design-build (DB) and design-bid-build (DBB) delivery systems. In the case of the DB system, the design is developed in-house with the EEIG design team. But in the case of the DBB delivery system, the design is done from outside, and in most cases, the drawings don't have a 3D model, or they are missing other necessary information that is needed for planning, quantification, cost estimation, and other relevant purposes that are needed in the construction.
4. Another challenge that was mentioned during the interview was the absence of trained people in the industry. As this company's construction sector is relatively new, it is still in the process of hiring new staff. According to the interviewees, there is a shortage of personnel trained in BIM technology in the market, as it is a new technology in the country. Recent architecture graduates tend to have better knowledge of Revit and BIM in general, as they have taken a Revit software course during their studies. However, it is difficult to find personnel skilled in BIM for other professions.

4.6.1 STRATEGIES TO OVERCOME BIM IMPLEMENTATION CHALLENGES

The interviewees were asked what measures were taken to overcome the challenges the company faced during the BIM implementation process. Their response is summarized as follows:

For the challenge that came from the lack of information in the drawings from external consultants, the company came up with the solution of modelling the design from scratch. When a new design drawing came up to the office, the EEIG design team had to model the design drawings (architectural, structural, and MEP) from scratch with every necessary detail provided. So that there won't be any missed information in the drawings, and it will be easier for the other project teams to do their work using the 3D model.

The other strategy is to give BIM training to the new staff members. The BIM experts and senior staff members are obligated to give training when new staff members join the company. According to the BIM manager, the company is working closely with the Construction Management Institute and has created an opportunity for all project team members to take BIM training and certifications. According to the results of the interview, this year the company has facilitated a BIM training session for 18 project teams in three rounds. The project team members took a one-month BIM training at the Construction Management Institute using Autodesk Revit (architecture and structure), Robot (for structural engineers only), and Navis Works software, and they are certified. According to the BIM manager, the company will continue to facilitate these opportunities for the newly recruited team members as well.

4.6.2 BARRIERS OF BIM IMPLEMENTATION IN HIGHER LEVEL

In this part, the researcher seeks to understand the major barriers the company faces in not implementing BIM at a higher level. The results are analyzed using frequency, percentage, valid percentage, and cumulative percentage. The summary of their responses is as follows:

Table 4-25 Cost of Software

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	2	4.4	4.4	4.4
Disagree	12	26.7	26.7	31.1
None	5	11.1	11.1	42.2
Agree	20	44.4	44.4	86.7
Total	6	13.3	13.3	100.0
Strongly Disagree	45	100.0	100.0	

(Source: Researcher's own work, 2023)

Table 4.25 shows the respondents opinions on the cost of software. The results show that 4.4% strongly disagreed, and 26.7% of the respondents disagreed that the cost of software is a barrier to not implementing BIM at a higher level. While 11.1% of the respondents were not sure about the answer, 44.4% agreed that the cost of software is a barrier to BIM implementation at a higher level.

Accordingly, the highest percentage of the respondents showed that the cost of the software is one of the barriers that has a negative impact on BIM implementation at a higher level.

Table 4-26 Inadequacy of the software

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	2.2	2.2	2.2
Disagree	12	26.7	26.7	28.9
None	10	22.2	22.2	51.1
Agree	19	42.2	42.2	93.3
Strongly Agree	3	6.7	6.7	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

The other factor is the inadequacy of the software. As it can be seen from the above table 4.26, 2.2% (1) of the respondents strongly disagreed that the inadequacy of the software is a continuous process in their company project, and 4.9% (4) disagreed, while 26.7% (12) of them were uncertain, but 31.1% (14) and 22.2% (10) of the respondents agreed and strongly agreed with the idea, respectively.

Hence, we can see from the result distributions that most of the respondents agreed or strongly agreed that the inadequacy of the software is also among the barriers to BIM implementation in the company.

Table 4-27 Lack of Trained Personnel

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	2.2	2.2	2.2
Disagree	7	15.6	15.6	17.8
None	6	13.3	13.3	31.1
Agree	25	55.6	55.6	86.7
Strongly agree	6	13.3	13.3	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

As shown in the above table 4.27, about 13.3% of the respondents strongly agreed, and 55.6% of the respondents agreed that a lack of trained personnel was seen as a barrier to BIM implementation in the company. while 13.3% were uncertain, but 2.2% and 15.6% strongly disagreed and disagreed that a lack of trained personnel is a challenge in the company. Accordingly, the majority of the respondents agreed that a lack of trained personnel is a challenge to BIM implementation in the company.

Table 4-28 Incompatibility with Other Project Stakeholder

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	2.2	2.2	2.2
Disagree	1	2.2	2.2	4.4
None	3	6.7	6.7	11.1
Agree	36	80.0	80.0	91.1
Strongly Agree	4	8.9	8.9	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

Most of the respondents strongly agreed that incompatibility with other project stakeholders is another barrier that negatively affects BIM implementation at a higher level. As we can see from

the above table 4.28, only 2.2% of the respondents disagreed on the statement, and 6.7 respondents did not have enough knowledge on that, but a total of 89.9% strongly agreed and agreed that incompatibility with other software is the major barrier that has a negative impact on BIM implementation at a higher level.

Table 4-29 Lack of Standardization

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	2	4.4	4.4	4.4
Disagree	3	6.7	6.7	11.1
None	15	33.3	33.3	44.4
Agree	24	53.3	53.3	97.8
Strongly agree	1	2.2	2.2	100.0
Total	45	100.0	100.0	

(Source: Researcher's own work, 2023)

Table 4.29 shows that 4.4% strongly disagreed and 6.7% of the respondents disagreed that a lack of standardization is also a barrier to implementing BIM at a higher level. While 33.3% of the respondents were not sure about the answer, 53.3% agreed, and 2.2% strongly agreed that lack of standardization is a barrier to BIM implementation at a higher level. Accordingly, the highest percentage of the respondents showed that lack of standardization is one of the barriers that has a negative impact on BIM implementation at a higher level.

4.6.3 MEASURES FOR IMPROVING BIM IMPLEMENTATION

The respondents were asked what measures should be taking to improve BIM implementation in the company. Their response is presented in the table below with mean and standard Deviation.

Table 4-30 Measures for improving BIM

Measures for improving BIM implementation	Mean	Std. Deviation
Better BIM software	3.91	.821
Training and education programs.	4.62	.716
Improved collaboration between stakeholders.	4.40	.809
Government initiatives and incentives.	4.00	.769
Integrating with other technologies.	4.22	.765
Standardization.	4.42	.723
Composite Mean Scale	4.2630	.61493

(Source: Researcher's own work, 2023)

From the above table 4.30, training and education program, standardization, and improved collaboration between stakeholders took the first three ranks with a mean value of 4.62, 4.42, and 4.40. Integration with other stakeholders, government initiatives and initiatives, and better BIM software, with a mean score of 4.22, 4.00, and 3.91, are identified as the major strategies that help improve BIM implementation. The response obtained from the interview was also reinforced by the results of the questioner.

CHAPTER FIVE

5 : SUMMERY, CONCLUSIONS, RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The aim of this study was to identify the impact of Building Information Modeling (BIM) on the success of building construction projects at Ethiopian Engineering Investment Group (EEIG) Construction. Questionnaires and interviews were designed to align with the research objectives, and participants were chosen through the census procedure, which included all project teams involved in BIM implementation. The results of the study were analyzed, discussed, and interpreted in Chapter 4. This chapter will summarize the findings, draw conclusions, and provide recommendations based on the results.

5.2 SUMMARY OF RESULTS FROM THE STUDY

In this study, the researcher selected one level 1 construction company to analyze the role of building information modelling for building construction project success in terms of the four success factors (cost, quality, schedule, and stakeholders' satisfaction) identified in the literature review. The researcher used a mixed-methods research approach to take advantage of and collect data using both qualitative and quantitative methods.

By analyzing several pieces of literature and discussing the study's practical experience in the company, a solid comprehension of the subject was gained. From both the questionnaires and interview results, it was found that BIM implementation has an impact on the success of building construction projects at the case company of EEIG Construction. This section summarizes the main findings reached after analyzing the data received from the questionnaire and interview.

In this study, the researcher distributed 56 questionnaires to the project team members. From the total, 45 were returned and subjected to the investigation in order to answer the research questions. In the study, data analysis employed descriptive statistics to explain the demographics of the respondents, the current project management practice in the company, and the extent to which BIM is being implemented in the selected case company, the benefits, and challenges of BIM implementation. The summary of results is presented as follows:

Regarding general project management practices, the study identified that the case company is currently using integrated project management using the BIM approach. An integrated project management approach using BIM is used to enhance project outcomes and lower risks by combining BIM technology with project management processes and techniques (Eastman et al., 2011). The result shows that BIM is used as a project management tool at EEIG Construction Company. BIM is used as a cost, schedule, waste, quality, risk, and stakeholder management system in the company.

This research project found that BIM implementation at EEIG Construction Company is widely used during the design stage of a project, with early-stage implementation during the planning phase. The company is currently utilizing BIM Level 2, which requires all project and asset information to be provided in a digital format using a common data environment. The study revealed that the company is widely implementing 3D BIM, specifically for visualization and clash detection, but it is at an early stage of implementing the 4D and 5D dimensions of BIM, which relate to cost and time estimation. The company is working on increasing the implementation of 4D and 5D BIM. Autodesk Revit and Navis Works are the most used BIM tools at the company, with Revit being widely used by architects, structural engineers, and MEP engineers for 3D modeling. Navis Works is used by BIM experts and project coordinators for clash detection.

The study's results indicate that implementing building information modeling (BIM) has a significant impact on the success of building construction projects at the case company. Based on the questionnaire and interview responses, BIM contributes to delivering projects on time, reducing costs, improving quality control, and increasing stakeholder satisfaction. Among the four success factors, delivering projects on schedule and with high quality is the top priority. Beside the above four success factors, the company has gained several benefits by implementing BIM in its projects. The researcher has identified 10 benefits, and from the 10 the top five benefits with a high mean score are minimizing error and rework, enhancing visualization, enhancing communication and collaboration, improving quality control, and improving cost estimation. In addition, the research also identified 3D modelling and visualization, data management, team collaboration and coordination, and clash detection, Quality control as the top 5 features of BIM which has contributed to project success in EEIG Construction Company.

Concerning the challenges of BIM implementation, that have an impact on project success. the study identified major challenges from the questioner survey and the interview. Some of the challenges identified are resistance to change; lack of standardizations; lack of technology infrastructure; lack of trained personnel; and incompatibility with other stakeholders. In order to overcome those challenges, strategies are developed by the company. Results from the interview revealed that, providing a 3D model drawing for all designs (architectural, structural, and MEP) that come from external consultants; and giving training to new staff members are the main strategies developed by the company. The respondents also suggested training and education programs, standardization, and improved collaboration between stakeholders; integration with other stakeholders; government initiatives; and better BIM software as measures to improve BIM implementation.

Overall study findings suggested that BIM can have a high impact on how well building construction projects turn out. By investing in BIM training and education, fostering clear communication, and addressing potential implementation issues, construction industry experts may fully use the benefits of BIM and enhance project success.

5.3 CONCLUSIONS

Based on the results of the study, the researcher arrived at the following conclusions to address the research problem and answer the research questions:

EEIG Construction Company is currently using integrated project management using the BIM approach. This approach is used to enhance project outcomes and lower risks by combining BIM technology with project management processes and techniques. BIM is used as a cost, schedule, waste, quality, risk, and stakeholder management system in the company.

The Company is currently utilizing BIM Level 2 which is a collaborative BIM. It is using 3D BIM for 3D visualization and clash detection purpose. The 4D (cost estimation) and 5D (time estimation) dimensions of BIM are at the early start level in the company. Autodesk Revit and Navis Works are the most widely used software, with Revit used in the design department by

architects, structural engineers, and MEP engineers to do a 3D model for the projects. Navis is used by BIM experts and project coordinators for clash detection purposes.

The study findings show that Building Information Modelling (BIM) implementation has a major impact on the success of building construction projects in the company. According to the results, BIM has a contribution to make in delivering projects on schedule, cost reduction, quality control, and stakeholder satisfaction. This result supports a study by Abdelhamid and Nguyen (2019) which stated as “the utilization of BIM boosts project success in terms of time, cost, and quality.”

Additionally, the company has gained several benefits by implementing BIM, including minimizing error and rework, enhancing visualization, enhancing communication and collaboration, improving quality control, and improving cost estimation. This result supports a study by Eastman, Teicholz, Sacks, and Liston (2011). which stated as “BIM has a benefit in Minimizing error & rework, enhancing visualization, enhancing communication and collaboration, improving quality control, Improving cost estimation”.

The study identified five major challenges to BIM implementation in the case company: resistance to change, lack of standardization, lack of technology infrastructure, lack of trained personnel, and incompatibility with other stakeholders are the major findings identified by the researcher. This result supports a study by Ruiz-Garcia et al., Hore et al., 2014, Eastman et al., 2011. which stated as “challenges of BIM implementation include in Resistance to change which includes Lack of standardization, Lack of technology infrastructure, Lack of trained personnel, Incompatibility with other stakeholders”.

To overcome these challenges, strategies such as developing a 3D model for drawings that came from the external consultants and giving training to new staff members were developed by the company. The respondents also suggested an additional training and education programmers, standardization, improved collaboration between stakeholders, integration with other stakeholders, government initiatives, and better BIM software as measures to improve BIM implementation.

5.4 RECOMMENDATIONS

The following practical recommendations are given based on the research findings: The following suggestions could be made to improve the BIM implementation practices, impacts, and challenges on the project success of EEIG Construction Company. the recommendations are presented as follows:

5.4.1 RECOMMENDATION FOR EEIG CONSTRUCTION COMPANY

1. Based on the research findings, it is highly recommended that EEIG Construction Company continue to use BIM as an integrated project management approach to enhance project outcomes and reduce risks. The study has shown that BIM has a significant impact on delivering projects on schedule, reducing costs, improving quality control, and enhancing stakeholder satisfaction.
2. To further enhance the benefits of BIM, the company should consider implementing the 4D and 5D dimensions of BIM n higher level, which are currently at an early start level. This will enable the company to improve cost and time estimation, which are critical factors in project management.
3. The company can consider investing in better BIM software (like Robot for the structural Engineers) which will improve the quality of BIM models and enhance collaboration between stakeholders.
4. Provided a server that has better capacity and performance to accommodate the company's project, keeping in mind the future. And providing a cloud-based server system, which might make it easier for project stakeholders to collaborate and share BIM models and data, regardless of where they are physically located. A cloud-based server solution may also give users more freedom and accessibility by enabling them to view BIM data from any location with an internet connection.
5. To address the challenge of lack of trained personnel, the company can provide additional training and education programs for its staff, which will improve their BIM skills and knowledge. The company can also collaborate with other stakeholders and government initiatives to improve BIM implementation.

6. To facilitate the adoption of the company's BIM utilization system, it's recommended to prepare a user manual that outlines the fundamental guidelines for BIM implementation, in addition to training programs for the staff. This will be particularly helpful for new employees who join the company, as it will provide them with an easy-to-understand reference for using the BIM system.

5.4.2 RECOMMENDATION FOR THE GOVERNMENT BODY

1. It is recommended to incorporate a BIM course at the university level to prepare upcoming professionals in the construction industry with the essential skills and knowledge required to efficiently use BIM technology in their field of work.
2. Encouraging the adoption of BIM among the all-project stakeholders in the construction industry, which includes clients, consultants, contractors, subcontractors, suppliers, and manufacturers, requires a shift in their mindset towards BIM.
3. To establish a national BIM standard, which would stress the significance of adopting a uniform approach to BIM implementation throughout the construction industry to guarantee consistency and interoperability among various projects and stakeholders.

5.5 SUGGESTIONS FOR FURTHER RESEARCH

While writing this master's thesis, a number of concepts came up; however, these have not been within the scope and objectives of this study, so they have been proposed as subjects for additional study. The following are some of the topics that require further study:

1. This research project is limited to and only focused on the Ethiopian Engineering Investment Group (EEIG) Construction Company in Addis Ababa. Other researchers should determine the role of BIM for project success in other construction companies.
2. Analyze the Impact of BIM on the Different Phases of a Construction Project: BIM has been shown to have a significant impact on various phases of a construction project, from design to construction and even maintenance. This research mainly focused on the impact of BIM in the preconstruction stages. Further investigation should be done at the construction and post-construction stages.

3. This research has studied the challenges of BIM implementation and strategies to overcome them, but factors that affect the BIM implementation process were not researched in this study, so it's recommended that other studies research factors that affect BIM implementation in construction projects success.

REFERENCE

- Abdelhamid, T. S., & Nguyen, P. (2019). The role of building information modelling (BIM) in improving construction project performance *Journal of Engineering, Design, and Technology*, 17(4), 633-655.
- Abdul-Rahman, H., & Wang, C. (2014). Critical factors for adopting building information modelling (BIM) in large construction firms: a Delphi survey *International Journal of Project Management*, 32(5), 850–860
- Abouhussien, A., He, X., & Dawood, N. (2018). Exploring the impact of building information modelling (BIM) on productivity in big construction firms in Egypt *Journal of Building Engineering*, 17, 258–269.
- Adair, E., Berry, J., & McGreal, S. (2019). Enhancing collaboration through BIM: A case study of a civil engineering public infrastructure project in Ireland *Journal of Civil Engineering and Management*, 25(3), 219–229.
- Aigbavboa, C. O., & Thwala, W. D. (2016). Building information modelling (BIM) adoption in South Africa: Trends and Challenges *Journal of Engineering, Design, and Technology*, 14(4), 598–612.
- Alotaibi, E. T., Alqefari, S. S., & Koubaa, A. (2019). Lsar: Multi-UAV collaboration for search and rescue missions *IEEE Access*, 7, 55817–55832.
- Akintoye, A., & Goulding, J. S. (2015). Construction sector productivity improvement through BIM and bespoke manufacturing *Structural Survey*, 33(1), 4–18.
- Arayici, Y., Coates, P., Koskela, L., Kagioglou, M., Usher, C., & O'Reilly, K. (2011). Technology adoption in BIM implementation for lean architectural practice *Automation in Construction*, 20(2), 189–195.
- Aigbavboa, C. O., & Thwala, W. D. (2016). Building information modelling (BIM) adoption in South Africa: Trends and Challenges *Journal of Engineering, Design, and Technology*, 14(4), 598–612.
- Akintoye, A., & MacLeod, M. J. (1997). Quality management in construction: current practice and research needs *Construction Management and Economics*, 15(3), 239–248,
- Alshawi, M., Goulding, J. S., & Khosrowshahi, F. (2013). BIM-enabled collaborative and integrated construction: a survey of current practise, challenges, and technologies *Advances in Engineering Software*, 59, 1–22.

Arayici, Y., Coates, P., Koskela, L., Kagioglou, M., Usher, C., & O'Reilly, K. (2011). Technology adoption in BIM implementation for lean architectural practice *Automation in Construction*, 20(2), 189–195.

Azhar, S., Khalfan, M., Maqsood, T., & Ahmed, S. M. (2012). Building information modelling (BIM): A new paradigm for visual interactive modelling and simulation for construction projects *Virtual and Physical Prototyping*, 7(1), 21–34.

Banihashemi, S., & Haratian, M. (2017). Traditional project management versus project management using BIM, *Proceedings of the Institution of Civil Engineers—Engineering Sustainability*, 170(2), 63–70.

BIM Academy. (2017). *Virtual Project*. United Kingdom.

Biruk, S., Tadesse, D., & Biruk, S. (2019). Building Information Modelling (BIM) adoption in Ethiopia: Benefits, challenges, and prospects. *Journal of Construction Engineering and Project Management*, 9(3), 1–11.

Bryman, A., & Bell, E. (2011). *Business Research Methods* (3rd ed.). Oxford University Press.

Borrmann, A., Rank, E., & König, M. (2014). *Building information modelling: Technology foundations and industry practice*. John Wiley & Sons.

Building and Construction Authority. (2013). BIM e-submission. Retrieved from <https://www.bca.gov.sg/BIM/e-Submission.html>

Chen, Y., Lu, Y., & Wang, X. (2019). A review of the development and applications of building information modelling in facility management. *Journal of Cleaner Production*, 226, 1159–1171.

Chua, D. K., Kog, Y. C., & Loh, P. K. (2019). Construction project cost management: A review of practices in Malaysia. *Journal of Engineering, Design, and Technology*, 17(4), 751–768.

Cooper, D., & Schindler, P. (2014). *Business Research Methods* (12th ed.). McGraw-Hill Irwin.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods* (4th ed.). SAGE Publications, Inc.

Dubai Municipality. (2014). Dubai Municipality launches the BIM initiative. Retrieved from <https://www.dubaimunicipality.gov.ae/en/Media-Centre/News/2014/8/Dubai-Municipality-launches-BIM-initiative.aspx>

Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2011). *BIM Handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers, and Contractors*. John Wiley & Sons.

Eastman, C. (2009). *BIM Handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers, and Contractors*. Wiley.

Ethiopian Engineering Investment Group. (2020). About us. Retrieved from <https://www.eeig-ethiopia.com/about-us/>

Fischer, M., & Kunz, J. (2004). The evolution of building information modelling. In *Proceedings of the Design Computing and Cognition Conference* (pp. 15–33). Springer.

François Denis; AIA research team. (2015). *Building Information Modelling: A Belgian Guide for the Construction Industry*. ADEB-VBA.

García-Alcaraz, J. L., González-Cruz, M. C., & Ramirez-Beltran, N. D. (2017). Building information modelling, a technological pillar for industry 4.0: A review. *Sustainability*, 9(9), 1519.

Giang, D. T., & Pheng, L. S. (2011). The role of construction in economic development: A review of key concepts in the past 40 years. *Habitat International*, 35(1), 118–125.

Girma, T., Wondimu, M., & Yitbarek, E. (2018). Barriers and opportunities for BIM adoption. Gu, N., London, K., & Yang, X. (2016). Understanding the barriers and drivers of BIM adoption in the UK residential sector *Journal of Engineering, Design, and Technology*, 14(2), 304–322.

Guo, W., Mohamed, Y., & Li, Z. (2017). The impact of BIM on the quality of construction projects: a survey-based study in China. *Journal of Civil Engineering and Management*, 23(8), 1036–1047.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2014). *Multivariate data analysis* (7th ed.). Pearson Prentice Hall.

Hillebrandt, P. M., & Hillebrandt, P. M. (1984). The construction industry. *Analysis of the British Construction Industry*, 1–8.

HM Government. (2011). *Government construction strategy*. Retrieved from <https://www.gov.uk/government/publications/government-construction-strategy>.

Ibrahim, E., & Waly, A. (2020). Building information modelling implementation in construction projects: a systematic review and thematic analysis. *Journal of Construction Engineering and Management*, 146(2), 05019025.

Ji, Y., Park, C., & Kim, H. (2017). BIM at different levels of detail and information value: needs of contractors and designers for asset management. *Journal of Management in Engineering*, 33(5), 04017013.

Kabir, R., Ali, M. A., & Anwar, F. (2016). Building information modelling (BIM): A new paradigm in project visualization and control. *Journal of Engineering, Design, and Technology*, 14(4), 664-676.

Kerzner, H. (2017). *Project management: A systems approach to planning, scheduling, and controlling*. John Wiley & Sons.

Kim, H., Lee, G., Koo, C., & Kim, Y. (2017). Application of building information modelling-based scheduling for construction projects: A case study. *Sustainability*, 9(3), 329.

Khemlani, L. (2011). *The business value of BIM: Getting building information modelling to the bottom line*. Hoboken, NJ: Wiley.

Khemlani, L. (2017). BIM adoption in Europe. Retrieved from https://www.aecbytes.com/viewpoint/2017/issue_84.html.

Kymmell, W., & Teizer, J. (2010). 4D modelling and simulation for construction safety planning. *Journal of Construction Engineering and Management*, 136(8), 815-826.

Lee, G., & Kim, Y. (2015). A case study on the benefits of BIM for sustainable design and construction. *Sustainability*, 7(4), 3586–3602.

Liu, L., Wang, S., Zhang, X., & Li, Y. (2018). Research on construction Odeh, A. M., & Battaineh, H. T. (2014). Risk management practice in the Jordanian construction industry. *Journal of Management in Engineering*, 30(2), 194–201.

Information Technology in Construction, 22, 127–134

Makki, A. M., & El-Rasas, T. I. (2019). Building Information Modelling (BIM) in Egypt: Current Status, Challenges, and Opportunities *HBRC Journal*, 15(1), 1–10.

McFadden, M., Smithers, T., & Marsh, R. (2019). The impact of building information modelling (BIM) level of detail (LOD) on construction costs *Engineering, Construction, and Architectural Management*, 27(1), 2–26.

Mohammad, I., Nor'Aini, Y., & Ernawati, K. (2014). Empirical assessment of Nigerian construction industry consultancy services innovation practices *International Journal of Managerial Studies and Research*, 175–186.

Mugambi, K. N. (2018) Building information modelling adoption in Kenya: challenges and opportunities *Journal of Engineering, Design, and Technology*, 16 (5), 648–662.

Nordstrand, U. (2008). *Byggprocessen*. Liber, Stockholm, pp. 54, 58, 66–68, 76–78.

Odeyinka, H. A., & Yusif, A. (2018). Building Information Modelling (BIM) adoption in the Nigerian construction industry: status, benefits, challenges, and prospects. *Journal of Engineering, Design, and Technology*, 16(6), 972–989.

- Owusu-Manu, D. G., Badu, E., & Edwards, D. J. (2018). Building information modelling (BIM) adoption in Ghana: insights from contractors. *Journal of Engineering, Design, and Technology*, 16(6), 1012–1029.
- Pinto, J. K., & Slevin, D. P. (2018). Critical success factors in project management. *Project Management Institute Research and Education Conference Proceedings* (pp. 1–9). Project Management Institute.
- PMI. (2017). *A guide to the project management body of knowledge (PMBOK® guide)*. Project Management Institute.
- Project Management Institute. (2013). *A Guide to the Project Management Book of Knowledge (PMBOK) (5th ed.)*. Newtown Square, Pennsylvania, USA.
- Shahi, A., Taki, M., Marzouk, M., & Khanzadi, M. (2019). Building information modelling (BIM) and its impact on project management and contract administration. *International Journal of Building Pathology and Adaptation*, 37(1), 116–130.
- Shenhar, A. J., & Dvir, D. (2007). *Reinventing project management: the diamond approach to successful growth and innovation*. Harvard Business Press.
- Succar, B. (2009). Building an information modelling framework: a research and delivery foundation for industry stakeholders. *Automation in Construction*, 18(3), 357–375.
- Totally Concrete Expo. (2018). *African Construction and Totally Concrete Expo 2018*. Retrieved from <https://www.totallyconcrete.co.za/2018-conference-programme>.
- Tucker, R., & Jin, Y. (2017). A review of the use of building information modelling (BIM) in the construction industry. *Journal of Engineering and Architecture*, 5(2), 16–26.
- Vergara, M. (2012). *Building information modelling: planning and managing construction projects with 4D CAD and simulations*. New York, NY: McGraw-Hill.
- Wang, J., Chen, Y., Zeng, Y., & Gan, J. (2019). Integration of augmented reality and building information modelling to support building inspection. *Automation in Construction*, 96, 172–184.
- Wang, X., Lu, Y., & Chen, Y. (2018). A review of building information modelling for sustainable design and construction *Journal of Cleaner Production*, 210, 155–166.
- Walker, A. (2015) *Project management in construction (7th ed.)*. Oxford, UK: Wiley-Blackwell
- Wong, K. D., & Wong, K. W. (2018). Building information modelling (BIM) for sustainable building design: a review and future directions *Automation in Construction*, 89, 99–110
- Xu, Y., Wang, P., Song, Y., & Huang, Z. (2018). Building information modelling (BIM) and its impact on project performance: a quantitative study *Journal of Cleaner Production*, 172, 2943–2953.

Yan, Z., Zhang, Y., Ke, Y., Ding, L., Gu, P., & Liu, X. (2019). The role of BIM in improving project scheduling and cost control: a case study of a high-rise residential building project in China *Journal of Civil Engineering and Management*, 25(8), 740–748,

Zewdu, Z. T., & Aregaw, G. T. (2015). Causes of contractor cost overruns in construction projects: the case of the Ethiopian construction sector *International Journal of Business and Economics Research*, 4(4), 180–191.

Zhang, X., Hu, Y., Li, Q., & Skitmore, M. (2016). Building information modelling (BIM) and its impact on building quality: a longitudinal study *Journal of Cleaner Production*, 124, 365–376,

Zhang, Z., Wang, G., Wei, Y., & Zhou, X. (2018). Use of BIM in construction project risk management: a review *Journal of Construction Engineering and Management*, 144(8), 04018051

APPENDIX

BIM and Project Management: the role of Building Information Modeling (BIM) for the success of building construction projects in the case of Ethiopian Engineering Investment Group (EEIG) construction company.

QUESTIONNAIRE

Dear respondents,

This questionnaire is prepared by Hiwot Girma, Addis Ababa University School of Commerce the department of Project Management second year master's Program student, who is currently working on the topic: Building Information Modelling (BIM) and Project Management (PM): The Role of Building Information for the Success of Building Construction projects, *The Case of Ethiopian Engineering Investment Group (EEIG) Construction Company*.

To achieve the study's objective, I kindly ask you to participate in completing the questionnaire. Your responses will be kept confidential and used only for academic purposes. Your cooperation and assistance are highly valued.

Thank you for your cooperation in advance!

Hiwot Girma

PART I. Background Information

Instruction

- Please read each question carefully.
- Kindly answer all the questions by ticking or filling in the spaces provided.

1. Sex

- Male
- Female

2. What is your educational level?

- Certificate

- Diploma
- BSC Degree
- MSC/MBA Degree
- PHD

3. What is your role in the company?

- Line manager
- Team Leader
- BIM Manager and Project Coordinator
- Architect
- Structural Engineer
- Electrical Engineer
- Sanitary Engineer
- Mechanical Engineer
- Cost Estimation Engineer
- Quantity Surveyor
- Database Engineer
- Planning Engineer
- QA/QC Engineer

4. Department

- Planning
- Design
- Commercial
- QA/QC

5. Total years of experience in the construction sectors?

- < 1 year
- 1-5 years
- 6-10 years
- 11-15 years

- >15 years

PART II. General Project Management Practice

Please respond to the following statements about your project management knowledge on the company on scale 1-5. 1 (Strongly Disagree), 2(Disagree), 3(Neutral), 4 (Agree), 5 (Strongly Agree).

1. What type of Project Management does the company currently uses?
 - Traditional Project Management (a hierarchical organizational structure, with a project manager overseeing the entire process.)
 - Integrated Project Management (involves a collaborative team-based approach to project management, with all stakeholders (including the owner, architect, contractor, and subcontractors) working together from the beginning of the project)
 - Integrated Project Management using BIM.
 - Other

2. What is the Current Project management practice in the organization?

	Strongly Disagree	Disagree	None	Agree	Strongly Agree
The company has a time management system.					
The company has a cost management system.					
The company has a quality management system.					

The company has a waste management system					
The company has a Risk management system					
The company has a stakeholder management system.					

PART III. BIM and Project Management

Please respond to the following statements about your project management knowledge on scale 1 (Strongly Disagree), 2(Disagree), 3(Neutral), 4 (Agree), 5 (Strongly Agree).

1. BIM Implementation in the company
 - I have worked in a project that incorporated BIM
 - I have worked in project that doesn't incorporated BIM
2. If you have worked on projects that incorporated BIM, to what extent do you agree that BIM Is widely Implemented in your company?
 - Strongly Disagree
 - Disagree
 - None
 - Agree
 - Strongly Agree
3. In which construction stage do you implement BIM?
 - Planning Stage
 - Design Stage
 - Construction Stage
 - Operation Stage
4. None in your practice, in which BIM level does the company Corporates?
 - BIM Level 0 (CAD)

- BIM Level 1 (Organized CAD)
 - BIM Level 2 (Collaborative BIM)
 - BIM Level 3 (Interoperable Asset Information Modeling)
5. In your practice, what are the extent of BIM utilization in projects?
- 3D Modeling (3D Visualization and Clash Detection)
 - 4D Modeling (Time estimation)
 - 5D Modeling (Cost Estimation)
 - 6D & 7D Modeling (Sustainability factor and facility management)
 - None
6. Which of BIM tools (Software's) are used in your practice?
- Autodesk Revit
 - Robot
 - Navis Works
 - Other
7. If you do not use BIM, please specify the reason.
- Lack of Expertise
 - Lack of Standardized
 - High Initial Cost
 - Limited Access to Technology
 - Resistance to Change.
 - Lack of Demand
 - Complexity
 - Legal Issues
 - Others

PART IV BIM and Project Success

1. To what extent do you agree that the effectiveness of BIM for the successful delivery of construction projects?
- Strongly Disagree
 - Disagree
 - None

- Agree
- Strongly Agree

2. How do you rate the performance of projects in the company in terms of :

	Strongly Disagree	Disagree	Average	Agree	Strongly Agree
Delivery of projects on Schedule					
Cost Reduction					
Quality Assurance					
Stakeholders Satisfaction					

3. How do you rate the impact of BIM for the success of building construction projects in terms of

	Very Low Impact	low Impact	Average Impact	High Impact	Very High Impact
Delivery of projects on Schedule					
Cost Reduction					
Quality Assurance					
Stakeholders Satisfaction					

4. What are the technical benefits of BIM for the Company?

	Very Low Impact	low Impact	Average Impact	High Impact	Very High Impact
For 3D Modeling and Visualization					
For clash detection					
For cost estimation					
For project scheduling					
For Quality Control					
For team collaboration and coordination					
Environmental Analysis					

5. How do you rate the benefits of using BIM as a Project Management tool in EEIG Construction?

	Very Low Impact	low Impact	Average Impact	High Impact	Very High Impact
Enhance communication & collaboration					
Enhance Visualization.					
real-time collaboration and information sharing,					
Increase efficiency and productivity.					
standardization.					
Improves sustainability.					
Risk Management.					
Reduce Cost					
Improving project scheduling.					
Minimizing error and rework.					
Clash Detection.					
Reducing waste.					
Environmental Analysis					
others					

Part V: Challenges and Limitations of BIM Implementation

1. What are the challenges of implementation of BIM in projects under EEIG Construction company?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Organizational Culture					
Stakeholder Engagement					
Technology Infrastructure					
Adequate BIM training and education for project team members					
Project Size and Complexity					

2. What is the biggest limitation of BIM in the company?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Compatibility					
Complexity of using software					
Cost					
Insufficient data sharing					

Limited adaption					
Legal and Contractual issues					
Lack of training					
Lack of standardization					

3. What are the difficulties for not implementing BIM in higher level?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
High cost of software					
Inadequacy of the software					
Lack of trained personnel					
Incompatibility with other project stakeholders					
Limited interoperability					

4. In your opinion, what measures can improve the implementation of BIM in the construction industry?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Better BIM software					
Training and education programs					

Improved collaboration between stakeholders					
Government initiatives and incentives					
Integrating with other technologies					
Standardization					

INTERVIEW QUESTIONS

This interview Question is prepared by Hiwot Girma, Addis Ababa University School of Commerce the department of Project Management second year master's Program student, who is currently working on the topic: BIM and Project Management; The Role of Building Information Modeling (BIM) for the Success of Building Construction projects; The Case of Ethiopian Engineering Investment Group (EEIG) Construction Company.

The goal of these interview questions is to gather information for academic research purpose only. any assistance is greatly welcomed.

1. Full name?
2. What is your Position in the company and how many years of experience do you have in the construction sector?
3. What number of projects does the organization take on annually?
4. When does the company start utilizing BIM technology in its projects? What drove the organization to adopt it?
5. What is the existing project management practice in the organization? How does BIM technology affect the company's project management procedures?
6. To what extent does BIM is adapted in the organization?
7. What benefits did the company encountered in implementing BIM in its projects?
8. In your experience how does BIM impacted the success of building construction projects in terms of scheduling, cost estimation, quality control, and stakeholders' satisfaction? Explain by giving examples.
9. Is there a BIM training culture in the company? What techniques have been most successful for educating and training staff members on the adaption of BIM technology?
10. What challenges did the company face in BIM implementation? And What strategies are used to overcome those challenges?
11. What are the lessons learned in BIM implementation?
12. What advice would you give to project team who are considering implementing BIM in their construction projects?