The School of Design and the Built Environment

Novel Employer-Oriented Frameworks to Manage Delay Causes in Traditional (Non-BIM) and Building Information Modelling (BIM)-Enabled Construction Projects

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Declaration

To the best of my knowledge and belief, this thesis contains no material previously published by any other person except where due acknowledgement has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university. The research presented in this thesis was conducted according to the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007), updated in March 2014. The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), approval number # HRE2018-0356.

Signature :

Date : June 2024

Dedication

This thesis is dedicated to my father, my mother, my adored spouse, and my children (Malaak, Lamar, Abdullah, Sedra, and Layal) for their understanding during my long journey to accomplish this research. I appreciate your help through the time I was required to spend on this study.

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I am privileged to have obtained all the help and consolation from many fantastic and generous educators, partners and loved ones who have helped me over all these years. These affirmations can scarcely offer all my thanks to them.

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List of Publications Included as Part of the Thesis

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Statement of Author’s Contributions

Co-author statements declaring and endorsing the candidate’s contributions to each paper included in this thesis can be found in Appendices G and H.

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List of Abbreviations

2D	Two-Dimensional
3D	Three-Dimensional
4D	Four-Dimensional
5D	Five-Dimensional
6D	Six-Dimensional
7D	Seven-Dimensional
4D BIM	Four-Dimensional Building Information Modelling
AEC	Architecture, Engineering and Construction
AHP	Analytical Hierarchy Process
AIP	Applying and Improving Productivity
AMOS	Analysis of a Moment Structure
AVE	Average Variance Extracted
BB	BIM Barrier Factors
BIM	Building Information Modelling
BIMB	Building Information Modelling Barriers
BIM-CPCSREWM	BIM Project Cost and Schedule Risk Early Warning Model
BIMS	BIM Implementation Strategies Moderator
BIS	Business Innovation
BSF	BIM Implementation Strategy Factors
CAD	Computer-Aided Design
CB-SEM	Covariance-Based Structural Equation Modelling
CFA	Confirmatory Factor Analysis
CPC	Cost and Schedule Risk Early Warning Model
CPM	Critical Path Method
CR	Convergent Validity
CSF	Critical Success Factors
DCA	Contractual Employer's Delay Aspect
DFA	Financial Employer's Delay Aspect

DMA	Managerial Employer's Delay Aspect
DMAIC	Define, Measure, Analyse, Improve and Control
DSA	Social Employer Delay Aspect
DTA	Technical Employer's Delay Aspect
DV	Dependent Variable
DWG	Drawing File
DXF	Drawing Exchange Format
EOT	Extension of Time
EPC	Engineering, Procurement and Construction
EQS	Environmental Quality Standard
EVA	Earned Value Analysis
FI	Frequency Index
GPS	Global Positioning System
H	Hypothesis
HRM	Human Resources Management
ICP	International Construction Projects
ICT	Industrialised Construction Technology
IMP. I	Importance Index
IV	Independent Variable
KSA	Kingdom of Saudi Arabia
LISREL	Linear Structural Relations
LITM	Labour Inputs Tracking Model
LOD	Level of Development
LPO	Letter of Purchase Order
LPS	Last Planner System
M	Unlimited Population Size
MM	Measurement Model
MAUT	Multi-Attribute Utility Technique
MEP	Mechanical, Electrical and Plumbing
N	Population Size

n	Sample Size
P	Value of the Population Proportion
PBC	Project Benchmark Characteristic
PC	Project Characteristics
PEE	Project's External Environmental
PhD	Doctor of Philosophy
PLS-SEM	Partial Least Squares Structural Equation Modelling
PMBOK	Project Management Body of Knowledge
PPC	Plan Per Cent Completion
p-value	Probability of the Observed Value
QS	Quantity Surveyor
R^2	Coefficient of Determination
RDS	Respondent-Driven Sampling
RFI	Request for Information
RFID	Radio Frequency Identification
RACI	Responsible, Accountable, Consulted, and Informed
RII	Relative Importance Index
RQ	Research Question
SCL	Society of Construction Law
SEM	Structural Equation Model
SI	Severity Index
SM	Management, Organisation and Financial Planning Success
SNA	Social Network Analysis
SRW	Standardised Regression Weights
SSPSS	Statistical Package for Social Science
ST	Team Success Aspect
UAE	United Arab Emirates
UK	United Kingdom of Great Britain
UN	United Nations
US	United States of America
UWBPS	Ultra-Wideband Positioning System

WOS	Web of Science
Z	Statistical Value for the Confidence Level

Abstract

Construction delays rank among the most prevalent challenges affecting project employers adversely. Thus, it becomes crucial to pinpoint the causes of these delays to mitigate them and the associated costs effectively. The extent of impact due to construction delays can vary significantly from one project type to another and across projects. Delays can span from a few days to several years. It's widely acknowledged internationally that delays are a pivotal factor influencing project delivery within budget, meeting contractual deadlines, and maintaining acceptable quality standards.

However, addressing construction delays and their root causes has encouraged researchers and industry experts to seek viable frameworks or solutions. While previous delay analysis studies have predominantly focused on specific continents or countries, traditional (Non-BIM) construction projects, and discrete viewpoints, none have rigorously tackled employer-initiated construction delays in isolation from the broader continental context or with insufficient previous research to draw from.

Research studies on delays have examined both traditional (Non-BIM) practices and the integration of Building Information Modelling (BIM) practices across different continents. Thus, this research endeavours to create innovative, comprehensive frameworks specifically aimed at preventing construction delays prompted by employers. Employing a mixed-methods approach, the research includes pilot interviews, surveys, case studies, and questionnaires to achieve its objectives.

This study aims to investigate employer-initiated delays in the context of non-BIM and BIM-enabled projects comprehensively to construct novel frameworks for each type of project to address the allocated employer's delays through their corresponding critical success factors.

This study employed a mixed methods approach to build a comprehensive and strong foundation for the selected research technique. The chosen methodology is aimed to include both qualitative and quantitative research methods, using a triangulation approach that integrates specific case studies. The complete strategy employed in this study improves the accuracy and dependability of the offered frameworks, guaranteeing a thorough and well-supported foundation for the study's conclusions. By incorporating a variety of research methods, a more comprehensive and

detailed understanding of the research questions can be achieved, leading to a more robust and trustworthy interpretation of the study's findings.

In this context, notable gaps concerning different project types, continents, and employer-initiated delays have been identified. This catalyses refining research surrounding delays instigated by employers. As an outcome, two distinct frameworks have been formulated to identify strategies for minimizing the origins and consequences of employer-initiated delays in traditional (Non-BIM) and BIM-enabled projects.

1 Introduction

1.1 Research Background

It is rare to find a project that was completed within the specified time (Shebob et al., 2011). In Australia, specifically in Sydney, the light rail project to the eastern suburbs has faced a delay problem; the budget was 1.6 billion Australian dollars, and the project was originally to be completed in 2018 (before the deadline was pushed to 2019). This case of a delay is compelling from a theoretical perspective; it was essential to conduct a sufficient analysis of the contractor's history of delays and construction profile for similar projects. Another Australian example is the Wheatstone Oil and Gas Project. With a construction value of AUD 29 billion and producing 8.9 million metric tons of gas annually, Chevron announced (in 2016) that the project would be delayed until the middle of 2017. In the United Arab Emirates (UAE), Dubai's airport planners have delayed launching construction to expand Maktoum Airport for five years, apparently for financial reasons. Several studies have been conducted on construction delays, causes and effects, and relevant success factors in establishing a deep understanding of the problem and constructing a practical framework and platform to reduce the problem.

It is crucial at the beginning of the study to understand the main reasons behind studying the employer-initiated delay factors separately apart from construction delay factors caused by the project's other parties. An in-depth analysis of the specific variables that cause delays for employers is crucial, as it helps to foster a comprehensive understanding of the unique challenges and problems posed by employers. This concentrated approach allows researchers to develop customised ways to address and reduce delays caused by employers efficiently. Segregation is necessary to determine the precise influence of employers on project deadlines and completion (Shebob et al., 2012). By using this analytical perspective, we can extract industry-specific knowledge and proven methods, which may then be applied to address delays caused by employers in a more focused and efficient manner. For example, the substantial consequences of late payments on construction projects have attracted much scrutiny. It is crucial to thoroughly investigate the causes that cause delays from employers, including those connected to delays in payment, as separate entities that necessitate specialised investigation (Chadee et al., 2023; Samaraweera et al., 2019). Ultimately, doing a focused examination of the specific causes that cause employers to delay construction is crucial for gaining a thorough grasp of the distinct difficulties they bring to construction projects. By carefully isolating and analysing these elements, researchers can develop precise plans and interventions. In conclusion, this concentrated strategy leads to the improvement of project efficiency and achievement by successfully addressing and reducing delays caused by employers.

Many researchers have attempted to define what is meant by ‘project’ and the main components of any proposed definition. For instance, Mintzberg (1983) has defined the term as ‘an organizational unit that solves a unique and complex task’; similarly, Collins (1987) defined a project as ‘an idea or plan that you intend to carry out in the future, or that is being carried out at present’. From the detailed literature review conducted, the key findings to emerge are that the common factors for employer-initiated delays include the lack of previous experience, delays in delivering the site to the contractor, delays in giving the order to commence or cease work and delays in the approval of schedules. Hegazy (2012) looked at existing literary works on construction tasks to determine the variables adding to construction delays and establish a basis for making delay claims. Nonetheless, a visible space in the research study checks out the one-of-a-kind collection of construction delay factors related to companies' decisions and actions. To connect this research gap, there is a requirement for a thorough evaluation of employer-initiated delay factors considering UAE building and construction tasks. By comprehensively analysing employer-initiated delay factors, researchers can contribute important knowledge to the building and construction market and provide practical suggestions for companies and project managers.

Alaghbari et al. (2007) focused on identifying and comprehending the elements resulting in construction delays in construction tasks in Malaysia. It aims to disclose the crucial factors behind project slowdowns, offering understanding right into problems such as cultural impacts, interaction between companies and specialists, political and regulatory elements, legal ambiguities, technical preparation, financial stability, legal structures, local comparisons, as well as the possible financial impacts of these delays. While the existing literature might determine employer-initiated aspects adding to delays, there could be a gap in understanding how companies' decision-making procedures directly influence project timelines.

Van et al. (2015) presented a theoretical design that shows the factors affecting construction delays in government buildings and construction projects. The design offered a framework for understanding the aspects of delay triggers, including task management, financial aspects, governing adherence, stakeholder engagement, and uncertain incidents. The theoretical model of delay variables influencing government construction projects might have a gap in its coverage of employer-initiated delay elements. This gap could be addressed by incorporating the company's decision-making and approval processes. Incorporating these employer-initiated delay factors into the conceptual model can offer a more detailed understanding of government building and construction projects.

Tafazzoli and Shrestha (2017) studied 30 factors and causes of construction delays in the United States of America (USA). They identified only six employer-initiated factors: (1) excessive change orders, (2) delayed payments by the employer, (3) delays in reviews, (4) delays in the approval of design drawings and documents, (5) unnecessary interference by the employer, and (6) delays in taking possession of the site by the contractor. This highlights a gap in the study of employer-initiated delays within the context of the USA.

In summary, it can be seen from the studies of Van et al. (2015) and Tafazzoli and Shrestha (2017) that conducting a comprehensive study of employer-initiated delays holds importance and significance in expanding the existing knowledge.

In general, a project is affected by the stakeholders. Freeman (1984) defines stakeholders as groups or persons who can influence or influence their establishment's objectives. Stakeholders can negatively or positively affect a project and its progress. The employer is usually the primary stakeholder and can be a significant 'owner' of the project, as represented by a project management team, engineer, and project team.

Regarding the research scope, construction delay factors are commonly categorized according to a project's main stakeholders: employer, contractor, consultant, or engineer. It is well-noted that although most previous studies have categorized delay factors according to the main stakeholders of construction projects, some researchers have selected different categorization methods. For example, Frimpong et al. (2003) group delay factors according to consultants, contractors, and employers. Similarly, Samarah and Bekr (2016) group delay factors around consultants, contractors, and employers; they add a category, external factors. Wong and Vimonsatit (2012) also group delay factors into the same categories: clients, consultants, and contractors. Tawil et al. (2014) adopt a different type of grouping for delay factors: input, internal, and external categories. Amoatey et al. (2015) consider grouping delay factors according to financial, technical, economic, environmental, governmental, operational, and political resources. In this study, only employer-initiated delay factors are considered, so the researcher has elected to categorize delay factors under the 'employer or owner' aspect. It is crucial to note that the process of categorizing employer-initiated delays and critical success factors has been thoroughly established in the subsequent chapters through careful literature review and evaluation.

Regarding the analysis methods for delay factors used in previous studies, many have employed conventional statistical analysis methods. For instance, Emam et al. (2015) and Frimpong et al. (2003) used the severity index (SI), frequency index (FI), and importance index (IMP. I) to analyze, rank, and compare collected data about construction delays in Qatar. Samarah and Bekr (2016) also used the IMP. I, FI, and SI will analyze their data. Wong and Vimonsatit (2012) used the relative importance index (RII) to analyze collected data on construction delays. Other researchers, such as Doloi, Sawhney, and Iyer (2012), have combined RII and factor analysis to develop a predictive model in an Indian context. In another study, Doloi et al. (2012) used structural equation modeling (SEM) to analyze and build a model of relations between construction delay factors in Indian projects; they adopted this method to construct a relationship between critical factors of delay regarding overall delays. This study utilized the Structural Equation Modeling (SEM) method and average ranking to assess the significance of employer-initiated delay factors in distinct countries and specific projects.

Regarding solutions, many previous studies have tackled delay issues through a combination of textual recommendations and partial remedies. For instance, Chan and Kumaraswamy (1997), Pai and Bharath (2013), Addo (2015), and Assbeibat (2016) offer suggestions to mitigate delay problems, including effective data communication, competence of hired consultants, and prompt payments. However, these recommendations are often seen as partial solutions for addressing delay factors in most construction projects, which validate the necessity for a novel framework to address employer-initiated delays in traditional (Non-BIM) and BIM-enabled projects.

In terms of future development in this research area, digitalisation and building information modelling (BIM) are becoming essential to help construction project parties, specifically employers, to reduce clashes during design, improve three-dimensional (3D) visualisation, assist in reducing project duration, reduce construction delays and future claims, disputes and conflicts (Liuet et al., 2019). BIM is an essential tool that typically creates a virtual setting for the construction team before and during a project (Becerik-Gerber et al., 2012). BIM's critical success factors and the influences and relations to employer-initiated delay factors have not been addressed broadly in previous studies (Barqawi et al., 2021). However, it is worth mentioning that a limited number of BIM-related papers have addressed construction delay factors in a comprehensive approach. To support this in-depth, only a few previous BIM-related papers have briefly mentioned delays initiated by the employer. Btoush and Harun (2017) included limited delay factors related to employers: 'negligence of the owner', 'change orders', 'slow decision-making by the employers', 'lack of communication between project parties and 'frequent change orders by the employer'. Similarly, Gardezi et al. (2013) reviewed several delay factors caused or initiated by the employer concerning BIM in the Malaysian construction trade. The employer factors reviewed and studied are 'frequent design changes', 'unrealistic time duration', 'no proper arrangement for funds', 'no timely payments', 'improper employer's interference' and 'slow decision-making and approvals'. In conclusion, prior research on BIM-enabled projects has shown limited coverage of employer-initiated delay factors, as explicitly outlined in Chapter 2. This study intends to thoroughly and methodically examine employers' delays and critical success factors, including BIM factors. This research will also systematically review specific continents and countries and reveal research gaps in previous studies of construction delays.

1.2 Problem Statement

The problem statement is a well-written statement that defines the problem and helps identify the variables investigated in the study. The problem statement provides the (a) rationale for the study and (b) uses data and research to confirm the need to address the problem in the study (Miles, 2016a). The statement grid tool is used to develop this Thesis's problem statement. In general, the statement grid is a helpful tool that aids in showing the problem statement visually. Table 1.1 presents the overall problem statement and its four sub-problems in a detailed manner.

Table 1.1. Problem Statement

<table>
<tr><td colspan="4">Overall Problem Statement:
The problem that is to be researched in this study is the shortage of studies on employer-initiated delay factors and their relevant critical success factors for traditional (Non-BIM) and BIM-enabled projects. This problem is noted worldwide, as no previous comprehensive construction delay studies have been conducted. In addition, this has a lot to do with the current problem statement shortage and the need for more detailed review and studies for this subject in some specific countries and continents worldwide with a lack of previous studies on construction delay in general and for the employer-initiated delays in specific. However, the central problem is that there are no previous detailed frameworks to address the employer-initiated delays in traditional (Non-BIM) and BIM-enabled projects, which necessitates the invent of a novel framework to address the delay based on specific analyses created.</td></tr>
<tr><td>Sub-Problem 1:
A research gap in the employer-initiated delay factors is noted where they are addressed partially in most previous studies. The necessity to conduct a comprehensive review and study for employer-initiated delay factors is important. It must be conducted separately without mixing with the other projects' stakeholders'</td><td>Sub-Problem 2:
A research gap in the previous studies for specific countries or continents is also noted, and a limited number of construction delay studies are carried out. Thus, conducting further studies in these areas is important and will add valuable value to the body of knowledge.</td><td>Sub-Problem 3:
A research gap is noted for ranking the employer-initiated delay factors and their success factors from the main projects' stakeholders' perspective and the projects' types perspective (some projects' types lacking previous studies). Moreover, relationships between the employer-initiated delay factors and their success factors are not reviewed from the perspective of analysing them using techniques such as SEM, considering the effects of the moderators.</td><td>Sub-Problem 4:
A research gap in the previous studies for a novel framework to address the employer-initiated delay factors using the available critical success factors is noted. Comprehensive frameworks to address the problem in traditional (Non-BIM) and BIM-enabled projects are important and will add value to the body of the research.</td></tr>
</table>

Emphasising the formation of the main thesis problem statement and its associated sub-problems is dominant in research, as it establishes the fundamental basis for the entire study. Chapters 2 and 3 thoroughly analyse the current body of literature, requiring a detailed evaluation. Identifying these sub-problems is informed by a comprehensive examination of existing academic literature and a meticulous evaluation of prior empirical research, which jointly form the foundation for the research framework.

Chapter 2 of the study includes a comprehensive examination of pertinent scholarly sources and empirical works directly applicable to the research subject. This comprehensive analysis enhances comprehension of the topic but also assists in identifying gaps or areas that necessitate additional research. Moreover, including empirical studies in Chapter 3 is crucial in developing precise research inquiries or sub-issues. The empirical investigations not only validate the significance of the research but also offer useful insights into the practical aspects of the selected subject of study.

Incorporating prior empirical research that supports the primary problem and subproblems outlined in Table 1.1 is essential in this section, despite Chapter 2 offering extensive evidence for these issues. This addition will serve to exemplify the issue from a universal perspective. Alinaitwe et al. (2013) identified the five primary causes of construction project delays in Uganda's public sector, specifically in the context of traditional (Non-BIM) projects. The reasons were modifications to the project's scope, payment delays, inadequate monitoring and control systems, high cost of capital, and the consequences of political uncertainty and instability. The report also emphasised the five main factors that contribute to cost overruns. Nevertheless, it is crucial to acknowledge that the research did not thoroughly investigate the factors associated with employer-initiated delays. As a result, the study did not thoroughly examine these delay factors influenced by employers or provide practical frameworks or solutions to tackle them successfully.

In a study conducted by Parsamehr et al. (2023), an extensive examination was carried out to investigate the incorporation of Building Information Modelling (BIM) in construction management research, specifically focusing on its contribution to facilitating predictive decision-making. The study examined multiple difficulties in construction management, but it placed particular emphasis on safety management as the primary area of investigation. Nevertheless, the task of dealing with delays caused by employers remains unfinished for projects that utilise Building Information Modelling (BIM).

Cevikbas and Isil (2022) conducted a study on mega airport projects with a specific focus on the selection of appropriate delay analysis methodologies. Their research sought to determine the optimal methodology for analysing delays in significant airport projects. Nevertheless, it is important to mention that their research did not investigate the factors causing construction delays, such as delays initiated by employers. Also, Paliwal et al. (2021) did a study on modular structures, specifically focusing on the perceived benefits and challenges of using environmentally friendly modular buildings in the hotel industry. The study highlighted that the adoption of modular construction can reduce project schedules by avoiding unexpected delays often encountered in conventional (Non-BIM) building methods, such as unfavourable weather conditions. Nevertheless, this study did not examine any factors related to delays in building.

Kassem et al. (2019) specifically examined the crucial risk factors associated with oil and gas building projects in Yemen. The analysis identified that the delay in the supply of materials was a significant factor contributing to project delays. This aspect can have an impact on the construction project and is exacerbated in oil and gas projects by logistical challenges arising from the distant placement of construction sites and complexities in project administration. The study examined many factors that cause delays in projects begun by employers, including government delays in decision-making, government instability, government interference in projects, interventions by oil corporations, modifications throughout the construction process, and delayed payment of contractor's dues. Hence, it is apparent that this study examined employer-induced delays from a narrow standpoint, lacking explicit remedies for mitigating these causes causing delays.

1.3 Research Scope of Work

This section aims to explain the scope of the research. This research scope has been defined by identifying the general scope, research question, objectives, aim, and limitations.

Research General Scope: Explains what the study aims to achieve, including studying employer-initiated delay factors and their relationship with the critical success factors, examining moderator factors, using statistical analysis techniques, and comparing traditional (Non-BIM) and BIM-enabled projects.

Research Question: States the fundamental research question related to confirming hypothesized relationships between employer-initiated delay factors, critical success factors, and the impact of moderation factors.

Research Aim: Clearly states the research's principal aim–to create comprehensive frameworks that address construction delays caused by employers in various project types and geographic locations.

Research Objectives: Lists the main goals of the research, which include systematically reviewing delay factors, developing a conceptual framework, confirming relationships, and creating comprehensive frameworks based on modeling and case studies.

Research Limitations: Acknowledges the study's limitations, including the narrow focus on specific delay factors and critical success factors, the reliance on a limited sample size and case studies, and the potential for a broader understanding with a larger sample and more diverse case studies.

1.4 Research's Aim and Objectives

The study aims to investigate employer-initiated delays in the context of non-BIM and BIM-enabled projects comprehensively to construct novel frameworks for each type of project to address the allocated employer's delays through their corresponding critical success factors. This section also discusses the research objectives used to address the research aim. In summary, the objectives are as follows:

Objective 1: This objective aims to analyze employer-initiated delays in both traditional (Non-BIM) and BIM-enabled projects. Chapter 2 identifies gaps in research, focusing on employer-initiated delays and critical success factors across various project types globally. The study seeks to enhance understanding of these interactions and provide insights for future research and industry practice.

Objective 2: This objective aims to create a conceptual framework illustrating the connections between employer-initiated delay factors and their critical success factors. The frameworks incorporate moderation factors such as project characteristics, external environments, Building Information Modeling (BIM) strategies, and barriers to BIM adoption. Establishing these frameworks set the stage for a comprehensive Structural Equation Modeling (SEM) analysis, which explores complex relationships among variables. The study aims to deepen understanding by investigating how these moderation factors impact the connections between employer-initiated delays and critical success factors.

Objective 3: The third objective is to identify and understand the variables contributing to employer-initiated delays and corresponding critical success factors. Using SEM, this phase examines the connections between these delays and project success factors across different countries and project types. By comparing traditional (Non-BIM) and BIM-enabled projects, the study delves into the underlying factors influencing delays and project outcomes. SEM helps clarify these variables within employer-initiated delays and critical success factors.

Objective 4: The fourth and key objective of this study is to create and consolidate comprehensive frameworks that address employer-initiated delay factors in traditional (Non-BIM) and BIM-enabled construction projects. These frameworks, tailored to each project type, are constructed based on SEM analysis and provide actionable guidance derived from the theoretical exploration, empirical findings, and analytical rigour.

1.5 Research Methodology

First and foremost, it is important to emphasize that the phrase "traditional (Non-BIM) projects" refers to projects that do not utilize BIM technology. These projects are typically executed using construction methods, often without the integration of Building Information Modeling (BIM) practices. Traditional (Non-BIM) approaches are employed in the generation of shop drawings, and human coordination remains the primary mechanism for managing all aspects of the project. The absence of BIM influence may result in a more manual and time-consuming process, as it relies heavily on established construction techniques and interpersonal communication for project coordination. On the other hand, BIM-enabled projects are a specific type that stands out due to the thorough incorporation of BIM technology, signifying a significant change in how projects are carried out. Moreover, it is importance to compare traditional (Non-BIM) projects with BIM-enabled projects in highlighting the profound impact of BIM, especially in relation to delays caused by employers. This comparative analysis provides a strategic perspective to distinguish the unique characteristics of each project type, hence illuminating important factors to consider. There are multiple convincing justifications for selecting these projects for comparison such as technology advancement, performance enhancement, BIM's capacity to simulate and analyze different project scenarios, long-term advantages of initiatives that utilize Building Information Modeling (BIM) and cost and time efficiency.

A combined quantitative and qualitative study was conducted to gain a more comprehensive view and establish the studies' viewpoints. Initially, the researcher presented the questionnaire to five well-experienced construction staff with more than 20 years of experience to check content validity. The questionnaire's content and purposes were reviewed in this step, including reviewing the text clarity and composition and avoiding repetition. Then, after the online questionnaire was established, it was distributed to 29 participants with different experiences, different types of projects and various countries to check Cronbach's alpha coefficient and help identify problems in the questionnaire and confirm its reliability (pilot questionnaire). This would also help determine if the respondents understood and answered the questions properly.

The responses received were utilized in developing the primary study questionnaire, including critical success factors for traditional (Non-BIM) and BIM methodologies. The determination of the sample size for both the pilot review and the primary study questionnaire was carried out with consideration of a robust technical foundation, ensuring adequacy. The final survey questionnaire was distributed digitally to construction practitioners across the study continents. Stringent criteria were applied in selecting practitioner qualifications to guarantee precise data input. After data collection, analysis followed, predicated upon well-founded hypotheses. These hypotheses were tailored to address separate thesis inquiries concerning employer-initiated delay factors. The analysis included ranking, success metrics, and the relationships between delays and critical success factors for diverse projects and specific continents. Given this domain's limited research, both SEM and conventional analytical tools were deployed to provide insights into the research questions. A visual representation of the methodology adopted in this study, summarising the creation of a framework addressing employer-initiated delays, is presented in Figure 1.1.

The attainment of the first objective materialized through an extensive systematic review to identify employer-initiated delay factors alongside their pertinent critical success factors in traditional (Non-BIM) and BIM-enabled projects. An exhaustive evaluation of an array of prior literature on construction delays underpinned this review. Notably, this process illuminated existing research gaps, including project typologies and study scopes.

The realization of the second objective transpired due to the construction of a conceptual research framework tailored to address employer-initiated delay factors. The foundation for this framework was established through the assembling and examining functional associations between employer-initiated delay and critical success factors. Additionally, available strategies for implementing success and tools for reviewing and measuring success were catalogued and categorized. These groupings and tools formed the preliminary structure of the targeted framework, aligning with the overarching aim of this study.

The third objective was achieved by subjecting the proposed hypotheses regarding the delay and critical success factors to scrutiny through SEM. The complete structural model was fashioned using Smart PLS, leveraging the indicators and latent variables explained in the conceptual framework. It is noteworthy that within this analysis, moderator factors influencing delay and critical success factors were identified and comprehensively evaluated.

The fourth objective was realized by consolidating the outcomes gleaned from the SEM methodology. This included rankings of delay and critical success factors and assessments of action and review tools for success. These outcomes were integrated to formulate comprehensive frameworks addressing employer-initiated delays within traditional (Non-BIM) and BIM projects.

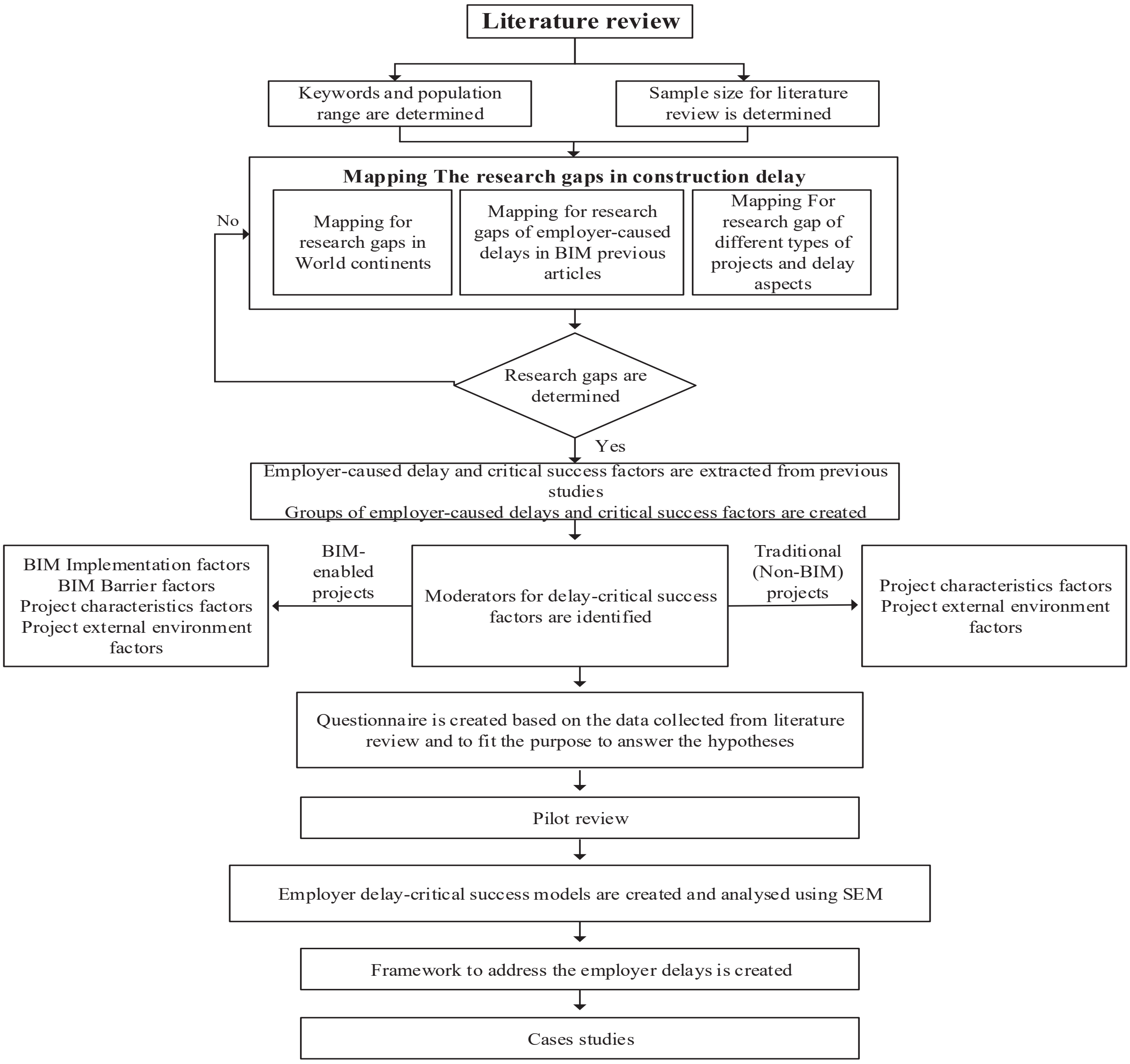

Figure 1.1. Summary of the Study Methodology

1.6 Research Importance

Construction projects have always been a critical factor in the economies of developed and developing countries. Projects with no delays are uncommon. Project delays are related to many aspects, such as social, technical and commercial factors. Shebob et al. (2011) consider delays a major problem in the construction industry because they have a significant financial and social effect on all project parties. Project delays also negatively affect local economies and development growth rates.

It is important to study and review the delays caused by the employer separately to address the gaps in the previous studies. Hamzah et al. (2011) presented a comprehensive framework for understanding the various factors contributing to construction delays. It aims to provide a structured approach to identifying, categorizing, and analyzing the underlying causes of delays in construction projects. The framework is designed to enhance the comprehension of delay factors, allowing stakeholders to address and mitigate these issues more effectively in the construction industry. They partially assessed delay factors caused by the employer, such as dealing with errors in plans and specifications and impractical project durations. However, their study only covered certain aspects of employer-initiated delay factors. Many dimensions were not fully considered, including technical, financial, contractual, and social aspects, which are thoroughly reviewed and addressed in this thesis.

Thus, reviewing employer-initiated delays worldwide is very important to understand the nature of delays globally. London's Crossrail project is a significant project expected to cost £17.6 billion when completed in Europe. Having employer-initiated delay and critical success factors defined early in this significant project will substantially affect how project time and cost are controlled.

This study compares employer-initiated delay factors between traditional (Non-BIM) and BIM-enabled projects. However, few previous studies have addressed the subject of employer delays from a BIM solutions perspective, and none have addressed BIM success attributes in addressing the disputes and delays caused by employer factors. For example, Gibbs et al. (2019) investigated whether BIM can assist with construction delay claims; this study presented BIM as a tool or platform to help delay analysts retrieve information for a more precise analysis of delayed extensions of time claims.

Tariq et al. (2023) explored the delays and conflicts encountered in construction projects and their interrelationship. Delays and conflicts are common challenges in the construction industry, often leading to cost overruns, schedule disruptions, and strained relationships among project stakeholders. Understanding the causes and effects of delays and conflicts is crucial for effective project management and successful project delivery. From the perspective of the employer's delays, the study had given limited attention to the employer-initiated delay in a particular aspect, and it lacks consideration of the areas of low previous studies in construction delays such as the UK, USA and Australia. While the review might cover delays and conflicts in construction projects, there could be a gap in addressing the specific influence of employer-initiated delays on the occurrence and escalation of conflicts.

Moreover, to clarify the importance of this study clearly, a journal paper published by the author of this thesis in *Advances in Civil Engineering Journal* (2021) was presented in Chapter 2. It detailed the gaps in the previous studies addressed in this thesis. In Chapter 2, a cross-sectional literature research was carried out to review the construction delay factors and the employer-initiated delay factors in both traditional (Non-BIM) and BIM-enabled projects, and it revealed the following: (a) a research gap in the employer-initiated delay factors where they are addressed partially in most of the previous studies; (b) a research gap in the previous studies for specific countries or continents where it is confirmed that a limited number of construction delay studies are carried out; (c) most of the delay factors aspects are addressed partially; (d) a research gap in the construction delay studies for some specific type of projects such as airports, and oil and gas projects, (e) the BIM implementation strategies factors and the BIM barrier factors were collected from previous literature; these factors were used in this research to study the influences of these moderators on the employer-initiated delay factors and their corresponding critical success factors.

Building upon the literature review above, this research highlights the gap in previous studies concerning the combined examination of BIM-enabled projects and employer-initiated delay factors. This gap underlines the need for further exploration in this area, as this study aims to investigate employer-initiated delays in the context of BIM-enabled projects comprehensively.

BIM can offer several advantages over traditional (Non-BIM) building construction methods from the perspective of the BIM's importance in construction delays. It can improve teamwork, reduce cost and time, and increase accuracy. However, it does require specialized software and training and may not be suitable for all projects. Traditional (Non-BIM) building methods may still be preferred for smaller, less complex projects. Traditional (Non-BIM) projects are built with the traditional (Non-BIM) construction method (mainly without BIM technology). BIM-enabled projects use BIM technology to assist in building the project, such as coordination between services, coordination of the design, following the site progress, and following the delay in the project from different project parties.

Further, BIM provides digital design demonstration and essential data and information for a project before construction starts (Eadie et al., 2014). Moreover, BIM can assist in construction project management (Xiao &Noble, 2014). BIM can provide a valuable database for improving construction procedures (Azhar, 2011). According to Brydeet et al. (2013), 'BIM is an appropriate tool for project managers and should be considered by the project management profession as a way to help manage construction projects'. Enegbuma et al. (2015) clarify that BIM has valuable tools to help users eliminate uncertainties. Thus, assessing the results of BIM technology on enhancing the understanding and recognition of delays caused by the employer is crucial and can aid in developing a balanced structure that will certainly address the problem. For example, Rowlinson et al. (2010) focused on the practical application of Building Information Modeling in the construction sector. Through a comparative case study approach, the authors investigate the actual implementation of BIM across various construction projects. The research aims to evaluate BIM adoption's effectiveness, challenges, and outcomes in real-world construction contexts. The study contributes insights into the benefits and complexities of integrating BIM technology, offering a practical perspective on its impact on construction processes and project outcomes.

Barlish and Sullivan (2012) researched the benefits of Building Information Modeling (BIM) using a case study approach. They undertook a comparative analysis, examining how BIM positively affected two non-BIM projects and two BIM pilot projects in similar serviceable areas. The results revealed a significant net gain of about 67% for the BIM project. Specifically, the study indicated that while the non-BIM project experienced delays of up to 15% beyond the standard schedule, the BIM project's delay was limited to just 5%. The research highlights how BIM technology reduces general delays in construction projects. However, a potential research gap within this study becomes apparent when exploring BIM's impact on employer-initiated delays. The study could benefit from investigating more comprehensively into aspects such as incorporating scenarios involving employer-initiated delays, assessing how BIM influences

decision-making processes in response to such delays, and examining how contractual considerations intersect with BIM's ability to manage and mitigate these delays.
A vital aspect that must be highlighted is explaining the key reasons behind selecting traditional (Non-BIM) and BIM-enabled projects for this study. This clarification is necessary to establish that both project types are different and that conducting separate studies is viable and valuable. Traditional (Non-BIM) and BIM-enabled construction projects represent two separate approaches to design, construction, and management. Despite the shared goal of achieving successful construction outcomes, these methods differ significantly in processes, collaboration, life cycle, and outcomes.

From the perspective of design and documentation, in traditional (Non-BIM) projects, design and documentation are often sequential processes. Architects and engineers create drawings and specifications independently, leading to potential inconsistencies or errors in the final plans. BIM integrates the project team's design efforts into a shared 3D model. This collaborative environment allows real-time modifications and updates to the model, ensuring better coordination and reducing design conflicts. Traditional (Non-BIM) projects can be disjointed in collaboration and communication due to separate teams working on different aspects. Teamwork among stakeholders might be limited, leading to misunderstandings and delays, while BIM emphasizes teamwork and communication by providing a central platform for all stakeholders to contribute and access project information (Li et al., 2021).

From the life cycle management perspective, traditional (Non-BIM) projects might lack comprehensive data for facility management after construction is completed, which can impact maintenance and future renovations; BIM-enabled projects contain valuable data about building components, systems, and materials, facilitating efficient facility management throughout the building's lifecycle.

From the standpoint of risk management and cost control, cost overruns and delays are relatively common in traditional (Non-BIM) projects due to the potential for design errors and miscommunication (Ugur and Artan, 2023); the BIM-enabled approach enhances cost estimation accuracy and allows for better risk assessment, minimizing the likelihood of budget and schedule overruns.

To emphasize the significance of this research, it is crucial to elaborate on how BIM-enabled projects can effectively address delay issues. The successful implementation of BIM has been shown to eliminate extra costs associated with design changes during construction phases (Wong & Fan, 2013).

Addressing delay issues in BIM-enabled projects involves several strategies, supported by findings from various research studies.A framework utilizing 4D BIM can help prevent and mitigate delays by reducing manual labor, minimizing human errors, and applying BIM-based solutions (Assafi et al., 2022). This approach integrates time-related information into the BIM model, allowing for better scheduling and visualization of project timelines, which can significantly reduce delays.

Additionally, a review of delay factors in traditional and BIM-enabled projects has led to the development of a novel framework to address employer-caused delays (Barqawi et al., 2021). This framework identifies and mitigates issues stemming from client-related delays, enhancing overall project efficiency. BIM also enhances risk management in large-scale construction projects by improving project understanding, organizing project data efficiently, reducing duplication and delays, and decreasing the need for on-site personnel (Tabejamaat, 2024).

By providing a centralized platform for all project information, BIM facilitates better decision-making and coordination among project stakeholders. Identifying critical delay risk drivers in BIM-based projects, such as contractor-related and external factors, is crucial for predictive modeling and risk mitigation (Egwim et al., 2022).

Understanding these drivers allows project teams to address potential issues before they cause significant delays proactively. Effective stakeholder management is another key aspect of improving project performance in BIM-enabled projects (Zhang et al., 2022). By fostering better communication and collaboration among all parties involved, BIM helps ensure that project goals are aligned and that any issues are promptly addressed. The integration of BIM application strategies can also effectively manage risks in building refurbishment projects (Anuar, 2023).

Refurbishment projects often face unique challenges, and BIM provides the tools needed to manage these complexities, ensuring projects stay on schedule. BIM aids in managing project budgets more accurately, reducing costs, and preventing delays (Zong et al., 2022). By providing detailed and accurate project information, BIM enables more precise cost estimation and financial management. Utilizing BIM tools for visualization, clash detection, quantity take-off, and construction process simulation helps ensure that projects are completed on time (Yin et al., 2021).

These tools allow project teams to identify and resolve potential issues before they impact the project schedule. Additionally, BIM assists in project safety management by integrating spatial, time, and geographic information to evaluate safety risks and enhance safety measures (Yang et al., 2023). By improving safety planning and monitoring, BIM contributes to a safer construction environment, reducing the likelihood of delays caused by accidents. Thus, leveraging BIM technologies, frameworks, and strategies can significantly help in dealing with delay issues in construction projects. By implementing BIM-based solutions, project teams can enhance collaboration, improve risk management, streamline processes, and ultimately ensure projects are completed efficiently and on time. This research underscores the critical role of BIM in transforming construction project management and addressing the challenges of delays in the industry.

1.7 The Structure of the Thesis

The intentional and careful organization of the thesis into eight chapters serves as a systematic guide for the reader, leading them through the research aim and objectives. In order to clarify the reasoning behind this organization, the thesis begins with Chapter 1, which serves as the Introduction. This introductory chapter provides a clear explanation of the importance, goals, objectives, and overall organization of the thesis, which is a common convention in academic writing. After the introduction chapter, the thesis smoothly moves on to the literature review, which consists of two extensive chapters, specifically Chapter 2 and Chapter 3. These parts involve a thorough examination of areas where research is lacking, utilizing knowledge gained from past empirical studies. The initial part of the literature review methodically introduces a conceptual framework, while the subsequent chapter focuses on providing hypotheses and establishing the foundation for these hypotheses. It also extracts employer-initiated delay factors and critical success variables from the current body of research. The choice to divide the literature review into two sections is driven by the necessity to offer a comprehensive analysis of these crucial elements. Chapter 4 occupies a unique position in the structure of the thesis, serving as an independent contribution that is considered a published work upgraded into its content to fit the purpose of the thesis. This chapter provides an extensive examination of projects that utilize Building Information Modeling (BIM), presenting a complete evaluation of the outcomes. It is essential in the thesis as it reveals comprehensive data analysis and results about the correlation between employer-initiated delay factors and success factors in BIM-enabled projects. Chapters 5 and 6 of the thesis focus on the methodological components of the research. Chapter 5 provides an overview of the technique used, while Chapter 6 delves into the details of data collecting, questionnaire design, pilot evaluations, and data analysis, with a specific emphasis on traditional (Non-BIM) projects. The deliberate arrangement of these chapters facilitates a smooth comparison of the findings acquired in Chapter 4. Furthermore, Chapter 7 is a crucial section that focuses on case studies and the process of combining data from previous chapters. This chapter serves as a vital basis for the development of distinct frameworks, including knowledge from both empirical research and real-world case studies. Lastly, Chapter 8 is the apex of this academic investigation, as it includes the development and consolidation of frameworks derived from prior research. This text not only provides the frameworks but also explains their operating procedures, giving a thorough grasp of how they work. Essentially, every chapter in this carefully organized thesis adds to a coherent storyline, leading the reader through a methodical examination of study goals and discoveries.

The thesis is organised into the following eight (8) key chapters: (1) Introduction, (2) Literature Review of Employer-Initiated Delay Factors in Traditional (Non-BIM) and Building Information Modelling-Enabled Projects: Research Framework, (3) Literature Review and Hypotheses Outlines for Delay Factors, Critical Success Factors, and Employer-Initiated Delay Factors in Traditional (Non-BIM) and BIM-Enabled Projects, (4) Effects of Critical Success Factors, Building Information Modelling Implementation Strategies and Barriers on Employer-Initiated Delays, (5) Research Methodology, (6) Pilot Review, Questionnaire, Data Collection, Data Analysis, and Interpretations (7) Case Studies and Triangulation Results, (8) Discussions and Conclusions.

The study's overall organisation is presented in Figure 1.2, in which a summary of each chapter is presented(excluding Chapter 1).

Chapter 2: Literature Review of Employer-Initiated Delay Factors in Traditional (Non-BIM) and Building Information Modelling-Enabled Projects: Research Framework.

This chapter presents a paper published in *Advances in Civil Engineering* (2021), co-authored by Mohammad Barqawi, Heap-Yih Chong and Emil Jonescu. It can be viewed at https://doi.org/10.1155/2021/6696203. It mainly reviews employer-initiated delays and critical success factors by conducting a cross-sectional literature search to assess building and construction delays and their aspects in traditional (Non-BIM) and BIM-enabled projects in previous studies. The chapter examines the following: (1) the research study gaps that exist in the construction industry in specific continents for traditional (Non-BIM) and BIM-enabled projects, (2) research gaps for the delays aspects, (3) identifying the delay and critical success factors and categorising them into the group, (4) identifying BIM-enabled project moderators for the relationship between delay and critical success factors and groups and (5) a conceptual research framework to address employer-initiated delays.

Chapter 3: Literature Review and Hypotheses Outlines for Delay Factors, Critical Success Factors, and Employer-Initiated Delay Factors in Traditional (Non-BIM) and BIM-Enabled Projects.

This chapter presents the findings from previous studies concerning construction delays related to construction outcomes. Most subjects mentioned during this chapter are associated with (1) project typology, (2) delay factors and delay groups in previous studies, (3) global critical success factors (CSFs), (3) types of construction delays, (4) BIM and effects in construction delay, (5) BIM implementation in previous studies, and (6) BIM in addressing employer-initiated delay factors in previous studies. Also, it examines employer-initiated delay factors and critical success factors in the major countries of the continents included in the study, namely, the US, United Kingdom (UK), China, Australia, Africa and Asia (with China separate from Asia). Additionally, it suggests the frameworks used to address construction delays in previous studies.

Chapter 4: Effects of Critical Success Factors, Building Information Modelling Implementation Strategies and Barriers on Employer-Initiated Delays.

This chapter presents a paper published in *the International Journal of Construction Management* (2022); it was co-authored by Mohammad Barqawi, Heap-Yih Chong and Robert Lopez. It can be viewed through DOI: 10.1080/15623599.2022.2097041. The chapter is arranged per the guidelines for thesis preparation and submission for Curtin University. It mainly reviews the problem of employer-initiated delays, their corresponding critical success factors in BIM-enabled projects, and the effects of BIM moderators on these relationships. Thus, this chapter aims to determine the effects of CSFs, BIM implementation strategies and barriers to employer-initiated delays in BIM-enabled projects. A total of 197 completed questionnaires were collected from various countries and analysed using SEM. The effects of moderators were studied. The relationships of the critical success factors relating to employer-initiated delays were affected by BIM implementation strategies and BIM barriers. A correlation analysis was conducted between the critical success factors and employer-initiated delay factors for BIM projects, emphasising countries or continents lacking delay studies, such as the US, the UK, Australia and China.

Chapter 5: Research Methodology.

The proposed study methodology is based on a new ontology that incorporates objectivism and subjectivism to develop a framework for employer-initiated delay factors for construction projects, using data collected worldwide, with specific attention given to some countries. Moreover, the methodology implements traditional (Non-BIM) statistical analysis tools for appraising and relating qualitative and quantitative data. The hallmark of statistical analysis is different regression models constructed based on the research questions. The statistical analysis and the conceptual models have been evaluated to test the different hypotheses considered in the proposed study.

Chapter 6: Pilot Review, Questionnaire, Data Collection, Data Analysis and Interpretations.

This chapter details the pilot review, the questionnaire development and the methods used in data collection. In general, the researcher refers to previous similar studies about SEM, supporting the convenient sample size used in this research. The questionnaire development procedure is also defined. Detailed descriptions of the data collected regarding the respondents' roles, years of experience, education level, geographical distribution, job title and project features are also presented in this chapter. Despite the growing importance of addressing construction delays while considering all associated aspects, it is still considered that construction delay aspects, especially employer-initiated delay factors and their critical success factors, have still not been reviewed in depth or examined concerning both traditional (Non-BIM) and BIM-enabled projects. Thus, this chapter mainly analyses data collected for employer-initiated delays for traditional (Non-BIM) projects and compares these with BIM-enabled project results. This chapter offers the analysis element of this study, in which the following are presented: (a) magnitude of worst delay in BIM-enabled projects and traditional (Non-BIM) projects, (b) ranking of delay factors caused by the employer and the factors of success to address the assigned delays in both BIM-enabled and traditional (Non-BIM) projects, (c) Spearman and Chi-squared coefficients analysis, (d) SEM analysis and its interpretations for traditional (Non-BIM) projects, including the moderators of project characteristics and external project environment, and (e) result comparison between BIM-enabled projects and traditional (Non-BIM) projects.

Chapter 7: Case Studies and Triangulation Results.

This chapter provides four projects (Project-1, Project-2, Project-3 and Project-4) as case studies. These projects were used to validate the results identified from the quantitative analysis using the triangulation method. In general, these case cases include the following: (1) a description of each task, (2) an identification of the related employer-initiated delay factors, (3) an evaluation of factors of success that may solve the delays caused by the employer and (4) an evaluation of the effect for the moderation factors for traditional (Non-BIM) and BIM-enabled projects.

Interviews were undertaken for four case studies, two for traditional (Non-BIM) and two for BIM-enabled projects. China and UAE were selected for the two traditional (Non-BIM) case studies, while the UK and UAE were selected for the two BIM-enabled projects.

During the interviews, participants were given one form summarising the thesis study and another to consent to participation; the Ethics Department of Curtin University has approved these two forms.

Chapter 8: Discussions and Conclusions.

A summary of the discussion of results is presented, along with the main two frameworks that address employer-initiated delay factors using the available critical success factors. Suggestions are made for current practitioners based on the research findings identified in this study. In addition, the research's theoretical contributions are presented as being of practical significance. Finally, the suggested directions for future work and the current limitations of this study are presented.

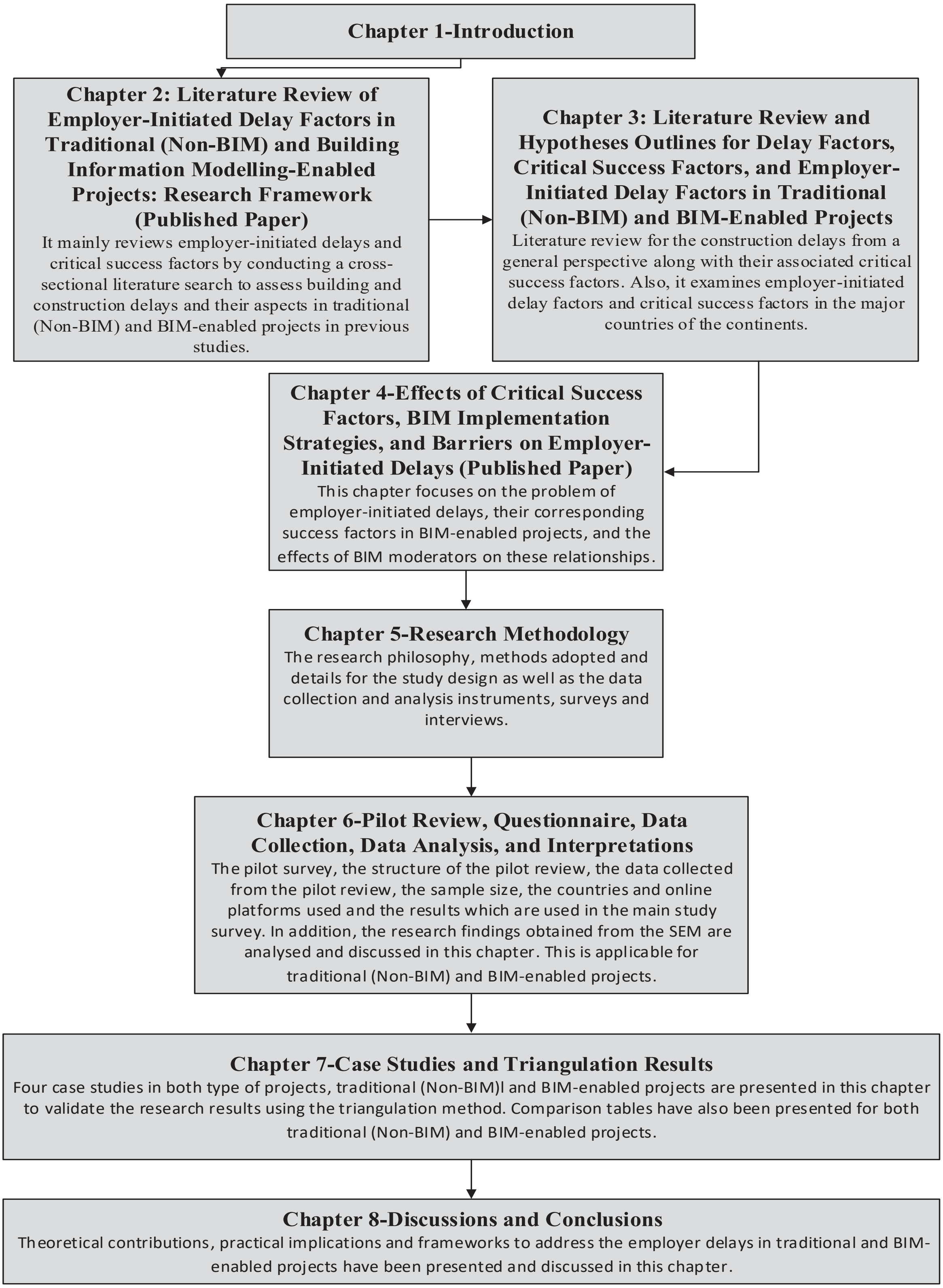

Figure 1.2. Thesis Structure

1.8 Summary of Chapter 1

Despite the advancements in technological and managerial approaches within the construction industry, delays in construction projects persist without a definitive resolution. Numerous studies have examined the issue of delays broadly. Yet, only a few studies have identified and addressed employer-initiated delay factors. To tackle this issue of construction delays, it is imperative to pinpoint effective strategies. Furthermore, this study delves into the significant disparities between traditional (Non-BIM) construction projects and those enabled by Building Information Modeling (BIM).

Moreover, the study takes a global perspective by examining specific project types that few prior studies have explored across continents. This chapter serves as a prelude to identifying research gaps and underlines the vital importance of this study. It also employs a statement grid method to present the problem statement. The research's significance lies in contributing to a profound understanding of delays stemming from employer actions, their underlying causes, and the pivotal success factors in mitigating these delays. The subsequent section provides an abbreviated but illuminating overview of the research methodology.

It is important to note that Chapter 2, with its position in the thesis, outlines the research gaps and introduces the conceptual framework devised to tackle employer-initiated delay factors. Furthermore, the chapter offers a condensed overview of prior research endeavours about employer-initiated delays in both BIM and traditional (Non-BIM) projects to identify the research gaps in this study from an empirical point of view.

Additionally, Chapter 4 establishes a coherent connection between Chapters 2 and 3, which consist of a literature review, and the other chapters of the thesis, namely Chapters 5, 6, 7, and 8. This study aims to enhance comprehension of the techniques and obstacles associated with Building Information Modelling (BIM) to manage employer-initiated delays in BIM projects effectively. Additionally, it offers a comprehensive conceptual framework to resolve delays caused by employers effectively. Additionally, this study examines the impact of Building Information Modelling (BIM) modifiers on the links between employer-initiated delay factors and essential success variables.

2 Literature Review of Employer-Caused Delay Factors in Traditional (Non-BIM) and Building Information Modelling (BIM)-Enabled Projects: Research Framework

2.1 Introduction

Construction delays are prevalent worldwide, posing challenges to projects across the construction industry. Extensive studies have investigated the factors contributing to these delays, considering the viewpoints of different stakeholders involved in the projects. However, a comprehensive analysis of these delays across various construction projects and geographical locations is still lacking, particularly concerning the impact of employers' delays on traditional (Non-BIM) projects and those utilizing Building Information Modelling (BIM).

This research proposes a robust framework to address potential delays employers initiate in traditional (Non-BIM) construction projects and those utilizing BIM technology. To achieve this, a cross-sectional literature search was conducted to identify and review construction delay factors and employer-initiated delay factors within the contexts of traditional (Non-BIM) and BIM-enabled projects. The study's findings revealed several key insights: (a) a noticeable research gap exists in traditional (Non-BIM) construction delay studies in specific continents and distinct project types. Similarly, BIM-enabled project studies also lack comprehensive exploration; (b) various aspects related to delays have either not been adequately addressed or have been only partially covered in prior research efforts; (c) the study suggests that by investigating the barriers to BIM implementation and the strategies employed, it is possible to develop a relationship model that connects employer-initiated delay factors with critical success factors.

This paper is a pioneering effort, offering a comprehensive overview of delay factors and introducing an innovative conceptual framework to address employer-initiated delays in traditional (Non-BIM) and BIM-enabled construction projects.

Construction delay remains a significant challenge for the construction industry, with its causes and contributing factors garnering substantial attention from academic and industry circles. Such delays are universal in construction projects, with the delays varying widely, ranging from minor disruptions lasting a few days to substantial setbacks spanning several years. A project is deemed delayed when it deviates from its initially planned schedule (Shebob et al., 2011).

Past studies have extensively investigated construction delays across diverse contexts and countries globally. For instance, Abinayasri et al. (2017) surveyed India's Erode district to identify delay factors within the construction industry. Orangi et al. (2011) proposed a comprehensive framework to tackle delays in pipeline projects and similar infrastructure ventures in Victoria, Australia. Mahamid (2011) aimed to establish a risk matrix for delay-causing factors in Palestinian road projects from the employer's standpoint. Additionally, Khair et al. (2017) explored construction delays in Sudanese road projects and formulated a management framework to mitigate and manage these delays.

However, it is important to compare traditional (Non-BIM) projects with BIM-enabled projects to highlight the significance of selecting them for comparison, focusing specifically on employer-initiated delay factors. Comparing traditional (Non-BIM) construction projects with BIM-enabled projects is valuable for several reasons: technological advancement, performance improvement, informed decision-making, risk management, long-term benefit, and cost and time efficiency.

Initially, from the angle of the technological advancement, BIM represents a significant technological advancement in the construction industry. By comparing it with traditional (Non-BIM) methods, employers can understand the benefits and limitations of adopting new technologies. By comparing both approaches, the project's employer can make informed decisions about which method best aligns with their goals and requirements (Musa et al., 2016). The option to decide the best approach for the project provides evidence that the traditional (Non-BIM) approach is significantly different from the BIM-enabled approach and shall be applied separately during the construction phase.

From the perspective of cost and time efficiency, comparing the two types of projects enables employers to assess the potential cost and time savings that BIM might offer through better coordination, clash detection, and reduced rework (Tahir et al., 2018). Considering the long-term benefit differences between the two approaches, BIM-enabled projects highlight the potential long-term benefits of BIM, including improved facility management, data utilization, and adaptability to future changes (Liu et al. 2017). Ultimately, comparing traditional (Non-BIM) projects with BIM-enabled projects allows employers to make well-informed decisions, optimize project outcomes, and contribute to the ongoing evolution of the construction industry toward more efficient and technologically advanced practices.

Ugur and Artan (2023) have supported the understanding that traditional (Non-BIM) construction projects and BIM-enabled projects are two separate types of projects or methods of construction in the design phase. Also, Al Hattab and Hamzeh (2015) have also supported considering that traditional (Non-BIM) and BIM-enabled projects are separate units due to the major advancement in BIM technology. Accordingly, it is scientifically understood that traditional (Non-BIM) and BIM-enabled projects can be dealt with and studied separately. Al Hattab and Hamzeh (2015) used social network theory and simulation to compare traditional (Non-BIM) versus BIM/lean-based environments for design error management. They presented a novel design error management strategy concerning team structures, interaction dynamics, and error diffusion. Theoretical results show that BIM and lean practice reconfigure the structures and communication of design teams to identify errors earlier, reduce their reoccurrence, and restrict their diffusion.

From a practical standpoint, the terminology of BIM-enabled projects as a distinct category within the construction market dates back to the mid-2000s, a milestone underscored by the research (Mohd and Latiffi, 2013). This period marked the inception of a transformative approach to project management that influences Building Information Modeling (BIM) technology. The United States of America (USA) stands as a pioneering force in the adoption of BIM-enabled projects, with a prominent early example being the application of BIM in the construction of the Sutter Medical Centre located in Castro Valley, California, as documented (Davis, 2007).

Since its initial implementation in the USA, BIM-enabled projects have gained considerable traction and have been successfully executed in various countries around the world. These projects serve as exemplary showcases of the potential and versatility of BIM technology in the construction industry. Some noteworthy instances include the iconic "Sydney Opera House" in Australia, the cutting-edge "One Island East Office Tower" in Hong Kong, the innovative

"Crussel Bridge" project in Helsinki, Finland, the state-of-the-art "National Cancer Institute (NCI)" facility in Putrajaya, Malaysia, and the transformative "Barking Riverside Extension and Rail Station" development in London, UK (Latiffi et al., 2013).

The employer is the party that enters into a contractual agreement with a contractor to oversee specific construction tasks or projects. Typically, the employer designates a representative to manage the project's execution. It is the employer's responsibility to ensure timely payments to the contractor, contingent upon the completion of work on or before the scheduled deadline. This research interchangeably references the employer, employer's personnel, employer's corporation, and employer's representative.

Despite the growing recognition of the significance of addressing construction delays while comprehensively considering all related sides, it is noted that discussions on construction delay aspects and employer-initiated delay factors have taken place in previous studies without conducting a comprehensive review that could effectively bridge the research gaps.

Following the observations of past studies, Tshaka and Deacon (2019) examined employer-initiated delay factors in South Africa. However, the paper lacks recommendations or suggestions to mitigate or prevent these causes of delay, which would be valuable for practitioners and policymakers. Additionally, the study focuses on just one province in South Africa.

Also, Amare et al. (2017) explored the causes of the delays in construction for road projects; the study does not explore the employer delay factors in depth and detail. The paper only lists 11 employer delay factors based on a literature review. It does not provide empirical evidence or data to support their relevance and significance in the Addis Ababa City Road Authority context. The paper also does not rank or prioritize the employer delay factors. Moreover, the paper does not analyse the interactions among the employer delay factors and the critical success factors that will help address the problem. Thus, previous studies generally cover the following gap areas concerning employer-initiated delay factors: limited studies conducted on specific projects, limited exploration of construction delay studies in certain continents, and the absence of a suitable framework to tackle construction delays.

Additionally, it is worth mentioning that modular construction has been considered a separate entity in this study because the subject of modular construction has garnered considerable attention from scholars and professionals in construction engineering and management, with separate studies conducted on such items. The modular building offers numerous advantages compared to conventional construction, including expedited project completion, enhanced quality control measures, minimised waste generation, heightened safety standards, and less environmental footprint. Nevertheless, modular construction encounters numerous hurdles and hazards, including elevated starting expenses, design limits, shipping complications, scarcity of qualified labour, and regulatory obstacles (Boafo et al., 2016). Examining modular construction separately allows for a focused investigation into its distinct attributes and unique issues that may not be universally relevant to alternative construction methodologies. As an illustration, implementing modular construction necessitates a significant synchronisation and amalgamation across the design, manufacturing, and assembly stages. This can give rise to distinct technical, managerial, and contractual challenges that differ from traditional construction methods.

2.2 Literature Review

2.2.1 Employer-Initiated Delays in Construction Projects

A project's delay can negatively affect its performance and all parties involved. Contractors might face unfavourable bank interests due to delayed payments due to project delays (Odeh and Battaineh, 2011). Delays can be categorized based on the party's source causing the delay. Delays instigated by the employer are termed employer-initiated delays. Some delays are the joint responsibility of the employer and the contractor, known as concurrent delays. Such concurrent delays might emerge when both parties experience delays on the critical path with separate but parallel activities (Bubshait and Cunningham, 2001). In other cases, employer and contractor delays may not coincide. These employer-initiated delays might be classified as excusable delays by the contractor or delays leading to the contractor's entitlement for prolongation costs (Afshari et al. 2010).

Furthermore, delays can also branch from neither party, resulting in third-party delays, such as those arising from wars (Ogunde et al., 2017). This paper specifically focuses on delays attributable to the employer. The causes of employer-initiated delays in construction projects can vary based on specific perceptions and classification methods used in different studies. Such delays could directly result from the employer (Ogunde et al., 2017). An example of these delays is compensable delays, primarily caused by the employer. These delays may branch directly from the employer, its agents, or representatives in the construction project. They could also arise due to errors or negligence by the employer, resulting in a delay beyond the contractually agreed end time. The contractor can request an extension or compensation when a compensable delay occurs. Ibironke et al. (2013) found that changes the employer implements, changes in working conditions, or work suspension can lead to compensable delays. Tumi et al. (2009) added that these reasons involve delays in reviewing and approving design documents, poor communication, sluggish decision-making by the employer, and payment delays caused by financial issues.

Occasionally, the employer's documents may be incomplete, incorrect, or contain variances that disrupt the work's progress (Abouorban et al., 2018). Tahera and Pandey (2013) identified the employer's organizational problems, such as delayed payments and a lack of planning experience, as key reasons for construction project delays. Samarah and Bekr (2016) highlighted continuous design changes and design errors as significant contributors to delays in Jordan's projects. Hasan et al. (2014) stressed that delays initiated by the employer in approving timetables, ongoing interference in the contractor's work, and changes in construction requirements are key reasons for project delays. Agu and Ibe (2015) identified delays in adopting design documents, revisions, and order changes as essential in prolonging Nigerian project completion. As confirmed by Aziz (2013) and Ezeldin and Abdel-Ghany (2013), approval of design documents can also lead to project delays. Marzouk and Abdelaty (2014), Haq et al. (2017), and Abdellatif and Alshibani (2019) pointed out that the employer's inconclusiveness hinders project progress. From the above discussion, it's clear that the employer's decisions significantly impact project delays and the need for time extensions. Therefore, this study examines employer-initiated delay factors and creates research frameworks to address these delays in traditional (Non-BIM) and BIM-enabled projects.

2.2.2 Potential Employer-Initiated Delays in BIM-Enabled Projects

Digital data models are used within a virtual space to manage various aspects of construction projects, including delays, effectively. Building Information Modeling (BIM) technology has positively impacted construction delay management across project lifecycles. Nonetheless, there remains a considerable risk of delays in BIM-enabled projects. For example, Chien et al. (2014) examined critical risk factors in BIM-enabled projects, identifying technical, management, environmental, financial, and legal risks. The primary risk factors influencing successful BIM implementation include insufficient project experience, software compatibility issues, and model management complexities. This highlights the need to carefully consider risks during the project lifecycle despite BIM's potential to reduce construction delays.

Ho et al. (2013) suggested using BIM technology for sharing construction information and proposed a BIM knowledge management system for engineers and project managers. Ganbat et al. (2020) established a connection between international construction project risks and BIM to enhance BIM's utility in construction. Their work demonstrated BIM's ability to enhance communication management and mitigate risks by overcoming language barriers among project stakeholders. Azhar et al. (2020) pointed out that despite the advantages of BIM implementation in construction and its growing adoption, numerous developing countries encounter obstacles that protract BIM implementation due to challenges. Eadie et al. (2014) highlighted that BIM barriers are perceived differently by users and non-users. Elhendawi et al. (2019) categorized 38 BIM barriers into groups, and certain barriers are directly linked to delays caused by BIM implementation issues, such as legal and contractual challenges, training costs, uncertainty about benefits, and difficulties in transition.

Ya'acob et al. (2018) classified BIM implementation risks into technology, management, financial, and legal categories. Barriers such as lack of skilled personnel, funding constraints, unclear responsibilities, and disputes can amplify employer-initiated delay factors. In conclusion, while BIM implementation benefits construction projects, various risks and barriers affecting multiple project stakeholders can undermine the advantages of BIM's implementation, including its ability to control delays. Moreover, because the employer plays a leading role in BIM implementation, it is essential to thoroughly study employer-initiated delay factors in construction projects and the effects of BIM implementation strategies and barriers on these delays. The relationship between the employer and the BIM implementation has been deliberated in previous literature. For instance, Dakhil et al. (2019) illustrated that employers are essential in promoting the use of BIM in construction projects. However, they mentioned that BIM's implementation and execution are commonly avoided from being more extensively accepted throughout the construction market by the employers' worries and concerns and the absence of a complete understanding of the advantages of BIM. Thus, they suggested that the employer organisation establish the required competencies and administrative staff to support the BIM execution. According to a Smart Market Report study (2011), customers can play an essential function in the BIM execution procedure; employers' needs can incentivise the market to begin carrying out BIM (Hill, 2011). However, the employer's worries and concerns and a lack of complete understanding of BIM advantages have barred adopting BIM in many projects (Dakhil et al., 2019.)

2.3 Review Approach

This paper presents the results of a comprehensive examination of delays in construction projects, with a specific focus on delay factors initiated by employers. Additionally, it proposes establishing a link between employer delay factors, relevant BIM implementation strategies, and BIM-related barriers to employer-initiated delays. The study follows a systematic research approach, illustrated in Figure 2.1, outlining the steps taken to construct a research framework for addressing employer-initiated delay factors. The diagram captures key research elements: regions and project categories for gap identification, sample sizes and populations from prior studies, essential attributes for mapping exercises, employer-initiated delay factors, and the envisioned delay aspects. The initial phase involves defining a population range within chosen database platforms by extensively searching for research papers on construction delays. The selection of target papers for each continent is guided by publication years and sample sizes recommended by Hogg et al. (2010). Google Scholar, Scopus, and Web of Science (WOS) are the selected databases for the search, and duplicate records are eliminated visually. Khoshnava et al. (2012) have scientifically compared the coverage of WOS and Scopus, revealing WOS's reliable coverage of studies dating back to 1990, whereas Scopus tends to focus on more recent papers. The search incorporates Asia, Africa, Oceania, Europe, North/Central America, and South America. The choice of keywords for the search is careful to ensure comprehensive coverage of construction delay research papers. Primary keywords include "Construction," "Employer," "Client," "Owner," "Delay," "Factor," "Element," "Cause," and "Reason."

The collected data undergo further refinement to ensure their relevance to the study's subject and to eliminate repeated reviews. This refinement process is conducted after each search. In Scopus, a minimum of five separate searches are conducted, and data refinement is executed to address relevance, repetition, and further exploration. It's worth noting that during each search iteration, the researchers visually checked the list of research papers, considering synonyms of the main keywords, the specific country, and the continent of the study.

The search strategy adopted to gather research papers related to the subject ensures comprehensive coverage for this review. This strategy involves interchanging the main search words into five different arrangements during the search across primary engines. For each search iteration within these five-word arrangements, the researcher visually reviewed the list of relevant research papers to guarantee thoroughness. It's important to emphasize that the search exclusively includes research papers, including theses or reports excluded. The time frame for the search is limited to research papers published between 2007 and 2023.

A similar systematic search is conducted focusing on BIM within the construction field. The population range remains within the same selected database engines. The chosen search engine keywords are deliberate to ensure comprehensive subject coverage. Key terms include "Construction," "Delay," "Factor," "Element," "Employer," "Owner," "Client," "Causes," "Reason," "Building Information Modelling," and "BIM." (refer to Figure 2.2).

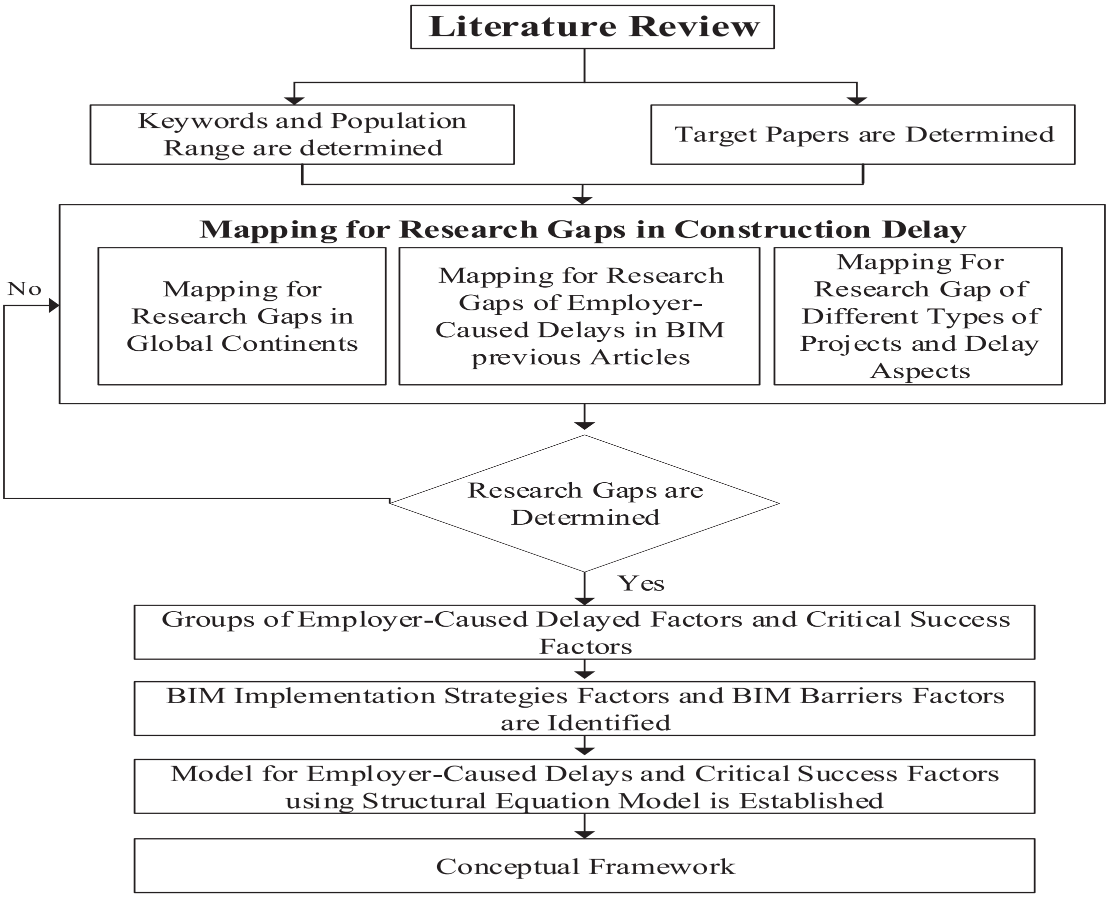

Figure 2.1. Research Map.

2.4 Data Analyses

Table 2.1 and Table 2.2 provide an overview of the compiled data for each continent concerning research papers on construction delays and BIM-related construction delays. Following Hogg et al.'s (2010) guidance, searching for a sufficiently representative sample was necessary to identify the targeted research gaps effectively. Table 2.3 outlines the calculated target size for each continent, determining the required number of research papers to offer a comprehensive representation of construction delays and BIM-related construction delays. A preliminary mapping was carried out for 38 research papers dealing with BIM construction delays in the subsequent step. As demonstrated in Table 2.4, these papers offer a limited perspective on employer-initiated delay factors. For example, Khoshnava et al. (2012) explored BIM's potential application in construction disputes and conflicts, addressing issues such as employer response delays, discrepancies in contract documents, and hesitance to verify constructability. Marzouk and Abdelaty (2014) discussed employer-initiated delay factors related to interim payment delays, order variations, and the employer's limited construction expertise.

Detailed mapping was conducted for 65 selected research papers, covering topography, delay aspects, and project types. This analysis aimed to discern and establish research gaps in construction delay in previous studies. This comprehensive review endeavours to identify existing research gaps in construction delay, paving the way for new research investigations. In line with this study's proposal, a future study could establish a model that links construction delay with critical success factors, considering research shortage, project types, and delay characteristics (as shown in Table 2.5 and Table 2.6).

Table 2.1. Population Size for Papers Related to Construction Delay in Traditional (Non-BIM) Project

Continent	Population [Scopus]	Population [WOS]	Population [Google Sc.]	Refined Population
Africa	16	8	28	52
Asia	56	30	103	189
Europe	5	1	2	8
Oceania	3	0	0	3
South America	2	2	0	2
Central and North America	1	2	2	5

Table 2.2. Population Size for Papers Related to BIM Construction Delay

Continent	Population [Scopus]	Population [WOS]	Population [Google Sc.]	Refined Population
Africa	1	0	1	2
Asia	18	9	3	30
Europe	2	2	0	4
Oceania	0	0	0	0
South America	1	1	0	2
Central and North America	0	0	0	0

Table 2.3. Sample Sizes for Papers for Construction Delay and BIM Construction Delay

Continent	Sample Size for Papers Related to Construction Delay	Sample Size for Papers Related to BIM Construction Delay
Africa	15	2
Asia	44	31
Europe	5	4
Oceania	3	0
South America	2	1

Central and North America	1	0

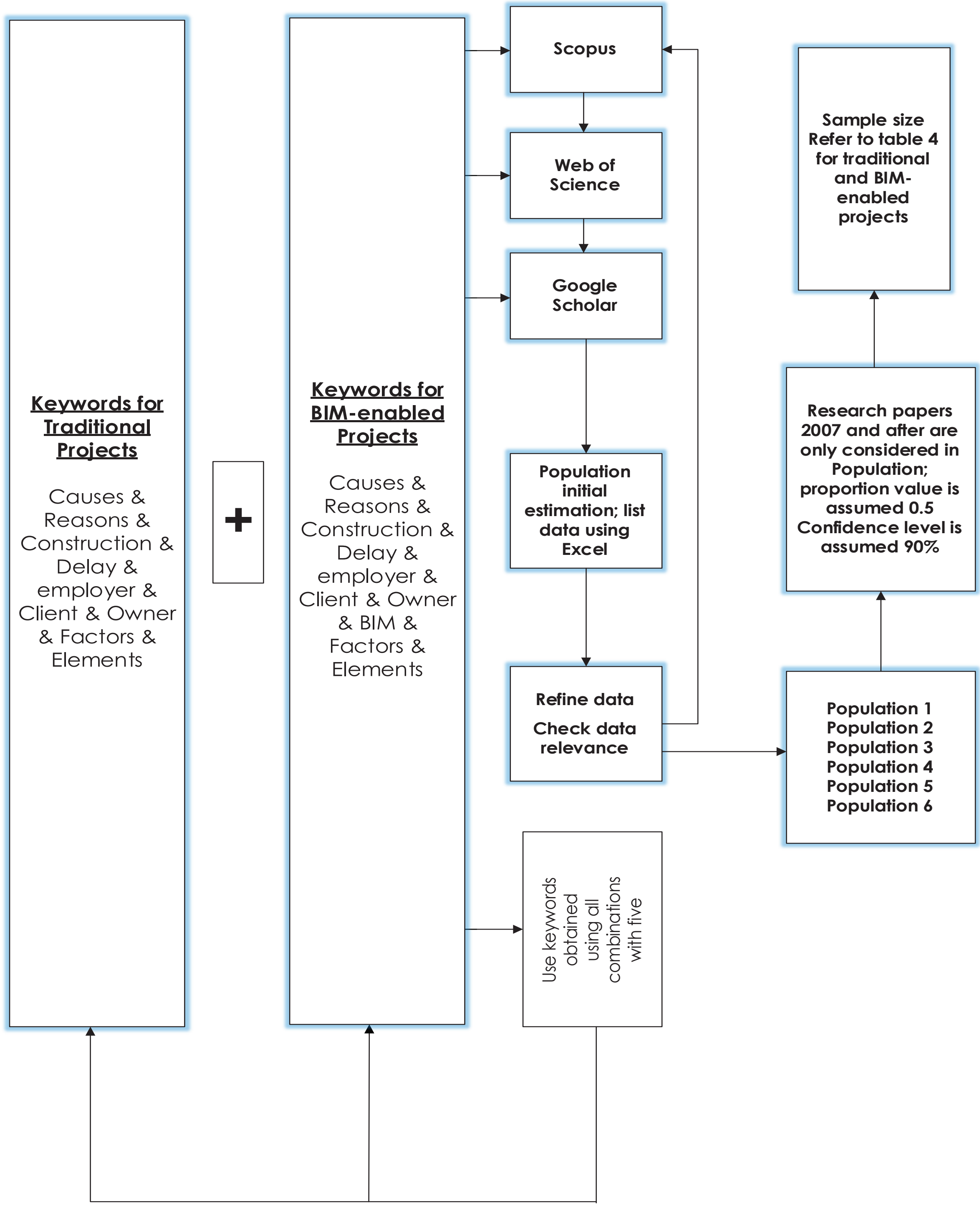

Figure 2.2. Search Methodology to Estimate Population/Sample Size for Target Research Papers.

In the third step, groups and relevant employer-initiated delay factors are established. Historically, researchers have categorized construction delay factors in various ways and groupings. For instance, Alaghbari et al. (2007) organized delay factors based on their contractual operation into groups such as "Excusable and compensable," "Non-excusable and non-compensable," and "Concurrent." Additionally, these factors have been classified according to different delay aspects, including social, technical, and financial dimensions. Thus, in this study, the delay aspects are categorized based on the following proposed segments:

(i) Managerial Aspects: This category primarily comprises (but is not limited to) leadership and staff management, planning capabilities, and communication proficiencies.

(ii) Social Aspects: This grouping primarily includes (but is not limited to) elements like construction culture, the employment of foreign labour, and the ability of labourers to communicate in the local language.

(iii) Technical Aspects: Technical considerations primarily span (but are not limited to) areas such as construction experience, qualifications, proficiency in planning software utilization, familiarity with construction equipment technology, adeptness in BIM technology, identification of design flaws, and recognition of construction defects.

(iv) Financial Aspects: Financial dimensions predominantly cover (but are not limited to) aspects such as procurement, client funding, client payments, the purchasing order's correspondence and its financial procedures, payments to subcontractors, material expenses, costs of employing skilled labourers, indirect costs, prolongation costs, and variations and changes in cash flow.

(v) Contractual Aspects: Contractual considerations mainly involve (but are not limited to) factors such as contractual knowledge and understanding, awareness of contractual obligations, breaches of contract, and the initiation of claims.

These categorized segments facilitate a structured exploration of employer-initiated delay factors and their diverse dimensions, contributing to a comprehensive understanding of delay factors within the construction context (refer to Chapter 3 for the complete strategy for categorisation for employer-initiated delay factors).

Table 2.4. Employer-Initiated Delay Factors in Previous BIM Papers

Author (Year)	Continent	Project Type	Employer-Initiated Delay Factors
Ham et al. (2018); Mehran (2016); Btoush and Harun (2017); Li et al. (2016); Latiffi et al. (2013); Bui (2020); Ma et al. (2015); Jia et al. (2017); Zhang et al. (2016)	Asia	Buildings	Not Attended
Tanoli et al. (2019)	Asia	Underground utilities	Not Attended
Macariola and Silva (2019); Mamter et al. (2017); Al-Ashmori et al. (2019); Telaga (2017); Pilyay and Shilova (2018); Tahir et al. (2017); Musa et al. (2016); Chou and Yang (2017); Chou and Chen (2017); Hatmoko et al. (2019); Won et al. (2016); Hamada et al. (2017)	Asia	Not identified	Not Attended
Hatem et al. (2017); Gardezi et al. (2014); Charehzehi et al. (2017);	Asia	Not identified	Partially Attended
Alenazi and Adamu (2017)	Asia	Infrastructure	Partially Attended
Shin et al. (2018)	Asia	Railway	Not Attended
Zhou et al. (2020)	Asia	Tunnels	Not Attended
Liao et al. (2019)	Asia	Buildings	Partially Attended
Li et al. (2018)	Asia	Railway	Not Attended
Vitasek, and Matjka (2017); Galić et al. (2017)	Europe	Buildings	Not Attended
Grzyl et al. (2017)	Europe	Not identified	Not Attended
Bensalah et al. (2019)	Africa	Railway	Not Attended
Aigbavboa and Thawala (2014)	Africa	Not identified	Not Attended
Aladag et al. (2016)	Asia/Europe	Buildings	Partially Attended
Matos and Miranda (2018)	South America	Public construction	Partially Attended

Table 2.5. Mapping Delay Factors in Continents for the Delay Aspects in the Targeted Research Papers in the Traditional (Non-BIM) Projects.

Authors	Continent							Aspects of Delay Factors											
	Oceania	Asia	South America	Central and North America	Europe	Africa	Total number of factors	Caused by employer	Caused by consultant	Caused by contractor/subcontractor	Caused by authorities	Project phases	Managerial aspects	Social aspects	Technical aspects	Financial aspects	Contractual aspects	Environmental aspects
Al-Hazim, and Abu Salem (2017)		√					20	8	4	7	1	×	P	N	P	P	P	P
Emam et al. (2015)		√					88	×	17	40	×	×	P	N	P	P	P	N
Samarah and Bekr (2016)		√					55	17	11	20	2	×	P	P	P	P	P	P
Motaleb and Kishk (2014)		√					×	×	×	×	×	×	×	×	×	×	×	×
Muhwezi et al. (2014)						√	81	15	18	27	3	×	P	P	P	P	P	P
Shah (2016)	√	√				√	×	×	×	×	×	×	P	N	N	N	N	N
Khan (2015)		√					70	26	20	28	3	×	P	N	P	P	P	P
Rahimipour and Shahhosseini (2014)		√					10	×	×	×	×	×	P	N	P	P	P	P
Upadhyay et al. (2016)		√					6	×	×	×	×	×	P	N	P	N	P	N
Tawil et al. (2014)		√					126	21	26	39	5	×	P	N	P	P	P	P
Oshodi and Rimaka (2013)		√				√	27	5	5	14	1	×	P	N	P	P	P	P
Amoatey et al. (2014)						√	37	7	7	16	3	×	P	N	P	P	P	P
Rauzana (2016)		√					×	×	×	×	×	×	×	×	×	×	×	×
Shehu et al. (2015)		√					×	×	×	×	×	×	×	×	×	×	×	×
Pai and Bharath (2013)		√					73	9	15	14	3	×	P	P	P	P	P	P
Gajare and Attarde (2014)		√					26	2	3	4	1	×	P	N	P	P	P	P
Kamanga and Steyn (2013)						√	72	18	12	29	N	×	P	N	P	P	P	P

Bekr (2015)		√					65	17	11	25	×	×	P	N	P	P	P	P
Al-Emad and Nagapan (2015)		√					81	22	20	33	3	×	P	P	P	P	P	P
Suksai et al. (2015)		√					18	1	0	16	0	×	P	N	P	P	P	N
Islam, and Trigunarsyah (2017)		√				√	53	7	7	10	3	×	P	N	P	P	P	P
Van et al. (2015)		√					31	×	×	×	×	×	P	N	P	P	P	P
Zou et al. (2007)		√					25	3	4	14	1	×	P	N	P	P	P	P
Addo (2015)						√	57	×	×	×	×	×	P	N	P	P	P	×
Dontul et al. (2015)		√					11	4	0	7	0	×	P	N	P	P	P	×
Senouci et al. (2016)		√					×	×	×	×	×	×	×	N	×	×	×	×
Samarghandi et al. (2016)		√					36	12	10	8	6	×	P	N	P	P	P	P
Assbeihat (2016)		√					45	6	8	20	2	×	P	N	P	P	P	P
Megha and Rajiv (2013)		√					59	9	7	9	3	×	P	P	P	P	P	P
Alamri and Amoudi (2017)		√					60	12	11	15	4	×	P	P	P	P	P	P
Khattri et al. (2016)		√					58	×	×	×	×	×	N	N	P	N	N	P
Alhajri, and Alshibani (2018)		√					23	6	3	11	1	P	P	P	P	P	P	P
Kim et al. (2015)		√					33	11	10	9	2	×	P	N	P	P	P	P
Sohu et al. (2017)		√					73	×	×	×	×	×	P	N	P	P	P	N
Hadithi (2018)		√					64	6	19	13	0	×	P	N	P	P	P	P
Tumi et al. (2009)						√	43	18	14	18	×	×	P	N	P	P	P	P
Akogbe et al. (2013)						√	35	4	14	10	1	×	P	N	P	P	P	P
Alinaitwe et al. (2013)						√	22	5	3	11	0	×	P	N	P	P	P	P
Famiyeh et al. (2017)						√	58	9	14	12	5	×	P	N	P	P	P	P
Damoah and Kumi (2018)						√	34	13	10	10	2	×	P	N	P	P	P	P
Olawale and Sun (2010)					√		20	6	4	6	3	×	P	N	P	P	P	P
Zidane, and Andersen (2018a)					√		10	6	5	5	0	×	P	N	P	N	P	N
Gunduz et al. (2015)					√		83	12	8	10	3	×	P	N	P	P	P	P
Zidane, and Andersen (2018b)					√		33	12	9	16	1	×	P	P	P	P	P	P

Maues et al. (2017)			√				30	6	9	9	1	×	P	N	P	P	P	N
Perez et al. (2015)			√				×	×	×	×	×	×	×	×	×	×	×	×
Tafazzoli, and Shrestha (2017)				√			17	4	3	8	1	×	P	N	P	P	P	P
Wang et al. (2018)		√					37	14	8	16	×	×	P	N	P	P	P	×
Abbasi et al. (2020)		√					50	10	10	21	0	×	P	N	P	F	P	N
Arantes and Ferreira (2020)					√		47	9	7	26	2	×	P	P	P	P	N	P
Muneeswaran et al. (2020)		√					49	11	8	30	0	×	P	N	P	P	P	N
Bajjou and Chafi (2020)						√	49	5	4	13	1	×	P	P	P	P	P	P
Bagaya and Song (2016)						√	27	5	4	6	1	×	P	N	P	P	P	N
Prasad et al. (2019)		√					62	11	9	28	1	×	P	N	P	F	P	N
Alaghbari et al. (2007)		√					32	8	8	8	1	×	P	P	P	P	P	P
Oshungade and Kruger (2017)						√	48	8	11	6	0	×	P	N	P	P	P	P
Ansah (2011)						√	15	5	0	7	0	×	N	N	N	P	N	N
Pall et al. (2020)	√						63	13	10	23	1	×	P	P	P	P	P	P
Ravisankar et al. (2020)		√					50	11	12	24	1	×	P	P	P	P	P	P
Hiyassat et al. (2020)		√					62	11	3	11	5	×	P	P	P	P	P	P
Xie et al. (2023)		√					16	9	×	5	×	×	P	P	P	P	P	P
Khahro et al. (2023)		√					1	1	×	×	×	×	P	×	×	×	×	×
Memon et al. (2023)		√					55	13	18	23	1	×	P	P	P	P	P	P
Do et al. (2023)		√					45	15	13	14	2	×	P	P	P	P	P	P
Derakhshanfar et al. (2020)	√						33	6	1	8	18	×	P	N	P	P	P	N

×: delay factors are not listed in the research paper context; N: delay factors are not identified; P: delay factors are partially identified in the context of the paper; F: delay factors are fully identified.

Table 2.6. Mapping of Delay Factors for Different Types of Projects in Traditional (Non-BIM) Projects.

Authors	Project Type									
	Residential buildings	Commercial buildings	Industrial buildings	Airports	Oil and gas	Other infrastructure	Modular structures	Power projects	Water/sewer/irrigation	General
Al-Hazim, and Abu Salem (2017)						√				
Emam et al. (2015)						√				
Samarah and Bekr (2016)										√
Motaleb and Kishk (2014)										√
Muhwezi et al. (2014)		√								
Shah (2016)										√
Khan (2015)					√					
Rahimipour and Shahhosseini (2014)										
Upadhyay et al. (2016)										√
Tawil et al. (2014)										√
Oshodi and Rimaka (2013)										√
Amoatey et al. (2014)	√									
Rauzana (2016)										√
Shehu et al. (2015)										√
Pai and Bharath (2013)						√				
Gajare and Attarde (2014)										√
Kamanga and Steyn (2013)						√				
Bekr (2015)										√
Al-Emad and Nagapan (2015)										√
Suksai et al. (2015)	√	√								

Islam, and Trigunarsyah (2017)										√
Van et al. (2015)										√
Zou et al. (2007)										√
Addo (2015)										√
Dontul et al. (2015)										√
Senouci et al. (2016)										√
Samarghandi et al. (2016)										√
Assbeihat (2016)										
Megha and Rajiv (2013)	√									
Alamri and Amoudi (2017)						√				
Khattri et al. (2016)										√
Alhajri, and Alshibani (2018)					√					
Kim et al. (2015)		√								
Sohu et al. (2017)						√				
Hadithi (2018)						√				
Tumi et al. (2009)										√
Akogbe et al. (2013)										√
Alinaitwe et al. (2013)										√
Famiyeh et al. (2017)	Educational Facilities									
Damoah and Kumi (2018)										√
Olawale and Sun (2010)										√
Zidane and Andersen (2018a)										√
Gunduz et al. (2015)										√
Zidane, and Andersen (2018b)										√
Maues et al. (2017)	√									
Perez et al. (2015)										√
Tafazzoli, and Shrestha (2017)										√

Wang et al. (2018)	√	√	√							
Abbasi et al. (2020)										√
Arantes and Ferreira (2020)										√
Muneeswaran et al. (2020)										√
Bajjou and Chafi (2020)										√
Bagaya and Song (2016)										√
Prasad et al. (2019)	√	√	√					√	√	
Alaghbari et al. (2007)										√
Oshungade and Kruger (2017)										√
Ansah (2011)										√
Pall et al. (2020)								√		
Ravisankar et al. (2020)										√
Hiyassat et al. (2020)										√
Xie et al. (2023)							√			
Khahro et al. (2023)	√	√	√							
Memon et al. (2023)	√	√	√							
Do et al. (2023)										√
Kassem et al. (2019)					√					
Derakhshanfar et al. (2020)										√

Table 2.7 and Table 2.8 present a timeline summary analysis (for the targeted research papers) to evaluate the research gaps in addressing the construction delay and the employer's delays in traditional (Non-BIM) and BIM-enabled projects from 2007 until 2023. Tables 2.7 and 2.8 present a comprehensive investigation into the past evaluation and analysis of prior studies conducted between 2007 and 2023. The provided tables offer a thorough and detailed compilation of research findings and perspectives regarding delay causes triggered by employers. This endeavour greatly enhances the scholarly discussion in this chapter by addressing a crucial gap in knowledge about projects that utilise Building Information Modelling (BIM) compared to traditional (Non-BIM) projects. More specifically, it focuses on the important matter of delay factors introduced by employers. The tables function as a crucial reservoir of knowledge, consolidating extensive research and facilitating a more profound comprehension of the progression of delay factors begun by employers throughout time. Moreover, the incorporation of data spanning from 2007 to 2023 highlights the current significance of this study, illustrating the evolving nature of construction methodologies and the growing utilisation of Building Information Modelling (BIM) technology. By illuminating this substantial period, the tables facilitate the identification of past and current difficulties and establish a basis for predicting future patterns and prospective advancements.

Table 2.7. A Timeline Progress Review for Construction Delay Aspects Addressed in the Previous Studies for Traditional (Non-BIM) Projects

Year Period	Research Papers- Traditional (Non-BIM) Projects	Review/Progress Discussion
2007–13	Zou et al. (2007); Tumi et al. (2009); Olawale and Sun (2010); Motaleb and Kishk (2013); Oshodi and Rimaka (2013); Pai and Bharath (2013); Kamanga and Steyn (2013); Akogbe et al. (2013); Alinaitwe et al. (2013).	For instance, Tumi et al. (2009) included almost 18 employer-initiated delay factors, such as improper planning, lack of effective communication, design errors, date of notice to proceed, and project management issues, that do not comprehensively cover the employer-initiated delay. For the targeted research papers between 2007 and 2013, employer-initiated delay factors have been either not considered or considered partially in the managerial, social, technical, financial, contractual, and environmental aspects. Furthermore, the research conducted by Alinaitwe et al. (2013) pinpointed the five foremost reasons for delays in construction projects within Uganda's public sector. These included alterations to the project's scope, delays in payments, deficient monitoring and control measures, the elevated cost of capital, and the ramifications of political uncertainty and instability. Additionally, the study also identified the five primary contributors to cost overruns. However, it's important to note that the research did not comprehensively explore factors linked to employer-initiated delays. Consequently, the study did not investigate these employer-driven delay factors in-depth or present practical frameworks or solutions to address them effectively. The recommendations put forth in the study were rather general. These included proposals aimed at enhancing project

		management practices, considering a transition to the design-build contract model, and seeking avenues to enhance clients' cash flow, thereby reducing payment delays. Although these recommendations are valuable, they may not holistically tackle the challenges posed by employer-initiated delays within Uganda's public sector construction projects.
2014–16	Muhwezi et al. (2014); Rahimipour and Shahhosseini (2014); Tawil et al. (2014); Amoatey et al. (2014); Shehu et al. (2014); Gajare and Attarde (2014); Bekr (2015); Khan (2015); Al-Emad and Nagapan (2015) ; Dontul et al. (2015); Suksai et al. (2015); Van et al. (2015); Kim et al. (2015); Gunduz et al. (2015); Perez et al. (2015); Emam et al. (2015); Samarah and Bekr (2016); Shah (2016); Upadhyay et al. (2016); Rauzana (2016); Addo (2016); Senouci et al. (2016); Samarghandi et al. (2016); Assbeihat (2016); Megha and Rajiv (2016); Khattri et al. (2016).	It is still that employer-initiated delay aspects have either not been addressed or partially addressed. For instance, Muhwezi et al. (2014) have considered 15 employer-initiated delay factors such as corruption tendencies, change orders, delay in payments, and delay in approving design documents. Moreover, it's worth noting that the study conducted by Emam et al. (2015) investigated the multi-layered landscape of factors contributing to project delays within the infrastructure projects in Qatar. This paper is undeniably valuable in shedding light on the challenges and issues that can impede the timely completion of infrastructure developments, thus offering crucial insights for the betterment of Qatar's construction industry. However, within a diversified construction sector, including various project typologies, the study's scope appears somewhat confined to infrastructure projects. While infrastructure projects represent a

		substantial facet of the construction landscape, it's important to recognize the existence of other significant project categories.
2017–18	Al-Hazim and Abu Salem (2017); Islam and Trigunarsyah (2017); Alamri and Amoudi (2017); Sohu et al. (2017); Famiyeh et al. (2017); Maues et al. (2017); Tafazzoli and Shrestha (2017); Wang et al. (2018); Hadithi (2018); Damoah and Kumi (2018); Zidane and Andersen (2018); Zidane and Andersen (2018).	It is still that employer-initiated delay aspects have either not been addressed or partially addressed. For instance, Wang et al. (2018) have reviewed the construction delay in Chinese building projects in which 14 employer-initiated delay factors have been considered, such as employer interference, employer variations/changes in scope, and defective materials provided by the employer.
2019–21	Abbasi et al. (2020); Arantes and Ferreira (2020); Muneeswaran et al. (2020); Bajjou and Chafi (2020).	The number of employer's initiated delay factors (the targeted research papers between 2019 and 2021) are 10, 9, 11, and 5. Abbasi et al. (2020) have managed to address the financial delay factors. They managed to address the delays and financial factors such as "problems in financing and providing sufficient and stable cash flow during the construction phase and financial problems.
2023	Xie et al. (2023), Khahro et al. (2023), Memon et al. (2023), Do et al. (2023).	In the sphere of this subject, it becomes evident that a holistic understanding is yet to be achieved regarding employer-initiated delays. The research undertaken by Do et al. (2023) highlighted and addressed 15 distinctive delay factors instigated by employers. Yet, this endeavour also emphasised the complexity and diversity of these factors, emphasizing that a complete and all-including compilation is still not available in the current body of research.

Table 2.8. A Timeline Progress Review for Construction Delay Aspects Addressed in the Previous Studies for BIM-Enabled Projects.

Year Period	Research Papers (BIM-Enabled Projects)	Review/Progress Discussion
2007–13	Latiffi et al. (2017); Kulatunga et al. (2011); Mahamid (2011); Tan et al. (2011); Oshodi and Rimaka (2013); Sutrisna (2009); Motaleb and Kishk (2013); Gardezi et al. (2014); Shebob et al. (2011); and Tumi et al. (2009).	BIM-related research target papers between 2007 and 2013 have not reviewed the construction delay in all aspects. For instance, Latiffi et al. (2017) have considered reviewing the BIM application in Malaysian construction, but they did not consider the subject of the construction delay in BIM applications.
2014–16	Ma et al. (2015); Zhang et al. (2016); Kekana et al. (2014); and Aladag et al. (2016).	The BIM-enabled project has noticed slight progress in considering the construction and employer-initiated delay factors. For instance, (for targeted papers for the years between 2014–and 2016), Aladag et al. (2016) have considered some of the employer's delay factors that complicate or obstruct the use of BIM in controlling employer delays, such as lack of employer demand and motivation to use BIM and additional cost arising from the BIM use. However, the level of consideration for the employer delay factors in BIM-enabled projects is still partial.
2017–18	Ham et al. (2018); Maues et al. (2017); Btoush & Harun (2017); Bui (2018); Jia et al. (2017); Won et al. (2017); Hamada et al. (2017); Wang et al. (2018); Chou et al. (2017); Chou and Chen (2017); Charehzehi et al. (2017); Alenazi and Adamu (2017); Li et al. (2018); Grzyl (2017); and Matos et al. (2018).	More advancement progress in the construction delay factors and the employer-initiated delay factors are noticed for the BIM-enabled project. For instance, Hatem et al. (2017); Charehzehi et al. (2017); and Liao et al. (2019); have considered the employer-initiated delay factors in the BIM research papers, which are concerning the construction delay.
2019–21	Al-Ashmori et al. (2019); Bensalah et al. (2019); Bui (2020); Hatmoko et al. (2019); Liao et al. (2019); Macariola et al. (2019); Tanoli et al. (2019); Zhou et al. (2020).	Liao et al. (2019) reviewed and studied many construction barriers to implementing BIM in construction projects. as "executives failing to recognise the value of BIM-based processes and needing training, resistance to changes in corporate culture and structure."

2023	Parsamehr et al. (2023); Egwim et al. (2023).	Parsamehr et al. (2023) conducted a thorough review to explore the integration of Building Information Modeling (BIM) in construction management research, particularly its role in supporting predictive decision-making. Their research framework included various challenges within construction management. The study examined numerous published articles addressing these challenges and found that safety management emerged as the predominant research focus. However, addressing the employer-initiated delay factors is still incomplete for BIM-enabled projects.

The review indicates that BIM researchers are increasingly focused on understanding how BIM technology can contribute to managing construction delays, both overall and those attributed to employers. The provided table further highlights an ongoing gap in effectively addressing construction and employer-related delays from a comprehensive viewpoint. Analysing the data summary in *Table 2.7*, it's evident that conventional projects still exhibit research gaps concerning partial approaches to dealing with delays. The persistent research gaps include inadequate coverage of addressing construction delays holistically and a lack of comprehensive examination of construction delays and employer-initiated delays, especially in specific project contexts like airports. Upon reviewing the data summary in Table 2.8 for BIM projects, an obvious trend emerges: BIM research papers are increasingly dedicated to exploring how BIM can positively impact addressing construction delays, even those originating from employers.

Table 2.9 is a comprehensive compilation of employer-initiated delay factors extracted through an exhaustive analysis of prior research. Initially, a diverse array of studies was examined precisely to construct an all-including delay factors tied to the employer's actions. Certain studies have categorised these delay factors based on their source of origin, resulting in employer-related, contractor-related, consultant-related, and so forth classifications. Conversely, other research endeavours have opted for alternative categorizations, as expounded upon in Chapter 3. For instance, Rahimipour and Shahhosseini (2014) and van et al. (2015) adopted a categorization framework rooted in the source of delay. In these instances, the compilation of employer-initiated delay factors proved to be relatively straightforward. However, when delay factors were organized along different dimensions, such as project-related, external-related, or financial-related, the research necessitated a more systematic approach to amassing employer-initiated delay factors. In these cases, identifying and compiling such factors called for a systematic and comprehensive method to ensure the inclusion of all relevant elements. In this context, the researcher employed a responsibilities matrix tailored for the employer's role in construction projects, an invaluable tool for clarifying the roles and expectations of various stakeholders involved. A common type of matrix used for this purpose is the RACI matrix, representing Responsible, Accountable, Consulted, and Informed roles. Based on the definition of responsibilities and accountabilities for each employer-initiated delay factor, these factors were collectively covered within the purview of employer-initiated delay factors. For instance, the absence of early project planning has contributed to employer-related delays in this study. This assertion stems from the understanding that such factors can later impact the project, particularly in terms of design modifications and contractor selection at an early stage—both of which fall squarely within the purview of the employer's responsibilities and accountabilities. Table 4.1 in this thesis represents the distribution of the employer-initiated delay factors based on the previous empirical studies in consideration of the RACI method.

Additionally, Fashina et al. (2021) explicitly assert that delays in approving major changes in the work scope and change orders during construction are primarily attributable to the employer's actions. Similarly, Mbatha et al. (2022) have classified this factor as one of the delays primarily induced by the employer. This effort identified and categorised thirty-one (31) employer-initiated delay factors.

In summary, the employer-initiated delay factors have been identified based on either being related to the employer in the previous literature or being categorised as employer-related factors based on their accountability and responsibility, as clarified above.

Table 2.9. Employer-Initiated Delay Factors Sorted Under the Proposed Delay Aspects

Delay Group/Delay Aspect	**Employer-Initiated Delay Factors**
Managerial Aspects	Delay in approving changes in the scope of work and specifications
	Lack of communication between all parties, including the employer
	Slowness in the decision-making process by the employer
	Failure to treat delays during project implementation
	Suspension of work by the employer
	Unreasonable constraints imposed by the employer
	The poor organisational structure of the employer's organisation
	Delay in furnishing and delivering the site to the contractor by the employer
	Lack of early planning for the project
	Delay in supply of material by employer
	Delay in tendering system requirements
Social Aspects	Delay in acquiring land from citizens
	Bureaucratic hurdles in the employer's organisation
Technical Aspects	Application of quality control based on foreign specifications
	Lack of experience of the employer in construction projects
	Irregular attendance at the weekly meeting
	Wrong selection of site by employer
Financial Aspects	Delay in the progress of payments by the employer
	Underestimation of the cost of projects
	Insufficiency of the budget available with the employer
	Improper investment criteria and feasibility study by employer
Contractual Aspects	Contract modifications and site changes by the employer
	Type of project bidding and awarding
	Unavailability of incentives for the contractor to finish ahead of schedule
	Ineffective delay penalties
	Damaging penalties imposed on the contractor

	Late contract awarding
	Problems with claims
	Delay by the employer in approving completed work (i.e., stage passing)
	Claims arising from late compensation for land acquisition
	Short original contract duration

Table 2.10. BIM Implementation Strategies for Employer-Initiated Delay Factors

BIM Implementation Strategy Factors for Employer-Initiated Delay Factors	**References to Previous Studies (Year)**
Implementation of BIM by the employer to avoid design clashes.	Latiffi et al. (2013); Khoshnava et al. (2012); Tahir et al. (2017); Alenazi and Adamu (2017); Crowther and Ajayi (2019); Charehzehi et al. (2017); and Jununkar et al. (2017).
Implementation of BIM by the employer for early warning of delay through earned value analysis and connection of BIM to scheduling.	Sun et al. (2015); Latiffi et al. (2013); and Jununkar et al. (2017).
Implementation of BIM by the employer for construction planning and management.	Khoshnava et al. (2012); Tahir et al. (2017);
Implementation of BIM by the employer to monitor the impact of changes on project progress.	---
Implementation of BIM by the employer to reduce claims by utilising a combination of responsibility matrix of claim causes and a five-dimensional BIM model for visualising and foreseeing project areas having claims or even potential of claims.	Marzouk et al. (2018)
Implementation of BIM by the employer for schedule visualisation.	Khoshnava et al. (2012); Tahir et al. (2017);
Implementation of BIM to support proper decision-making for any anticipated changes.	

Implementation of BIM by the employer to reduce project duration through various simulated proposals.	Alenazi and Adamu (2017)
Implementation of BIM by the employer to use algorithmic procedures to learn from previous problems and proactively identify the same/similar problems later in the project.	Crowther and Ajayi (2019);

Table 2.11. BIM Barrier Factors for Employer-Initiated Delay Factors

BIM Barrier Factors for Employer-Initiated Delay Factors	**References to Previous Studies (Year)**
Legal and contractual challenges (ownership of data)	Chien et al. (2014); Eadie et al., 2014; and Azhar et al. (2008)
Cost implications at the outset of BIM implementation on purchase of software licenses, hardware upgrade, and training cost and time	Gerges et al. (2017) and Matarneh and Hamed (2017)
Uncertainty regarding benefits and return on investment	Azhar et al. (2008)
Lack of contractual arrangements	Harrison (2014); Banawi (2017)
Lack of BIM specialists	Bui et al. (2016); Gerges et al. (2017);
Difficulties in managing changes in BIM	Chien et al. (2014); and Azhar et al. (2008)
Drastic changes in the organisational chart and workflow because of BIM implementation	Volk et al. (2014)

Table 2.12. Moderator Groups Affecting Relationship Between Delay and Critical Success Factors

Group	**Item description**
PCs	The high value of the project
	The large size of the project
	Complexity and uniqueness of project activities
	The urgency of the project outcome
	Project type (new, existing, maintenance)

PEEs	Economic and financial aspects such as price and local currency value
	Climate matters such as winds, rains, high humidity, and high temperature
	Social and cultural interferences such as population demographics, educational levels, norms and values, and language and attitudes

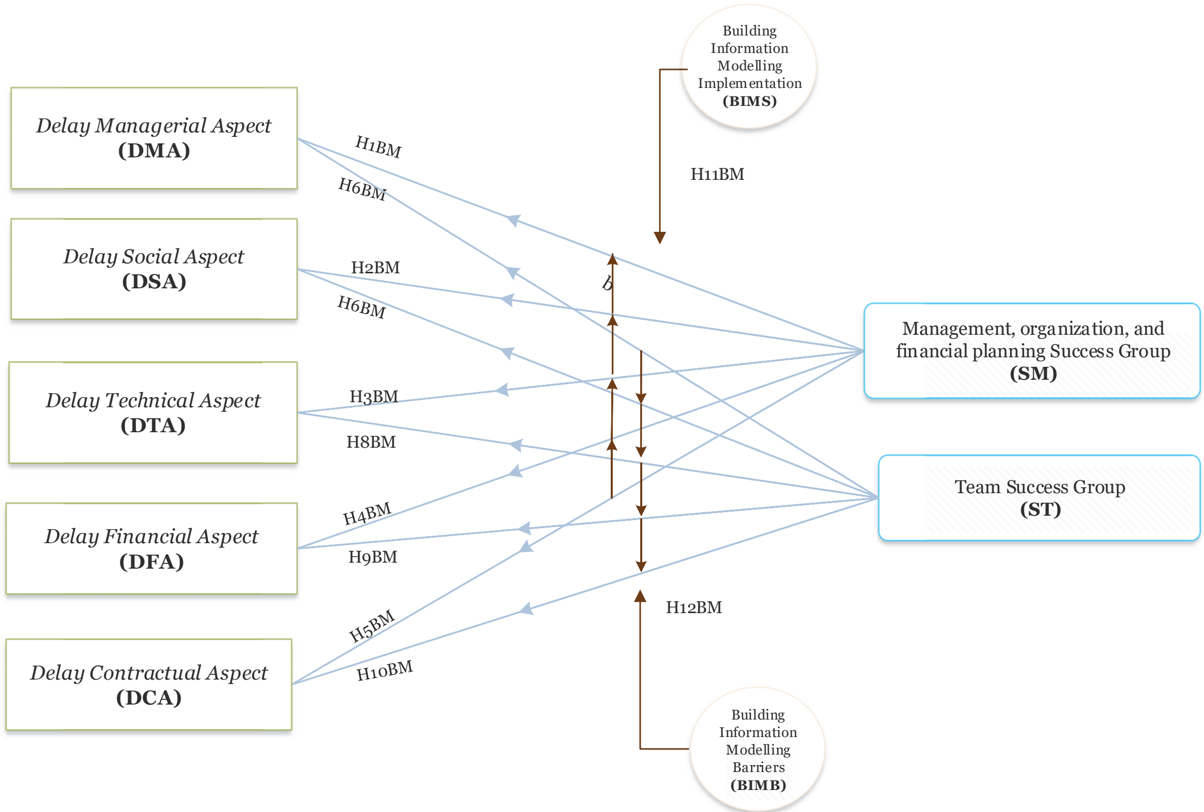

Figure 2.3. Conceptual Model for Critical Success Factors and Employer-Initiated Delay Factors with Moderators of BIM Implementation Strategy Factors and BIM Barrier Factors.

In the fourth step of the process, factors related to BIM implementation strategy were collated through a thorough literature review, identifying barriers and obstacles that might hinder BIM adoption. Within this step, particular attention was given to BIM factors that specifically aid employers in addressing delays and mitigating delay risks. Both Table 2.10 and Table 2.11 provide an inclusive compilation of BIM implementation strategy factors and BIM barrier factors, respectively, drawn from an extensive assessment of 130 research papers focusing on BIM's application in construction.

Moving on to the fifth step, the research framework was formulated based on the outcomes of prior studies. The recommendation is to analyse the relationships between critical success factors and employer-initiated delay factors. This entails establishing hypothetical connections to understand the interdependencies between these factors and their associated critical success components. This analytical approach ensures that the study adequately incorporates BIM implementation strategies and barriers.

Figure 2.3 visually presents the proposed research model to explain the correlations between employer-initiated delay factors and their corresponding critical success factors. This model considers BIM implementation strategy factors (BSFs) and BIM barrier factors (BBs) as moderators potentially influencing the relationship model's outcomes. An integral aspect of the framework involves depicting relationships between employer-initiated delays and success factors. Notably, this model demonstrates the interconnections among data concerning delays and success gathered via a questionnaire developed in the literature review.

The moderator model is a widely utilised method in research that aims to evaluate the extent to which the anticipated relationship between dependent and independent factors stays stable, even in the presence of other independent variables. Moderator variables are crucial in shaping the magnitude and orientation of the outcomes of this interaction. In his doctoral thesis, Alkhathami (2004) extensively examined construction delay factors and their interplay with success factors in construction projects in the Kingdom of Saudi Arabia. The researcher suggested a negative association between delay factors and success variables, providing insights into the details of project management in this particular geographical area. To explain this link, Alkhathami employed a range of statistical methodologies, carefully examining the impact of seven crucial success criteria on seven essential delay factors. By conducting a thorough investigation, the researcher discovered that specific success indicators had a greater impact than others in preventing or reducing project delays. This provides valuable insights that project managers can use to take practical measures. Furthermore, Alkhathami conducted comprehensive research that extended beyond statistical data. This analysis involved a comparison of the viewpoints held by project owners and contractors who were both involved in the same projects. The comparison analysis revealed significant disparities in their perspectives on the significance and consequences of success and causes causing delay. The observation above highlights the necessity for enhanced communication and collaboration among stakeholders involved in the project, in addition to a focus on improving understanding and proficiency in Building Information Modelling (BIM). These measures were evaluated as promising strategies for enhancing project performance and mitigating construction delays. However, it is important to mention that the study conducted by Alkhathami did not examine the correlation between employer-initiated delay factors and their associated success variables. The absence of this element highlights the need to examine and resolve this critical factor, thus necessitating additional investigation and inquiry, which the present thesis endeavours to do. By conducting an in-depth analysis of this particular aspect of construction project dynamics, we can acquire a more holistic comprehension of the variables that influence project achievement and postponement, thereby enhancing project management approaches' efficacy.

Altarawneh (2018) conducted an independent analysis that revealed a significant association between the degree of achievement and the frequency of construction delays in water infrastructure construction undertakings throughout the Abu Dhabi Emirate. The research conducted by Altarawneh provides significant insights into the importance of success criteria in effectively addressing delay factors in complicated projects. The study utilised a comprehensive methodology, which included administering a questionnaire survey and implementing the partial least squares structural equation modelling (PLS-SEM) approach for rigorous data analysis. The survey garnered a substantial sample size of 323 respondents, yielding a comprehensive analytical dataset. Altarawneh's study revealed six primary success elements that substantially positively influenced the assessment and reduction of delay causes in water infrastructure projects. These considerations comprised diverse aspects of project management and the organisation's competencies. The factors considered in this study included the efficacy of the project management process, the proficiency of both the project manager and the project team members, the thoroughness of organisational planning for the project, the optimal allocation of project resources, and the degree of organisational dedication to achieving the project's objectives. Additionally, Altarawneh conducted a study that explored the domain of how particular characteristics of project benchmarks influenced the effects of these aspects of success on the factors that contribute to project delays. The presented analysis provided a comprehensive examination of the relationship between the unique attributes of a project and the efficacy of aspects contributing to its success. This study offers significant and informative perspectives for both project managers and stakeholders. Altarawneh (2018) suggested that the increase and thorough execution of the abovementioned qualities could potentially result in significant advantages in project performance and efficiency. By prioritising these essential elements, construction undertakings in the water infrastructure domain within the Abu Dhabi Emirate have the potential to attain enhanced efficacy and mitigate the occurrence of expensive setbacks, thereby fostering the comprehensive advancement and durability of the region's crucial infrastructure.

In summary, it is evident from the previous empirical studies the relationship between the construction delay factors and the success factors; however, studying this relationship for the employer-initiated delay factors with their critical success factors in BIM-enabled projects and traditional (Non-BIM) projects considering moderators of BIM barriers, BIM implementation strategies is still considered as a lack in the existing research body which requires further studies.

2.5 Results and Discussion

2.5.1 Research Gaps in Terms of Continents and Project Types

Table 2.13 indicates that most papers are related to Asia (72.6% with +56.0% variance from the average). In comparison, the corresponding contributions are 20.1% (3.5%variance) for Africa, 1.5% (−15.1% variance) for Oceania, 3.1% (−13.5% variance) for Europe, 0.8% (15.8% variance) for South America, and 1.9% (−14.7% variance) for Central and North America.

Table 2.13. Distribution Percentages of Population Papers Obtained in Literature Search.

Continent	**Number of Papers**	**Percentage per Continent [%]**	**Linear Variance from Average [%]**
Africa	52	20.1	+3.5
Asia	189	72.6	+56.0
Europe	8	3.1	–13.5
Oceania	3	1.5	–15.1
South America	2	0.8	–15.8
Central and North America	5	1.9	–14.7
Total	**260**	**Average = 16.6**	-

Table 2.14 seems to suggest a lack of research related to delays in the construction of airports, modular structures, oil and gas projects, power projects, and water/sewer/irrigation projects, with the percentages of papers on these projects being 0%, 1.4%, 2.7%, 2.7%, and 1.4%, respectively. The project type is not identified in 44% of the reviewed papers.

Table 2.14. Mapping Project Types for Papers on Construction Delay

Project Type	**Number of Papers**	**Percentage [%]**
Residential buildings	8	11.0
Commercial buildings	7	9.6
Industrial buildings	4	5.4
Airports	0	0
Oil and gas	3	4.1
Other infrastructure	7	9.6
Modular structures	1	1.4
Power	2	2.7
Water/sewer/irrigation	1	1.4
General	41	54.8
Total	**74**	--

This study has identified two significant research gaps and gained valuable insights through an exhaustive review process. Firstly, most prior research concerning construction delays originates from Asian contexts. Major delay factors in Asia are closely associated with order fluctuations, procurement process challenges, and financial constraints. Among the top ten delay factors, order variations stand out as the most prevalent. This occurrence might be attributed to the tendency of employers in Asia to initiate projects early. At the commencement stage, design drawings might lack the necessary level of detail to preclude or minimize future requisites, ultimately leading to order variations during the construction phase.

Following Asia, Africa emerges as the second most prominent contributor to the literature on construction delay. Within the African context, financial difficulties take precedence as the leading construction delay factor, trailed by issues about payment and material procurement timelines. The dominance of financial difficulty as a delay factor can likely be attributed to the absence of a robust funding system.

The dominant delay factors' rankings and primary characteristics vary across different continents. These differences primarily stem from diverse factors such as project types and sizes, construction methodologies, the availability of precise construction specifications, distinct construction cultures, quality benchmarks, and varying approaches to funding. These regional nuances significantly influence the nature and ranking of delay factors within each context.

In addition to the limited scholarly investigation into the construction of airports, modular structures, oil and gas projects, power projects, and water/sewer/irrigation projects, which represents a research gap addressed in this thesis, this notion is elaborated more by a deep review of previous literature content on construction delays in some types of these projects to navigate and substantiate the research gap. For instance, Cevikbas and Isil (2022) conducted a study focusing on mega airport projects, specifically examining the selection of effective delay analysis approaches. Their research aimed to identify the most suitable approach for analysing delays in major airport projects. However, it's worth noting that their study did not address construction delay factors, including employer-initiated delays. Therefore, there is a need to explore further and incorporate such factors. For modular structures, Paliwal et al. (2021) conducted a study that examined the perceived advantages and obstacles associated with the implementation of environmentally sustainable modular buildings within a hospitality-oriented context. The research emphasised that the utilisation of modular building has the potential to decrease project timelines by circumventing unanticipated delays commonly seen in traditional (Non-BIM) construction approaches, such as adverse weather conditions. Additionally, the possible advantages of modular construction include heightened product quality, enhanced labour productivity, improved on-site safety, and fewer instances of on-site rework. However, this study did not review any of the construction delay factors. In another study for modular structures, Rausch et al. (2020) undertook a case study to evaluate and enhance the dimensional quality of modular building projects. The study showcased the implementation of continual benchmarking and improvement of dimensional quality by comparing as-built and nominal 3D geometric data in several modular building projects. The study's findings indicate that implementing strategic enhancements can effectively enhance the quality and minimise the need for rework in subsequent modular building endeavours. It is evidenced that the research gap relating to reviewing and addressing the construction delay factors persists in the available modular structure studies. For oil and gas projects, Kassem et al. (2019) focused on critical risk factors in Yemen's oil and gas construction projects. The study identified the delay in the supply of materials as an important cause of project delay. This factor can influence the construction project and is compounded in oil and gas projects by transportation problems due to the remote location of construction sites and complications in project management. However, the study reviewed the following employer-initiated delay factors: government delays in decision-making, government instability, government interference in projects, interventions by oil companies, changes during the construction process, and delayed payment of contractor's dues. Thus, it is evident that this study approached employer-initiated delays from a limited perspective without offering clear solutions for addressing these delay factors.

Given the lack of prior investigations conducted in certain continents and the limited number of delay studies in Europe, it is crucial to explore the present literature further to comprehend the prevailing gaps in this region better. To provide empirical evidence supporting this assertion, Gunduz et al. (2015) undertook a research study to assist contractors in estimating the probability of project delays in construction projects, specifically within the geographical context of Turkey, a European country. The study employed the relative importance index approach and fuzzy logic to evaluate the impact of 83 crucial contract administration parameters quantitatively.
The findings of their study indicated that the process groups of change control management, financial management, and claims and dispute resolution management had a substantial impact on the overall performance of contract administration. In addition, the operational execution of their suggested framework resulted in the discovery of crucial tactics to improve the performance of vital contract administration. The implemented tactics included reorganising the risk management process; a structured training programme focused on risk management and contract closeout, and regular performance assessments. Notably, this study was carried out within the context of a European country. The study did not specifically investigate the reasons contributing to delays induced by employers. This underscores the necessity for additional research in this particular domain. Also, Zidane and Anderson (2018a) conducted a study for the European continent to ascertain the prevalent factors contributing to project delays in construction projects globally and in Norway. The study used the relative significance index technique to prioritise the delay factors based on frequency and severity. Additionally, the study compared the results with previous research conducted in various countries and locations. This study identified the ten primary factors

contributing to delays in construction projects. These factors include design changes during construction or change orders, delays in contractor payment, inadequate planning and scheduling, subpar site management and supervision, incomplete or improper design, insufficient contractor experience or ineffective building methods and approaches, contractor financial difficulties, sponsor/owner/client financial difficulties, resource shortages. However, the study approached a limited number of employer-initiated delay factors and did not present a comprehensive solution for these factors. Thus, it is noted that there is a limited review in the European continent for construction delay factors, including employer-initiated delay factors. This gap in the existing literature is evident when we consider the scholarly research conducted by Olawale and Sun (2010). Furthermore, a similar void can be observed in the work of Zidane and Andersen (2018a). These researchers' investigations have shed light on specific aspects of the research landscape but have left unexplored or inadequately addressed the gap we seek to investigate and address in our study. Therefore, our research aims to build upon their contributions, bridging this gap and advancing our understanding of the subject matter.

In Australia, a limited body of research has been dedicated to studying construction delays. Moreover, the existing studies have offered only partial insights into employer-initiated delay factors in traditional (Non-BIM) and BIM-enabled projects. One noteworthy study in this regard was conducted by Derakhshanfar et al. (2020), which focused on analysing the hazards associated with the construction industry in Australia. This comprehensive study investigated the effects, associations, and temporal aspects of delay risks within Australian construction, yielding valuable insights into the primary factors contributing to project delays and their interconnectedness.

Another relevant study in the Australian context was conducted by Suresh and Nathan (2020), who explored the preparedness for lean procurement practices within building projects. While the primary focus of this study did not centre around delay analysis, it nonetheless offers valuable insights into procurement practices. However, this study's comprehensive examination of employer-initiated delays from various angles remains noticeably absent.

Tafazzoli and Shrestha (2017) investigated the factors contributing to delays within the construction sector in the United States of America. This research was conducted through a comprehensive countrywide survey that targeted knowledgeable professionals with extensive expertise in the field. The researchers employed the relative importance index (RII) technique to assess the significance of 30 probable causes of delay. Additionally, they conducted a factor analysis to categorise these factors into four distinct groups: communication, decision-making process, designer's inefficiency, and contractor's efficiency. A notable limitation of their research lies in the lack of addressing the full spectrum of employer delay factors. Delay factors such as insufficient project planning and a lack of comprehensive feasibility assessment, the approval process for design papers and the disbursement of money are experiencing a delay, and the occurrence of frequent modifications in project scope and requirements were found missing in the study. The presence of employer delay factors can exert a substantial influence on the overall performance of a project, as they possess the potential to disrupt various aspects such as cost, quality, schedule, and stakeholder satisfaction. Hence, it is imperative to identify and thoroughly examine these elements in order to limit their impacts and enhance the project's results.

2.5.2 Research Gaps in Delay Aspects

The proposed definitions highlight a deficiency in adequately addressing delay aspects. This inadequacy arises from the failure to fully capture the distinctive characteristics of each aspect while establishing the matrix for relevant delay factors derived from existing studies. To illustrate, a substantial number of prior studies only offer a partial treatment of social aspects. This limitation is evident in including incomplete social delay factors within their questionnaires. Moreover, the spectrum of delay factors included in these reviewed papers falls short of comprehensively spanning all project phases, spanning from tendering to final construction. Recognizing this scientific gap, the researchers of this current study are motivated to investigate the extent to which previous studies have tackled delay factors and propose a framework that bridges these gaps.

In Table 2.15, a concise summary outlines the research gaps observed within the scope of the reviewed papers concerning delay aspects. As an example, environmental aspects are often only partially addressed. To illustrate, Muhwezi et al. (2014) exclusively included the delay factor "Natural disasters (flood, hurricane, earthquake)," whereas Tawil et al. (2014) considered "Bad weather conditions" and "Natural disasters" under the environmental aspect. In terms of contractual aspects, Muhwezi et al. (2014) introduced incomplete contractual delay factors, including "Inadequate definition of substantial completion," "Slowness in decision-making," "Legal disputes between project participants," and "Ineffective delay penalties." Shifting to technical aspects, Khan (2015) covered factors like "Inadequate planning and scheduling," "Inadequate contractor experience," "Lack of coordination at the site," "Contractor's lack of planning at preconstruction," "Poor site management and supervision," "Unsuitable management structure of the contractor," "Lack of communication," "Inappropriate overall organisation structure," "Poor managerial skills," "Inadequate control over site resource allocation," "Unsuitable leadership of contractor's management," and "Improper incentive policy." However, when considering social aspects, Muhwezi et al. (2014) only addressed factors such as "Strikes" and "Personal conflicts among the labour force."

An in-depth review of prior articles on construction delay was conducted to address this research gap. From the managerial aspect, in one such study, Al-Hazim and Abu Salem (2017) investigated the details of delays and cost overruns in infrastructure projects within the specific context of Jordan. Their research involved collecting data from 40 projects managed by the Ministry of Public Works and Housing. Their analysis identified 20 factors contributing to project delays, further categorized based on frequency and severity. The study addressed the delay from a managerial perspective, including the following factors: inadequate planning and scheduling, insufficient monitoring of project progress, modifications to the project scope, shortcomings in design and documentation, and the issuance of variation orders. While these findings provided valuable insights into the managerial aspects of construction delays, it's worth noting that certain critical factors, such as suspension of work by the employer, imposition of unreasonable constraints, and delays in meeting tendering system requirements, were not examined in this study. This lack represents a notable gap in addressing the complete spectrum of managerial delay aspects. As such, there remains a need for further research to investigate these unexplored sides of construction delay factors. Besides, the study conducted by Samarah and Bekr (2016) aimed to examine the factors contributing to project delays in the public sector of Jordan. The researchers collected data from 50 projects that the Ministry of Public Works and Housing carried out. A total of 55 elements contributing to delays were identified and subsequently ranked based on their perceived significance. This ranking was determined by administering a questionnaire survey, which garnered responses from 80 individuals representing various stakeholders involved in construction projects. The researchers discovered that the primary contributors to delays from a managerial perspective were as follows: inadequate management and supervision by the contractor, insufficient planning and control by the contractor, the utilisation of the lowest bid resulting in diminished performance, errors in design and contract documents, rework caused by construction errors, and low productivity levels. However, the whole spectrum of the managerial factors was not presented in this study, which leaves a gap in this research regarding addressing many managerial delay factors in the knowledge. This gap can also be realized in much previous research, such as Khan (2015), Rahimipour and Shah Hosseini (2014), Upadhyay et al. (2016), Tawil et al. (2014); and Oshodi and Rimaka (2013).

From a technical aspect point of view, the research conducted by Muhwezi et al. (2014) investigated many factors contributing to construction delays in Uganda. The study analysed to identify and classify 81 elements contributing to project delays. These factors were categorised into four broad groups based on their association with the project: the owner, the consultant, and the contractor. The research revealed that the primary reasons contributing to technical delays were errors and omissions in the design process, insufficient design information, and substandard quality of materials. However, the study lacked technical delay factors, such as lack of experience and wrong site selection. Thus, this study is considered lacking in attending to the technical delay factors from a comprehensive perspective. This gap can also be realized in many previous research such as Khan (2015); Rahimipour and Shahhosseini (2014); Upadhyay et al. (2016); Tawil et al. (2014); and Oshodi and Rimaka (2013).

From a social aspect standpoint, Pai and Bharath (2013) investigated the factors contributing to delays in building projects in India, as well as the subsequent impacts of these delays. The researchers employed a questionnaire survey methodology, gathering responses from 50 stakeholders involved in such projects. A total of 83 delay factors were identified and subsequently ranked based on their relative significance index. The research revealed that the primary contributors to social delays were labour strikes, political intervention, cultural and religious concerns, and public opposition to the project. The study additionally proposed several strategies to address these problems, including promoting labour welfare and motivation, mitigating governmental influence and intervention, demonstrating respect for local culture and religion, fostering engagement with the public and stakeholders, and strengthening coordination and collaboration among relevant parties. The study did not consider the influence of societal delay factors on several project categories, including residential, commercial, industrial, and infrastructure projects. The study did not investigate the interconnectedness between the elements contributing to social delay and their mutual influence on one another. This is an example of many studies conducted in the construction delay where the social aspects are ignored and not addressed comprehensively. This gap can also be realized in many previous research such as Al-Emad and Nagapan (2015), Megha and Rajiv (2013), and Alamri and Amoudi (2017).

This review underlines the collective scientific gaps apparent in research concerning delay factors. These gaps warrant consideration for future comprehensive studies on delay factors. Notably, many reviewed papers omitted details regarding the respondent sample size. This omission can potentially impact the quality of work and the reliability of results. For instance, Amoatey et al. (2014) briefly mentioned utilizing a purposive sampling approach, yet the determination of the sample size was not elaborated upon. In the case of Alaghbari et al. (2007), simple random sampling was employed, but specifics regarding the mathematical model or equation used in this context were omitted.

Table 2.15. Summary of Research Gaps for Construction Delay Factors.

Factor/Aspect	Position	Summary of Review
Environmental aspects	P, N, ×	Partially addressed, Not Addressed, Not Mentioned
Contractual aspects	P, N, ×	Partially addressed, Not Addressed, Not Mentioned
Financial aspects	P, N, ×	Partially addressed, Not Addressed, Not Mentioned
Technical aspects	P, N, ×	Partially addressed, Not Addressed, Not Mentioned
Managerial aspects	P, N, ×	Partially addressed, Not Addressed, Not Mentioned
Social aspects	P, N, ×	Partially addressed, Not Addressed, Not Mentioned
Project phases	×	Not Mentioned

2.5.3 Research Gaps of Employer-Initiated Delay Factors

A limited number of research papers have delved comprehensively into employer-initiated delay factors in traditional (Non-BIM) construction projects and those enabled by Building Information Modeling (BIM). Most prior studies have taken a broad approach, addressing this issue from a general perspective, without investigating the exhaustive spectrum of employer-initiated delay factors in traditional (Non-BIM) and BIM-enabled projects. Cheng and Darsa (2021) investigated employer-initiated delay factors of change orders, corruption and bribery, and delay in payments to the contractor, while several other employer-initiated delay factors, such as unreasonable constraints imposed by the employer, poor organisational structure of the employer's organisation, delay in furnishing and delivering the site to the contractor by the employer, lack of early planning for the project were not considered. Besides, Abeysinghe and Jayathilaka (2022) constitute a significant and noteworthy addition to the existing knowledge on building project delays in Sri Lanka. The researchers employ a questionnaire survey and a relative importance index (RII) analysis to identify and prioritise the factors that impact the timely completion of construction projects in Sri Lanka. The article does not comprehensively examine all the elements contributing to employer delays. The analysis focuses on twelve factors contributing to employer-related delays: deficient project planning and design, insufficient financial and resource allocation, delayed payments, and alterations in scope and specifications.

Nevertheless, it is important to consider additional variables that may contribute to delays in the Sri Lankan construction business. These issues include tendencies towards corruption, interference from employers, provision of substandard supplies by employers, and a lack of expertise and competence on the employer's part. A more comprehensive methodology would involve conducting a systematic literature review and a stakeholder analysis to identify and incorporate all potential elements contributing to employer-related delays that may impact the timely completion of building projects in Sri Lanka. The gap in addressing the employer-initiated delay factors can also be noted in the previous research of Thapanont et al. (2018), Asmi & Djamaris (2021), Lim et al. (2021), and Seboru (2015).

From the perspective of BIM-enabled projects, Btoush and Harun (2017) contributed a study on minimizing delays in Jordanian construction projects using BIM technology. They identified three primary delay causes within the Jordanian construction sector and proposed corresponding BIM strategies to mitigate them. For instance, they suggested hiring BIM specialists to segment the design phase and address issues arising from inadequate design choices. However, the comprehensive treatment of employer-initiated delay factors remains limited. In another instance, El Hawary and Nassar (2015) investigated the impact of BIM on reducing or preventing construction claim causes. Their work covered many employer-initiated delay factors, such as poor communication, project scope changes, slow decision-making, payment delays, and contractual errors and defects. In the context of BIM's application in specific countries or continents, the researchers identified 38 relevant papers, mostly centred around Asian countries. Figure 2.4 provides a comparative visual showing the number of employer-initiated delay factors addressed in traditional (Non-BIM) and BIM-focused papers across continents. For instance, when examining papers from Asia, 26 employer-initiated delay factors were considered for traditional (Non-BIM) projects, whereas only 11 factors were explored for BIM-enabled projects. Similarly, 18 employer-initiated delay factors were examined in African papers for traditional (Non-BIM) projects, while no such factors were investigated for BIM-enabled projects. Notably, the percentages in the graph are calculated concerning the total number of employer delay factors within each project type.

Considering BIM barriers and implementation strategies, a total of ten BIM strategy factors (BSFs) and seven BIM barrier factors that are directly relevant to employers were identified. These factors are believed to directly influence the relationship between employer-initiated delay factors and their corresponding critical success factors.

From the relationship between BIM barriers and project success factors, it is worth mentioning that Olanrewaju et al. (2021) discussed and explained the correlation between obstacles encountered when adopting Building Information Modeling (BIM) and achieving success in sustainable building projects. The research analyzed 12 barriers to implementing Building Information Modeling (BIM) and identified ten characteristics contributing to sustainable building projects' success. This analysis was based on a comprehensive examination of relevant literature and interviews with experts in the field. The research employed a statistical methodology called Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine the data and evaluate the proposed hypotheses. The research revealed that successfully resolving obstacles related to Building Information Modeling (BIM) has a significant and beneficial influence on achieving sustainable construction projects, particularly concerning long-term sustainability. However, it's important to note that this study did not specifically address the relationships between BIM barriers and construction project success in the context of employer-initiated delay factors. Therefore, further investigation into this matter requires further research.

From the perspective of the relationship between BIM implementation strategies and the project success factors, Manzoor et al. (2021) investigated the impact of Building Information Modelling (BIM) implementation strategies in tall structures using the integration of exploratory factor analysis and structural equation modelling (SEM) methodologies. The study gathers data from 200 participants engaged in high-rise construction projects in Malaysia and finds ten key elements that influence the application of Building Information Modelling (BIM). The study demonstrated a good relationship between using Building Information Modelling (BIM) implementation strategies and project performance, including project quality, cost, and time. Nevertheless, this study did not deeply approach this relationship from the aspect of the employer-initiated delays and their corresponding success factors, which shall urge further research to be conducted in this field.

In addition, it is important to study and confirm the interrelationship between the BIM barriers and the employer-initiated delay factors based on previous empirical studies. The relationship between BIM barriers and construction delays has not been extensively studied. However, it can be inferred that barriers to BIM implementation can contribute to construction delays. For example, suppose there is a lack of knowledge and awareness about BIM. In that case, it may lead to difficulties in implementing BIM processes and technologies, which can delay BIM-enabled projects. Alemayehu et al. (2021) suggested a correlation exists between Building Information Modelling (BIM) obstacles and factors contributing to construction delays. Their findings indicate that BIM barriers adversely influence project performance, leading to delays in the construction process. The researchers administered a questionnaire survey to a sample of 120 construction professionals in Ethiopia and employed structural equation modelling (SEM) as the analytical technique for data analysis. The researchers discovered that obstacles related to Building Information Modelling (BIM) have an impact on project performance, which may be attributed to four underlying factors: project cost, project time, project quality, and project communication. The authors have also identified six significant obstacles, namely: insufficient national standardisation, limited information exchange in the context of Building Information Modelling (BIM), the substantial initial expense associated with BIM implementation, inadequate training and education in BIM practises, insufficient awareness of BIM, and a lack of collaboration in BIM utilisation. It has been suggested that these challenges should be resolved by governmental bodies, industry stakeholders, and academic institutions to facilitate the uptake and integration of Building Information Modelling (BIM) practises within the Ethiopian context. However, although this study confirmed the relationship between the construction delay factors and the BIM barriers, the gap in the research body persists regarding the influence of these factors on the employer-initiated delay factors, which requires further studies as conducted in this study.

Similarly, Tan et al. (2019) established a correlation between BIM barriers and construction delay factors, highlighting that BIM barriers significantly contribute to construction delays in Malaysia. They employed factor analysis and structural equation modelling (SEM) techniques to analyse the collected data. The researchers discovered that restrictions related to Building Information Modelling (BIM) impact factors contributing to construction delays. This impact is mediated through four latent variables: project management, design, procurement, and site management. The researchers additionally identified twelve significant obstacles: insufficient knowledge and skills in Building Information Modelling (BIM), absence of established standards and guidelines for BIM implementation, limited awareness of BIM's potential benefits, inadequate collaboration in BIM practice, substantial initial costs associated with BIM adoption, insufficient training and education opportunities for BIM proficiency, lack of support from top-level management in BIM initiatives. It has been suggested that the government, business, and academia should collectively address these impediments to enhance the application of Building Information Modelling (BIM) and mitigate building delays in Malaysia. The relationship between the construction delay factors and the BIM barriers factors is well established in many previous studies, such as Olanrewaju et al. (2020), Salvi (2022), and Ahmed (2018).

In Summary, from an empirical point of view, it is evident that the relationship between the project delay factors and the BIM barriers in construction projects is confirmed; however, this relationship needs further studies with the subject concerning the employer-initiated delay factors.

In conclusion, this paper uncovers research gaps specific to various continents. It introduces a conceptual structural equation model to examine the relationships between employer-initiated delays and project success in regions where research gaps exist. Ultimately, this comprehensive literature review enhances the understanding of delay factors and employer-initiated delays within the construction industry. The insights gathered from this study are composed to assist researchers and practitioners in navigating unforeseen challenges, especially in international construction projects.

2.5.4 Research Framework

The primary objective of the research framework is to identify strategies for minimizing the impact of delays in construction projects, with a particular emphasis on measures to prevent or mitigate delays initiated by employers. It's noteworthy that previous approaches to delay reduction have largely concentrated on various management tools, while others have emphasized implementing specific procedural steps to control or alleviate construction delays. The schematic representation of the research framework is depicted in Figure 2.5, encapsulating its comprehensive structure. This framework pioneers the investigation of construction delay issues by examining the interplay between delays and critical success factors pertinent to the employer. It also delves into the selection of optimal tools for implementing these success factors and evaluates the outcomes of their implementation.

The framework draws inspiration from Cooper's (2006) five-gate framework for significant new projects but has been adapted and tailored for the current study's purposes. The framework can be summarized through its principal phases: scoping identification, concept development, framework development, framework evaluation, and final framework development. Each phase requires identifying relevant activities, analysis processes, and desired outcomes to construct a successful framework effectively.

The proposed framework adopts a comprehensive methodology that involves a four-stage process to address the challenge of delays. In Stage 1, data collection and the formulation of a delay–success relationship model occurs, employing a questionnaire for data gathering. Moving to Stage 2, an action plan is developed to implement the critical success factors. Here, the questionnaire results aid in identifying the most suitable tools for implementing these factors. Stage 3 covers a review and evaluation of the implementation of success factors, guided by the approaches suggested by Discenza and Forman (2007) and Kikwasi (2018). Finally, Stage 4 involves measuring success, which is determined based on the outcomes derived from Stage 2. Importantly, the implementation phase is initiated only when the Key Performance Indicator (KPI) method attains the objectives.

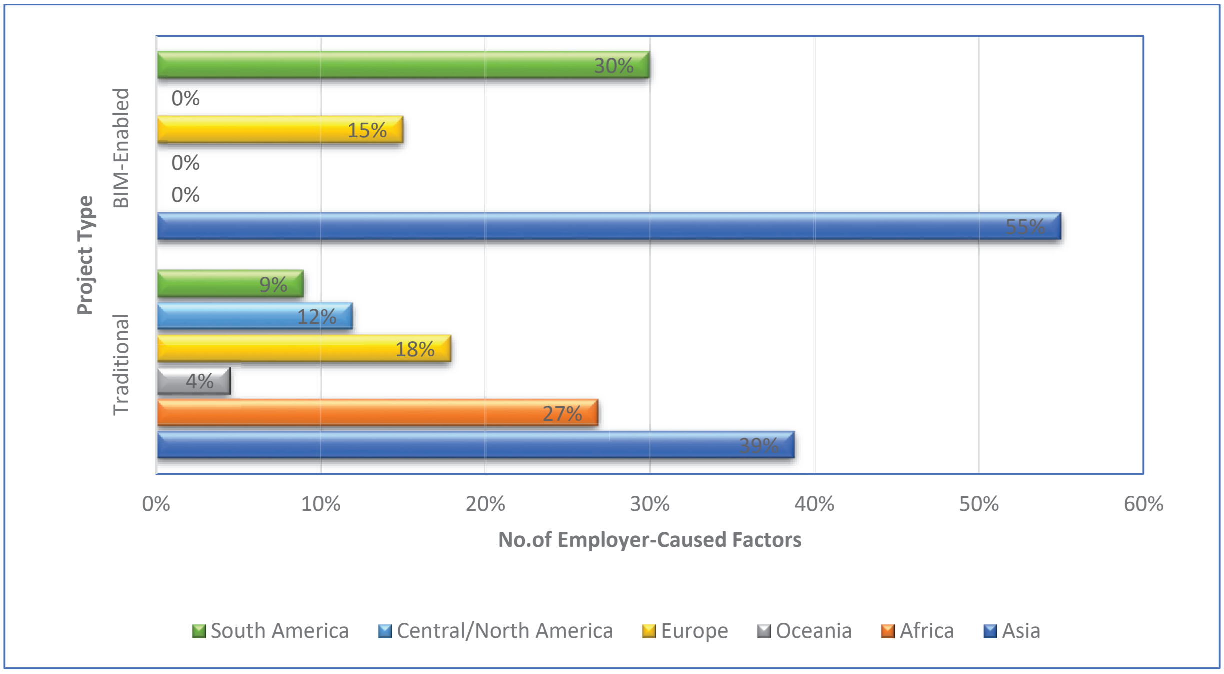

Figure 2.4. Percentage of Employer-Initiated Factors for Traditional (Non-BIM) and BIM-Enabled Projects in Different Continents

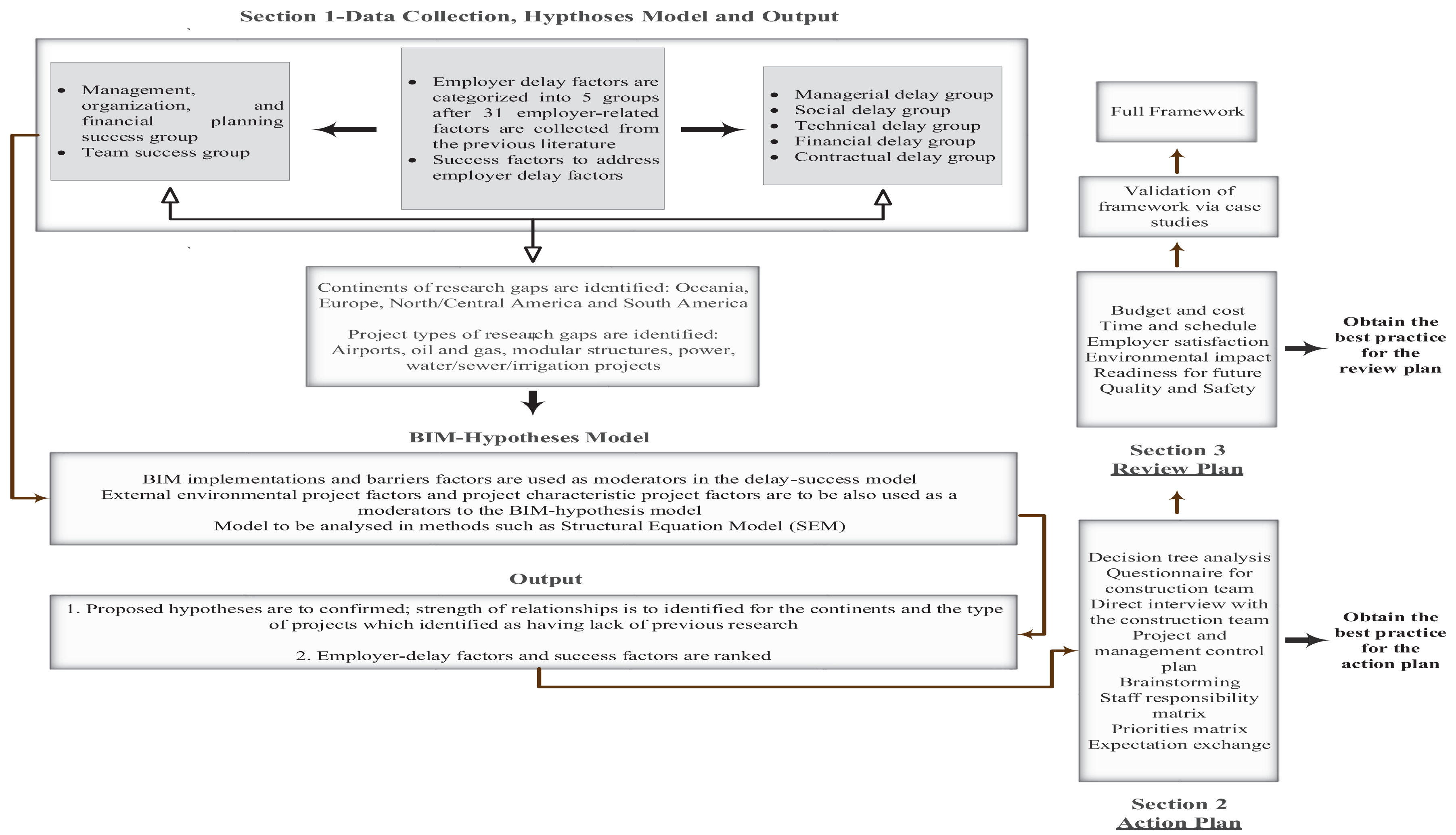

Figure 2.5. Research Framework

2.5.5 The Theoretical and Practical Contribution to the Construction Industry.

Theoretically, this study effectively identified research gaps within certain project contexts, such as airports and modular structures. Undertaking a comprehensive review of the predominant delay factors in these specific project types can significantly enhance efforts to minimise delays in such projects. The scarcity of studies addressing construction delays in regions like Europe, Oceania, Central, and North America has opened up new avenues for academic researchers to delve into the intricacies of construction delays within countries such as Australia, the United States of America, and the UK.

Considering construction delays are global, numerous studies have converged on common reasons underlying such delays. In light of this, the proposed framework puts forth precise and practical strategies to manage delays in BIM-enabled projects effectively. By pinpointing delay–success relationships, formulating a model to correlate delays with project success, developing a tailored action plan for successful implementation, and subjecting it to review, the framework contributes significantly to the construction delay landscape. It intends to mitigate and address employer-initiated delays in projects that leverage BIM technology. This concerted effort aims to foster advancements in the construction delay market.

2.6 The Theoretical and Practical Contribution to the Construction Industry

The central focus of this study revolves around the issue of employer-initiated delays in construction projects. These delays include a range of consequences, including cost and time overruns, compromised project quality, and even project abandonment or cancellation. All of these consequences certainly result in additional budget allocations or associated costs. The study extensively explored construction delays triggered by employers across diverse countries and continents, examining 59 research papers about construction delays and 38 related to BIM delays. Subsequently, a research framework was created to define research gaps and establish a well-defined linkage between employer-initiated delay factors and critical success factors. This framework considers the potential impact of BIM implementation strategies and barriers.

The outlined framework constructs a hypothesis for a delay–success model, incorporating pertinent moderating elements such as BIM implementation factors and BIM barriers, The study's outcomes underscore the absence of comprehensive research across certain continents and project types, signifying a need for future investigation. It is worth noting that the findings from this research hold relevance beyond specific delay aspects, covering a broad spectrum of delay sources (employers, contractors, consultants) and varied project types. This research identifies project categories, namely airports and power projects, that have not been thoroughly studied in this context. Most prior studies within the construction domain are geographically concentrated in Asia and Africa, constituting around 84% of the target papers. Contrastingly, papers from Oceania comprise merely 3.1% of the total.

This paper introduces a comprehensive research framework centred on the BIM impact on project success concerning employer-initiated delay factors. The framework discloses three integral components and is composed to transform construction project management. It serves as a roadmap for employers to navigate the challenges posed by delays in making more skilfully. The study anticipates enhanced delay minimization, project monitoring, and adept problem resolution within the construction by applying this management framework.

In summary, a cross-sectional literature research was carried out to review the construction delay factors and the employer-initiated delay factors in both traditional (Non-BIM) and BIM-enabled projects, and it revealed a research gap in the employer-initiated delay factors where they are addressed partially in most of the previous studies; it also revealed a research gap in the previous studies for specific countries or continents where it is confirmed that a limited number of construction delay studies are carried out. In addition, it is explained that most of the delay factors aspects are addressed partially in most of the previous papers until 2023. Besides, a research gap in the construction delay studies for specific projects such as airports and oil and gas projects is identified.

Certain limitations of this study need to be considered and clarified. The results and conclusions are limited to the scope of the target papers. New delay causes can be extracted from different scientific papers. Nevertheless, the target papers' sample size has been selected correctly, reflecting the research results' validity and importance.

2.7 Summary of Chapter 2

This chapter marks a pioneering stride, presenting an extensive examination of delay factors and introducing an innovative conceptual framework designed to address employer-initiated delays in both traditional (Non-BIM) and BIM-enabled construction projects. This chapter primarily examines delays caused by employers and identifies key elements that contribute to successful outcomes. This is done by conducting a comprehensive literature search to analyze delays in building and construction projects, both in traditional (Non-BIM) and BIM-enabled projects, as documented in prior research. The chapter explores several key areas in the construction industry. Firstly, it identifies the research gaps in traditional (Non-BIM) and BIM-enabled projects in specific continents. Secondly, it focuses on the research gaps related to delays in construction projects. Thirdly, it aims to identify and categorize the factors that contribute to delays and critical success. Fourthly, it seeks to identify the moderators in BIM-enabled projects that affect the relationship between delays and critical success factors. Lastly, it proposes a conceptual research framework to address delays initiated by employers.

3 Literature Review and Hypotheses Outlines for Delay Factors, Critical Success Factors, and Employer-Initiated Delay Factors in Traditional (Non-BIM) and BIM-Enabled Projects

3.1 Introduction

Construction delays are a problem in academic research and the construction industry. They can happen in most construction projects, ranging from a few days to several years. Some researchers describe these delays as extra time beyond the original completion date set in the contract. Others see delays as jobs not following their planned schedules. No matter how advanced the tools used to manage construction projects are, delays remain a global problem many construction businesses face. They happen throughout project phases, often leading to conflicts and legal actions. Completing a project on time and within budget depends on making good decisions and meeting the expectations of all parties involved.

Research on this topic aims to figure out why projects get delayed. It also tries to find gaps in the existing knowledge. Previous studies have pointed out some key factors for success, and researchers have proposed ways to deal with these delay issues. There are still gaps in understanding delay factors, especially delays initiated by employers. In simple terms, a delay means the project takes longer to finish than agreed upon in the contract, whether the employer allows extra time or imposes penalties for the delay. These delays can happen due to various events. In a construction project, the employer or owner has the initial idea, which a designer plans and a contractor brings to life. The contractor is a legal entity experienced in construction, and the employer funds the project. The engineer or consultant is responsible for designing and overseeing the project to ensure it matches the plans and requirements. The term "employer" can sometimes refer to the party that hires a specialist or contractor for specific construction tasks. Employers often hire representatives to act on their behalf during the project. In this research, terms like "employer," "employer's personnel," "employer's participation," and "company's representative" are used interchangeably.

Ugur and Artan (2023) examined the risks from the perspective of employers and consultants in both traditional (Non-BIM) design and BIM contracts. As a result of a survey undertaken with 55 experts, the risks that emerged in contracts implemented with traditional (Non-BIM) design and BIM-based design were analysed, and the new risks that emerged in the transition from traditional (Non-BIM) design to BIM were identified. The change in the impact and likelihood of the existing risks were examined in detail. They compared the risks for traditional (Non-BIM) and BIM projects, and it was indicated that risks such as defective materials, loss, or delay due to resource availability and site access had decreased significantly with BIM. In addition, new risks arising from the lack of software and hardware emerged with BIM when surveys were conducted with experts who worked on traditional (Non-BIM) design projects. Ugur and Artan (2023) concluded that BIM appears to have a significant impact concerning BIM-enabled projects in the direction of design risks, legal risks, logistic risks, contract risks, political risks, general construction risks, and environmental and social risks have decreased significantly.

Another important point is that BIM experts determine high-risk levels while evaluating the new risks emerging with BIM. Experts think that these risks pose more significant impacts than other risks. Many BIM experts seek ways to mitigate these new risks in BIM applications. It can be concluded that, although BIM experts and traditional (Non-BIM) design experts have similar views on risk items, the risk levels significantly decrease with BIM applications, according to BIM experts. Based on this paper, it became important to review the employer-initiated delay factors and their critical success factors from the perspective of the traditional (Non-BIM) and BIM-enabled projects to compare, review and understand both types of project implementation deeply.

Eschenbruch and Bodden (2018) remarked that experience with BIM applications is so new that no unified contract strategy has yet been developed. Changes in responsibilities in BIM applications and the fact that stakeholders work with many different systems reveal the necessity of legal changes. Numerous legal systems, particularly the American and British ones, have put forward various standards, guidelines, and protocols. Even though these standards establish a general approach in BIM applications, they may be insufficient in projects with different characteristics. At this point, standard forms of contracts can provide the most appropriate solution. Based on this, it can be concluded that studying or reviewing the BIM-enabled projects separately will be feasible compared to traditional (Non-BIM) projects for all construction research problems, including employer-initiated delays.

Also, Li et al. (2021) remarked in their study, "BIM's Formal and Informal Collaborative Networks in Traditional (Non-BIM) Procurement: Insights from the Construction Phase of a Hospital Case Study," that BIM could change the interaction between organizations and project teams, especially during construction. They also stated that applying BIM changes a project's original workflow, resulting in architects working more closely with engineers and builders while focusing on the project's final delivery. Based on this study, It can be concluded herein that BIM changes the characteristics of traditional (Non-BIM) construction projects, which made it feasible to review the BIM-enabled projects independently from the traditional (Non-BIM) projects.

Besides, Al Hattab and Hamzeh (2015) reviewed in their paper named "Using social network theory and simulation to compare traditional (Non-BIM) versus BIM–lean practice for design error management," in which they remarked on the need for a novel perception and a more effective management of design errors to improve the current solutions that are not always effective for traditional (Non-BIM) and BIM-enabled projects. This study stemmed the need to review and study the traditional (Non-BIM) and BIM-enabled projects during the design and construction phases because BIM-enabled projects became more complex, and they need more research efforts to address them from all perspectives, including the employer-initiated delays and their critical success factors.

3.2 Typology of Construction Projects

Construction projects have been defined by Winch (2010) as '[a] planned effort designed to create assets such as factories, hospitals and roads and other constructed infrastructures to comprehend mostly the socio-economic needs of the society'. Bennett (2003) suggests that construction projects are arrangements within a period, price, and quality margins towards creating newly built or refurbished assets. Table 3.1 categorises the types of projects reviewed and considered in this study. An extensive search was conducted for the most available construction projects to ensure that the general categories cover global project types. This study has selected this project typology to ensure that most project types not examined in previous studies are included. It is worth mentioning that the typology reviewed in this section has been adopted in the research questionnaire to guarantee that the research covers most project types, including those with no or few previous studies.

Table 3.1. Typology of Construction Projects

Project Categories	Project Types
Residential Buildings	Apartments, townhouses, villas, retirement homes or similar.
Social and Commercial Buildings	Dormitories, institutions, medical centres, hospitals, office buildings, shopping centres, hotels, warehouses, automobile repair shops, commercial laboratories, newspaper buildings, trading posts, car washes, theme or amusement parks, bowling alleys, theatres, funeral homes, showroom buildings, or similar.

Industrial Buildings	Manufacturing buildings, industrial hangers, refrigeration/cold storage buildings, and light manufacturing buildings.
Airports	Control towers, landing areas, runways, helipads, terminals, airport aprons, taxiways, control centres, facilities and related buildings.
Oil and Gas	All facilities related to oil and gas projects.
Other Infrastructure	Transportation, communication, desalination plants, dams, highways and all related buildings.
Modular Structure	Prefabricated buildings or houses such as schools, classrooms, housing and industrial facilities.
Power Projects	Power plants, power towers, power lines and any related buildings.
Water/Sewage/Irrigation	Water networks, plants, wastewater networks, wastewater plants, irrigation networks, and related buildings.

Residential Buildings: Residential construction projects range from single-family to living buildings (Hendrickson et al., 2000). This structure is commonly occupied by individuals or families (Koushki et al., 2005). Residential buildings are constructed by investors responsible for setting contracts regarding design and construction (Walker, 2015).

Commercial Buildings: Commercial projects are categorised separately. They include but are not necessarily limited to offices, hotels, factories, shopping centres and hospitals (Hendrickson et al., 2000). Because such buildings are large and expensive, they are commonly constructed and owned by governmental entities (Medrano et al., 2008).

Industrial Buildings: Industrial buildings are commonly large and are defined by a high level of complexity (Clough et al., 2000). After incorporating associated procurement, such projects require contractors to supply materials and equipment and coordinate works (Olsen & Osmundsen, 2005; Puri, 2016).

Airport Projects: Airports have services to maintain aeroplanes and sophisticated control facilities. Landing areas with wide spaces include a taxiway for planes to take off and adjacent supporting buildings with accessways and passenger terminals.

Oil and Gas: This type of project is a massive contributor to the economy of many countries and states worldwide. Major oil and gas projects are vast and complex and use advanced technology.

Water/Sewage/Irrigation: Sewage is a type of wastewater a community produces. The irrigation system has sewage water pipelines, clear water pipelines, sewage water mechanical cleaning constructions and reservoir basins. Watering blocks are created on a slope with a natural biological cleaning area. Watering blocks are restricted by longitudinal windows defining passages with profiles suitable for travelling farm machines. Water distributors and irrigators with sewage water-supplying constructions are built to provide sewage water to watering blocks.

General Infrastructure: Such projects maintain and increase the public's accessibility to the necessary infrastructure for convenient expansion (Goodman & Hastak, 2006). Infrastructure projects are commonly owned publicly (Winch, 2010). Accordingly, funds come from government entities. (Clough et al., 2000).

Modular Structures: Modular buildings, or structures, are prefabricated buildings with repeated units or modules. Modular construction uses building unit frames far from the building site. These are then delivered to the project site for construction.

Power Projects: Power projects involve large structures that produce power, such as electricity. Power projects are necessary for houses, large buildings and factories. Such projects include nuclear plants, power towers, power lines and wind power plants.

3.3 Delay Factors Groups in Previous Studies and Groups Categorisation Strategy

In construction, a significant project involves collaborating with various individuals to ensure it is completed within the scheduled timeframe, without exceeding the original budget, and while meeting predefined quality standards. However, achieving project success in the construction sector, particularly in developing nations, is often challenging, leading to delays and cost overruns. Multiple factors contribute to these challenges, prompting researchers to investigate various variables, including project type, location, and size (Chan & Kumaraswamy, 1997; Chan & Kumaraswamy, 2002; Kaming et al., 1997; Sambasivan & Quickly, 2007).

Construction time, cost, and quality are success variables in construction projects. Researchers have categorized factors influencing construction project duration into four primary classifications: project size, monitoring, environment, and management features. These classifications include project scope, complexity, environment, and management characteristics (Chan & Kumaraswamy, 1997; Chan & Kumaraswamy, 2002; Kaming et al., 1997; Sambasivan & Quickly, 2007).

The term "delay" is consistently defined in previous studies. It refers to events that disrupt a project's planned timeline, leading to an extension of the project's duration. Delays are typically attributed to four main categories: contractors, consultants, employers, and external factors (Assaf & Al-Hejji, 2006; Enshassi et al., 2009; Sanders & Eagles, 2001; Aibinu & Jagboro, 2002).

Consultant-related delays may result from factors like insufficient knowledge, inexperienced site staff, decision delays, and reluctance to share information (Ahmed et al., 2003; Alaghbari, 2005; Alaghbari et al., 2007; Gardezi et al., 2014).

Contractor-related delays are influenced by issues such as cash flow problems and inadequate supervision, with cash flow difficulties having a significant impact (Enshassi et al., 2009; Ahmed et al., 2003; Alaghbari, 2005; Alaghbari et al., 2007; Gardezi et al., 2014). Specific contractor-related delay factors include delays in material transportation, material shortages on-site, structural errors, substandard work, inexperienced labour, labour shortages, financial problems, supervision issues, subcontractor deficiencies, staff shortages, poor site management, and equipment shortages (Mochal & Mochal, 2003; Ali et al., 2010; Dada et al., 2003; Ruiz-Torres & Farzad, 2006; Aibinu & Odeyinka, 2006; Kadir et al., 2005; Toor & Ogunlana, 2008; Sweis et al., 2008).

Inappropriate planning is often cited as the primary cause of contractor-related delays, leading to material shortages (Mochal & Mochal, 2003). Ineffective communication between contractors and material suppliers can also lead to significant delays (Ali et al., 2010). Using unreliable material suppliers who deliver materials in small quantities can result in project delays (Dada et al., 2003).

Proper site management is crucial to prevent delays, and a lack of knowledge, inadequate planning, and coordination issues with material procurement can contribute to project delays (Kadir et al., 2005). Insufficient site management is consistently identified as a common cause of contractor-related factors (Ahmed et al., 2003; Toor & Ogunlana, 2008; Sweis et al., 2008).

For employer-initiated delay factors, issues may include financial problems, lack of technical and managerial knowledge, work delays, slow decision-making, material selection issues, coordination problems with project stakeholders, and contract changes (Enshassi et al., 2009; Gardezi et al., 2014; Alaghbari, 2005; Alaghbari et al., 2007). Employers may also be responsible for delays due to financial constraints caused by unfavourable economic conditions (Ahmed et al., 2003).

External factors contributing to delays may include the unavailability of materials in the market, a shortage of construction equipment, adverse weather conditions, unfavourable site conditions, economic weaknesses like inflation rates, and regulatory changes due to public entities (Ahmed et al., 2003; Alaghbari, 2005).

Different studies have categorized delay factors in various ways, such as by the parties responsible for the delays or by organizational and operational aspects. It's important to note that some factors, like regulations, safety, external factors, and acts of nature, are not directly related to employer-initiated delays and are categorized separately.

Based on an extensive review that looked at various common categories used in previous studies, as summarized in Table 3.2 (highlighted in grey and red), the most frequently encountered groups of delay factors have been compiled in Table 3.3. Many prior studies have grouped construction delay factors into several categories, including those related to employers, consultants, contractors, contracts, project issues, design issues, material resource shortages, external factors, and financial aspects.

However, since this study specifically focuses on employer-initiated delay factors, it is more practical to categorize them based on the nature of the delay itself. Therefore, Table 3.3 provides a detailed breakdown of previous studies linking delay factors to technical, contractual, financial, environmental, and social aspects. This categorization aligns with recommendations from earlier research. In summary, this study has chosen to classify employer-initiated delay factors based on the specific type of delay factor, drawing on insights from previous research.

Table 3.2. Groups of Delay Factors in Previous Studies

Authors (Year)	Government and Regulation Related	Employer/ Owner Related	Consultant Related	Contractor Related	Others	Contracts Related	Project Issues Related	Site Construction Related	Project Management Related	Design Issues Related	Materials/Resources Shortage Related	Equipment/Plant Related	Manpower/Labour Issue Related	External Factors	Relationship/Poor Communication	Financial Related	Organisational Related	Environmental/Weather Related	Human Behaviour Related	Act of God-Related	Technical Issues Related	Personal/Experience Related	Economic Related	Operational Related	Security/Safety Related	Legal Aspects	Engineering Related	Interface Related
Rahimipourand Shahhosseini (2014)	√	√	√	√	√																							
Van et al. (2015)		√	√	√		√								√														
Megha and Rajiv (2013)		√	√	√			√			√	√	√	√	√														
Wong and Vimonsatit (2012)		√	√	√																								
Adam et al. (2017)							√		√		√				√	√	√	√	√									
Cakmak and Cakmak (2014)		√		√		√	√			√				√					√									
Khan (2015)	√					√		√	√	√						√				√								
Muhwezi and Otim (2014)		√	√	√										√														
Abinayasri et al. (2017)	√	√							√	√	√	√	√			√						√						
Chan and Kumaraswamy (1997)		√		√			√			√	√	√	√	√														
Amoatey et al. (2015)	√										√				√	√		√			√		√	√	√	√		
Pai and Bharath (2013)		√	√	√			√		√		√	√	√	√														
Santoso and Soeng (2016)		√	√	√			√							√														
Motaleb and Kishk (2014)			√	√	√				√																			
Samarah and Bekr (2016)		√	√	√										√														
Sambasivan and Soon (2007)		√	√	√		√					√		√	√		√												
Odeh and Battaineh (2002)		√	√	√		√					√	√	√	√		√												
Mahamid et al. (2012)		√	√	√			√			√	√	√	√	√														
Mezher and Tawil (1998)	√							√	√	√	√	√	√			√		√										
Niazai and Gidado (2012)		√	√	√			√			√	√		√	√														
Islam and Trigunarsyah (2017)		√	√	√			√	√	√				√	√		√												
Lo et al. (2006)		√	√	√			√				√			√					√									
Addo (2016)		√	√	√							√	√	√	√		√												
Fallahnejad (2013)		√	√	√		√					√	√		√	√	√											√	√
Alwi and Hampson (2003)									√	√	√		√	√														
Jahangir (2013)		√	√	√			√			√	√	√	√					√										
Haseeb et al. (2011)		√	√	√		√		√					√	√														

Table 3.3. Employer-Initiated Delay Factors Proposed Categorisation (Based on Previous Studies)

Authors (Year)	Most Common Groups in Previous Studies for Delay Factors	Previous Studies Review to Form Groups of Employer-Initiated Delay Groups
Rahimipour and Shahhosseini (2014); Van et al. (2015); Megha and Rajiv (2013); Wong and Vimonsatit (2012); Muhwezi and Otim (2014); Abinayasri et al. (2017); Chan and Kumaraswamy (1997); Pai and Bharath (2013); Santoso and Soeng (2016); Motaleb and Kishk (2014); Samarah and Bekr (2016); Sambasivan and Soon (2007); Odeh and Battaineh (2002); Mahamid et al. (2012); Niazai and Gidado (2012); Islam and Trigunarsyah (2017); Lo et al. (2006); Addo (2016); Fallahnejad (2013); Jahangir (2013); Haseeb et al. (2011)	Employer, consultant, and contractor related; Contracts related; Projects issues related; Design issues related; Material resources shortage related; External factors; Financial related	Muhwezi and Otim (2014) suggested that all change order demands must be evaluated to assess their impact on the quality of work envisaged scope and cost, possible claims and disruption to work to avoid unnecessary disputes and litigation. It is clearly understood from their recommendation that such change orders are a factor that requires **contractual skill** to address. They related this factor directly to possible future disputes. According to Fisk (1988), a change order is any modification to the **contractual guidance** provided to the contractor by the employer or employer's representative. Muhwezi and Otim (2014) recommended that employers should ensure that interim payment certificates are paid on time within the stipulated time frame so as not only to avoid having interest penalty clauses invoked but also to facilitate the progress of works to ensure timely completion. They classified can be categorised under the financial related factors. Jarkas and Younes (2013) stated that although the relative influence and the underlying determinants of factors contributing to construction delays, depending on the **social, cultural, economic, political, and environmental** conditions, can be different in different countries and across geographical regions, and apart from the special circumstances. Samson and Lama (2002) remarked that performance and delays arise in large construction projects for many reasons, such as incompetent

		designers/contractors, poor estimation and change management, **social** and technological issues, site-related issues and improper techniques and tools. Toor and Ogunlana (2010) stated that delays are frequent and recurring in construction projects in developing countries. Although the principal reasons for construction delays are comparable across developing countries, several factors about local industry, **socioeconomic** and cultural issues and project characteristics also contribute to construction delays. According to Moungnos and Charoenngam (2014), not only the technical aspect that must be considered but also the **managerial aspects**, such as approval, change order, and system testing, should also be regarded seriously. Pietrosemoli and Monroy (2013) stated that construction has become more complex and challenging with its progress. To be feasible, any construction must consider multiple issues related to **technical constraints**, resources such as energy and water, and **environmental, social**, cultural and economic issues.

3.4 Global Success Factors in Addressing Construction Delays and Strategy to Categorise the Critical Success Factors

The existing body of research indicates that a universally accepted definition of project success does not exist. Various scholars have provided distinct definitions of project success. Following Meskendahl (2010), the term "project" denotes the fundamental component employed in the execution of strategies. According to Imtiaz et al. (2013), critical success factors refer to a corporation's essential actions to achieve specific success. Critical Success Factors (CSFs) are the features, conditions, or factors that substantially influence a project's success in a specific area, provided they are appropriately sustained, maintained, and controlled (Alias et al., 2014). Critical success factors (CSFs) are employed to facilitate and evaluate the effectiveness of a strategy framework and execution strategies for projects aimed at guaranteeing project success and optimising the allocation of scarce resources. Success factors refer to the various inputs within a management system that have the potential to directly or indirectly contribute to the achievement of project success within an organisation. In the present study, it is imperative to establish a precise differentiation between general success variables and critical success elements (CSFs). The concept of general success factors includes a wide range of characteristics that contribute to the overall success of a project, including multiple aspects and dimensions. These various aspects contribute to the project's capacity to attain its specified aims and objectives comprehensively. In this study, critical success factors are specifically associated with elements closely interconnected with delay factors launched by employers. As mentioned earlier, the aspects have a distinct relevance within the framework of the study, as they have a direct influence and may even ascertain the project's promptness and effectiveness. The assessment of the influence of employer-initiated delays on a project's progress necessitates the identification and resolution of crucial success elements.

Cooke-Davies (2002) identified 12 critical success factors for projects, categorizing them into three main groups: (1) factors critical to project management success, (2) essential factors specific to the project, and (3) factors forming the basis for continuous project improvement. However, this study did not tailor the success factors to address delay-related issues, employer-initiated delays or consider specific regional or country-specific variations, leaving a gap for further research in these areas.

The study by Yong and Mustaffa (2013) investigated the critical success factors (CSFs) for construction projects in Malaysia, particularly emphasising the human-related aspects. One important aspect they considered in their research was employer-initiated delays, although this specific term may not have been explicitly mentioned in the provided text. However, it can be inferred that employer-initiated delays are part of the broader context of factors affecting project success. Yong and Mustaffa's research strongly emphasised human-related factors, such as proficiency, dedication, and participation. This focus recognizes that the success of construction projects often hinges on the skills and commitment of the individuals involved. The study surveyed 48 stakeholders from different categories, including developers, consultants, and contractors. By examining the perceptions of these key stakeholders, the authors gained insights into how various factors, including employer-initiated delays, impact project success. The research revealed that stakeholders favoured a balanced approach to project success. This means that they didn't solely prioritize financial or schedule-related success but also recognized the importance of factors related to human performance and collaboration. The authors proposed a consolidated framework of critical success factors (CSFs) to address these findings. This framework covered three major aspects: project personnel, commitment and communication, and site management and supervision. These aspects are critical in mitigating factors like employer-initiated delays, as they promote effective teamwork and communication. The authors suggested implementing these CSFs would enhance project success and improve stakeholder trust and teamwork. This is particularly relevant when dealing with employer-initiated delays, as effective communication and commitment can help resolve disputes and minimize delays. However, the authors did not cover all success factors concerning employer-initiated delays, and they also didn't address research gaps in countries lacking studies on construction delays and specific project types that require further investigation.

Toor and Ogunlana (2009), Tabish and Jha (2012), Thi and Swierczek (2010), Albakri (2015), and Babu (2015) have studied critical success factors in construction projects. However, they did not focus on employer-initiated delay factors, and there is a lack of studies in countries like the USA, UK, Australia, and China. Their concentration did not extend to projects such as airports and modular structures, requiring further research.

Albakri (2015) suggests applying and improving the productivity (AIP) approach to address construction delays. He found that the main reason for delays in any organisation is that construction enterprises do not practice productivity analyses. Thus, a project's time and cost estimation will not be accurate. Moreover, it is essential to note that critical success factors are not always similar for all projects because circumstances, project areas and culture are not identical. Productivity analyses and databases help contracting companies estimate the labour and equipment available to meet project requirements. Albakri (2015) recommends measuring and calculating productivity methods, such as the Labour Input Tracking Model (LITM). The lean construction technique is widely used for waste construction and time and effort management (Aziz & Hafez, 2013; Koskela et al., 2002). Abdel Razek et al. (2007) researched to enhance construction labour efficiency in Egypt by using two lean construction principles: benchmarking and decreasing the changeability of construction labour. Marhani et al. (2012) state that lean construction techniques reduce project costs and delays.

Alinaitwe (2009) explains a construction company's concept of lean construction technique: this technique can use visual inspection, daily meetings, quality management, business process re-engineering, last planner system (LPS), teamwork and value-based management. Babu (2015) conducted a comprehensive study of critical success factors for construction projects for the critical success factors groups. He collected 60 critical success factors into ten groups: (1) cost factors, (2) time factors, (3) quality factors, (4) productivity factors, (5) employer satisfaction factors, (6) community satisfaction factors, (7) people factors, (8) health and safety factors, (9) innovation and learning factors and (10) environmental factors. Salleh (2009) also categorised critical success factors under the groups of (1) organisation planning, (2) project team, (3) motivation and goal orientation, (4) clarity of the project's scope of work, (5) project manager capabilities and experience, (6) safety precautions and (7) applied procedures and control system use.

Based on the summary of success factor categorisation and grouping provided in Table 3.4, it is believed that most of the success factors for construction delay, mainly for employer-initiated delay factors, are categorised under two main components: (1) management, organisation, and financial aspect and (2) teamwork aspect. Table 3.4 has been highlighted in red and green to identify the most common categorisation groups for the critical success factors.

From the perspective of the teamwork aspect, Excellence (2004) has reported and discussed in his guide that effective teamwork is important and one of the major key tools used for the success of any project. According to Tennant and Langford (2006), teams are an essential feature of modern management theory and practice (Tennant and Langford, 2006). In addition, Dhurup et al. (2016) remarked that organizations or project teams require the involvement of every member as it is a composition of human multitasking, including owners and construction professionals, to facilitate and allow synergy that ensures more output and, ultimately, success. The importance of individual skills is certainly not suppressed, but to achieve maximum performance, an individual must be competent in the context of the team. Besides, Huemann et al. (2007) stated that in human resources management in project-based organizations, team-building is a core aspect of success. In summary, it can be distinguished that teamwork forms an important component and is considered the main group for critical success factors to address the employer-initiated delay factors.

From the management, organisation and financial planning standpoint, Ashley et al. (1987) offered an insight review into factors that influence construction project effectiveness through interviews with construction project personnel and a literature review of relevant studies. They started with a list of approximately 2000 success factors from previous studies and construction management personnel interviews, which then reduced to 46 success factors that categorised them under the group of (1) management, organisation and communication and (2) scope and planning and controls. Thus, it is feasible to categorize the remaining parts of the critical success factors of the employer-initiated delay factors under management, organisation and financial planning. Table 3.4 explains the groups used in these studies for global success factors. Based on this table, the researcher has established the critical success factors groups in the investigation into two main groups: (1) the management, organisation and financial planning group and (2) the team group. However, Table 4.2 (in Chapter 4) shows, with reference to the previous studies, the distribution of the critical success factors to the assigned two success groups.

Table 3.4. Success Factor Groups for Delays in Previous Studies

Authors (Year)	Groups of Critical Success Factors
Alias et al. (2014)	*Project management action *Project procedure Human-related factors Project-related factors External environment
Salleh (2009)	*Organisation planning **Project team Motivation and goal orientation Clarity of project Scope of work **Project manager capabilities and experience Safety precautions and applied procedure Use of a control system
Altarawneh et al. (2018)	*Project management process *Project manager competency *Project organisational planning **Project resources utilisation *Project organisational commitment

	Project benchmark characteristics Project external environment
Derrick et al. (2011)	*Project management factors Procurement-related factors Employer-initiated factors **Design team-related factors Contractors-related factors **Project manager-related factors Business and work environment-related factors
Olawale and Sun (2010)	Preventive Corrective–Predictive Corrective Preventive *Organisational

In Table 3.5, Thirty-five (35) success factors are identified from previous studies that address delays. It is worth mentioning that some essential critical success factors appear more frequently than others. For instance, the SFs' approval and confirmation of the design concept, construction drawings, material selection, and logistics planning before construction' only appeared in Mydin et al. (2014), while the SFs of 'new rules and regulations should be relayed to the developers and Contractors on an urgent basis, so the developers/contractors are aware of changes to the rules and regulations that appeared in two previous studies: Mydin et al. (2014) and Vijay and Kumar (2017).

Furthermore, Table 3.5 functions as an inclusive source that has compiled essential success criteria from prior research to guarantee a full compilation of all relevant factors contributing to construction project success. Nevertheless, Table 3.5 holds a greater importance than just compiling data. It is a crucial tool in identifying and classifying essential success elements relevant to addressing delay issues introduced by employers. The categorisation process involves identifying and differentiating the particular aspects contributing to success, which own the capacity to improve or address delays created by employers.

By isolating these success variables from the larger global context, academics and practitioners can obtain a more precise and concentrated viewpoint on the elements that hold the greatest significance in addressing employer-initiated delays in building projects. Separating enables a focused analysis of the actions that may be utilised to reduce these delays, which can have significant financial and operational consequences.

The process of categorising involves carefully examining the essential success elements present in the global matrix, intending to find those that have a discernible influence on delays initiated by employers, whether direct or indirect. Various factors that exhibit a visible correlation with the causes of delays caused by employers are identified and assigned to a separate category.

Table 3.5. Comprehensive List of Global Success Factors to Address Delays in the Previous Studies

Overall Success Factors	Author (Year)
Proper planning and scheduling before the commencement of the project.	Mydin et al. (2014); Alamri and Amoudi (2017); Fackroon et al. (2008); Tumi et al. (2009); Thorat et al. (2017); Gardezia et al. (2014); Halim and Zin (2016); Muhwezi et al. (2014); Sha (2016); Mahamid et al. (2012); Emeka (2016); Venkatesh et al. (2012); Khan et al. (2017); Upadhyay et al. (2016)
Approval of the design concept, construction drawings, material selection, and logistics planning before construction.	Mydin et al. (2014)
Regular meetings and site visits with the relevant parties to solve problems on time.	Mydin et al. (2014)
Monitoring the site workers to improve productivity.	Mydin et al. (2014); Assbeihat (2016); Al-Emad et al. (2017); Pai and Bharat (2013); Santos and Soeng (2016); Assaf and Al-Hejji (2006); Mahamid et al. (2012)
New rules and regulations should be conveyed to the developers/ contractors as soon as possible so that the developers/contractors are aware of changes to the rules and regulations.	Mydin et al. (2014); Vijay and Kumar (2017)
Employer to stick to the original plan and allocate an adequate budget for contract modifications.	Mydin et al. (2014); Kikwasi (2012); Adugna (2015)
Good site management, supervision, and timely award are essential to avoid project delays.	Sivaprakasam et al. (2017); Chan and Kumaraswamy (1997); Mydin et al. (2014); Al-Tabtabai (2002); Abdullah et al. (2017); Mali and Warudkar (2016); Olawale and Sun (2010); Alhajr and Alshibani (2018); Aziz and Abdel-Hakam (2016); Thorat et al. (2017); Mizanur et al. (2014); Famiyeh et al. (2017); Ruqaishi and Bashir (2015); Assaf and Al-Hejji (2006); Lo et al. (2006); Jahangir (2013); Safri (2009)
Close monitoring of the progress of work.	Mydin et al. (2014); Al-Emad et al. (2017); Haseeb et al. (2011); Koushki et al. (2005); Shebob (2012)
Check the accuracy of data on work progress with the physical completion versus the cost expended.	Mydin et al. (2014)
Propose a 'bonus' scheme for early completion.	Mydin et al. (2014)
Employers should hire a capable consultant or Engineer and make	Pourrostam and Ismail (2012); Khan et al. (2017); Famiyeh et al. (2017); Chan and Kumaraswamy (1996); Pourrostam and

the interim progressive payments on time.	Ismail (2011); Halim and Zin (2016); Jalal (2016); Koushki et al. (2005); Adugna (2015); Sivaprakasam et al. (2017); Rafieizonooz et al. (2015); Al-Emad et al. (2017); Pai and Bharat (2013); Assaf and Al-Hejji (2006); Mahamid et al. (2012); Islam and Trigunarsyah (2017); Shebob (2012); Al-Ghafly (1995); Jahangir (2013); Gunduz et al. (2015)
Consultants should achieve the design and construction phase professionally to minimise changes during construction.	Pourrostam and Ismail (2012); Pourrostam and Ismail (2011)
Contractors should provide adequate finance, material and schedule management processes to manage the construction phase of any project.	Patil et al. (2013)
Employers should improve their financial management systems.	Famiyeh et al. (2017)
Employers expedite the deliberate process of decision-making.	Tafazzoli and Shrestha (2017); Al Tami (2015); Jahangir (2013); Lo et al. (2006); Mahamid et al. (2012);Rafieizonooz et al. (2015); Vijay and Kumar (2017)
Contractors need to be able to manage their financial resources and plan cash flows by using progress payments.	Kamanga and Steyn (2013) Assbeihat (2016); Al-Emad et al. (2017); Pai and Bharat (2013); Assaf and Al-Hejji (2006); Mahamid et al. (2012); Jahangir (2013); Shebob (2012)
Contractors should be offered financial incentives to finish their projects according to the schedule.	Al-Tabtabai (2002); Odeh and Battaineh (2002); Gardezia et al. (2014); Motaleb and Kishk (2014)
Employers should consider planning the project intelligently.	Tawil et al. (2014)
The contractor should provide well-trained workers or labourers.	Tawil et al. (2014); Doloi et al. (2012); Al-Tabtabai (2002); Omarov and Ismail (2017); Saeed (2009); Hassan (2016); Albatsh(2015); Faridi and El-Sayegh (2006); Iyer and Jha (2005); Addo (2015); Lo et al. (2006); Islam and Trigunarsyah (2017); Mezher and Tawilb(1998); Frimpong et al. (2003); Odeh and Battaineh (2002); Santos and Soeng (2016); Chan and Kumaraswamy (1996); Yalini and Alan (2015); Hasmori et al. (2018); Chan and Kumaraswamy (1996); Aziz and Abdel-Hakam (2016); Zidane and Andersen (2018); Khoshgoftar et al. (2010); Kamanga and Steyn (2013); Doloi et al. (2012)
Procurement, shortage, approval and quality of material.	Sivaprakasam et al. (2017); Emeka (2016); Juwairah (1997); Toussi (2015); Shebob (2012); Hassan (2016); Adugna (2015); Rivera (2004); Gunduz et al. (2015); Kaming et al. (1997); Koushki et al. (2005); Islam and Trigunarsyah (2017); Shahsavand et al. (2018); Frimpong et al. (2003); Haseeb et al. (2011); Amoatey et al. (2015); Sha (2016); Ahzahar et al. (2011); Rothbart (1970); Yalini and Alan (2015); Gündüz et al. (2013); Mydin et al. (2014); Devi and Ananthanarayanan (2017); Enshassi et al. (2009); Aziz and Abdel-Hakam (2016); Alhajr and Alshibani (2018); Khattri et al. (2016); Omarov and Ismail (2017); Patil et al. (2013); Rahsid et al. (2013); Pourrostam and Ismail (2012); Mydin et al. 2014); (2010)

Coordination between the parties involved in the project.	Motaleb and Kishk (2014); Sivaprakasam et al. (2017); Shebob (2012); Adeoye (2014); Adugna (2015); Gunduz et al. (2015); Iyer and Jha (2005); Mahamid et al. (2012); Halim and Zin (2016); Gardezia et al. (2014); Al-Emad et al. (2017); Gündüz et al. (2013); Mpofu et al. (2017); Enshassi et al. (2009); Assbeihat (2016); Khan et al. (2017); Enshassi et al. (2010); Kamanga and Steyn (2013); Fackroon et al. (2008); Gajare and Attarde (2014) ; Rauzana (2016)
Proper estimation of the initial cost for the projects.	Hasmori et al. (2018); Pourrostam et al. (2011); Khan et al. (2017); Ibironke et al. (2013); Sivaprakasam et al. (2017)
An experienced contractor should be hired for the construction projects for timely completion.	Upadhyay et al. (2016); Al-Ghafly (1995); Albatsh (2015); Oyegoke and Al Kiyumi (2017); Wong, Vimonsatit (2012); Famiyeh et al. (2017); Aziz and Abdel-Hakam (2016); Thorat et al. (2017); Mpofu et al. (2017); Chan and Kumaraswamy (1996); Sambasivan and Soon (2007); Pourrostam et al. (2011)
Site conditions should be tested together with the design.	Safri (2009); Lo et al. (2006); Mahamid et al. (2012); Chan and Kumaraswamy (1996); Wong and Vimonsatit (2012); Halim and Zin (2016); Chan and Kumaraswamy (1996); Aziz and Abdel-Hakam (2016); Khan et al. (2017); Chan and Kumaraswamy (1997)
A clear definition of responsibilities for the project team.	Chan and Kumaraswamy (1997); Lo et al. (2006); Motaleb and Kishk (2014); Chan and Kumaraswamy (1996); Al Tami (2015); Ruqaishi and Bashir (2015); Asnaashari et al. (2009); Devi and Ananthanarayanan (2017)
Comprehensive (risk, delays, mitigation and project objectives) strategies must be formulated to minimise delays and variations.	Chan and Kumaraswamy (1997); Toussi (2015); Adugna (2015); Roachanakanan (2005); Lo et al. (2006); Wong and Vimonsatit (2012)
Value management techniques.	Chan and Kumaraswamy (1997)
Consultants and project managers to contribute to time and cost estimates.	Emeka (2016); Shebob (2012); Rivera (2004); Elhaniash and Stevovic (2016); Alinaitwe et al. (2013); Kaming et al. (1997), Al-Hazim et al. (2017); Mahamid et al. (2012); Assaf and Al-Hejji (2006); Frimpong et al. (2011); Pai and Bharat (2013); Sha (2016) Muhwezi et al. (2014); Hasmori et al. (2018); Alinaitwe et al. (2013); Mydin et al. (2014); Pourrostam et al. (2011); Devi and Ananthanarayanan (2017); Enshassi et al. (2009); Shirowzhan et al. (2016); Suksai et al. (2015); Olawale and Sun (2010); Heravi and Mohammadian (2017); Khan et al. (2017); Musarat et al. (2016); Alnuaimi and Al Mohsin (2013); Mydin et al. (2014); Ibironke et al. (2013); Alamri and Omar (2017); Vijay and Kumar (2017); Motaleb and Kishk (2010); Sivaprakasam et al. (2017)
Employers should take exceptional interest in paying the contractors on time.	Sivaprakasam et al. (2017); Hadithi (2018); Pourrostam and Ismail (2012); Patil et al. (2013); Damoah and Kumi (2018); Aziz and Abdel-Hakam (2016); Al-Emad et al. (2017); Pourrostam and Ismail (2011); Amoatey et al. (2015); Pai and Bharat (2013); Haseeb et al. (2011); Assaf and Al-Hejji (2006); Mahamid et al. (2012); Gunduz et al. (2015); Jahanger (2013); Al-Ghafly (1995); Shebob (2012); Emeka (2016)

The contractor should consider the weather conditions when preparing the time plan for the project.	Tami (2015); Masood et al. (2015); Bevian Al Hadithi (2018)
The contractor must identify sources of funding and the need to develop a financial plan for each project beforehand.	Toussi (2015); Frimpong et al. (2003); Marzouk and El-Rasas (2013); Al Hadithi (2018); Ibironke et al. (2013); Aziz (2013); Altoryman (2014)
Adequate allocation of contingency funds for the project will be necessary.	Amoatey et al. (2015); Halim and Zin (2016); Mpofu et al. (2017); Ibironke et al. (2013); Amoatey et al. (2014); Adugna and Shebob (2012); Al Tami (2015); Adugna (2015); Lo et al. (2006); Frimpong et al. (2003); Chan and Kumaraswamy (1996); Heravi and Mohammadian (2017)
Early employer involvement during project design and planning phases to help clarify project objectives and requirements.	Amoatey et al. (2015); Olawale and Sun (2010); Amoatey (2014); Alsolaiman (2014); Faridi and El-Sayegh (2006); Alhajr and Alshibani (2018)
Raising capital from the international financial market through a bond issue.	Amoatey et al. (2014); Amoatey et al. (2015); Famiyeh, Amoatey and Adaku (2017);
Employers and contractors should be committed to appropriate.	Doloi et al. (2012); Emeka (2016); Enshassi et al. (2009); Omarov and Ismail (2017)

3.5 Employer-Initiated Delay Factors and their Corresponding Critical Success Factors in Previous Studies

Employer-initiated delay factors should be sorted into groups to develop an appropriate foundation for the conceptual framework and address the problem. This section aims to provide the theoretical foundations and basis for the research by reviewing and studying delays caused by employers and critical success factors in previous global studies. This section mainly provides a detailed review of the following elements: (1) delays caused by the employer and critical success factors collectively gathered from previous studies considering papers from all continents, with the delay and critical success factors categorised under certain groups selected based on the previous literature review; (2) a review of employer-initiated delay factors in some selected countries with primary construction markets in the continents under review; (3) research gaps for BIM-enabled projects concerning employer delays; and (4) frameworks used in previous studies to address the construction delay problem.

The causes of delay in construction projects are linked to the employer in various ways. Each study had a specific perception of and classification for identifying these causes commensurate with the study's nature. Delays caused by an employee can be caused directly or by another party representing the owner, such as the owner's agents or the consulting engineer. Sometimes, the employer appoints a representative to perform onerous duties. Hegazy (2012) argues that these actions and duties require the employer to know about project management; thus, in some cases, the owner appoints a project manager or consulting engineer representative. This manager or consultant is usually responsible for project design, including architectural, structural, electrical and mechanical designs, and preparing project documents such as drawings, specifications, bills of quantities and quality control. This person is also responsible for monitoring contractor performance and implementing the work.

Many reasons are considered common for delays caused by employers, including a lack of previous experience, late delivery of a site to the contractor, delay in giving the order to start work, stopping work and delaying the approval of schedules. Hamzah et al. (2011) clarify that mistakes in the construction layouts and specifications and an impractical period for the project's construction represent two main factors that cause delays in construction projects. Hegazy (2012) adds a set of factors contributing to delays in completing construction projects resulting from the employer, including changing instructions (i.e., change design requirements) and an incapability to make decisions on time.

Compensable excusable delays are among the primary delays that an employer can create. These hold-ups are triggered by the employer or one of the employer's agents. These delays might also arise from a mistake brought on by the company or any neglect that results in a delay in identifying the agreement's end, apart from the one planned. When this kind of delay occurs, the contractor can ask for an extension of time or financial compensation for problems arising from the delays. In many cases, the documents the employer supplies to the contractor might be incomplete, influencing the job program (Abouorban et al., 2018.). Ibironke et al. (2013) state that one aspect that may lead to a compensable excusable delay is the adjustments made by the employer via various working conditions as well as suspension of the job. Tumi et al. (2009) state that these reasons consist of a delay in accepting and evaluating layout documents, inadequate communication and coordination between the tasks, slowness of the employer in making vital choices, and postponed payments because of economic difficulties.

Shebob et al. (2011) conclude that construction projects in developing countries face more delays than those in developed countries. Taher and Pandey (2013) conclude that organisational problems related to an owner are considered fundamental reasons for delaying construction projects, mainly due to late payments and a lack of experience in planning matters. Most of these reasons are connected to the employer and result from the ongoing changes in the project's scope of work, a consultant's weak capabilities, a delay in delivering the project to the contractor and a delay in the payment process.

A critical factor that forces a contractor to repeat the work is the lack of or unclear job specifications (Hammadi & Nawab, 2016). This may result from a lack of funding, inaccuracy in preparing working documents, a lack of information technology and reduced communication between the project's design members. Yang and Wei (2010) and Khoshgoftar et al. (2010) find that poor communication with the rest of the team members delays the work. In many cases, the employer may stop a project if the project's materials are inappropriate. Moreover, Marzouk et al. (2014), Haq et al. (2017), and Abdellatif and Alshibani (2019) find that a weak ability to make decisions (by the employer) affects the progress of a project. In many cases, decision-making delays may also affect the quality of the project.

The above shows that the employer is critical in delaying and extending the time required to complete a project. The employer-related causes are mainly connected to changing orders continuously, delays in providing design documents and poor communication between the employer and the team, which affects an employer's decision-making abilities.

In Table 3.6, employer-initiated delay factors were collectively gathered from the previous literature. Thirty-one (31) factors were recognised after repetition was excluded. The factors have been categorised under the group delay aspect. Table 3.6 summarises the whole set of employer-initiated delay factors under the proposed aspects. In this table, the researcher collected employer-initiated delay factors from previous studies and refined the text to understand the questionnaire respondents better.

Table 3.6. Collective Set of Employer-Initiated Delay Factors and the Coding Parameters

Groups/Aspects	**Based on the Literature Review**
Managerial aspect (DMA)	DMA01: Delay in approving changes in the scope of work and specifications.
	DMA02: Lack of communication between all parties, including the employer.
	DMA03: Slowness in the decision-making process by the employer.
	DMA04: Failure treatment delays when implementing the project.
	DMA05: Employer to suspend the work.
	DMA06: Unreasonable constraints by the employer.
	DMA07: The poor organisational structure of the employer's organisation.

	DMA08: Delay in furnishing and delivering the site to the contractor by the employer.
	DMA09: Lack of early planning for the project.
	DMA10: Delay in material supplied by the employer.
	DMA11: Tendering system requirements for selecting the lowest bidder.
Social aspect (DSA)	DSA01: Delays in acquiring land from owners.
	DSA02: Bureaucracy in employer's organisations.
Technical aspect (DTA)	DTA01: Application of quality control based on foreign specifications.
	DTA02: Lack of experience of the employer in construction projects.
	DTA03: Irregular attendance of the weekly meeting.
	DTA04: Wrong site selection by the employer, such as non-availability of infrastructure, location, or requirements for soil works.
	DTA05: Difficulties in defining project requirements.
Financial aspect (DFA)	DFA01: Delay in progress payments by the employer.
	DFA02: Underestimation of the cost of projects.
	DFA03: Employer faces difficulty in budget.
	DFA04: Investment criteria and improper feasibility study by the employer.
Contractual aspect (DCA)	DCA01: Contract modifications and site changes by the employer.
	DCA02: Type of project bidding and award.
	DCA03: Unavailability of incentives for a contractor to finish ahead of schedule.
	DCA04: Ineffective delay penalties.
	DCA05: Damaging penalties imposed on the contractor.
	DCA06: Late contract award.
	DCA07: Claims problems.
	DCA08: Slowness by the employer to consent to completed work.
	DCA09: Late compensation by the employer to the land's owners for the acquisition.
	DCA10: The original contract duration is too short.

Doloi et al.(2012) clarify that the project critical success factors can be divided into four main sections:(1) factors associated with the project, which describe the characteristics of the project, such as the project's size and the level of complexity; (2) factors associated with project management such as the level of project efficiency, the project manager's competence in communication, the project manager's ability to control, organise the agenda, and others; (3) factors associated with project personnel, such as the contractor, employer, consultant and others. These include the level of employer experience, contractor competence, the consultant's cognitive and technical capabilities, and (4) external factors that affect the project's efficiency, such as weather conditions and technical support capabilities.

Regarding the project critical success factors associated with employers, the theoretical literature includes factors that help to avoid project delays. Bryde and Robinson (2005) note a set of project-critical success factors related to the employer, such as the ability to make decisions, the ability to design, the ability to submit designs and drawings on time, the ability to communicate effectively with the rest of the team members, especially with the contractor.

Frodell et al. (2008) emphasise that reviewing the working documents regularly ensures that accurate and error-free documents are provided; recurring order changes can be avoided during project implementation. Silva et al. (2016) state that properly using time and avoiding wasting time checking and correcting drawings or changing orders is considered one of the most critical factors contributing to a project's success. Control of the project's parts from the beginning, checking drawings and designs and presenting them after an audit helps the contractor save time and use them properly. Doloi et al. (2012) find that an employee's efficiency is essential to a project's success to ensure timely completion. Doulabi and Asnaashari (2016) add that adherence to a contractor's payment deadlines and enhancing communication with a contractor ensure the project's success.. Asnaashari et al. (2009) also indicate that effective communication ensures success. Effective communication ensures cooperation between team members to overcome any problems. Communicating between the parties to a project ensures that individuals perform their assigned tasks without confusion. Moreover, it is agreed that scheduling business meetings regularly is considered one of the most important factors that guarantee a project's success and its implementation on time. The above factors indicate that project success can be achieved by avoiding the various factors that could lead to the project being delayed, instead developing the level of competence and experience of the owner, reviewing designs and drawings before implementing the project and enhancing the effective communication between team members. Based on the data collected for critical success factors of traditional (Non-BIM) projects, they were reviewed to isolate those purely related to the employer's ability to manage or address the delay factors they may cause. Table 3.7 summarises the critical success factors and their proposed groups. It is also important to note that the success factor groups were selected following the literature review of groups in previous studies. This study found that the most critical success factors can be categorised into (Management, Organisation, Financial Planning 'SM'), and (Team 'ST'.)

Table 3.7. Collective Employer's Critical Success Factors

Group Code	Critical Success Factors
SM	Approval of the conceptual design drawings, material selection and logistic planning before the start of the project construction.
SM	Regular/fruitful meetings and site visits with the relevant parties
SM	New rules and regulations should be relayed to the developers/contractors as soon as possible so that the developers/contractors know the changes to the rules and regulations.
SM	The employers should stick to the original plan and allocate an adequate budget for contract changes.
SM	Proper monitoring and management of the construction project progress
SM	Check the data accuracy on the work-in-progress with the actual physical completion versus the cost expended.
SM	Propose a 'Bonus' scheme for early completion.
SM	The employer expedites the slow decision-making process.
SM	The employer must plan the project wisely and consider an unexpected construction event.
SM	The investigation of site conditions and the design of groundworks and foundations should be thorough, complete and presented beforehand.
SM	The employer should adopt proper value management techniques.
SM	The employer should give special attention to paying the contractors on time.
ST	The employer should recruit competent consultants and make progress payments on time.
ST	Coordination is to be led by the employer or employer's representative between the parties involved in the project.
ST	The roles and responsibilities of those involved in the project team should be clearly defined.

3.6 Employer-Initiated Delay Factors and Success Factors in USA, UK, China, Australia, Africa and Asia

This section provides an extensive overview of employer-initiated delay factors and their corresponding success factors across various continents and countries considered in this research. It is important to acknowledge the limitations of the data collection process, which exclusively involved the examination of technical papers available on Google Scholar, Web of Science, and Scopus. The factors contributing to employer-initiated delays can significantly vary based on the work environment and the specific type of project, as highlighted by Abdellatif and Alshibani (2019). These factors are further shaped by the unique characteristics of each country, including differences in values, customs, principles, and legal frameworks governing work environments.

In the United States, numerous studies have scrutinized employer-initiated delay factors. Tafazzoli et al. (2017) concluded that employers have a substantial role in delaying projects nationwide. Key issues identified include the constant changes in executive orders during project implementation, payment delays, delays in the approval of design documents, the employer's weak decision-making abilities, and unwarranted interventions in a contractor's work, all of which are central to project delays. Megha et al. (2013) emphasized that the project owner's personality directly impacts the team's motivation and productivity. Additionally, Tafazzoli et al. (2017) noted that inadequate communication between the employer and the contractor or employees can have detrimental effects on projects, leading to delays.

In many instances, employers may face challenges in effectively leading and managing project work, resulting in erroneous decisions that disrupt workflow and cause delays. Furthermore, employers might delay making crucial decisions vital to the project's progress. Owolabi et al. (2014) revealed that changes in orders issued by employers or owners can impede effective communication, an indispensable factor contributing to delays in U.S. projects.

In Australia, Orangi et al. (2011) identified several employer-related factors affecting project implementation timelines, including frequent changes in orders, design errors, the employer's communication weaknesses with the contractor, issues related to client approvals, estimation errors in project completion times, and shortcomings in employer leadership capabilities. Mills et al. (2010) found that a lack of understanding on the part of employers regarding the consequences of late work is a significant contributor to delays in Australian construction projects. They further emphasized that business owners may lack the necessary competence and experience to effectively manage construction projects, potentially issuing erroneous orders that disrupt project operations, particularly for contractors. Shah (2016) concluded that late payments and the employer's inability to monitor and oversee work can lead to project delays in Australia.

In the United Kingdom, there is a growing trend of construction projects experiencing delays and exceeding specified timeframes. Al Moumani (2000) pinpointed delays in receiving orders from employers and late submission of documents to contractors as critical factors contributing to project delays. Yusof et al. (2007) highlighted that employer-initiated changes in orders are responsible for causing delays in a substantial portion of construction projects in Britain. Shebob et al. (2012) linked project delays in the UK to changes in design procedures, sluggish decision-making in project management, clients' limited efficiency and expertise, and delays in providing necessary work equipment.

In China, Lo et al. (2008) identified a weak employer's ability to plan and frequent changes in orders as major contributing factors to project delays. Le-Hoai et al. (2008) concurred with these findings, indicating that employers often lack effective planning before project commencement and may lack leadership skills, leading to communication breakdowns with contractors and other project team members. Financial issues faced by employers can also hinder contractors' ability to complete projects promptly, as noted by Wu et al. (2008). Wang et al. (2018) identified a change in work procedures and the employer's deficient communication skills as significant obstacles to on-time project completion in China. Additionally, they highlighted that project delays may result from the employer's inability to make timely decisions or by imposing additional requirements on contractors that cannot be implemented within the specified timeframe.

In Egypt, Abed Al-Razek (2008) identified poor employer communication skills as a key factor contributing to project delays. Marzouk et al. (2008) emphasized the role of design errors in employer-provided documents, the frequent changes in project personnel, and the employer's inability to meet the contractor's requirements in affecting project completion timelines. Aziz and Abdel-Hakam (2016) conducted a study in Egypt, concluding that continuous changes in orders and delays in preparing drawings and approvals significantly contribute to construction project delays.

The United Arab Emirates (UAE) faces severe challenges with project delays, as highlighted by Faridi and El-Sayegh (2007). They identified key reasons for delays attributed to employers, including delays in approving drawings, inadequate planning capabilities, and sluggish decision-making. Saeed (2009) found that poor employer planning capabilities and employer-initiated delays in obtaining approval for drawings significantly impact project scheduling. Motaleb and Kishk (2010) concluded that factors such as the lack of client experience, preliminary design and drawing issues, ineffective communication, weak teamwork capabilities, and deficient planning skills are the primary contributors to project delays in the UAE. Rehman (2015) pointed to the employer's delay in submitting design specifications, coordination problems, and delays in decision-making as notable employer-initiated delay factors in Abu Dhabi. Johnson and Babu (2018) identified key factors, including the inability to make timely decisions, delays in decision-making, financial constraints, weak funding capabilities, inaccurate cost estimation, and frequent changes in orders and designs, as prominent contributors to project delays.

The previous studies of the selected continents/countries (USA, UK, China, Australia, Africa and Asia) are reviewed from employer-initiated delay factors and success factors. Notably, success factors are identified in these countries in relevance to their corresponding delay factors in a text recommendation format. For instance, Wong and Vimonsatit (2012) studied the delays in construction projects in Western Australia, and they identified the major causes of delays by employing literature reviews and a questionnaire. In general, highly ranked factors are discussed from the point of view of solutions, such as the factor 'low speed of decision', where they propose a text recommendation to overcome this delay factor by identifying the deadline to shorten the waiting time for decisions from clients or consultants. However, having a text recommendation to solve a delay problem might be insufficient, considering the projects' complexities and tight time frames.

In summary, a compilation of studies conducted in six countries reveals that continuous changes in orders, ineffective communication within project teams, and errors in work drawings and designs emerge as common factors contributing to project delays. These factors underscore the need for tailored strategies and solutions to address employer-initiated delay issues in various cultural and regulatory contexts. Table 3.8 provides an overview of articles discussing construction delays in the studied countries and their associated employer-initiated delay factors and critical success factors.

Table 3.8. Delay Factors Caused by the Employer and their Proposed Success Factors in the Previous Studies for Countries of the US, UK, China, Australia, Africa, and Asia.

Country	Author/Year	Employer-Caused Delay Factors	Success Factors Related to the Employer
China	Chan and Kumaraswamy (1996)	Variations, whether employer-initiated or consultant-initiated, always lead to reduced time performance when introduced midstream during construction.	Minimising variations; complete and present project brief.
	Lo et al. (2006)	Variations and changes in scope.	Exercise robust change control, particularly on comprehensive project planning and risk assessment at the outset.
		Unrealistic contract duration imposed.	Allow sufficient time to properly consider all relevant project factors and mobilise the necessary resources to deliver projects.
		Unavailability of the site access area.	Ensure more integrated input from different disciplines.
		Imbalance in the risk allocation.	Reassess the recommendations of the consultancy study on the contract conditions for public works projects to achieve a more equitable allocation of risks between contracting parties.
		Unrealistic requirements.	Develop a better understanding of the different facets of the construction of delivery prices, set precise project requirements and maintain close involvement in project implementation.
	Zou et al. (2007)	Tight project schedule.	Prepare a realistic schedule allowing sufficient but not redundant time to accommodate all design and construction tasks.

		Project funding problems.	Prepare a project forecast and strategic plan as practically as possible, and designers should develop the design within the employer's financial capability.
			Develop a straightforward and appropriate plan, envisage a contingency fund, secure standby cash flow in advance, and control schedule and cost.
		Variations by the employer.	A knowledgeable initial project team should be established as early as possible to define the project scope and functions precisely.
	Chan and Kumaraswamy (1997)	Slow speed of decision-making involving all project teams.	Communication between various groups involved in a project stresses the need for efficient information processing methods in the construction industry. The responsibilities of project parties involved in the project team should be clearly defined, and the designated decision-makers should also be identified.
		Employer-initiated Variations.	Comprehensive approaches must be formulated to minimise variations, whether employer-initiated or consultant-initiated. A bright and thorough client brief is the most helpful strategy for reducing variations.
	Chen et al. (2017)	Slow progress payment.	Not mentioned.
		Frequent change orders are raised.	Not mentioned.
		Slow decision-making.	Not mentioned.
Australia	Wong and Vimonsatit (2012)	Financial difficulties.	Proper cash flow management will improve the project's cash flow and afterwards improve the timely performance of a project.

		Poor communication.	Effective communication between the project's parties must be created during the planning stage. Suitable communication schemes linking all project groups and weekly meetings should be established throughout the project's life cycle to fast-track the decision-making among all parties.
		Slow speed of decision-making.	The goal must be made and met at all times to shorten the waiting time for the decisions from the client or consultants.
	Orangi et al. (2011)	The risk is that late design changes will impact project delivery timeframes.	Control measures: quality assurance, design checklist, and consultation.
Egypt	Marzouk and El-Rasas (2012)	Unrealistic contract duration.	Specification of a realistic duration in the contract for the contractor to execute the project.
	El-Razek et al. (2008)	Delays in contractor's payment.	---
		Design changes by the owner or his agent during construction.	---
		The difficulty of coordination between various parties.	---
		The slowness of the owner's decision-making process.	---
		Obtaining permits from the municipality.	---
		Excessive bureaucracy in project owner operation.	---
	Aziz and Abdel-Hakam (2016)	Owner financial problems/client finance.	---
		Slow land expropriation due to resistance from occupants.	---
		Design changes by the owner or his agent during construction.	---
UK	Shebob et al. (2012)	Changes in the scope of the project.	---
		Poor communication between contractors and other parties.	---

		Slow decision-making by the owner organisation.	---
		Delay in progress payments by the owner.	---
		Delay in delivering the site to the contractor by the owner.	---
		Unrealistic contract duration.	---
		Improper project feasibility study.	---
		Lack of experience of the owner in the construction.	---
		Delay in issuing change orders by the owner.	---
USA	Tafazzoli and Shrestha (2017)	Excessive change orders by the owner during construction.	---
		Delayed payments.	---
		Delay in approving design documents.	---
		Time-consuming decision-making process.	---
		Unnecessary interference.	---
		Delay in delivering the site to the contractor.	---
UAE	Faridi and El-Sayegh (2006)	The slowness of the employer's decision-making process.	---
		Materials type and specification change during the construction.	---
		Excessive bureaucracy/uncooperative owner.	---
		Unrealistic contract duration imposed.	---
	Motaleb and Kishk (2010)	Delays in the contractor's progress payment (of completed work) by the employer.	---
		Change orders.	---
		Slow decision-making by the employer.	---
		Lack of capability of the employer's representative.	---
		Lack of experience of the employer in construction.	---
		Employer's financial difficulties.	---

		Unreasonable constraint to the employer.	---
	Motaleb and Kishk (2013)	Delays in the contractor's progress payment (of completed work) by the employer.	---
		Change orders.	---
		Slow decision-making by the employer.	---
		Lack of capability of the employer's representative.	---
		Lack of experience of the employer in construction.	---
		Employer's financial difficulties.	---
		Unreasonable constraint to the employer.	---
	Salama et al. (2008)	Extended time for approval and decision-making by the shareholder and employer's representatives.	---
		Slow response and decision-making.	---
		Change orders during Engineering, Procurement, and Construction (EPC) by the employer.	---
		Lack of communication among different parties involved.	---
		Lack of communication among different parties involved.	---
		Ambiguous or incomplete definition of employer's requirements.	---
	Moobela et al. (2016)	Unrealistic contract duration imposed by the employer.	---
		Too many scope changes and change orders.	---
		Slowness in the decision-making process by the employer.	---
		Late in reviewing and consenting design documents by the employer.	---
		Selection criteria for consultants and contractors are based on the lowest price.	---
		Confusing and ambiguous requirements.	---

		Excessive bureaucracy/uncooperative employer.	---
		Late handover of the site.	---
		Regular interference.	---
		Delay in materials supplied by the employer.	---
		Suspension of work by the employer.	---
		Delay of payment by the employer.	---
	Ren et al. (2008)	Unrealistic control duration.	---
		Many provisional sums and prime costs.	---
		The nomination of subcontractors and suppliers.	---
		Employer's irregular payment to the main contractor.	---

3.7 Frameworks to Address Construction Delays in Previous Studies

Many researchers have tried to establish frameworks for addressing construction delays, which are crucial issues in the construction industry. These frameworks serve as theoretical and practical tools to tackle these problems and systematically enhance project efficiency. However, it's worth noting that the approaches and comprehensiveness of these frameworks can vary significantly among different studies. Al Sehaimi et al. (2013) emphasize the importance of adopting various research methodologies, including framework methods, to address managerial construction problems and construction delays. However, they also point out that many previous studies primarily rely on textual recommendations as tools to address construction delays. This highlights the need for more comprehensive and practical frameworks.

A significant portion of previous studies, such as Muhwezi et al. (2014), Chan and Kumaraswamy (1997), and many others, offer textual recommendations to address construction delays. While these recommendations can provide valuable insights, they often lack the systematic structure a dedicated framework can offer.

Ansah & Sorooshian (2018) emphasized the need for a comprehensive framework for systematic analysis and grouping of delays in construction projects. They argue that optimizing project performance through root cause analysis is imperative for every project manager. The authors highlight the complexity and significant budgets involved in construction projects, making a systematic analysis of delays crucial for performance improvement and profit maximization. Egwim et al. (2022) propose a conceptual framework for BIM-based construction projects. This framework focuses on critical drivers for delay risk prediction and highlights the potential of using Building Information Modeling (BIM) for delay analysis in construction projects. The authors conduct a systematic review of existing literature to develop this framework.

In contrast, a few studies have proposed frameworks to address construction delays in a more structured manner. For instance, Hamzah et al. (2011) presented a theoretical framework that categorizes delays into excusable, concurrent, and non-excusable while identifying the causes based on their sources. However, this framework does not explicitly provide success factors or procedures to mitigate delays.

Using a risk management model, Albogamy et al. (2014) introduced a methodology for employers to control project risks, including delays. This model integrates analytical hierarchy processes and Monte Carlo simulations to manage risks effectively. While this approach is valuable for risk management, it doesn't offer a comprehensive framework for addressing construction delays.

Alsharif and Karatas (2016) developed a framework for identifying causal factors of delay in nuclear power plant projects. This framework aids in data collection, factor identification, and analysis but lacks a strong emphasis on success factors.

Khair et al. (2018) focused on addressing critical delay factors in Sudanese road projects and proposed a management framework to mitigate delays. While this framework is valuable, it primarily addresses road construction delays and lacks specific connections to delays caused by employers.

While there is existing research on frameworks to address construction delays, there are gaps in the literature regarding frameworks specifically addressing employer delay factors. Most of the frameworks mentioned in the previous references focus on project planning, communication, and site management but do not specifically investigate employers' role in causing or mitigating delays.

To bridge these gaps, risk management techniques and management plans can play a pivotal role in implementing critical success factors to eliminate or reduce delays, especially those caused by employers. Techniques such as brainstorming, interviews with project teams, checklists, and decision tree analysis can help identify and control risks effectively. Although previous research has contributed valuable insights into construction delay management, a comprehensive and practical framework addressing employer-initiated delay factors is currently lacking. Further research is needed to develop a novel and holistic framework that considers success factors and risk management techniques to address construction delays effectively. Such a framework could provide valuable guidance to the construction industry in managing delays caused by various factors, including employers.

3.8 Building Information Modelling (BIM) Implementation Factors in Previous Literature

Charehzehi et al. (2017) introduced an innovative and proactive approach to address the most persistent challenges in the construction industry: delays and disputes. Their research recognized that construction projects are often marred by delays, leading to disputes among project stakeholders, resulting in increased costs, legal conflicts, and project disruptions. Charehzehi et al. (2017) harnessed the power of Building Information Modeling (BIM). This sophisticated digital tool enables comprehensive project management by creating a 3D model enriched with data and information about every aspect of the construction project. The researchers reviewed the specific dynamics of construction projects and the causes of delays and disputes, initiating questionnaire surveys. These surveys allowed them to collect primary data directly from industry stakeholders, including contractors, architects, engineers, and project managers. This data collection process provided valuable insights into construction professionals' real-world challenges.

In addition, Charehzehi et al. (2017) employed the Analytic Hierarchy Process (AHP), a decision-making technique used to evaluate and prioritize various factors and criteria. In this context, AHP likely helped identify critical factors contributing to construction delays and disputes, providing a structured framework for analysis. Also, the researchers incorporated the Multiple Attribute Utility Theory (MAUT), a mathematical model used to make decisions in situations with multiple conflicting objectives or attributes. MAUT may have been used to develop a framework for resolving disputes and conflicts related to construction delays. It helps assess the trade-offs and potential solutions when faced with complex, multi-dimensional problems. The key outcome of their research was the development of a proactive framework. This framework was designed to address construction delays and disputes before they escalate. By leveraging the data collected through surveys, AHP, and MAUT, the framework likely provided stakeholders with tools and strategies to mitigate delays and minimize the risk of disputes. It could have included recommendations for better project planning, communication, risk management, and collaborative practices. In summary, Charehzehi et al. (2017) proposed an advanced approach that combines BIM technology with data-driven decision-making methodologies like AHP and MAUT. Their innovative framework aimed to empower construction professionals to identify potential delays and disputes and take proactive measures to prevent them, ultimately contributing to more efficient and successful construction projects. Latiffi et al. (2013) reviewed previous studies on BIM and its applications in the Malaysian market. They presented the applications and benefits of BIM in construction projects generally and in the Malaysian market. They outlined five primary advantages of implementing BIM in construction projects: supporting design, serving as a platform for evolutionary design, accelerating the design process, visualizing the construction process, and demonstrating the impact of construction projects on traffic flow and access roads using 4D BIM. Table 3.9 outlines the BIM implementation factors in construction projects believed to contribute to the success of BIM-enabled projects based on the previous literature.

Table 3.9. General BIM Implementation Factors in Previous Studies

Study (Year)	**Software and Tools**	**Implementation Factors Related to BIM in Construction**
Sun et al. (2015)	BIM-Project Cost and Schedule Risk Early Warning Model (BIM-CPCSREWM)	BIM combined with the EVA model to provide early warning for the delays.
Latiffi et al. (2013)	Revit, Navisworks and Cost-X	Implementing BIM to avoid design clashes, implementing BIM for early warning for delays and implementing BIM to reduce disputes.
Khoshnava et al. (2012)	BIM 3D BIM 4D	Implementing BIM to avoid design and shop drawings clash detection, implementing BIM for construction program visualisation and implementing BIM for proper project management and planning.
Tahir et al. (2018)	Navisworks Bentley Navigator Vico Office Digital Project Suit Tekla Structures	Implementing BIM to avoid design and shop drawings clash detection, implementing BIM for construction program visualisation and implementing BIM for proper project management and planning.

	Solibri Model Checker	
Alenazi and Adamu (2017)	General BIM Applications	Implementing BIM to improve design quality, implementing BIM for early and more accurate visualisation of a design by the employer, implementing BIM to support decision-making regarding the design, implementing BIM to improve undertaking the sequence of construction, implementing BIM to improve the supply chain process, implementing BIM to increase the ability to resolve RFIs, implementing BIM to improve communication between stakeholders, implementing BIM to reduce project duration, implementing BIM for more accurate scheduling, implementing BIM for quick reaction to design changes and implementing BIM to avoid design, and shop drawings clash detection.
Marzouk et al. (2018)	5D BIM	Implementing BIM to reduce the impact of claims on construction projects. This uses a claims causes' responsibility matrix and a 5D BIM model.
Crowther and Ajayi (2019)	4D BIM	Implementing 4D BIM to present the variances of where deviation happened from the original plan; implementing 4D BIM with site time-lapse cameras to identify the actual progress; implementing 4D BIM for dispute resolution; design and shop drawings clash detection is used with 4D BIM to highlight the sequence of work; 4D BIM is used for early risk identification; implementing 4D BIM to help in identifying more than one type of project risk (e.g. health and safety, cost, quality.
Jununkar et al. (2017)	Framework incorporating BIM model with Ms-Project scheduling	Implementing BIM to reduce delays and early warning of the delays.
Charehzehi et al. (2017)	General BIM Applications	Implementing BIM to avoid design and shop drawings clash detection, implementing BIM for structural analysis, implementing BIM for cost estimation, implementing BIM for scheduling, implementing BIM for shop drawings process and implementing BIM for facility management.

3.9 Building Information Modelling (BIM) in Addressing Employer-Initiated Delay Factors in Previous Literature

BIM, an innovation that has reshaped the construction sector, holds great promise for the future of the Architecture, Engineering, and Construction (AEC) industry (Hoffer, 2008). BIM finds application in various phases of the building project lifecycle, delivering substantial advantages for stakeholders. An Autodesk internet study (2008) highlights that BIM significantly enhances performance within three to four months and surpasses basic CAD applications in numerous ways. It notably improves synchronization among project parties.

Despite its numerous advantages, BIM has faced restrictions and obstacles (Yan & Damian, 2008; Zhang & Gao, 2013), and it's still evolving (Cao et al., 2015). Therefore, it's crucial to examine barriers in BIM implementation and assess their impact on addressing construction project delays, particularly those initiated by employers.

Tahir et al. (2018) investigated how BIM benefits project cost and time management. They concluded that delays and cost overruns are costly and risky, often leading to disputes and lawsuits. Researchers have categorized most causes of delay and cost overrun into four categories: contractor's responsibility, consultant's responsibility, employer's responsibility, and external factors. It's anticipated that the evolution of BIM will enhance efficiency and quality in the construction industry by identifying and mitigating these causes.

Ziad (2016) presented a model combining Building Information Modeling (BIM) and the Last Planner System (LPS) to enhance management practices and reduce project delays. His findings indicated that BIM and LPS positively impact construction project execution times.

Alenazi and Adamu (2017) developed a BIM framework to mitigate delays in Saudi Arabian construction projects, focusing on cost consequences. Their global literature review emphasized BIM's specific benefits in delay management. They observed that not all delay factors benefit equally from BIM, with changes initiated by employers being the primary beneficiaries. Other factors, such as slow employer decision-making and ineffective planning and scheduling, also derive varying levels of benefit from BIM.

Parsamehr et al. (2023) have conducted a review to focus on construction management's four key bottom lines (i.e., schedule, cost, quality, and safety management) and how a BIM-based construction management platform helps monitor these aspects. This review revealed that the primary focus of the researchers was to develop BIM-based automated prediction models and enhance communication and collaboration among project participants. Based on the findings of this research, a BIM-based construction decision-making framework was proposed. They concluded that safety management was the most popular research focus for each construction management challenge. The increased emphasis on improving construction safety with state-of-the-art technology can be a positive development. However, it is also noted that this study has not addressed the employer-initiated delay factors in BIM-enabled projects, and it lacks consideration of the important success factors to address this problem.

The potential of BIM application in managing construction projects aligns closely with the Project Management Body of Knowledge (PMBOK) principles, making it an indispensable tool for effective and efficient project management. BIM seamlessly integrates stakeholders into the project (Rokooei, 2015). This promising technology facilitates project management and integrates building models and products, giving it a high potential to manage project life cycles (Gourlis & Kovacic, 2016). BIM can be applied throughout a project's entire lifespan, aiding in understanding the employer's project requirements. Virtual models enhance collaboration and communication, offering valuable visual aids during meetings with employers and designers.

Recent research has shown that 48% of construction company employees reported that BIM resulted in a superior end product to projects without BIM. BIM enables ongoing monitoring of a building's status based on predefined benchmarks, with data exchange occurring among all team members at various production levels.

Despite the evident advantages of BIM, it's worth noting that previous studies often fall short of conducting a comprehensive analysis of BIM's critical success factors concerning employer-initiated delay factors. Table 3.10 provides an in-depth review of prior research on BIM and employer-related delay factors in this study.

For instance, Marzouk et al. (2018) present structured modeling (BIM) based on case evaluation and design analysis. Their study demonstrates how BIM can help anticipate potential claims and offers a well-structured framework for addressing them. While they partially review and address delay factors like delayed payment, variation orders, and the employer's lack of experience in the construction industry, a comprehensive analysis is lacking.

Similarly, Tahir et al. (2018) delve into the root causes of construction delays and cost overruns, often leading to conflicts or disputes in construction projects, tarnishing the industry's image.

They propose methods and applications to reduce construction costs and time. However, it's important to note that Tahir et al. (2018) do not directly address delay factors associated with the employer. In summary, and based on the detailed literature review conducted in Table 3.10 for employer-initiated delay factors in BIM's projects, it is evidenced that BIM's previous studies lack to address the employer-initiated delay factors comprehensively.

Table 3.10. Mapping for BIM Previous Studies for Employer-Initiated Delay Factors

Study (Year)	**Country**	**Overall Delay Factors Reviewed in the Relevant Research**	**Employer-Initiated Delay Factors**	**Status of Employer-Initiated Delay Factors**
Man and Wang (2015)	China	Price of labour and materials.	Design changes	Partially attended
Latiffi et al. (2013)	Malaysia	Not identified.	Not identified	Not identified
Khoshnava et al. (2012)	Not identified	Lack of precision in the contract documents; failure to count the cost; the psychology of people in construction; design deficiency; defective plans; the underground or subsurface problems; construction process; no damage for the delay in the contract clause; poor communication; over design; incompleteness of drawing; reluctance to seek for clarification; delayed works; and poor scheduling.	Failure to respond promptly to changes	Partially addressed
Tahir et al. (2018)	Not identified	Not identified.	Not identified	Not addressed
Marzouk et al. (2018)	Not identified	Financial problems, cash flow problems; wrong cost estimate; shortage of workforce and low productivity; procurement plan deficiency; defective construction work or a defective design; incomplete and unclear drawings; unforeseen ground conditions; acts of nature; labour disputes and strikes; weather conditions; political situation; economic conditions; an increase in prices in construction materials; planning and	Delayed payments, variation orders, and employer's lack of experience in the construction	Partially addressed

		scheduling problems; equipment management problems and shortage of equipment; poor site management and supervision; failure to possess site; insufficient resources of organisations; poor technical performances; inadequate site inspection; low speed of decision-making involving all projects team; poor contractor management; coordination and communication problems; contract management; original contract duration is too short; and social and cultural factors.		
Chelson (2010)	Not identified	Requests for information (RFIs) and change orders.	Change orders	Partially addressed
Barlish and Sullivan (2012)	Not identified	RFIs and change orders.	Change orders	Partially addressed
Rowlinson et al. (2010)	Case studies in Macau and Hong Kong	Design clash and timing of the payment structure of the project.	Timing of the payment structure	Partially addressed
Zhang (2012)	Not identified	Low productivity; construction rework; design process; and complicated schedule and cost-control work.	Design process	Partially addressed
Lui (2018)	Montreal Canada	Lack of information and weak decision-making.	lack of knowledge and processes; weak decision-making	Partially addressed
Charehzehi et al. (2017)	Not identified	Insufficient or improper monitoring of CPM scheduling and update requirements; non-payment to the subcontractor; defective construction (quality); inadequate contractor management, supervision and coordination; failure to understand and correctly bid or price the works; inadequate CPM scheduling and update requirements; delay/suspension of works; late payment to the contractor; discrepancies or	Delay in paying the running bill of quantities and excessive change orders	Partially addressed

		ambiguities in contract documents; delay in running bill payment; failure to respond in time; lowest price mentality in the engagement of contractors, and designers; and excessive change orders.		
Al-Keim (2017)	Not identified	Senior managers lack strategies to reduce cost overruns and schedule delays; lack training; lack effective coordination and communication among the stakeholders; lack understanding of the design requirements, and lack budget planning.	Not identified	Partially addressed
Losavanh and Likhitruangsil (2013)	Not identified	Not identified.	Not identified	Not identified
Jununkar et al. (2001)	Not identified	Construction projects are becoming complicated due to errors in certification and coordination, calculating constructability and recognising design conflicts before construction starts; over budget, delays, rework, poor communication and cost overrun.	Not identified	Not identified
Liao et al. (2019)	Singapore	Lack of collaboration and model integration, lack of continuous involvement and capabilities, and lack of executive vision and training.	Lack of continuous involvement and capabilities and lack of executive vision and training	Partially addressed
Haron et al. (2019)	Not identified	Not identified.	Not identified	Not identified
Btoush and Harun (2017)	Jordan	Poor scheduling and planning; frequent change orders; site conditions; late deliveries; poor designs; and lack of competent technical staff.	Frequent change orders	Partially addressed
Ayoade et al. (2012)	Nigeria	Inadequate supervision; poor quality material; denial of approval of drawing; harassment	Employer-initiated delays (lack of payments/delayed progress payment)	Partially addressed

		by government officials; delays in approving drawings/applications for transformation infrastructure; lack of training and a limit on human skill retention by workers; lack of psychometric validity; and lack of specialist knowledge; employer-initiated delays (lack of payments/delayed progress payment).		
Crowther and Ajayi (2019)	Not identified	Lack of shared responsibility outside the planner and BIM coordinator; lack of understanding and training regarding 4D BIM; the complexity of carrying out the process effectively; and lack of innovation and lingering inefficiencies.	Not identified	Not identified
Hussein (2016)	Not identified	Ineffective planning and control; poor site management; labour shortage and productivity; material supply chain and procurement; lack of experience and skills in lean methods; lack of leadership commitment; lack of research concerning the interaction between BIM and lean construction; lack of financing for project activities; and lack of data gathered from participants.	Lack of leadership commitment and lack of financing for project activities	Partially addressed
Hergunsel (2011)	Not identified	Lack of labour productivity and knowledge of the contractors during the design phase.	Not identified	Not identified
Koc and Skaik (2014)	Not identified	Different site conditions, payment delays, errors in tendering, and ineffective communication.	Payment delays, errors in tendering and ineffective communication	Partially addressed

Allen and Shakantu (2016)	Not identified	Lack of cooperation; limited trust; ineffective communication; contractual dispute and adversarial working.	Lack of cooperation and ineffective communication	Partially addressed
Lin et al. (2014)	Not identified	Lack of quality and operation efficiency, especially in document-based media in the defect management quality; failure to properly manage quality defects effectively during the construction phase; difficulty tracking relevant history defect information based on the traditional 2D drawings at the construction site; lack of complete records provided for each defect; and few effective platforms to assist on-site quality managers in improving quality inspection and defect management work effectively.	Not identified	Not identified
Zhang et al. (2014)	China	Not identified.	Not identified	Not identified
Latiffi et al. (2016)	Malaysia	Design clashes and delays in delivering RFI.	Not identified	Not identified
Wong et al. (2013)	South Korea	Design changes and improper design.	Design changes	Partially addressed
Mamter et al. (2017)	Malaysia	Absence of BIM policy and compulsion; poor holistic readiness; software integration competition strategy; and reluctance to change and share knowledge.	Absence of BIM policy and compulsion	Partially addressed
Jiaa et al. (2017)	China	Not identified.	Not identified	Not identified
Hamada et al. (2017)	Iraq	There is a lack of capable professionals in using modern technology in construction projects, a lack of experts in BIM technology, and a lack of skills and knowledge for stakeholders.	Not identified	Not identified

Liu et al. (2017)	China	Not identified.	Not identified	Not identified
Park and Cai (2017)	Not identified	Inaccurate and incomplete as-built documentation during the construction phase contributes to misunderstanding, lack of early warning, project delays; lack of complete as-built documentation after the completion of construction.	Not identified	Not identified

3.10 Design Parameters and Hypotheses for the Proposed Framework to Address Employer-Initiated Delay Factors

This section establishes a comprehensive conceptual framework that plays a pivotal role in identifying and defining the main components of the framework itself. The development of this conceptual framework is rooted in an extensive review of existing literature, serving as the foundation upon which both the research questionnaire and the comprehensive research framework are constructed to address the problem of employer-initiated delays within construction projects effectively. The conceptual framework is structured into five distinct windows, each meticulously crafted and elaborated upon, drawing extensively from the insights gleaned from the preceding literature review:

Window 1: Distinguishing Project Types

This window splits into two distinct toolkits, reflecting the primary focus of the research, which delved into examining two project types: traditional (Non-BIM) and BIM-enabled. Window 1 effectively provides the groundwork for understanding the intricacies and nuances of these project categories.

Window 2: Relationships Mapping

Window 2 serves as the platform for delineating the anticipated relationships between employer-initiated delay factors and critical success factors while also considering the moderating factors that may influence these relationships. This window presents insights from case studies and the mean rank analysis, offering a comprehensive perspective on these intricate interconnections.

Window 3: Strategic Implementation Plan

Within Window 3, a well-structured implementation plan for the critical success factors emerges, meticulously crafted through synthesising insights from the prior literature review. This plan is designed to involve the entire spectrum of construction projects, from inception to completion, including all project phases, including pre-tender, tendering, design, and construction.

Window 4: Review Methodology

Window 4 is dedicated to identifying optimal review methodologies for assessing project implementation. These methodologies are not only discerned from the preceding literature. Still, they are also thoughtfully ranked, ensuring that users of the framework possess the essential tools needed to ascertain the direction and progress of their projects.

Window 5: Success Measurement Strategies

Drawing extensively from prior research findings, the fifth window is dedicated to discerning the most effective strategies for measuring project success. These strategies are meticulously identified and ranked to empower the end-users of the proposed framework with the means to assess project success throughout its entire lifecycle.

This conceptual framework is a dynamic roadmap, offering a structured and comprehensive approach to understanding and addressing employer-initiated delays within construction projects. It synthesises existing knowledge and provides a practical guide for practitioners and researchers seeking to navigate the complex landscape of construction project management (refer to Figures 3.1, 3.2, 3.3, 3.4 and 3.5 for a visual description of the proposed framework parameters and the hypotheses outlines).

Window 2 is central to the conceptual and primary frameworks devised to address delays initiated by employers in construction projects. This pivotal element empowers users by providing a comprehensive view of the connections between employer-initiated delays and critical success factors. It does so while considering the factors influencing traditional (Non-BIM) construction projects and those enhanced by Building Information Modeling (BIM) technology.

The primary objectives of Window 2 are to practically identify the positions of employer-initiated delay factors in both BIM-enabled and traditional (Non-BIM) projects. Additionally, it seeks to determine the positions of the most critical success factors impacting both projects.

Moreover, Window 2 aims to identify the impact of moderators on the relationship between employer-initiated delays and critical success factors, thereby enhancing our understanding of these dynamics.

It's essential to highlight that qualitative interviews were conducted with experts to gather insights, and the data collected represents a holistic understanding of the project. This approach ensures comprehensive information, enabling a more accurate assessment of the complex factors in construction projects affected by employer-initiated delays.

Developing the hypotheses and data for Window 2 has been meticulously executed, drawing upon a robust foundation of literature concepts accurately compiled through an exhaustive and systematic literature analysis and review. This comprehensive literature analysis served as the wellspring of knowledge, formulating hypotheses that underpin the framework's effectiveness in addressing employer-initiated delays.

Notably, the hypotheses crafted for Window 2 are a direct product of a rigorous examination of previous literature, as detailed in Table 3.11. It is crucial to emphasize that the prior literature review revealed a common trend – a fundamental but somewhat limited narrative relationship between employer-initiated delay factors and success factors. Recognizing this limitation, the researcher has gone beyond the conventional narrative approach to establish a more robust and nuanced understanding of these relationships. This evolved understanding is essential to address the multifaceted challenge posed by employer-related delays comprehensively.

Window 2 connects theory and practice, offering users a sophisticated analytical tool to navigate the intricate landscape of employer-initiated delays. By transcending the conventional narrative, it equips researchers and practitioners alike with a more powerful means to diagnose, assess, and ultimately mitigate these delays, enhancing the efficiency and success of construction projects, both traditional (Non-BIM) and BIM-enabled.

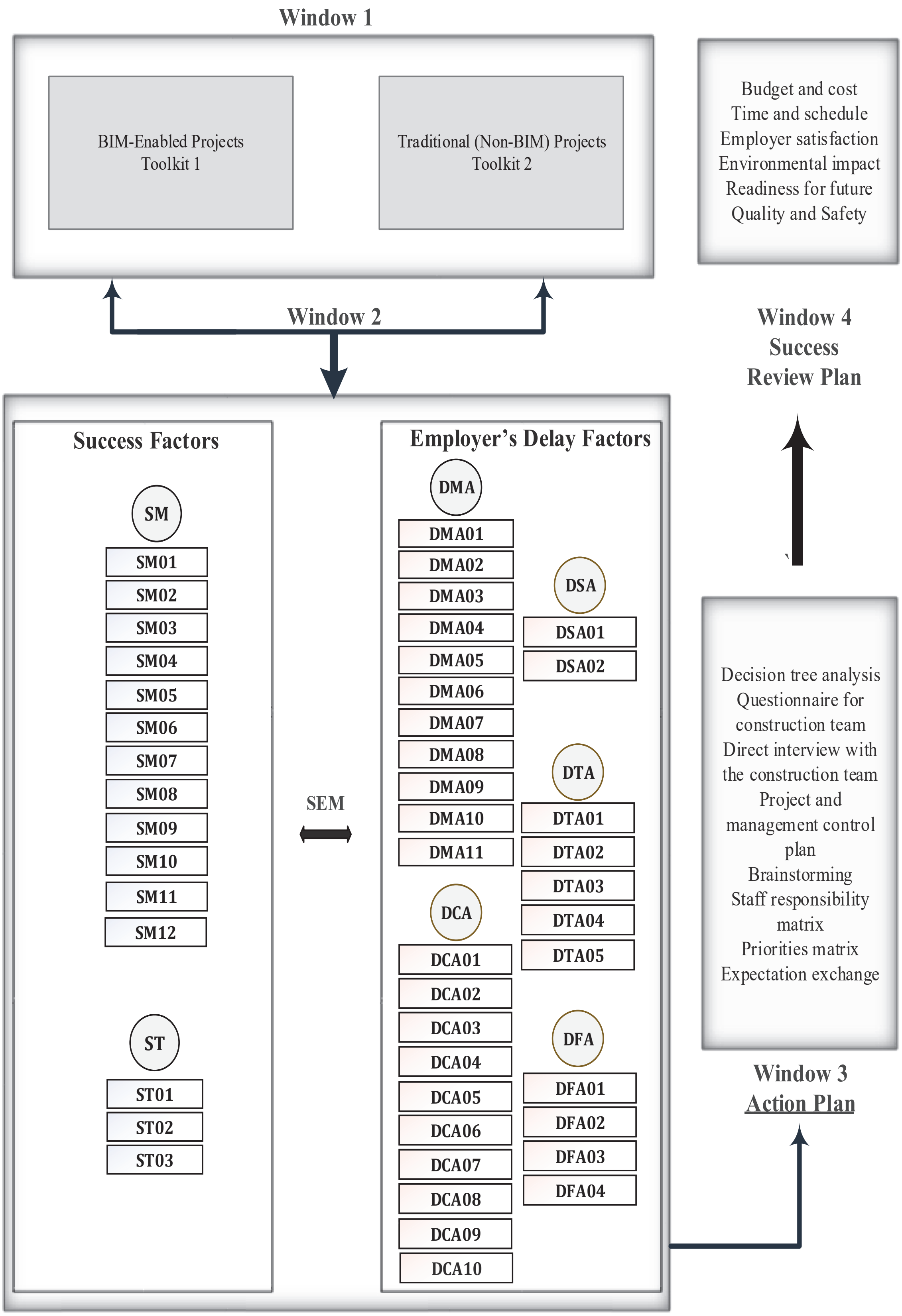

Figure 3.1. The Conceptual Framework to Address Employer-Initiated Delays in Traditional (Non-BIM) and BIM-Enabled

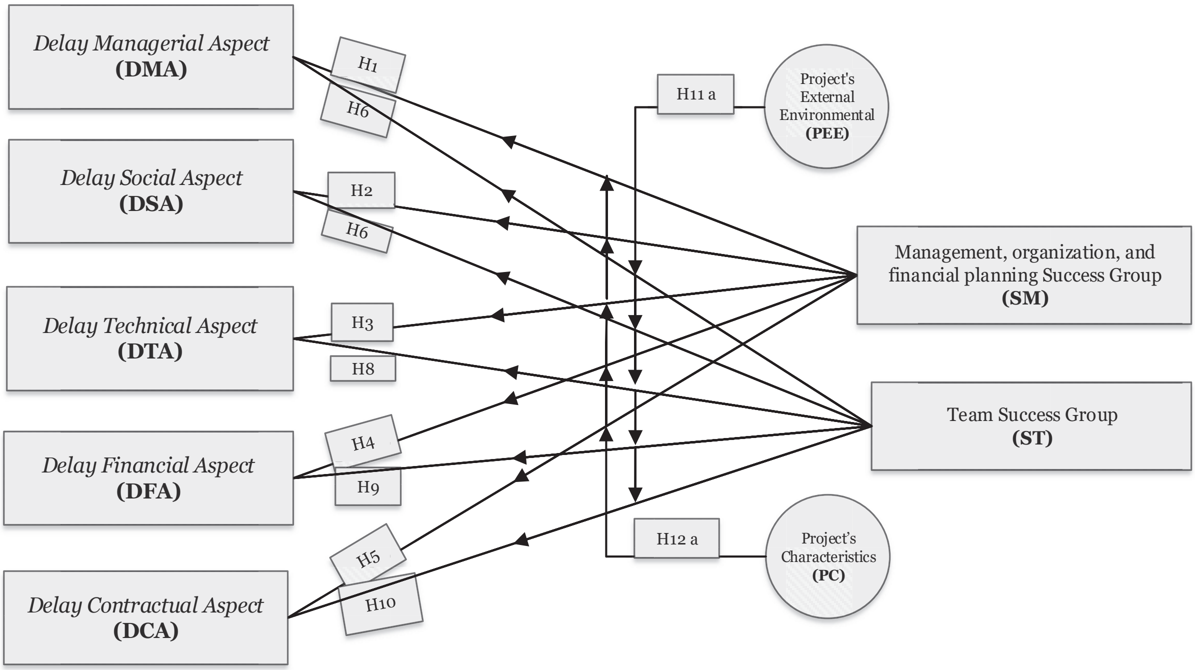

Figure 3.2. Conceptual Hypothesis Model for Traditional (Non-BIM) Projects

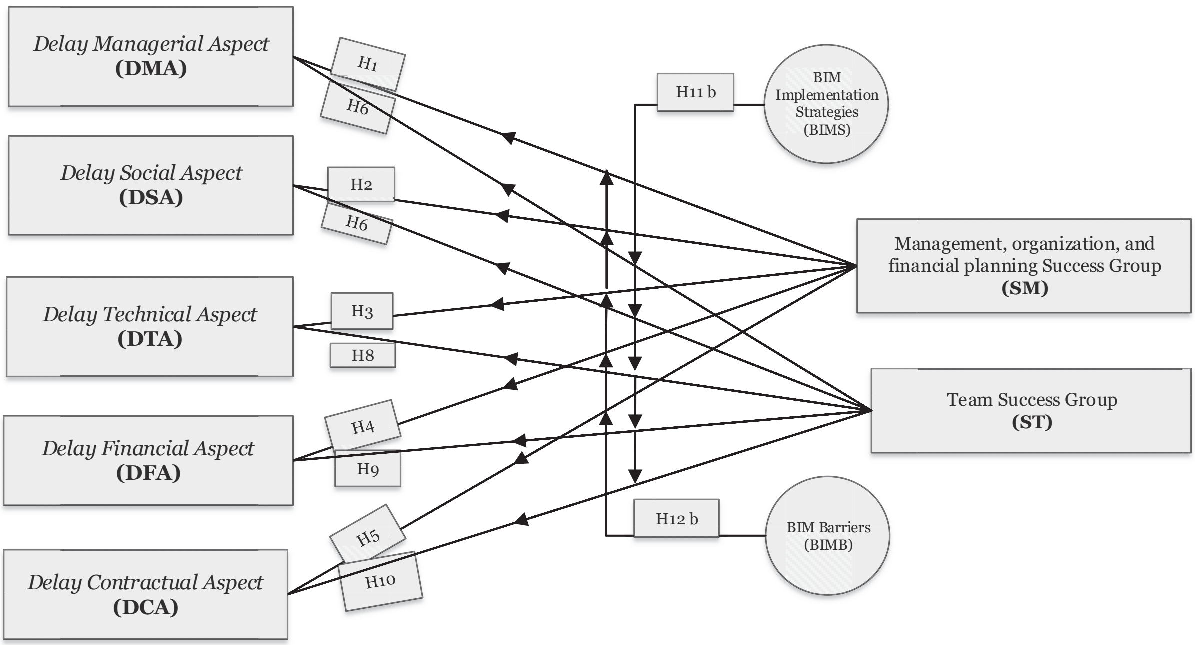

Figure 3.3. Conceptual Hypothesis Model for BIM-Enabled Projects

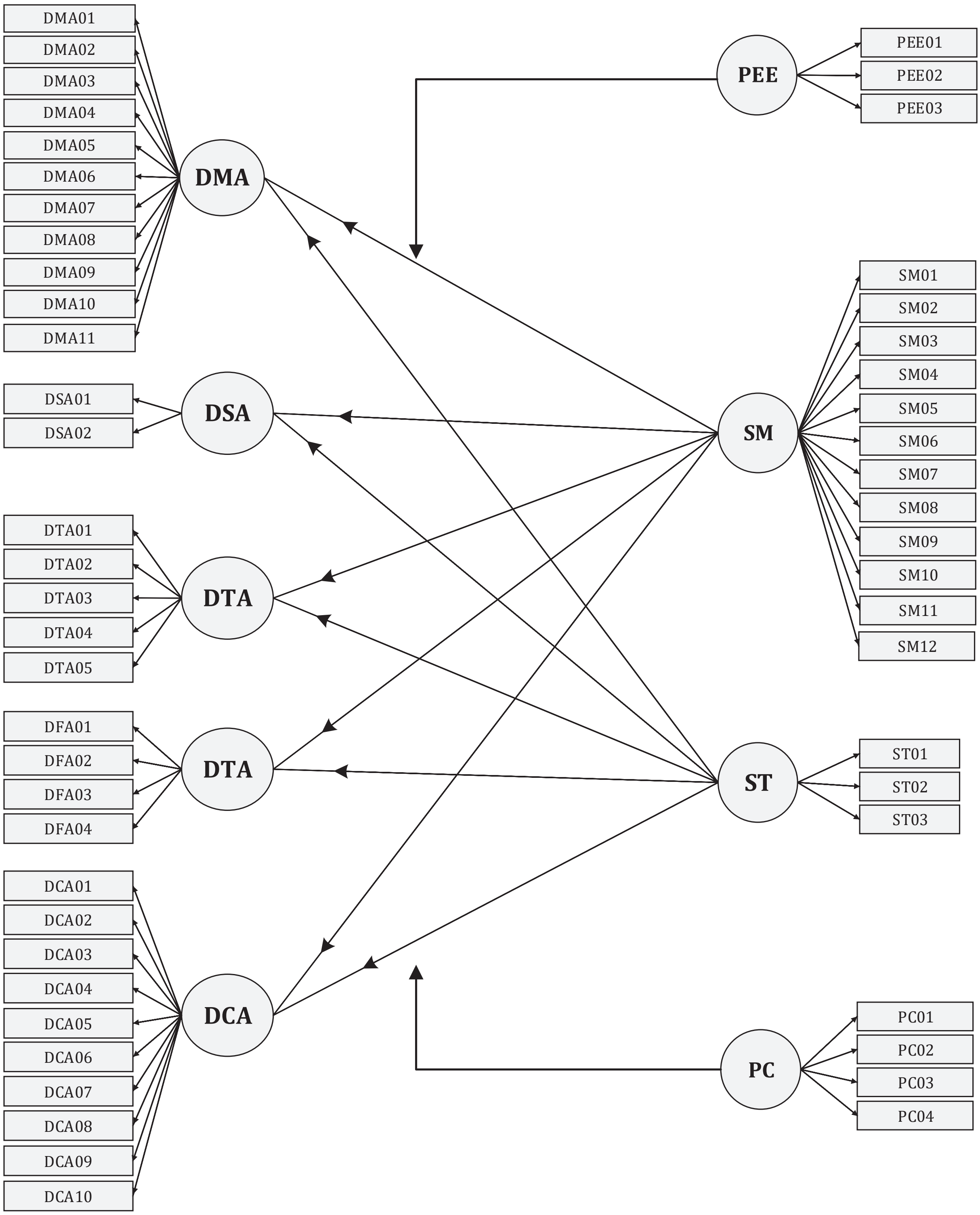

Figure 3.4. Conceptual CFA Model for Traditional (Non-BIM) Projects

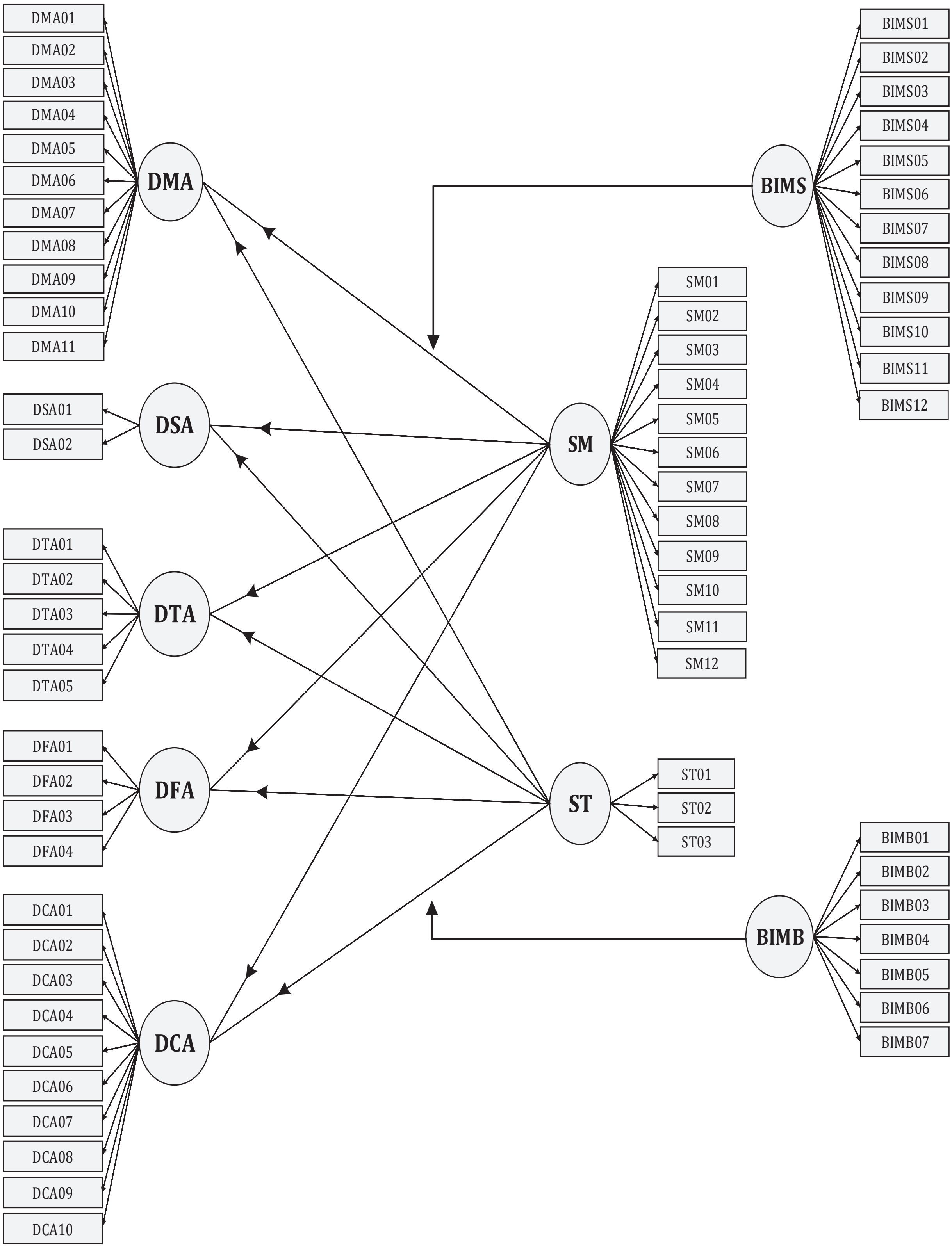

Figure 3.5. Conceptual CFA Model for BIM-Enabled Projects

Table 3.11. Research Hypotheses for the Traditional (Non-BIM) and BIM-Enabled Projects

Code	Description	Path	Observable Variables/Available Sources Contributing to the Development of Hypotheses
H1 H1BM	SM has a positive effect on DMA	SM→DMA	Salleh (2009) suggests that an employer's organisational planning and management critical success factors (SM) have a positive influence on the delay factors of slow decision-making (DMA03), change orders (DMA01) and lack of communication (DMA02). Adugna (2015) suggests that an employer's quick decisions (SM08) and power have a positive influence on the delay factor of slow decision-making (DM03). Adugna (2015) suggests that an employer's objectives are well established before the start of the design phase (SM14), which has a positive influence on slow decision-making (DM03). Muhwezi (2015) suggests that employers' proper planning (SM09) has a positive influence on the delay factor of stoppage or suspension of the project (DM05). Pai and Bharath (2013) suggest that avoiding delay in reviewing and approving design documents (SM01) has a positive influence on controlling the delay factor of late revision and approval by the employer (DMA01). Pai and Bharath (2013) suggest that checking the resources and capabilities (the employer should plan the project properly-SM09) of the contractor before awarding the contract to the lower bidder has a positive influence on reducing delay due to selecting lower bidder's contractors (DMA11).
H2 H2BM	SM has a positive impact on DSA	SM→DSA	Gunduz et al. (2015) suggest that handing over the site to the contractor on time (the employer should have planned the project wisely and accurately (SM09) has a positive influence on acquiring the land from citizens timely and then handing the site over to the contractor (DSA01).

			Seboru (2015) suggests that the employer expedites the slow decision-making (SM08) and has a positive impact on reducing the bureaucracy in the employer's organisation (DSA02).
H3 H3BM	SM has a positive impact on DTA	SM→DTA	Koushki et al. (2004) suggest that proper planning by the employer (SM09) has a positive influence on the delay factor of the lack of experience of the employer in construction projects (DTA02). Alamri and Amoudi (2017) suggest that approval and confirmation of the design concepts and logistic planning (SM01) have a positive impact on the delay factor of difficulties in defining project requirements (DTA05). Mydin et al. (2014) suggest that regular/fruitful meetings (SM02) have a positive influence on the delay factor of lack of experience of the employer in construction projects (DTA02) and irregular attendance of the weekly meeting (DTA03).
H4 H4BM	SM has a positive impact on DFA	SM→DFA	Kaliba et al. (2009) suggest that the employer should give special attention to pay (SM12), which has a positive influence on the delay in progress payments by the employer (DFA01). Mydin et al. (2014) suggest that the employer stick to the original plan and allocate an adequate budget for any contract modifications (SM04) positively influence the investment criteria and improper feasibility study by the employer (DFA04). Mydin et al. (2014) suggest that proposing a bonus scheme for early completion (SM04) has a positive influence on the difficulty in budget availability from the side of the employer (DFA03).
H5 H5BM	SM has a positive impact on DCA	SM→DCA	Mydin et al. (2014) suggest that approval and confirmation of the design concept, construction drawings, material selection, logistics planning, etc., before construction (SM01) positively influence employer contract modifications and site changes. (DCA01.) Mydin et al. (2014) suggest that close monitoring of the progress of work

			(SM05) positively influences damage penalties imposed on the contractor (DCA05.)
H6 H6BM	ST has a positive impact on DMA	ST→DMA	Adugna (2015) suggest that an employer with qualified and well-experienced personnel positively influences the delay factor of the design changes.
H7 H7BM	ST has a positive impact on DSA	ST→DSA	Hughes and Murdoch (2001) suggest that the coordination led by the client's representative between the parties involved in the project (ST02) positively influences the bureaucracy in the employer's organisation (DSA02) Abednego and Ogunlana (2006) suggest that the excellent coordination between the parties involved in the project is also essential to ensure an effective and efficient project development process, which can be achieved if all stakeholders have a sense of trust (ST02) has a positive delay in acquiring land from citizens (DSA01.)
H8 H8BM	ST has a positive impact on DTA	ST→DTA	Oshodi and Rimaka (2013) suggest that clients recruit competent consultants and make timely payments. (ST01) has a positive on difficulties in defining project requirements (DTA05.) Hughes and Murdoch (2001) suggest that the coordination led by the employer's representative between the parties involved in the project (ST02) positively influences the irregular attendance of the weekly meeting. (DTA03.) Chan et al. (2004) suggest that the roles and responsibilities of all project participants should be adequately defined (ST03) and positively influence the employer's lack of experience in construction projects.
H9 H9BM	ST has a positive impact on DFA	ST→DFA	Oshodi and Rimaka (2013) suggest employers recruit competent consultants and make timely progress payments. (ST01) positively influences the delay in progress payments by the employer (DFA01.)
H10 H10BM	ST has a positive impact on DCA	ST→DCA	Oshodi and Rimaka (2013) suggest that employers recruiting competent consultants and making progress payments on time (ST01) positively influence the delay factor of ineffective delay penalties. (DCA04.)

Window 3 is an accurately crafted matrix, offering a comprehensive blueprint for action plans for critical success factors. These action plans have been thoughtfully constructed through an extensive review of prior literature, aimed at assembling the most effective methods employed by construction management teams to implement critical success factors to mitigate or address employer-initiated delay factors.

Within organizations, implementing these action plans often involves a systematic approach to risk management, a concept elucidated by scholars such as Berg (2016) and Harry et al. (2005). Berg (2016) defines risk management as a methodical technique employed to establish a strategy that enhances predictability by identifying, assessing, comprehending, acting upon, and interacting with risks to evaluate the success of a project. Meanwhile, Harry et al. (2005) highlight risk management as an ongoing process where the sources of unpredictability are systematically identified, and their potential impacts strike a balanced equilibrium between risks and opportunities for addressing and reviewing them. This continuous process typically includes risk preparation, evaluation, ranking, and monitoring. Berg (2016) extends the associated strategies by expanding the risk management concept. These strategies for risk recognition, analysis, and mitigation have been traced in the works of scholars like Gagliano et al. (2015) and Chinenye et al. (2016) and include:

- Decision Tree Analysis.
- Questionnaires for the Construction Team.
- Interviews with the Construction Team.
- Management Control Plans.
- Brainstorming Sessions.
- Staff Responsibility Matrices.
- Priorities Matrices.
- Expectation Exchange.

In the context of this research and the review plan for project success concerning mitigating employer-initiated delays, the researcher has thoughtfully adopted these eight risk management strategies. They are crucial tools for construction management teams to proactively identify, analyze, and address potential risks, strengthening the project's ability to navigate and manage employer-initiated delays effectively. In essence, Window 3 presents a comprehensive action plan and aligns it with well-established risk management strategies, emphasizing a proactive and holistic approach to ensure the success of construction projects and the timely resolution of employer-initiated delays.

The ultimate outcomes of a project are profoundly shaped by the judicious selection of the planning procedure, a notion emphasized by Arditi (1985). Naeem (2018) further elucidates that success often results from exceptional strategies and meticulous protocols employed throughout the project's lifecycle. Datta and Mukherjee (2001) add that the successful completion of a project is essentially tied to the adept identification and management of immediate risks. Consequently, recognizing the pivotal role of risk management in shaping project success, the researcher has strategically chosen risk management tools to critically assess and enhance the implementation of critical success factors throughout the project's duration.

Table 3.12 and Table 3.13 serve as valuable resources within this research endeavour, illuminating insights into the ranking results of a survey of 197 respondents. These respondents evaluated and ranked the most suitable action plans for implementing critical success factors, specifically focusing on BIM-enabled and traditional (Non-BIM) projects. The rankings, determined based on the average grades assigned by these respondents, furnish a comprehensive and data-driven understanding of the preferred strategies for critical success factor implementation within these distinct project contexts.

These tables encapsulate the collective wisdom and preferences of a diverse pool of respondents, shedding light on the most effective approaches for ensuring the success of BIM-enabled and traditional (Non-BIM) projects. The researcher leverages this empirical data to refine the framework's recommendations, enhancing its practical applicability and effectiveness in addressing employer-initiated delays. These tables are invaluable tools for project managers and stakeholders seeking evidence-based guidance in optimizing critical success factor implementation, consequently elevating the likelihood of project success.

Table 3.12. Action Plan Ranking for Traditional (Non-BIM) Projects.

Factor	Description	Average	Rank
M07	Priorities matrix	4.43	1
M06	Staff responsibility matrix	4.36	2
M04	Project control and management control plan	4.34	3
M05	Brainstorming	4.21	4
M08	Expectation exchange	4.10	5
M03	Direct interview with the construction team	4.06	6
M01	Decision tree analysis	4.04	7
M02	Questionnaire for the construction team	3.89	8

Table 3.13. Action Plans' Ranking for BIM-Enabled Projects

Factor	Description	Average	Rank
M04	Project control and management control plan	4.10	1
M06	Staff responsibility matrix	4.09	2
M07	Priorities matrix	4.04	3
M05	Brainstorming	3.86	4
M08	Expectation exchange	3.70	5
M01	Decision tree analysis	3.70	6
M03	Direct interview with the construction team	3.63	7
M02	Questionnaire for the construction team	3.41	8

Window 4 investigates a crucial aspect of project management, where the notion of success takes centre stage. It is important to emphasize that success in project management is a multifaceted concept with various perspectives and dimensions. Scholars and researchers have offered insightful definitions and viewpoints on what constitutes success in construction projects. Chovichien and Nguyen (2013) stress the significance of task success as the foundational framework for overseeing ongoing projects while preparing for future ones. It includes the structure for managing existing tasks and orienting future endeavours. Also, Parfitt and Sanvido (1993) bring forth the idea that job success is the measure of whether a task achieves its objectives and often carries a subjective aspect. They acknowledge that the interpretation of task success can differ from one individual to another, but it fundamentally hinges on fulfilling task expectations and goals. Besides, Baker et al. (2008) introduce the notion that there is no absolute success in a project; rather, success is perceived. They emphasize the importance of how stakeholders perceive the outcome and impact of a project. Silva et al. (2016) define task success as "the degree of accomplishment of predetermined efficiency goals and individuals' expectations regarding the execution of a project." This definition underscores the role of performance metrics and stakeholder expectations in evaluating success. Lim and Mohomed (1999) highlight success as a useful concept or criterion against which anything can be assessed. This perspective recognizes that success can vary depending on the context and objectives of a project. Chan and Chan (2001) define job success requirements as a set of concepts or criteria that allow beneficial results to be achieved within specific parameters. They acknowledge that success criteria may vary depending on the project's objectives and constraints.

Researchers often categorize success requirements into various elements or aspects of project success. These elements can include performance measures, efficiency indicators, and stakeholder satisfaction (Baccarini, 1999; Pinto & Slevin, 1988; Shenhar et al., 2001).

In construction project success, criteria are frequently organized into performance measures (Atkinson, 1999; Beloit, 1998; De Wit, 1988; Pinto & Slevin, 1988). These measures include various aspects of project management and execution, including cost, time, quality, and stakeholder satisfaction.

Table 3.14 serves as a valuable synthesis of the previous literature's diverse perspectives and definitions of construction project success. It offers a comprehensive overview of the criteria and metrics used to evaluate success in construction projects, underscoring the multidimensional nature of this concept and its role in project management and assessment. This compilation provides a foundation for understanding and measuring success within the context of construction projects, aiding researchers and practitioners in pursuing successful project outcomes.

Table 3.14. Literature Summary of the Criteria to Measure the Project's Success

Criteria	References (year)	Definition
Budget and Cost	Elattar (2009); Chan & Chan (2001); Chovichien & Nguyen (2013); Serradora& Turner (2014); Wai et al. (2012)	The construction worker's compliance level is within the estimated cost and budget.
Time and Schedule	Elattar (2009); Chan & Chan (2001); Chovichien & Nguyen (2013); Serradora & Turner (2014); Wai et al. (2012)	The level of compliance for the construction work within the estimated project time.
Employer's Satisfaction	Al-Tmeemy et al. (2011), Pinto & Slevin, (1988); Al-Serradora & Turner (2014); Wai et al. (2012)	The degree of fulfilment over accomplishing the customer's expectation in performing the task.
Environmental Impact	Chan & Chan (2001); Chovichien & Nguyen (2013); Wai et al. (2012)	The degree of unfavourable effect triggering to the environment due to the execution of the job.
Readiness for Future	Takim & Adnan (2008); Wai et al. (2012)	The level of expert experience and favourable market effects to deal with the future.

Quality and Safety	Chan & Chan (2001);Al-Tmeemy et al. (2011); Chovichien & Nguyen (2013)	Compliance and conformity with the project's specifications and safety requirements.

Table 3.15 and

Table 3.16 provide the ranking results (based on the average grades) for 197 respondents asked to answer the question for the most proper review plans in implementing the critical success factors for BIM-enabled and traditional (Non-BIM) projects.

Table 3.15. Review Plan Ranking for Traditional (Non-BIM) Projects

Factor	Description	Average	Rank
MR02	Time and Schedule	4.48	1
MR01	Budget and Cost	4.38	2
MR06	Quality and Safety	4.26	3
MR03	Employer's Satisfaction	4.07	4
MR04	Environmental Impact	4.03	5
MR05	Readiness for Future	4.01	6

Table 3.16. Review Plan Ranking for BIM-Enabled Projects

Factor	Description	Average	Rank
MR02	Time and Schedule	4.24	1
MR01	Budget and Cost	4.14	2
MR06	Quality and Safety	3.95	3
MR03	Employer Satisfaction	3.79	4
MR05	Environmental Impact	3.55	5
MR04	Readiness for Future	3.52	6

3.11 Summary of Chapter 3

This chapter serves as a comprehensive and meticulous exploration of construction delays within projects, including a global perspective. It lays the groundwork for a thorough understanding of various facets related to delays in construction projects, project typologies, delay groups, the impact of delays, and the role of Building Information Modeling (BIM). Let's delve into the key aspects covered in this chapter:

Project Typology Analysis:

The chapter commences with an extensive examination of project typology. This examination provides the researcher with a holistic perspective on different project types. This comprehensive understanding is essential to assess and address delays across diverse project categories effectively.

Review of Delay Categories:

It proceeds to investigate delay groups, drawing insights from previous studies. By categorizing and analyzing these delay groups, the chapter sets the stage for a nuanced understanding of the multifaceted nature of construction delays.

Impact of Delays:

The chapter does not merely stop at identifying delay factors but also investigates their effects on construction projects. It sheds light on the far-reaching consequences and ramifications that delays can have on project timelines, budgets, and overall success.

BIM and Construction Delays:

The role of Building Information Modeling (BIM) in construction is explored in detail. This includes examining how BIM can impact and potentially mitigate construction delays. It also investigates various BIM implementation elements and strategies, emphasizing the role of BIM tools and software.

Research Gap Identification:

An important contribution of this chapter is the identification of research gaps in the existing literature, particularly concerning BIM-enabled projects and their approach to addressing employer-initiated delay factors. It highlights the need for more focused research in this area and underscores the limited attention given to employer-initiated delay factors in previous studies.

Collection and Categorization of Factors:

The chapter collects and categorises employer-initiated delay factors and their corresponding critical success factors, drawing from various sources. This process contributes to the formation of organized groups that inform the subsequent development of the research frameworks.

Regional Perspectives:

Additionally, the chapter takes a regional approach by reviewing employer-initiated delay factors and critical success factors within specific countries and continents, including the US, UK, Australia, China, Africa, and Asia. This adds a geographical dimension to the understanding of delay factors.

Framework Development:

To conclude, the chapter outlines the design parameters and hypotheses that will serve as the foundation for the research framework. It provides a systematic structure for this framework, offering a roadmap for addressing employer-initiated delay factors comprehensively.

This chapter serves as a comprehensive springboard for the subsequent research, providing a robust foundation built upon global perspectives, in-depth analysis, and the identification of critical research gaps. It not only defines the scope of the research but also contributes to the overarching goal of enhancing project management practices by addressing the vexing issue of construction delays, particularly those initiated by employers.

4 Effect of Critical Success Factors, BIM Implementation Strategies, and Barriers on Employer-Initiated Delays

4.1 Introduction

A lack of study has been undertaken on the complexities associated with employer-initiated delays in projects utilising Building Information Modelling (BIM). This study addresses the existing research gap by examining the influence of important success factors, techniques for implementing Building Information Modelling (BIM), and obstacles to delays imposed by employers in the context of projects utilising BIM. To accomplish this objective, 197 questionnaires were gathered and comprehensively analysed. The questionnaires were obtained from various geographical regions, and the rigorous Structural Equation Modelling (SEM) approach was employed for the analysis. In this extensive research, we also considered the impact of moderating factors on the observed associations.

A noteworthy discovery of this study pertained to the intricate interaction of important success variables, methodologies for implementing Building Information Modelling (BIM), and the obstacles faced in projects utilising BIM. The study revealed that these characteristics substantially impacted the occurrence and severity of delays initiated by employers, illuminating a crucial feature frequently overlooked in more comprehensive analyses of construction delays.

It is important to acknowledge that previous studies within the construction sector have predominantly concentrated on identifying and resolving delays arising from diverse origins while allocating comparatively less attention to delays emanating from employers in Building Information Modelling (BIM) projects. Wang et al. (2018) investigated the factors contributing to construction delays in Chinese construction projects. Their study adopted a multi-stakeholder viewpoint, considering all project participants and sources of delay. Similarly, the study conducted by Barqawi et al. (2021) examined the factors contributing to delays in BIM projects that employers began. However, the researchers noted that prior studies had not extensively investigated these delays.

Building Information Modelling (BIM) is an innovative methodology that leverages electronic information designs to optimise the oversight and control of construction projects, including identifying and mitigating factors contributing to project delays. Implementing Building

Information Modelling (BIM) innovation holds significant promise in enhancing the comprehensive control of construction delays across various projects. Nevertheless, despite the commitment above, the enduring issue of project delays in projects utilising Building Information Modelling (BIM) remains a substantial concern. This can be attributed to various factors, including the phenomenon of cultural lag identified by Sadeh et al. (2021) and the inherent risks involved with implementing BIM, as highlighted by Chien et al. (2014).

This study focuses on analysing employer-initiated delays from the individual views of each project party without attempting to integrate or combine these opinions. The rationale for adopting this approach stems from multiple factors. Firstly, prior research has not adequately explored the comprehensive analysis of delays initiated by employers. Secondly, by examining individual factors contributing to employer-initiated delays separately, it becomes possible to develop focused frameworks to address these delays effectively. Lastly, our team posits that a broad investigation including all aspects and project stakeholders may inadvertently neglect crucial factors that are unique to delays caused by employers. According to Barqawi et al. (2021), organisational challenges within the employer's domain have a significant role in causing delays in construction projects.

Our analysis is notable for its worldwide viewpoint, as only a few scholars have conducted extensive global studies of employer-initiated delays (e.g., Zidane and Olsson, 2017; Amarkhil et al., 2021). Our study prioritised three crucial elements that have not been thoroughly investigated in previous scholarly works, as emphasised by Barqawi et al. (2021): This study aims to investigate three main areas: (a) the examination of delays caused by employers and the factors that contribute to their success, (b) the analysis of employer-initiated delays and critical success factors in countries where this topic has received limited attention, specifically the United States, the United Kingdom, Australia, and China, and (c) the exploration of effective strategies for implementing projects enabled by Building Information Modelling (BIM), as well as the barriers. Therefore, our work aims to offer significant insights into these crucial facets.

To collect empirical data for this study, a questionnaire survey was administered in nations known for their substantial building activity, namely Australia, Egypt, China, the United Arab Emirates (UAE), the United Kingdom (UK), and the United States (US). Following this, we utilised a meticulous Structural Equation Modelling (SEM) methodology to examine the gathered data and assess the suggested hypotheses. This methodology guarantees a comprehensive and statistically valid analysis of the intricate connections and variables being studied, enhancing the comprehension of delays initiated by employers in projects utilising Building Information Modelling (BIM).

Viles et al. (2020) remarked that more than 50 per cent of the construction delay studies were undertaken in Asia, and more than 80 per cent of the total studies were carried out in Asia and Africa. The remaining 20 per cent is divided equally between North America and Europe. The lack of previous studies on construction delay in Europe and North America appears more apparent when related to employer-initiated delay factors.

Previous research on construction delay analysis has primarily focused on particular nations and traditional (Non-BIM) building methodologies. However, a notable study lacks a thorough investigation of employer-induced delays across several countries or continents. In addition, there has been a lack of comprehensive examination of the influence of current Building Information Modelling (BIM) methodologies on the occurrence of construction delays. The main goals of this research can be briefly summarised as follows:

(a) Systematic Hypothesis Development: The primary aim is to systematically formulate coherent hypotheses that clarify the connections between employer-initiated delay factors and relevant critical success factors while also considering potential moderating effects.

(b) The second purpose is empirically assessing these assumptions using Structural Equation Modelling (SEM). This robust statistical methodology enables a rigorous analysis of intricate interactions within a model.

(c) The third purpose of this study is to evaluate the impact of BIM implementation strategies and barriers on the identified direct links among the hypotheses. The comprehension of this particular feature is of utmost importance when examining the impact of contemporary technical breakthroughs such as Building Information Modelling (BIM) on delays imposed by employers in construction projects.

This study has the potential to generate substantial and innovative contributions to the area due to its thorough investigation into factors that cause delays started by employers. This study aims to fill the existing research void and offer a comprehensive and relevant resource for the construction sector.

To explain the importance of this research, it is necessary to examine prior studies conducted, such as Hegazy (2012) and Hamzah et al. (2011). Although the authors briefly discussed many employer-initiated delay factors, their analysis lacked a complete examination. Hegazy (2012) identified various causes of project delays, specifically focusing on employer-initiated issues. These factors covered changing orders, design adjustments, sluggish decision-making processes, and impediments to contractor productivity. Nevertheless, the research above did not thoroughly examine all aspects of delay causes initiated by employers.

Furthermore, examining the influence of Building Information Modelling (BIM) technology on our comprehension of delay causes introduced by employers is an important area that has received limited attention. The study conducted by Rowlinson et al. (2010) provided evidence of the beneficial impacts of Building Information Modelling (BIM) technology in the Cathay Pacific Cargo Terminal's development in Hong Kong. The employer instructed the implementation of Building Information Modelling (BIM) methodologies from the first phases of the project to minimise the potential for schedule disruptions and budgetary excesses. The utilisation of Building Information Modelling (BIM) throughout the construction process has substantially impacted several aspects of the project. It has been observed that the integration of BIM technology has led to a considerable reduction in service clashes, mitigated the potential hazards of delays, and enabled rigorous monitoring of construction operations.

This study seeks to fill the existing gaps by conducting a comprehensive evaluation of the relationship between delays caused by employers, factors contributing to project success, and the use of Building Information Modelling (BIM) practises. The objective is to offer practical insights and a comprehensive framework for effectively tackling this significant challenge within the construction sector. Engaging in this practice enhances the efficiency of projects, mitigates delays, and eventually enhances the overall performance of construction projects.

The classification of groups related to delay factors introduced by employers has utilised the comprehensive literature evaluation done in Chapter 3 of this study. The procedure of categorising is of utmost importance as it facilitates the organisation and systematic evaluation of elements contributing to delays following established scholarly perspectives and research discoveries. However, clarifying the methodology employed in determining each group's delay factors is crucial. The determination and categorization of these elements causing delays have also been impacted by previous scholarly studies and established literature in the respective sector. This methodology guarantees that the delay factors found are thorough and relevant, covering the collective knowledge and experiences reported in prior research.

By utilising a solid base of pre-existing scholarly investigations, this study not only derives advantages from a well-informed classification of various groups but also guarantees that the causes causing delays within each group are firmly rooted in recognised academic literature. Table 4.1 clarifies the basis on which the employer-initiated delay factors are classified based on the suggested groups of delays. For instance, the delay factor “Irregular attendance of the weekly meeting” has been classified under the technical aspect group. The irregular weekly meeting attendance is regarded as a technical factor within the framework of construction delay (Zidane and Andersen, 2018). The basis for this classification is that the weekly meeting plays a crucial role in providing a foundational platform for discussing technical matters, overcoming obstacles, and monitoring the progress of project milestones (Sepasgozar et al., 2019). Irregular attendance can have several adverse consequences for the project's technical components. These implications may include a range of potential consequences or effects. Communication breakdown can result in several negative consequences, such as a lack of clarity about technical requirements (Alaghbar et al., 2007). Construction projects often face technical issues that must be resolved promptly, yet inefficient problem-solving methods can hinder the resolution process. The lack of regular attendance may hinder the prompt detection and settlement of technical problems, potentially enabling their escalation and consequent delays.

4.2 Literature Review

In a research conducted by Manzoor et al. (2021), the primary objective was to investigate the efficacy of various strategies in implementing Building Information Modelling (BIM) in sustainable construction projects in Malaysia. The researchers found three key tactics that demonstrated substantial importance in the use of Building Information Modelling (BIM) in sustainable building projects, which are: (a) public awareness via workshops, lectures, and conference Events at which Manzoor et al. (2021) emphasised a significant strategy, which involves organising workshops, lectures, and conferences to enhance public knowledge regarding the advantages and implications of Building Information Modelling (BIM) in sustainable projects. The objective of this strategy was to promote a more profound comprehension of Building Information Modelling (BIM) technology and its potential advantageous influence on sustainability within the building sector; (b) the research underscored the imperative of providing inclusive and thorough disclosure about the costs and advantages included in using sustainable materials within construction endeavours. By offering stakeholders a comprehensive understanding of the economic benefits associated with these materials, it becomes increasingly viable to promote their integration into sustainable construction methodologies; (c) the pivotal approach outlined in the study was the imperative to strengthen sustainable development activities. This entails the integration of Building Information Modelling (BIM) practises with sustainability goals and principles, guaranteeing that BIM tools and methodology actively contribute to the overarching sustainability objectives of the project. In addition, the study conducted by Manzoor et al. (2021) examined the viewpoints of significant project stakeholders, including contractors, consultants, and employers. The viewpoints were compared to data from the United States and New Zealand, providing insight into the worldwide applicability and significance of the suggested methods. Thus, it is evident from Manzoor et al. (2021) the importance of BIM in construction projects and the importance of studying BIM-enabled projects separately as a single entity to explore the advantages of such technology towards improving the reduction of the delay in construction projects.

In a distinct investigation by Manzoor and Othman (2021), the researchers examined the various elements that contribute to accidents in construction projects, covering those that involve Building Information Modelling (BIM) technology. The study primarily examined the application of visualisation technologies in construction safety management. Manzoor and Othman (2021) conducted a study to determine the relative significance of various safety issues in BIM building projects, emphasising the need to integrate safety measures within the BIM framework.

Marzouk et al. (2021) undertook a comprehensive investigation to bridge the gap between the Building Information Modelling (BIM) framework and environmental assessment approaches utilised in construction projects. The researchers' study provided evidence supporting the viability of implementing a framework that facilitates cooperation and environmentally friendly practises throughout different phases of construction by the Building Information Modelling (BIM) technology. The objective of this strategy is to establish a connection between the BIM framework and environmental evaluation, with the ultimate goal of allowing construction practices that are more ecologically responsible. This study supports the scientific requirements for establishing a framework to address BIM in construction by conducting a separate study for BIM-enabled projects. However, in this thesis, the BIM-enabled projects have been addressed only from the perspective of the employer-initiated delay factors and their corresponding critical success factors.

Ruzicka et al. (2022) investigated the possible data workflows for automatic assessment in BIM-enabled projects based on the experience gained from real pilot projects. Using data from an information model in the design phase enabled us to assess different design strategies and structural variants efficiently, resulting in higher final design quality. The experience gained by combining BIM and automatic complex building quality assessment was also discussed.

The employer generally creates compensable delays. These delays can also result from a mistake or neglect created by the employer. The common factors that might lead to compensable delays are adjustments or changes by employers that create various work problems or lead to the suspension of jobs (Nguyen and Do, 2021). When compensable delays occur, the contractor can request an extension of time. As a result, the employer or enterprise pays some financial compensation because of the damage caused by the contractor.

The existing body of literature in construction management offers significant insights into utilising Building Information Modelling (BIM) implementation strategies. These strategies aim to improve coordination and tackle the diverse issues encountered in projects that employ BIM technology. Numerous scholarly investigations have clarified the benefits of employing these tactics to address challenges such as excessive fines, inadequate incentives, and project delivery delays (Badi et al., 2021; McNamara and Sepasgozar, 2021).

Moreover, Chahrour et al. (2021) underscored the significance of BIM implementation strategies in accelerating project completion by facilitating the timely identification of contractual delays, such as conflicts emerging from design modifications before and during project implementation. According to previous studies conducted by Nagalingam et al. (2013) and Olanrewaju et al. (2021), implementing these tactics has effectively optimised project management processes and mitigated delays caused by managerial factors. Despite the extensive research in this domain, a significant knowledge gap exists regarding the comprehension of employer-induced project delays in Building Information Modelling (BIM) technology. Btoush and Harun (2017) conducted a study to examine the issue of building project delays in Jordan. The researchers identified three main causes of these delays and proposed minimising them using Building Information Modelling (BIM) approaches. One such technique involves dividing the project into stages to amend any wrong selections made during the process.

The study conducted by Martin et al. (2020) examined the effects of utilising four-dimensional

(4D) Building Information Modelling (BIM) in construction planning, which is considered a crucial strategy for implementing BIM. The focus of the research was to investigate how this approach may effectively address the many issues that contribute to delays induced by employers. Incorporating three-dimensional (3D) models in conjunction with time or scheduling elements mitigates misunderstandings and knowledge deficiencies, diminishing the necessity for rescheduling and delays in project completion. The authors also investigated the difficulties associated with implementing 4D Building Information Modelling (BIM) technology in the Brazilian construction sector, utilising software products such as Revit, Navisworks, Tally, and Green Building Studio.

Previous research by Altarawneh et al. (2018) and Alkhathami (2004) examined the correlation between success variables and delays in building projects. However, these studies did not specifically concentrate on delays that employers initiate. In contrast, the study conducted by Barqawi et al. (2021) focused on identifying and examining employer-initiated delays in projects utilising Building Information Modelling (BIM) and the elements that contribute to their success.

Table 4.1 presents an overview of the scholarly activities conducted by several researchers, including Gardezi et al. (2013), Koc and Skaik (2014), and Barqawi et al. (2021). These studies have focused on identifying delay causes, particularly those related to employer-initiated delays in projects utilising Building Information Modelling (BIM) technology. This study largely focused on delay causes introduced by employers, operating under the assumption that these delays resulted from direct interference by employers. Therefore, the inclusion of factors such as DTA1, DCA1, and DCA2 in the employer-initiated delay group was justified due to their classification as direct consequences of employer orders. Furthermore, the DFA2 factor, which pertains to underestimating project expense, was classified as an employer-initiated delay due to its origination from direct employer intervention. In their study, Ubani et al. (2015) examined the phenomenon of project cost underestimation in Nigeria. They identified several factors contributing to this issue, including insufficient consultancy in project cost estimation, limited experience or expertise among cost estimators, alterations in project scope, inadequate information, and suboptimal information flow. These factors were found to be directly influenced by employers. Also, Table 4.1 provides evidence for employer-delay factors' categorisation of their groups.

Table 4.1. Employer-Initiated Critical Delay Factors and their Codes

Group	Item Code	Item Description	Previous Literature References	Evidence for Employer-Delay Factors' Categorisation in Their Groups
Managerial	DMA1	Delay in approving changes in the scope of work and specifications.	Chelson (2010); Man and Wang (2015); Barqawi et al. (2021).	Chelson (2010) conducted a study investigating the impact of Building Information Modelling (BIM) on productivity within construction sites. The study specifically focuses on the influence of delays, including the acceptance of changes related to the scope of work and requirements. The research suggests that this particular component is among the managerial factors that exert an influence on production, alongside communication, coordination, planning, and supervision. Lukhele et al. (2021) found that the prevalence of scope changes in projects, which can result in significant adverse effects on project costs and schedule delays, is purely related to managerial factors. Proper management skills are essential to manage and mitigate these changes effectively. Thus, Lukhele et al. (2021) have observed that alterations in project scope are considered a managerial element that has the potential to lead to delays in construction.
	DMA2	Lack of communication capacities between the employer and the employer's representative.	Koc and Skaik (2014); Allen and Shakantu (2016); Barqawi et al. (2021).	Lack of communication capacities between the employer and the employer's representative is indeed considered part of the managerial delay factors in construction projects. This factor has been highlighted in the literature as a significant contributor to delays in construction projects (Mahamid, 2017).
	DMA3	Slow decision-making process by the employer or authorised employer's representative.	Barqawi et al. (2021); Eccles et al. (2014).	Eccles et al. (2014) explored the relationship between corporate sustainability and organizational processes and performance. They found that firms with a strong sustainability orientation tend to have more effective decision-making processes and higher operational efficiency. This paper suggests that a slow decision-making process by the employer or an authorized employer's representative can cause various problems in construction projects,

				such as misunderstandings, misinterpretations, mistrust, delays, cost overruns, quality defects, and dissatisfaction among project stakeholders.
	DMA4	Weak managerial capacities by the employer or the employer's representative to treat the delay caused by the employer.	Lui (2018); Liao et al. (2019); Tavassolirizi et al. (2020); Barqawi et al. (2021).	The factor is a managerial factor by its definition.
	DMA5	Suspension of work by the employer.	Assaf and Al-Hejji (2006); Barqawi et al. (2021); Lui (2018); Liao et al. (2019).	In Lui's (2018) study, an examination is conducted on the origins and consequences of construction project delays in Hong Kong. The findings reveal that the cessation of work by the employer emerges as a prominent factor contributing to delays, alongside subpar site management, insufficient contractor expertise, and a lack of labour resources. Liao et al. (2019) examine the correlation between project governance and project performance within the context of China. The authors posit that when employers suspend work, it can have detrimental effects on project governance, subsequently leading to diminished project quality, increased project costs, and prolonged project duration. The articles mentioned above posit that the act of suspending work by the employer in construction projects can give rise to a range of issues, including escalated costs, diminished efficiency, and the emergence of disputes. Hence, it is imperative to mitigate or reduce work suspension initiated by the employer proactively or to handle such instances if they do arise proficiently. Several strategies can be employed to achieve this objective, including effective and prompt communication, contractual clauses, and the utilisation of cutting-edge technologies.
	DMA6	Unreasonable constraints by the employer.	Motaleb and Kishk (2010); Motaleb and	A study conducted in China by Wang et al. (2018) discovered two distinct factors contributing to delays within the

			Kisk (2013); Barqawi et al. (2021); Wang et al. (2018).	construction business. These factors include challenges associated with claiming indemnity and the client's desire for excessive upfront capital. Various elements have the potential to impede and prolong the advancement of a project. Furthermore, the study elucidated many factors contributing to delays, thereby offering a full comprehension of the obstacles encountered within the Chinese construction sector. The study has classified this factor as a managerial factor of delay.
	DMA7	The poor organisational structure of the employer's organisation.	Assaf et al. (1995); Satyanarayana and Iyer (1996); Iyer and Jha (2005); Barqawi et al. (2021); Shirazi et al. (1996).	Shirazi et al. (1996) explained that the organisational framework inside the employer's organisation could lead to project delays in building endeavours due to its impact on communication, coordination, and decision-making mechanisms among the involved stakeholders. Several elements have a significant role in shaping the organisational structure. These factors include the complexity, dynamism, and hostility of the project environment, as well as the certainty, complexity, and dependency of the project technology. Also, the study clarified that such a factor is a managerial factor.
	DMA8	Delay to furnish and deliver the site to the contractor by the employer.	Doloi et al. (2012); Al Hadithi (2018); Barqawi et al. (2021).	The factor is a managerial factor by its definition.
	DMA9	Lack of capabilities to early plan for the project.	Al-Emad and Nagapan (2015); Barqawi et al. (2021).	The factor is a managerial factor by its definition.
	DMA10	Delay in material supplied by the employer.	Muhwezi and Otim (2014); Bekr (2015); Barqawi et al. (2021).	The factor is a managerial factor by its definition.
	DMA11	An improper tendering system, such as	Assaf and Al-Hejji (2006); Altarawneh et al. (2018);	The factor is a managerial factor by its definition.

		selecting the lowest bidder.	Barqawi et al. (2021).	
Social	DSA1	Delays in acquiring land from citizens.	Kamanga and Steyn (2013); Barqawi et al. (2021).	According to a study by Hussein et al. (2018), land acquisition is a complex and lengthy process that involves legal, social, and environmental issues. The study found that rural residents in Pakistan perceived land acquisition as a major cause of delay in construction projects, affecting their socio-economic conditions and quality of life. The study also suggested some strategies to improve the land acquisition process, such as involving the local community, providing fair compensation, and ensuring transparency and accountability.
	DSA2	Bureaucracy in employer's organisations.	Kamanga and Steyn (2013); Barqawi et al. (2021).	Within the Indian context, the presence of bureaucracy has been recognised as a prevalent factor contributing to delays in construction projects, particularly within the urban sector. This is primarily attributed to the involvement of numerous regulatory, social and administrative entities in the approval process (Manivannan et al., 2022). The presence of bureaucratic obstacles has a substantial effect on the schedules of projects and the overall effectiveness of operations (Manivannan et al., 2022). To effectively tackle bureaucratic difficulties, it is imperative to enhance transparency and efficiency and streamline approval processes in order to facilitate the timely execution of projects.
Technical	DTA1	Application of quality control based on foreign specifications.	El-Razek et al. (2008); Barqawi et al. (2021).	The factor is a technical factor by its definition.
	DTA2	Lack of experience of the employer and the employer's representative in construction projects.	Mezher and Tawil (1998); Samarah and Bekr (2016); Barqawi et al. (2021).	The factor is technical by its definition.
	DTA3	Irregular attendance of the weekly meeting.	Barqawi et al. (2021); Zidane and Andersen, 2018); (Sepasgozar et al., 2019);	The delay factor "Irregular attendance of the weekly meeting" has been classified under the technical aspect group. The irregular weekly meeting attendance is regarded as a technical factor within the framework of construction delay (Zidane and Andersen, 2018). The basis for this

			Alaghbar et al., 2007).	classification is that the weekly meeting plays a crucial role in providing a foundational platform for discussing technical matters, overcoming obstacles, and monitoring the progress of project milestones (Sepasgozar et al., 2019). Irregular attendance can have several adverse consequences for the project's technical components. These implications may include a range of potential consequences or effects. Communication breakdown can result in several negative consequences, such as a lack of clarity about technical requirements (Alaghbar et al., 2007).
	DTA4	The employer's improper site location selection, such as non-availability of infrastructure, location or requirements for soil works.	Barqawi et al. (2021).	Site location selection is a technical factor because it involves the analysis and evaluation of the physical characteristics and suitability of the site for the project. Site location selection can affect the design, engineering, and construction aspects of the project in various ways. For example, if the site lacks adequate infrastructure, the contractor may have to modify the design or engineering solutions to accommodate them. This can result in additional work, rework, or changes in scope. Similarly, if the site requires soil works, the contractor may have to perform additional tests, treatments, or reinforcements to ensure the stability and safety of the structure. This can also result in additional work, rework, or changes in scope. Barqawi et al. (2021) have categorised this factor under the technical aspect based on this understanding.
	DTA5	Difficulties in defining project requirements.	Al-Tabtabai (2002); Barqawi et al. (2021).	The factor is technical by its definition.
Financial	DFA1	Delay in interim progress payments by the employer.	Koc and Skaik (2014); Charehzehi et al. (2017); Marzouk et al. (2018); Barqawi et al. (2021).	The factor is financial by its definition.

	DFA2	Underestimation of the cost of projects.	Frimpong et al. (2003).	The factor is financial by its definition.
	DFA3	Difficulty in budget availability from the side of the employer.	Koushki et al. (2005); Barqawi et al. (2021).	The factor is financial by its definition.
	DFA4	Improper investment criteria and improper feasibility study by the employer.	Barqawi et al. (2021).	The factor is financial by its definition.
proloContractual	DCA1	Contract modifications; change in specifications. Change in material; general site changes by the employer.	Faridi and El-Sayegh (2006); Alaghbari et al. (2007); Barqawi et al. (2021).	The factor is contractual by its definition.
	DCA2	Improper type of project bidding and awarding.	Luu et al. (2009); Aziz et al. (2016); Barqawi et al. (2021); Shahsavand et al. (2018).	Improper type of project bidding and awarding can be a delay contractual factor that affects the construction process and causes disputes between the parties. Project bidding and awarding is the process of selecting a contractor to execute the project based on certain criteria and conditions. For example, Shahsavand et al. (2018) stated that such a factor can cause contractual problems if it is not suitable for the project characteristics, complexity, or risks and does not provide adequate incentives or safeguards for the contractor's performance.
	DCA3	Unavailability of incentives for the contractor to finish ahead of schedule.	Assaf and Al-Hejji (2006); Kamanga and Steyn (2013); Barqawi et al. (2021).	The unavailability of incentives for the contractor to finish ahead of schedule can be a contractual delay factor that affects the construction process and causes disputes between the parties. Contract incentives are clauses that reward or penalize the contractor for meeting or failing to meet certain performance criteria, such as time, cost, quality, or safety. Contract incentives can motivate the contractor to improve their efficiency,

				productivity, and quality of work and reduce the risks of delays and claims. Barqawi et al. (2021) considered his item to be a contractual item as it is always part of the contract conditions and agreements.
	DCA4	Ineffective delay penalties.	Gidado and Niazai (2012); Megha and Rajiv (2013); Pai and Bharath (2013); Muhwezi and Otim (2014); Santoso and Soeng (2016); Barqawi et al. (2021).	The factor is contractual by its definition.
	DCA5	Imposing unreasonable penalties or liquidated damages on the Contractor.	Tyler (1994); Assaad and Abdul-Malak (2020); Barqawi et al. (2021).	The factor is contractual by its definition.
	DCA6	Late contract award.	Akogbe et al. (2013); Barqawi et al. (2021).	The factor is contractual by its definition.
	DCA7	Claims and disputes resulting from changes by the employer.	Gidodo and Niazai (2012); Megha and Rajiv (2013); Pai and Bharath (2013); Cakmak and Cakmak (2014); Muhwezi and Otim (2014); Barqawi et al. (2021).	The factor is contractual by its definition.
	DCA8	Delay in approval of completed work by the employer (i.e., stage passing or milestone).	Barqawi et al. (2021).	The employer's delay in approving finished work, such as the stage passing or milestone, can be considered a contractual delay factor that has an impact on the construction process and may lead to disagreements between the involved parties. A contractual delay factor pertains to the contractual obligations, rights, and responsibilities of the parties engaged in

				the project. Various reasons related to contractual delays might have an impact on the project's cost, schedule, and overall quality. Several instances of contractual impacts due to this factor, such as prolongation cost to be paid by the employer. Barqawi et al. (2021) have based its categorisation of this factor based on this description.
	DCA9	Claim due to late compensation of land acquisition.	Barqawi et al. (2021).	The factor is contractual by its definition.
	DCA10	The original contract duration is short.	Megha and Rajiv (2013); Santoso and Soeng (2016); Adam et al. (2017); Barqawi et al. (2021).	The factor is contractual by its definition.

Critical success factors are the elements that contribute to attaining project objectives. The significance of project success elements becomes apparent in situations characterised by heightened complexity. Han et al. (2012) underscored the view that while the success elements of a project are generally seen as stable, they are subject to variation over time due to contextual factors and surrounding variables. According to the study conducted by Silva et al. (2016), critical success factors (CSFs) for a project were identified as inclusion, efficiency, commitment, and communication. According to Doloi et al. (2012), project success variables can be categorised into three distinct groups: factors related to the project itself, factors related to the project staff, and external factors.

The study conducted by Toor and Ogunlana (2009) examined the comprehension of construction experts concerning critical factors for success in large-scale projects in Thailand. The researchers discovered that important success elements at a high level were mostly associated with project preparation, personnel factors, and employer involvement. In their recent study, Barqawi et al. (2021) conducted a comprehensive evaluation of the elements contributing to the success of employer-initiated delays. Consequently, all critical success factors, including indirect ones such as SM09, SM10, SM11, and ST03, were presumed to be active in assisting the employer in resolving their issues, including delays. Appelbaum and

Steed (2005) comprehensively analysed critical success factors (CSFs) within employer-consultant partnerships. Specifically, they focused on cases where the consultant assumed the role of a doctor-patient model, employing a diagnostic method to assess the organisational challenges faced by the employer. This model emphasises the significance of establishing robust connections and fostering trust between clients and consultants. Furthermore, it acknowledges that both the employer and the consultant can exert influence and contribute towards achieving project objectives. Appelbaum and Steed (2005) outlined the critical success factors of optimal employer-consultant engagement. These factors include visible executive support, establishing a genuine partnership with consultants, and ensuring clear and effective communication expectations and outcomes. These elements are crucial in fostering strong relationships between employers and consultants. This study focused on examining the influence of indirect critical success factors on employer-initiated delays and assessing the delays themselves and their associated critical success factors.

However, Table 4.2 provides a complete and thorough overview of the success criteria multiple researchers have established concerning improving or mitigating delays generated by employers in building projects. The classification and arrangement of these variables into the designated categories in the table are based on an extensive examination of relevant scholarly sources. The assignment of each success criterion to its corresponding group systematically, taking into account the insights and trends identified in previous study findings.

This methodology guarantees that the classification of success criteria is based on comprehensive information and is consistent with the established body of knowledge in the respective subject. Using a planned and organised approach enables a coherent and systematic demonstration of these criteria, enhancing comprehension of their role in mitigating and handling delays initiated by employers.

Table 4.2. Employer-Initiated Critical Success Factors and their Codes

Group	Item Code	Item Description	Previous Literature Review	Evidence for Critical Success Factors Categorisation of Their Groups
Management, Organisation, and Financial Planning	SM01	Before construction, approval and confirmation of the design concept, construction drawings, material selection, logistics planning, etc.	Jefferies and Gameson (2002); Mydin et al. (2014)	The factor is management by its definition.
	SM02	Regular and fruitful meetings and site visits with the relevant parties to solve problems in time.	Mydin et al. (2014)	The factor is management by its definition.
	SM03	New rules and regulations should be relayed to the developers / Contractors as soon as possible so that the developers/contractors know the changes to the rules and regulations.	Mydin et al. (2014)	The factor is management by its definition.
	SM04	Employer to stick to the original plan and allocate an adequate budget for contract modifications.	Mydin et al. (2014)	The factor is management by its definition.
	SM05	Close monitoring of the progress of work.	Nassar and AbouRizk (2014); Kavishe et al. (2019)	The factor is management by its definition.
	SM06	Countercheck the data accuracy on the work-in-progress with the actual physical completion versus the cost expended.	Mydin et al. (2014)	The factor is management by its definition.
	SM07	Propose a ‘Bonus’ scheme for early completion.	Bower (2000); Mydin et al. (2014)	The factor is financial planning by its definition.
	SM08	Employer to speed up the slow decision-making process.	Seboru (2015)	The factor is management by its definition.
	SM09	The employer must plan the project wisely and consider	Kometa et al. (1995)	The factor is management by its definition.

		unexpected construction events.		
	SM10	The investigation of site conditions, groundworks and foundations should be	Chan and Kumaraswamy (1997)	
	SM11	Proper value management techniques are to be deployed by the employer.	Shen and Liu (2003)	The factor is management by its definition.
	SM12	Employers should give special attention to paying the contractors on time.	Ansah (2011)	The factor is financial planning by its definition.
Team	ST01	Employers should recruit competent consultants	Le-Hoai et al. (2008); Ibironke et al. (2013); Alaghbari et al. (2007); and Odeh and Battaineh (2002).	Alaghbari et al. (2007) stated that one of the critical success factors for construction projects is the selection of a competent project team, which includes consultants, contractors, and suppliers. The study states that "the competence of consultants can be judged based on their experience, reputation, past performance, and technical and managerial. According to Odeh and Battaineh (2002), teamwork is another key factor for successful construction projects, especially in complex and uncertain environments. The paper defines teamwork as "the process of working collaboratively with a group of people in order to achieve a goal. Thus, it can be seen that this factor is to be satisfactorily categorised under the team group.
	ST02	Coordination is to be led by the employer or employer's representative between the parties involved in the project.	---	The factor is teamwork by its definition.
	ST03	The roles and responsibilities of those involved in the project team should be clearly defined.	Lo et al. (2012); Dang and Le-Hoai (2016); Olatunde et al.	Dang and Le-Hoai (2016) emphasise the significant impact that the project team has on the overall quality of project deliverables. It is suggested that the presence of a proficient and diverse

				project team, characterised by strong team cohesion, is crucial in attaining optimal system quality within design-build projects. The study highlights the need for the project team's active involvement in project management rather than depending simply on contractors. This suggests that it is essential for the project team to possess well-defined roles and actively participate in order to achieve the project's objectives. It can be concluded that such a factor is a team success factor more than a management factor. Similarly, according to Olatunde et al. (2017), within the framework of construction projects in higher institutions in Nigeria, the authors contend that the significance of team roles surpasses the importance of individual competency levels of team members in achieving project success. The selection of project teams is influenced by factors such as experience and competence. However, it is crucial to acknowledge that the absence of mutual accountability and conflicting objectives might result in departures from the desired team composition. This implies that the establishment of well-defined roles and tasks is necessary in order to guarantee the harmonisation and collaboration among individuals within a team.

The study conducted by Barqawi et al. (2021) involved a comprehensive examination of the existing literature, specifically concentrating on strategies for implementing Building Information Modelling (BIM). The researchers operated under the premise that these strategies significantly impact the correlation between project success and the occurrence of delays initiated by employers in projects that utilise BIM technology. Furthermore, the authors assessed BIM barrier elements to evaluate their negative impacts on the linkages above and identify these solutions. The compilation was derived from a comprehensive examination of over 130 papers that pertained to projects involving Building Information Modelling (BIM). In a study conducted by Alenazi and Adamu (2017), the researchers examined the effects of Building Information Modelling (BIM) on delays in project management, specifically focusing on its ability to address design clash problems. The significance of this component has been confirmed as crucial in mitigating delays introduced by employers within the framework of projects utilising Building Information Modelling (BIM). The cumulative results of this research enhance our comprehension of how Building Information Modelling (BIM) can be utilised to enhance project outcomes and mitigate delays caused by employers. Table 4.3 presents a concise overview of the BIM implementation strategies identified in prior research. In addition to the findings by Barqawi et al. (2021), Akponeware and Adamu (2017) have shown that clashes in mechanical, electrical, and plumbing (MEP) systems in 3D BIM can be attributed to isolated working. Also, Hasannejad et al. (2022) emphasised the significance of development collaboration and coordination within design teams to mitigate conflicts from the outset at the construction site proactively. This reveals the employer's importance in adopting necessary procedures to avoid design clashes during the design and construction period.

Furthermore, a crucial element within building project management is an early warning for employer delays by utilising 4D Building Information Modelling (BIM). 4D BIM, also known as 4-dimensional Building Information Modelling, integrates the conventional 3D BIM model with the temporal dimension, enabling the representation and analysis of construction activities throughout their duration (Gledson and Greenwood, 2017). The incorporation of time inside the Building Information Modelling (BIM) model allows for the monitoring of real-time construction progress and facilitates the identification of any delays (Vilventhan et al., 2020). Using BIM implementation as a moderator to understand the effect of the project's success was explained by Papadonikolaki (2018). Inter-organizational alignment in implementing Building Information Modelling (BIM) emerges as a crucial factor when considering BIM as a moderator, as highlighted by Papadonikolaki (2018). The successful implementation of

Building Information Modelling (BIM) necessitates the teamwork and coordination of diverse stakeholders from multiple disciplines (Papadonikolaki, 2018).

Table 4.3. BIM Implementation Strategies for Employer-Initiated Delays.

Item	Item Description
BIMS01	Implementing BIM by the employer to avoid design clashes using 3D BIM.
BIMS02	Implementing BIM by the employer for early warning for the employer delays using 4D BIM (i.e., 4D BIM) can monitor the project's critical path and thus enable the employer to understand delay risk better and how to resolve the constraints early.
BIMS03	Implementing BIM by the employer to reduce disputes using 4D BIM.
BIMS04	Implementing BIM by the employer for construction planning and project management using 4D BIM. Time constraints can be viewed and resolved.
BIMS05	Implementing BIM by the employer to reduce claims by utilising a combination of claims' causes responsibility matrix and a 5D BIM model for visualising and foreseeing projects' areas of claims or even a potential of claims.
BIMS06	Implementing BIM by the employer for schedule visualisation using 3D and 4D BIM.
BIMS07	Implementing BIM to support proper decision-making for any anticipated changes using 4D BIM.
BIMS08	Implementing BIM by the employer to reduce the project duration.
BIMS09	Implementing BIM by the Employer uses algorithmic procedures to learn from previous issues and proactively identify identical/similar issues later in the project.
BIMS10	Implementing BIM 4D to analyse employer delay events using a 4D visual interface.
BIMS11	BIM 4D can create a (what-if) scenario to monitor/control employer delays.
BIMS12	Using BIM-Last planner system (LPS) to monitor/control employer delays.

On the other hand, Table 4.4 provides a comprehensive summary of the obstacles related to Building Information Modelling (BIM) that have the potential to hinder the successful adoption and utilisation of BIM in construction endeavours. According to Gamil and Rahman (2019), the adoption of Building Information Modelling (BIM) is hindered by financial constraints, recognised as a significant barrier. The financial burden of adopting Building Information Modelling (BIM) is a considerable obstacle for construction firms, particularly small and medium-sized organisations with restricted financial means. This burden includes expenses related to software acquisition, hardware procurement, and training initiatives. Insufficient financial backing and the absence of incentives from governmental bodies or other relevant players might intensify this predicament. One further notable obstacle is the insufficient understanding and recognition of Building Information Modelling (BIM) among professionals in the building industry (Gamil & Rahman, 2019). Many individuals in the construction sector may possess limited knowledge of Building Information Modelling (BIM) principles, methodologies, and technological advancements. Insufficient understanding of the subject matter can impede the effective integration and application of Building Information Modelling (BIM) within construction endeavours. Implementing effective training and education programmes is crucial in overcoming this obstacle and improving the Building Information Modelling (BIM) proficiency of those working in the construction industry.

Table 4.4. BIM Barrier Factors for Employer-Initiated Delay Factors.

Item Code	Item Description
BIMB01	Legal and contractual challenges (ownership of data).
BIMB02	Cost implications of BIM implementation strategies about the purchase of software license, hardware upgrade, and training cost and time.
BIMB03	Uncertainty regarding benefit and return on investment.
BIMB04	Lack of contractual arrangements.
BIMB05	Lack of BIM specialists.
BIMB06	Difficulties in managing changes in BIM.
BIMB07	Drastic changes in an organisational chart and workflow because of BIM implementation strategies

4.3 Methodology and Hypothesis Development

There are three fundamental incentives for investigating and evaluating the influence of critical success variables on employer-initiated delays in projects enabled by Building Information Modelling (BIM) with BIM moderators:

(a) Addressing Global Perspectives: The existing scholarly literature has exhibited a deficiency in providing a complete examination of delays within the framework of employer-initiated measures, particularly concerning specific continents and countries. This study aims to address this lack by adopting a global perspective.

(b) Development of a Framework: A lack of comprehensive frameworks specifically tailored to address employer-initiated delays on a global level exists. The present study aims to solve this gap in the literature by constructing a complete framework capable of effectively mitigating delays in various scenarios.

(c) Investigating the Impact of BIM: Previous studies have failed to consider the impact of strategies for implementing Building Information Modelling (BIM) and impediments connected to BIM on the connections between delays initiated by employers and elements contributing to overall critical success, as well as the specific relationship between success and employers. The present study aims to investigate the consequences mentioned above.

A research methodology incorporating both quantitative and qualitative approaches was employed to carry out this study. The qualitative part of the study consisted of conducting direct interviews and a pilot review. On the other hand, the quantitative phase entailed using an online structured questionnaire survey to gather data. A total of 29 people were initially chosen for the pilot review. This decision is under the guidelines proposed by Connelly (2008), which prescribe that the sample size for a pilot study should be around 10% of the total sample size of the main study.

The primary objective of the pilot review was to evaluate the suitability of the questions incorporated in the questionnaire. Furthermore, the study included an analysis of the association among participants, as assessed by Cronbach's Alpha coefficient (0.94). The terminology utilised in the questionnaire was enhanced by incorporating feedback and insights acquired during the pilot review phase.

The determination of sample size is a fundamental component of research methodology. In the research, it is customary for scholars to derive information about a population by examining a select group of individuals, creating a sample that is anticipated to provide a faithful representation of the entire population. To determine the appropriate sample size for this investigation, the researchers utilised the equation provided by Hogg and Tanis (2015). The equation mentioned above was employed to ascertain that the sample size would be enough to attain statistically significant outcomes within the broader framework of the research.

$$(n) = m/(1 + ((m - 1)/N)) \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$m = (Z^2 \times P \times (1 - P))/e^2 \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where n, m, and N represent limited, unlimited, and available population samples, respectively. Here, Z is the statistical value of the confidence level used, P is the estimated population proportion, and e is the sampling error of the point estimate. To calculate the sample size as described above, the following values were used for estimation: N = total value of the population size (assumed as unlimited), Z = linked to 90% confidence interval (1.64 was used), P = 0.5 as a conservative value, and e = 0.06 (significance level or sample error). These values reflect the accuracy of the sampling and result generalisation. Based on the statistical analysis conducted, it has been concluded that an acceptable minimum sample size should be 190 and above, considering that the population size is unlimited. However, in the methodology chapter, another method is also used to estimate the proper sample size for SEM analysis, specifically based on the previous empirical studies. As a result, the sample size selected for this study exceeds the established threshold, guaranteeing that it is both convenient and adequate for accurately representing the entire population being investigated. A complex analytical technique called Structural Equation Modelling (SEM) was utilised to examine the data obtained from the survey questionnaires. The review of information and data was conducted using a two-step approach. The project's initial phase was the establishment of measurement models for the latent constructs. This step was undertaken after verifying these constructs' dependability, reliability, and validity in the second phase. In the subsequent stage, the research hypotheses were subjected to hypothesis testing using Structural Equation Modelling (SEM). It is important to highlight that the Shapiro-Wilk test revealed the possibility of deviations from normality in the indicators. It is a frequent observation when using the Likert scale for data gathering (Hair et al., 2014). Therefore, the researchers chose Partial Least Squares Structural Equation Modelling (PLS-SEM) as the analytical approach, as it is well-suited for handling limited sample sizes (Hair et al., 2013). Figure 4.1 presents a comprehensive representation of the study framework with the following main components:

(a) Factor Identification: The preliminary phase involves identifying delay factors launched by employers, variables contributing to success, and moderators related to Building Information Modelling (BIM); (b) The formulation of hypotheses follows the identification of these components; (c) Development of Questionnaires: The process of developing a questionnaire involves designing and refining the instrument through qualitative assessments; (d) Model Construction: The process of constructing a Structural Equation Model (SEM) involves the creation and evaluation of many components, including assessments of convergent validity, discriminant validity, and a review of the structural model (SM); and (e) Model Testing: The present study aims to establish and assess the relationships within the primary employer-initiated delay and critical success factors model. A total of 400 survey questionnaires were sent to participants through several routes, including popular social media platforms like LinkedIn and direct interviews. The survey was designed to focus on gathering data from professionals involved in BIM-enabled projects in regions or countries with limited study on construction delays, such as the United States, the United Kingdom, and Australia. The poll was designed to include people with a wide range of experience, from less than five years to over 20 years. Additionally, the survey sought to include persons with varied educational backgrounds and work titles. The survey was distributed to persons whose expertise and job profiles were linked with the study's aims, with careful consideration taken to assure data accuracy. To ensure the preservation of data integrity, a thorough examination was conducted on all replies, and any occurrences of duplicated Likert ratings were omitted from the analysis.

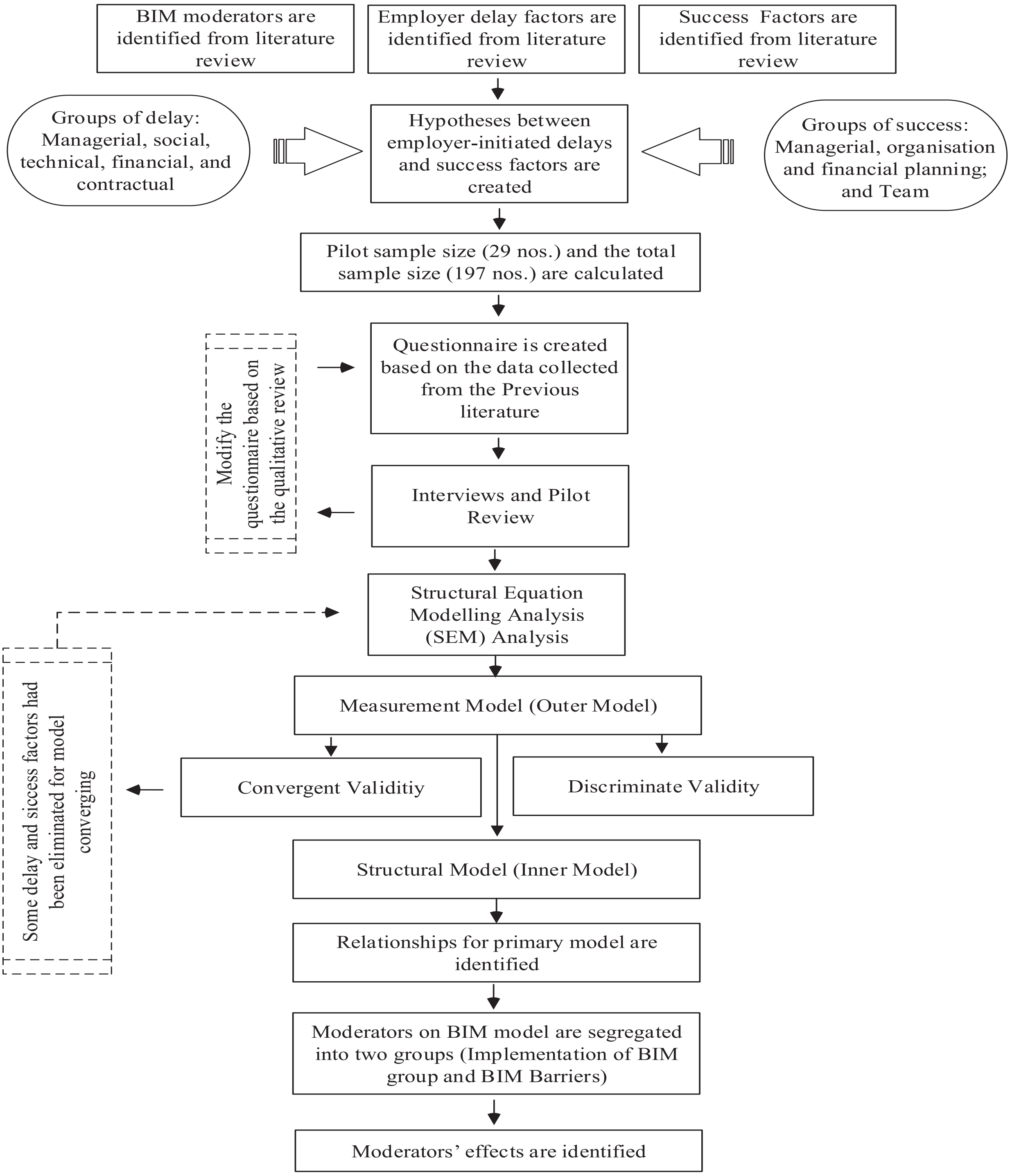

Figure 4.1. Research Map

As a result, 197 completed survey questionnaires were returned by the field research participants in their entirety and were deemed satisfactory. The survey questionnaire consisted of closed-ended questions and was created using Likert scales rated from 1 to 5. The Likert scale helps gather the attitudes and opinions of respondents. Based on the study's goals and previous literature, the survey questionnaire instrument consisted of seven main parts: demographic area, respondent background information, employer-initiated delay factors, critical success factors, project moderators for BIM-enabled projects, success implementation tools, and success review tools.

The focus of this study was on employer-initiated delays. Thus, in this study, a questionnaire was designed and arranged to implement this critical feature. For instance, to avoid misunderstandings regarding this study and because the BIM implementation strategies were studied only for employer-initiated factors, one question in the questionnaire was, 'From your experience, how much do you agree that the following BIM implementation factors can influence the critical success factors positively to address the employer delays in BIM-enabled projects?' Similarly, to draw the attention of the target respondents to the fact that BIM barriers influence the effect of the critical success factors only on employer-initiated delays, the question had to be precise to reflect this critical feature in this study. Thus, the question context was, 'From your experience, how much do you agree that the following BIM barriers can influence the critical success factors negatively to address the employer delays in BIM-enabled projects?'

Table 4.5 presents the characteristics of respondents based on their demographic information. The data size collected from each country was also identified. The data were collected mainly from continents and countries where fewer studies on construction have been conducted.

Table 4.5. Demographic Information of Respondents

Years of Experience	**Frequency**	**Percentage (%)**
Less than 5	37	18.78%
05–09	43	21.83%
10–19	82	41.62%
20 or above	35	17.77%
Level of Education		
B.Sc.	98	49.75%
M.Sc.	65	32.99%
PhD or higher	6	3.05%
Others	28	14.21%
Country		

Australia	59	21.61%
Egypt	19	6.96%
China	8	2.93%
United Arab Emirates	90	32.97%
United Kingdom	49	17.95%
United States of America	22	8.06%
Others	26	9.52%
Job Title		
Employer	20	10.15%
Consultant	70	35.53%
Contractor	75	38.07%
Others	32	16.24%

Qualtrics is a web-based survey and data collection platform to create and conduct online surveys and was used in this study. Figure 4.2 demonstrates a sample of the questionnaire used, which shows how the questionnaire is oriented toward professionals with BIM experience.

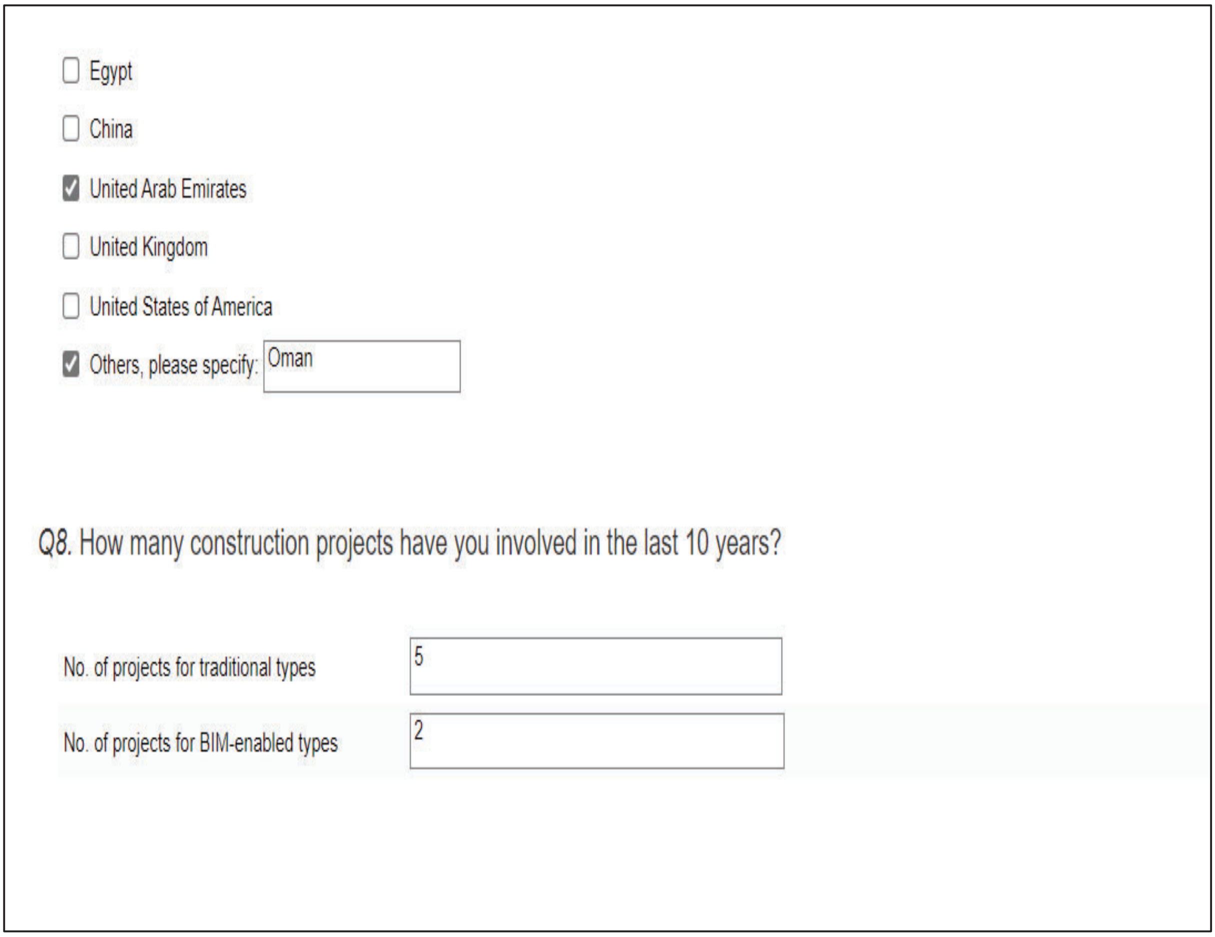

Figure 4.2. Questionnaire Sample Snapshot Shows the Researchers Have Collected Data from Professionals Who Worked on BIM-Enabled Projects

The conceptual model for the proposed framework is depicted in Figure 4.3. This model investigates the complex correlation between employer-initiated delays and the critical success variables in projects utilising Building Information Modelling (BIM). It is important to mention that the model in question was initially formulated by Barqawi et al. (2021). The rationale behind adopting this model is based on the significant lack observed in prior research. Specifically, the limited scope of inquiries into the interrelationships between employer-induced delays and the corresponding factors contributing to project success within the context of Building Information Modelling (BIM)-enabled projects. To elaborate further on the research gaps, it is important to highlight that in a recent scholarly investigation conducted by Alsulamy (2022), an examination was undertaken to identify the key factors contributing to major failures in building projects during the planning phase, specifically within the context of Saudi Arabia. The research revealed that there was involvement from government officials and contractors in causing delays to the projects. This study emphasises the significance of identifying and resolving failure sources to minimise construction project delays. While the primary objective of this study was to examine and get a deeper understanding of the causes of delays in building projects, it is important to recognise that it does not provide specific and actionable remedies. The study predominantly relies on textual suggestions while neglecting the crucial factor of delays induced by employers in the construction industry. Furthermore, Gunduz and Al-Naimi (2021) employed the balanced scorecard and quality function deployment methodologies to devise a framework to address and minimise delays in building projects. The study revealed that elements of customers, contractors, and project management teams were identified as the most influential factors in determining the attainment of financial goals. This implies that considering these aspects can enhance the likelihood of success in a project. Similarly, Gunduz and Al-Naimi's (2021) study did not study the relationships between the employer-initiated delay factors and their corresponding critical success factors. Also, Hussain et al. (2019) proposed an intelligent method to analyze causal relationships between delay factors in construction projects. They validated their approach through a real case study. They found that accurate estimation of workload, weakness of laws and regulations, and lack of foreseen fines and encouragements in contracts were the most significant root factors of delay. Likewise, this study lacked to review the relationship between employer-initiated delays and their corresponding critical success factors.

A total of 12 BIM implementation strategies and 7 BIM barrier factors assumed to be directly related to the employer were collected. These factors directly influence the relationship between employer-initiated delay and their corresponding critical success factors. The relationships between the primary and full model (including the influence of moderators) must be identified.

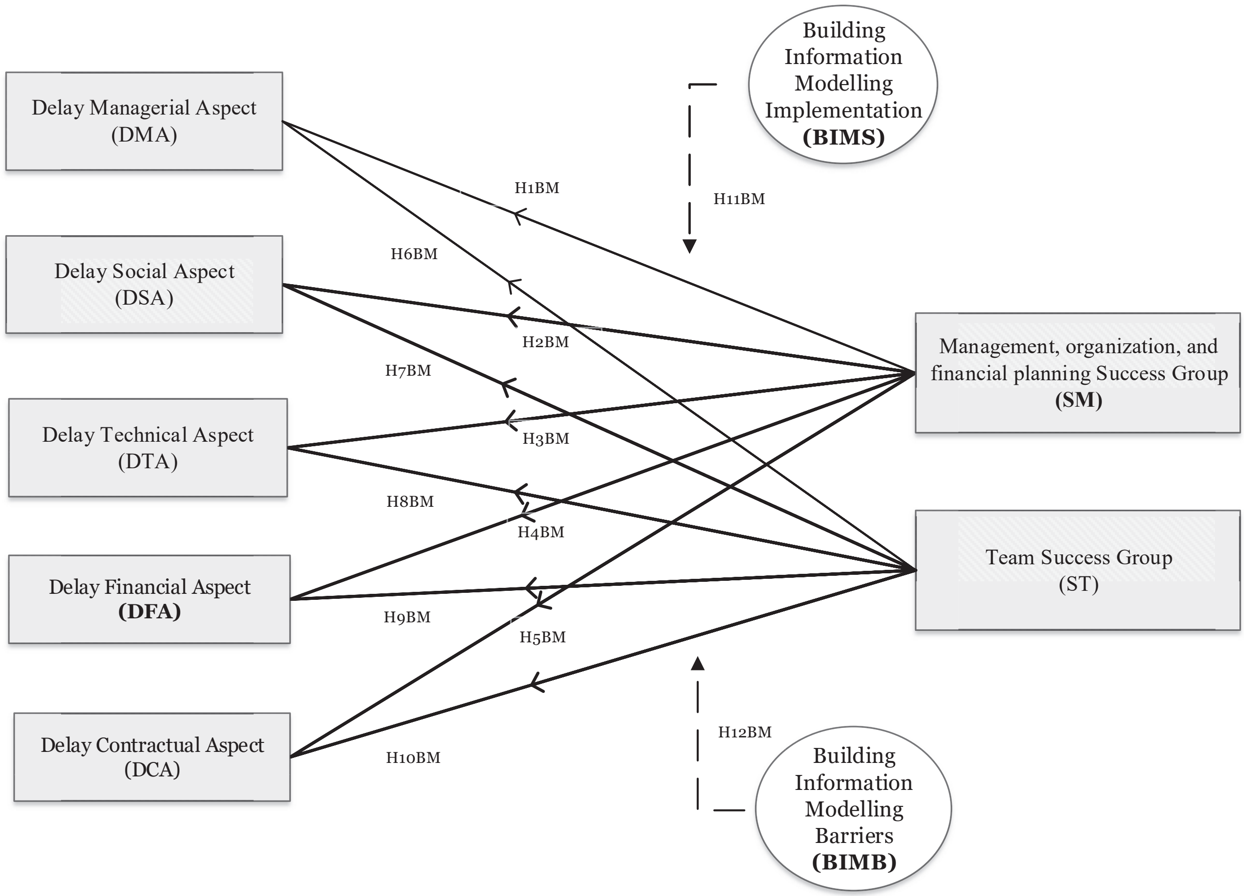

Figure 4.3. A Conceptual Model for Critical Success Factors and Employer-Initiated Delays

In sequence, the measurement model (MM) was generated within the context of the current study and considering the related theory used to examine the direct relationships among the variables. The MM was first created for the primary model without moderators, followed by a model with the effects of moderators. The MM was part of the SEM model that analyses and examines the relationships between latent variables and their measures. The SM cannot be assessed if the MM is not fit; thus, MM fitness is an essential part of the SEM SM analysis.

BIM implementation strategies are considered to benefit and control employer-initiated delays. Barison and Santos (2010) showed that BIM specialists can act in owner organisations, design firms, general construction, and subcontractor firms. Thus, in large projects, the employer should have its own BIM specialist to help implement the target benefits of the employer from

BIM. For instance, the employer can utilise BIM technology and BIM implementation strategies to obtain the necessary early warning of employer delays, reduce disputes with contractors regarding future claims, and reduce expected claims. Thus, in this research, BIM implementation strategies were chosen carefully to be close to benefiting the employer or the employer delays.

Finally, after validity and reliability tests and verifications, the structural models were assessed by bootstrapping and by examining the relationships between the various latent variables. This was conducted by initially evaluating the impact path of the critical success factors on various employer-initiated delays, followed by the impact path of the moderator effects. Bootstrapping involves a nonparametric process that permits testing of the statistical significance of numerous PLS-SEM results, including the p-value and t-statistic of the path coefficients. In this study, bootstrapping ran a minimum sample of 5,000 to assess the path coefficients (Hair et al., 2011).

4.4 Data Analyses and Results

Five aspects of the delays were studied: managerial delays (DMA), social delays (DSA), technical delays (DTA), financial delays (DFA), and contractual delays (DCA). Furthermore, the critical success factors that caused these delays were identified from literature sources and were considered the independent variables for the analysis. Thus, the dependent variables were management, organisation, and financial planning success (SM) and team success (ST). In addition to these factors, other factors were considered in the study to explore their moderating influence on the relationship between the critical success factors indicated and project delays. These factors included project BIM implementation strategies (BIMSs) and BIM barriers (BIMBs). SEM using Smart-PLS v.3.3.3 was adopted to review the structural relationships among the abovementioned variables. The results are presented in two parts: one without the moderator effect and the other with the moderator effect.

In the present study, all latent variables were reflective; hence, a reflective measurement scale was used, and the reliability and validity of the variables were tested. The configured PLS algorithm was executed by defining the outer and inner models. The inner and outer models were specified based on the conceptual framework developed from the literature review.

The models were evaluated by examining the MM in which the interior uniformity between the observed and latent variables was checked. This phase was accomplished in the following steps. The first step consisted of inspecting the model efficiency after each calculation iteration (individual reliabilities and convergent validities), and the second step was the evaluation of the discriminant validities of the model. Figure 4.4 and Figure 4.5 show the results obtained for the CFA and structure for the primary model of employer-initiated delay and critical success factor hypotheses.

The MM must be assessed for convergent validity, and the individual item reliability values are generated concurrently. Three parameters used to determine the convergent validity were the average variance extracted (AVE), convergent validity (CR), and Cronbach's alpha. The results show that the analysed data achieved the required threshold values for the parameters: AVE ≥ 0.5, CR ≥ 0.7, and Cronbach's Alpha ≥ 0.7.

The following action step for the measurement assessment of the PLS-SEM model was to examine the discriminant validity, which shows the degree to which a construct is distinct from other constructs. The results showed that the primary model generated values at which each manifest was higher in their relative independent variables than the other independent variables. Moreover, the diagonal correlations of the independent variables were higher than those of the non-diagonal values, satisfying the discriminant validity of the tested model. Thus, this model achieved discriminant validity.

In sequence, the SM was examined. SEM was mainly used to confirm research design rather than to explore or explain phenomena. In other words, the focus was on the strength of the relationships between variables in a hypothesis. When using SEM, a tidy visual display that is easy to interpret is obtained, even if the statistics behind the data are complex. Table 4.6 summarises the results of the hypothesised direct effect of the constructs between employer-initiated delays and critical success factors without moderator effects.

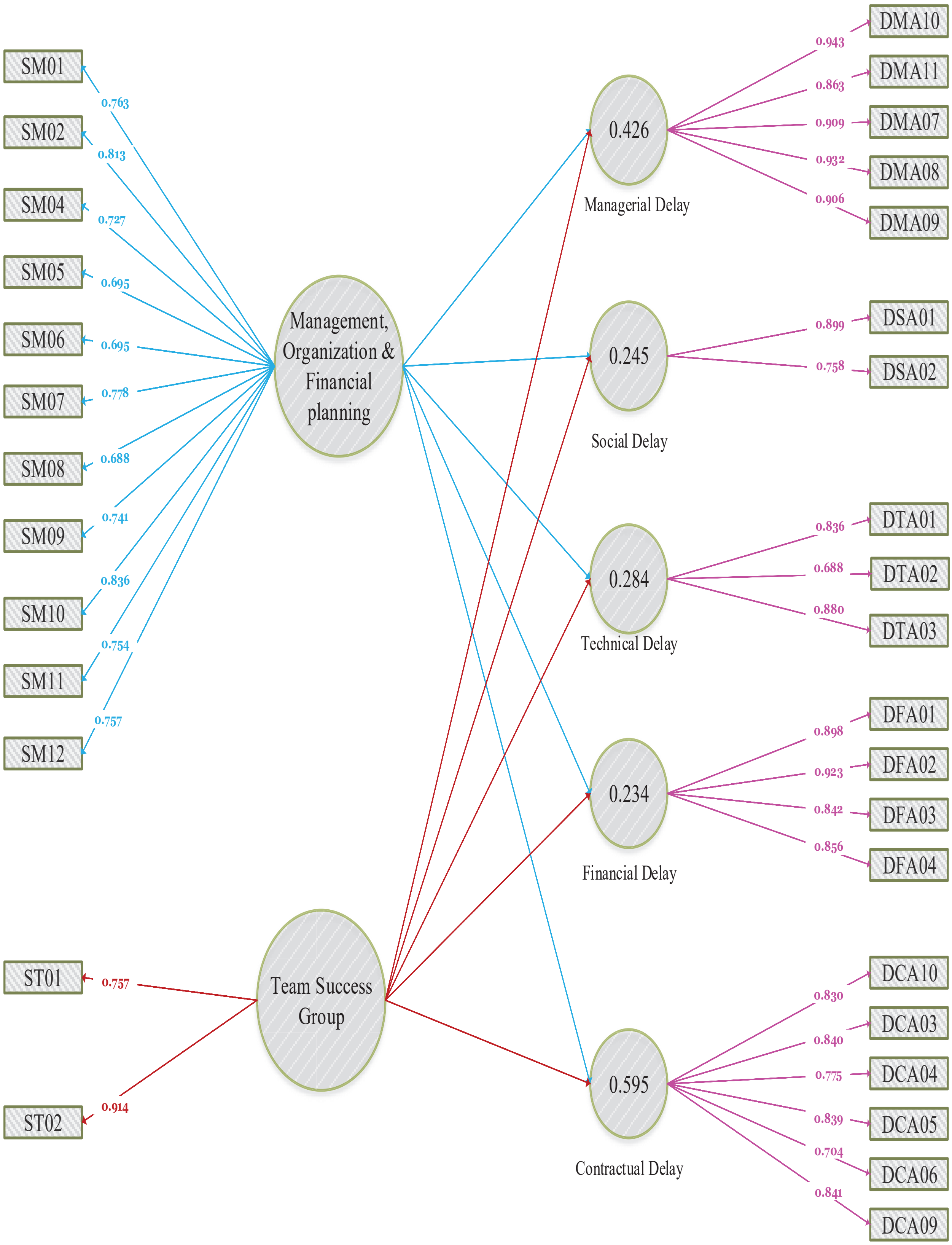

Figure 4.4. CFA Model for the Direct Effects of the Primary Model (without Moderators)

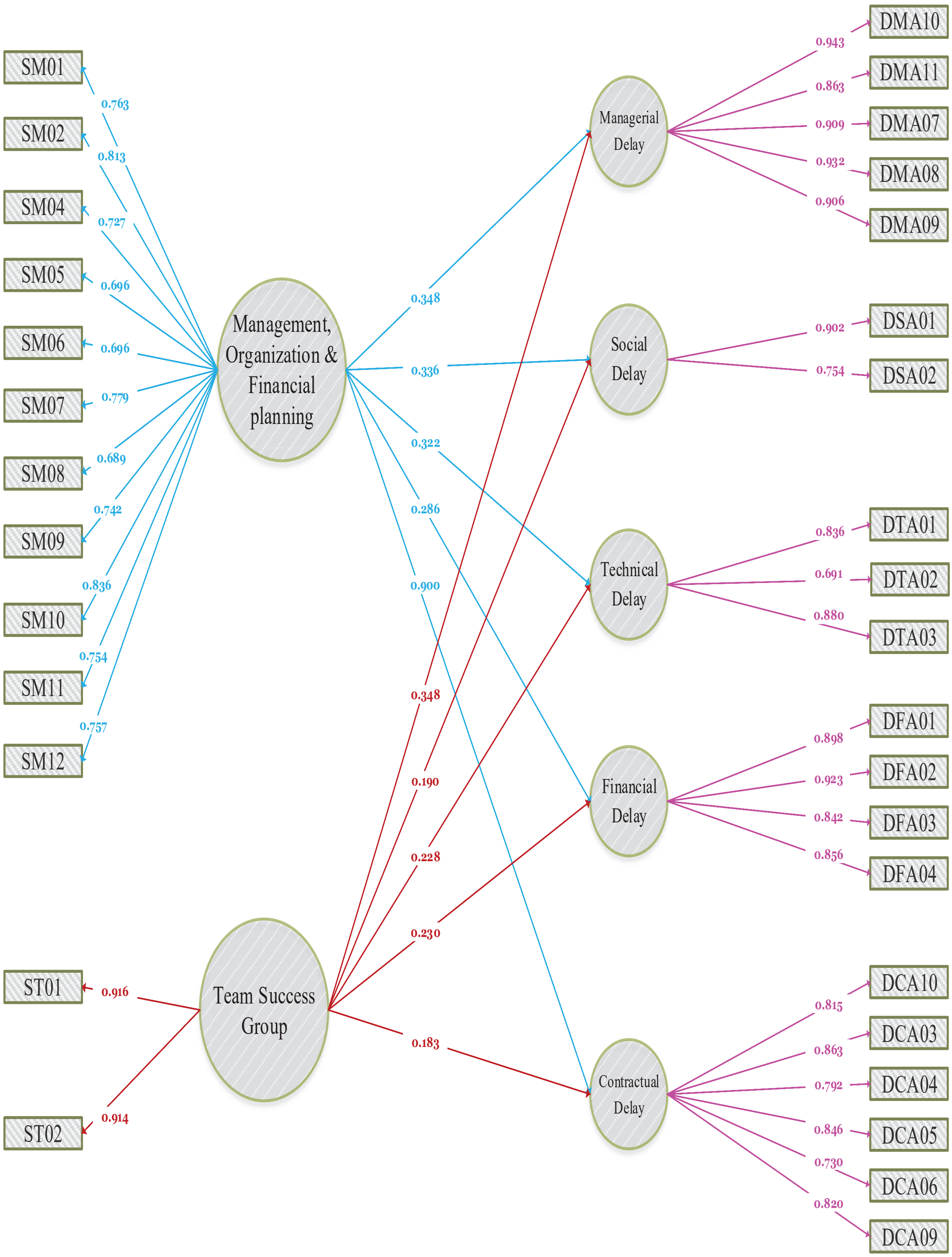

Figure 4.5. Structural Models for the Direct Effects of Primary Model (without Moderators)

Table 4.6. Results of Hypothesised Direct Effects of the Constructs (without Moderators)

Relationship	Hypothesis	β-Value	T-Statistics	T-Critical	P-Value	Hypothesis Result
SM → DCA	H5BM	0.900	14.873	1.96	0	Supported
SM → DFA	H4BM	0.286	2.899	1.96	0.008	Supported
SM → DMA	H1BM	0.348	5.213	1.96	0	Supported
SM → DSA	H2BM	0.336	4.705	1.96	0	Supported
SM → DTA	H3BM	0.322	3.828	1.96	0	Supported
ST → DCA	H10BM	–0.183	2.309	1.96	0.034	Supported
ST → DFA	H9BM	0.230	2.400	1.96	0.032	Supported
ST → DMA	H6BM	0.348	5.493	1.96	0	Supported
ST → DSA	H7BM	0.190	2.166	1.96	0.029	Supported
ST → DTA	H8BM	0.246	2.430	1.96	0.022	Supported

After the hypotheses for the primary model (without moderators) were verified and confirmed, the structural model was checked against the effects of the BIM moderators on the relationships of the employer-initiated delay and critical success factor model. The *t*-statistics and *p*-values are presented, along with the hypothesis status. Table 4.7 and

Table 4.8 present the data obtained after the model was analysed using PLS-SEM to review and understand the moderator effects on the primary model relationships.

Table 4.7. Results of BIM Barrier Moderator Effect on Direct Relationships

Relationship	Hypothesis Code	β-Value	T-Statistics	P-Value
SM*BIMB-DCA	H11BM	0.119	2.559	0.011
SM*BIMB-DFA	H11BM	–0.305	3.540	0.000
SM*BIMB-DMA	H11BM	0.022	0.263	0.792
SM*BIMB-DSA	H11BM	–0.256	3.780	0.000
SM*BIMB-DTA	H11BM	–0.273	3.769	0.000

ST*BIMB-DCA	H11BM	0.099	2.315	0.021
ST*BIMB-DFA	H11BM	0.029	0.453	0.650
ST*BIMB-DMA	H11BM	0.147	2.447	0.014
ST*BIMB-DSA	H11BM	–0.114	1.492	0.136
ST*BIMB-DTA	H11BM	0.021	0.359	0.720

Table 4.8. Results of BIM Success Implementation Moderator Effect on Direct Relationships

Relationship	Hypothesis	β-Value	T-Statistics	P-Value
SM*BIMS-DCA	H12BM	0.170	3.542	0.000
SM*BIMS-DFA	H12BM	–0.079	1.103	0.270
SM*BIMS-DMA	H11BM	–0.110	2.440	0.015
SM*BIMS-DSA	H11BM	–0.278	5.094	0.000
SM*BIMS-DTA	H11BM	–0.184	3.235	0.001
ST*BIMS-DCA	H11BM	0.097	2.324	0.021
ST*BIMS-DFA	H11BM	0.009	0.053	0.958
ST*BIMS-DMA	H11BM	–0.016	0.304	0.761
ST*BIMS-DSA	H11BM	–0.182	2.693	0.007
ST*BIMS-DTA	H11BM	–0.077	1.133	0.258

Table 4.9 shows the coefficient of determination (R^2) measures of the model's predictive accuracy, computed as the squared relationship between the actual and projected values of a precise endogenous construct. This coefficient, by definition, explicitly denotes the collective effects of the 'exogenous latent variables' on the endogenous construct and the amount of variance in the endogenous constructs explained by all the exogenous latent variables connected to it (Hair et al., 2014).

Table 4.9. Explanatory power R^2 value for groups of delays

Group	R-Square	R-Square Adjusted
Contractual Delays	0.595	0.591
Financial Delays	0.234	0.226
Managerial Delays	0.426	0.420
Social Delays	0.245	0.237
Technical Delays	0.284	0.277

Figure 4.6 shows the values of the t-statistics factors and p-values for the proposed hypotheses of employer-initiated delays and the direct critical success model. The *t*-statistics values in all relationships were above the threshold of 1.96, and the *p*-value was less than the maximum threshold for relationship convergence, which was set to 0.05.

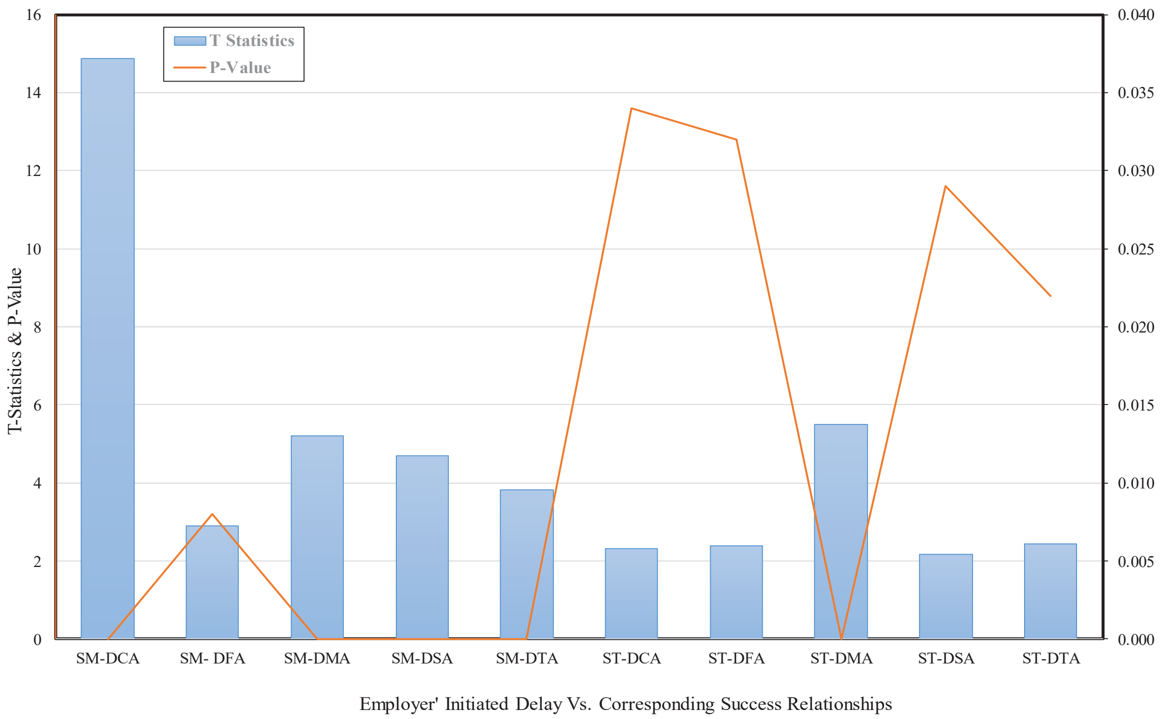

Figure 4.6. T-Values and P-Values for the Original Primary Model

4.5 Discussion

According to the proposed model, the influencing factors were management, organisation and financial planning (SM), and team (ST). The influence of these critical success factors on BIM-enabled project delays in the presence of BIMSs and BIMBs was assessed. The PLS-SEM approach was used to analyse exploratory data because this approach is powerful, with structural models including mediating and moderating effects (Rigdon et al., 2017). Measurement and structural models were assessed, and significant relationships were established. Based on the results shown above, the SM relationships with DCA, DMA, DSA, and DTA were high compared with the other relationships, which also occurred for the ST relationship with DMA. The *t*-statistics and p-values were used to identify the strength of the relationships. The *t*-values for SM-DCA, SM-DMA, SM-DSA, and SM-DTA were 14.873, 5.213, 4.705, and 3.828, respectively, and the corresponding p-values were all 0.000. In addition, the *t*-statistics and *p*-values for ST-DMA were 5.492 and 0, respectively (Table 4.6). These results are only related to the primary model.

The results obtained were compared with those of similar studies. Altarawneh et al. (2018) showed that the critical success group of project organisational planning had a high impact on the delay factors; for instance, they assumed that the 'design and construction control meetings' critical success factor can be considered to improve employer-initiated delay factors, such as 'change scope, design, and specifications'. Likewise, in this study, critical success factors with the same category positively influenced the employer contractual delay factors (i.e., SM factors substantially improved DCA employer delay factors). In addition, team success (ST) had the maximum impact on managerial delays (DMA). These results are consistent with previous findings highlighting the importance of a competent workforce and coordination between project parties to control delays in BIM projects (Btoush and Harun, 2017). In contrast, Alkhathami (2004) reviewed delay–success factors and delay factors in the Saudi construction industry. He suggested that the success factor of a 'superior safety record' was associated with more efficient project owner operation (less bureaucracy). In the present study, the critical success factor of 'superior safety record', classified under team success (ST) solutions, was weakly related to addressing the bureaucracy of the group's employer (DSA).

Table 4.8 presents the results of the t-statistics and p-values for the impact of the BIMS on the primary relationships between critical success factors and employer-initiated delays for the effect of moderators on the relationships of the primary model. The results show that BIMS significantly influenced employer-initiated delay relationships with the critical success factors of SM-DSA, SM-DCA, and SM-DTA, with t-statistic values of 5.904, 3.542, and 3.235 and p-values of 0.000, 0.000, and 0.001, respectively. These values are considered significant for firmly adopting the robust influences of BIMS moderators on assigned relationships. Table 4.7 also shows the t- and p-values for the BIMB effects on the primary employer-initiated delay–success model. BIMB significantly influenced the SM-DSA, SM-DTA, and SM-DFA relationship with t-statistics values of 3.780, 3.769, and 3.540 and *p*-values of 0.000, 0.000, and 0.000, respectively. Thus, management, organisation, and financial planning significantly influence social, technical, and financial delays in the scheduled performance of BIM-enabled projects.

As shown in Figure 4.7, the moderator BIMS strengthened the relationship between DCA and SM. This graph was created by inputting the variables of the path coefficient between the independent variable (IV) and the dependent variable (DV). Furthermore, the path coefficient for the moderator was required. Similarly, a graph was plotted for the moderator models to check the effect of the moderator on the original primary model. A graph was also plotted for the effect of BIMS on the relationship between SM and DTA, in which the path coefficient between IV and DV was 0.157, the path coefficient for the moderator was 0.378, and the path coefficient for the interaction was –0.314, indicating that BIMS dampened the positive relationship between SM and DTA.

Another finding of this study was that barriers to BIMSs, such as cost implications of BIM implementation, lack of awareness regarding BIM implementation, lack of contractual arrangements, and drastic changes in organisational workflow, negatively influenced the critical success factors in controlling employer-initiated delays in BIM-enabled construction projects. However, despite the high impact of BIM awareness on project management, studies have shown a lack of BIM implementation in Jordan's construction projects. Chien et al. (2014) reported cost implications as one of the leading barriers that negatively influenced the impact of critical success factors on delays in construction projects in Taiwan.

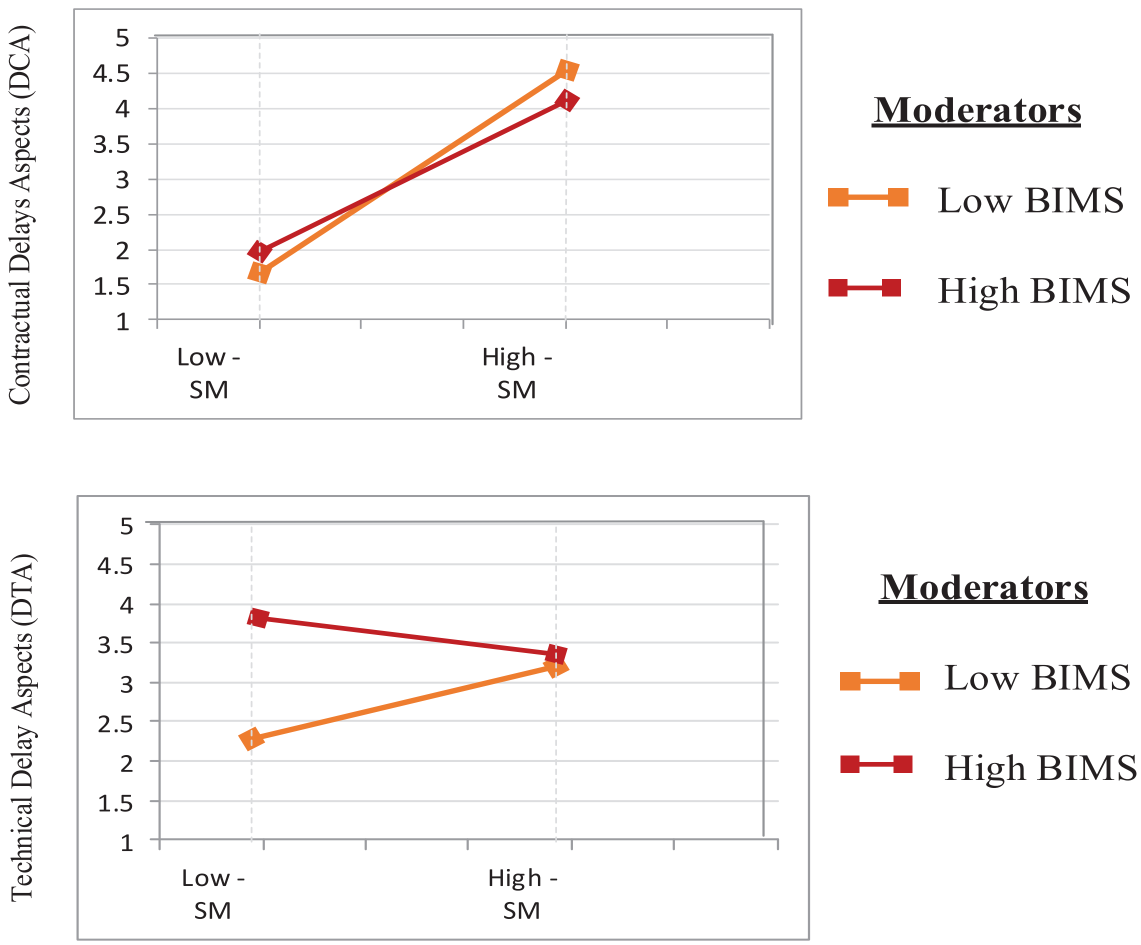

Figure 4.7. Two-Way Interaction Effect for Variables DCA, DTA, SM and BIMS

From the perspective of ranking the factors of the project parties (engineer, contractor, employer, and others) for employer-initiated delays and their relevant critical success factors, the ranking was conducted separately for each party, showing that all parties agreed that ineffective delay penalties were the most likely cause of project lags. Employers and contractors concluded that improper tendering systems were minor influential delay factors. Engineers and other workers attributed the least effect of the completion time delays to incorrect investment criteria and incomplete feasibility criteria. Moreover, employers, contractors, and others attributed project success to regular, successful meetings that included all stakeholders and led to practical problem-solving, whereas engineers maintained that a bonus scheme is more efficient. By contrast, all parties agreed that efficient value management by the employer was a minor influential success component of a BIM-enabled project. Employer-initiated delay factors and critical success factors were ranked for components across various regions for the BIM-enabled projects. Delays in site furnishings and deliveries in Africa were the most significant lag factors. However, short contract durations caused the most lags in China, and ineffective delay penalties contributed significantly to delays in Australia. In China, incorrect investment and incomplete feasibility criteria affected the completion time delays the least. However, in Australia and Africa, improper tendering systems were considered to contribute the least to lags during construction.

Moreover, in China and Australia, project success was primarily attributed to regular, successful meetings that included all stakeholders and led to practical problem-solving. In Africa, three components impacted construction success the most: counterchecking work data accuracy with completion progress, introducing a bonus scheme to encourage early completion, and wise employer planning to integrate unexpected tendencies. In contrast, none of the regions ranked the same element as least significant.

In addition, improper investment strategies and incomplete feasibility studies were ranked in the UK and Asia as the least significant delay causes. However, the USA judged incorrect tendering systems to cause minor construction delays. Furthermore, in the UK, regular, successful meetings to aid problem-solving and a bonus technique to prompt completion were the two most essential elements for success. Asia and the USA also shared similarities with the UK. A bonus scheme and successful stakeholder gatherings were the most impactful factors in Asia and the USA, respectively.

Considering the study results, a conceptual framework model was developed, which is divided into three parts: (a) reviewing, studying, and understanding the relationships between critical success factors and employer-initiated delay factors and understanding the impact and influence of BIMSs and BIMBs on these relationships, (b) reviewing and understanding the best practices for the action plans available and their ranking to implement the critical success factors, and (c) reviewing and understanding the best practices for the assessment plans to evaluate how the critical success factors improve the capabilities of the employer to address delays. Figure 4.8 illustrates the proposed conceptual framework in a graphical mode.

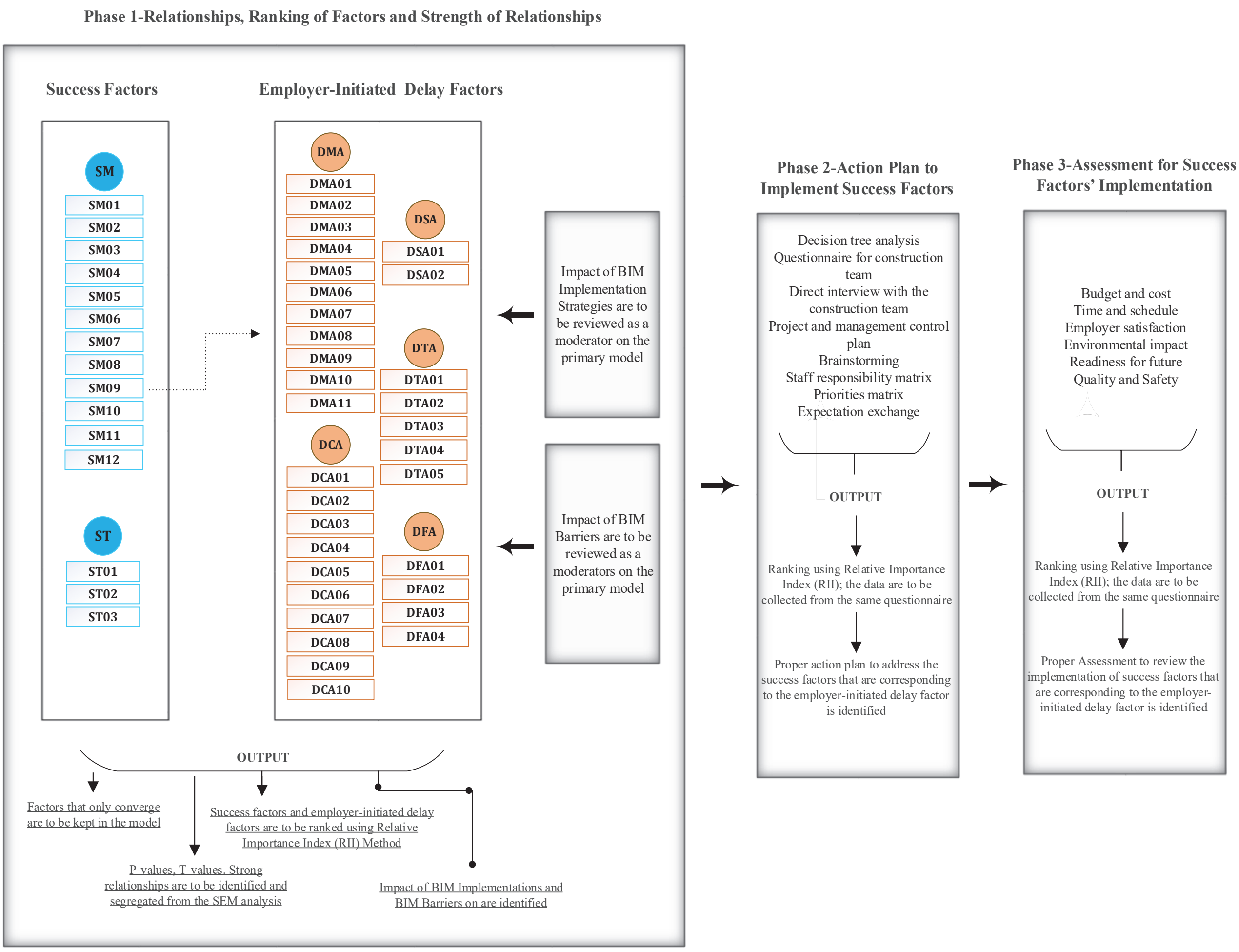

Figure 4.8. Conceptual Framework to Address employer-initiated Delays

4.6 Summary of Chapter 4

This study focused on the problem of employer-initiated delays and their corresponding critical success factors in BIM-enabled projects and the effects of BIM moderators on these relationships. A correlation analysis was conducted between the critical success factors and employer-initiated delay factors for BIM-enabled projects. The 31 primary causes of employer-initiated delays in construction worldwide and their corresponding critical success factors in the USA, the UK, Australia, Egypt, and the UAE were reviewed and correlated using the SEM analysis method. Management, organisation, financial planning success, and team success influenced employer-initiated delay factors with different levels of importance and strength. Several previous studies support the findings of this study, such as the relationship between conducting fruitful meetings with all project parties (SM02) and contract and specification changes (DCA01). However, different relationships between critical success factors and employer-initiated delay factors were indicated in the present study, such as the relationship between proposing a bonus scheme (SM07) and contract and specification changes (DCA01.) For instance, the SM relationship with DCA and the ST relationship with DMA have two high-ranking hypothesis relationships in the proposed employer-initiated delay and critical success factors model. The results of this study indicate that many of the proposed BIMSs and barriers influence primary model relationships. The influence of BIMSs was demonstrated in the relationship between SM-DCA and ST-DSA. Moreover, BIMB affected the SM-DCA relationship. These findings agree with previous results; however, many of these findings are new, emphasising the importance of this study.

This study contributes to developing a comprehensive managerial framework to address employer-initiated delays in BIM-enabled projects. For example, BIMS significantly affected contractual employer-initiated delays related to management, organisation, and financial planning critical success factors. Furthermore, this research provides an in-depth study of employer-initiated delays and their critical success factors on continents and countries lacking similar studies, such as Australia, the UK, and the US. In addition, understanding the exact effect of BIMSs and barriers on each employer-initiated delay and critical success factor relationship is innovative and practical. All the above contributions improve the understanding of project parties (particularly the employer) regarding the importance of implementing BIM to reduce delays initiated by the employer. In addition, previous studies only offered a review of construction delays and their corresponding critical success factors in traditional (Non-BIM) projects, with limited consideration of employer-initiated delay factors. This study extends the knowledge by providing a holistic study of employer-initiated delays regarding their corresponding critical success factors separately from other project parties' delays for BIM-enabled projects. In addition, this research is the first to offer an in-depth review of the impact of BIMSs and BIMBs on employer delays and their corresponding critical success factors.

Certain limitations of this research must be considered. The results and conclusions are limited to the scope of the construction phase in projects in the UK, the USA, Australia, the UAE, and Egypt. This research is valid and significant for the causes of delays in these countries under BIM-enabled projects in particular. Future research should focus on studying the influences of other moderators, such as project characteristics and the project environment. These moderators are similar to project size, value, and social and cultural interference. Continued expansion of knowledge and understanding of the causes of construction delays should lead to solutions that improve project performance.

5 Research Methodology

5.1 Introduction

In the previous four chapters, an extensive examination of the current literature on building delays was conducted, and gaps within this body of research were highlighted. This study had a specific emphasis on comprehending the variables that contribute to delays caused by employers. We also identified key factors essential for achieving success in both traditional (Non-BIM) construction projects and those that apply Building Information Modelling (BIM). The insights mentioned above played a crucial role in formulating methods to effectively manage and mitigate delays stemming from variables associated with employers. Furthermore, a comprehensive analysis of the diverse approaches utilised for data collection about employer-associated delays and achievements was conducted. To provide a clear direction for our research, we have developed a conceptual research framework to overcome delays imposed by employers efficiently.

The present chapter functions as a crucial stage at which we synthesise the facts and information necessary for attaining the objectives of this study. The main objective is to examine the factors contributing to global construction delays caused by employers and comprehend their complex relationships with the features contributing to project success. The primary objective of our study is to propose novel and all-including frameworks that can efficiently tackle the diverse factors that lead to project delays caused by employers.

Over the past few decades, a substantial expansion has been observed in the building and real estate sectors. Notwithstanding the expansion mentioned above, the continuing problem of projects failing to adhere to their designated timelines has persistently afflicted the industry. There is a growing necessity to comprehensively examine the factors that impede the punctual completion of construction projects. This chapter comprehensively examines the research methodologies utilised in the present study.

This work is grounded in a comprehensive examination of the fundamental research philosophies and processes. Our study strategy is based on integrating objectivism and subjectivism, which allows for a comprehensive knowledge of the complex dynamics of construction delays attributed to employers. This approach ensures a balanced perspective in our analysis.

Moreover, our research approach entails the development of an extensive survey instrument derived from a careful examination of academic sources, embracing a worldwide outlook including many continents. This literature study expands its scope to involve several countries and continents, including Australia, China, the United States, the United Kingdom, Africa, and Asia. By examining various geographic regions and construction situations, we aim to comprehensively understand the obstacles and possibilities in addressing employer-related delays in the construction industry. The data were gathered through an online survey, which underwent validation through a pilot evaluation. This pilot evaluation involved 29 online participants and was conducted to establish the reliability of the questionnaire. Furthermore, it is important to note that employer-initiated delay factors and the corresponding critical success factors are classified into distinct groupings, with delay factors being classed separately from the critical success factors. The groups for the employer-initiated delay factors and their corresponding critical success factors were created based on a thorough review of previous studies and literature. The present study thoroughly examines SEM analysis, focusing on its portrayal in existing scholarly literature.

5.2 The Philosophical Stance

The concepts of ontology and epistemology are fundamental principles in the field of research, specifically in the business research domain, as Don-Solomon et al. (2018) emphasised. Business research is an impartial endeavour to acquire novel knowledge, with the primary objective of utilising this knowledge to tackle distinct difficulties exclusive to an organisation (Jarzabkowsk et al., 2010). The abovementioned procedure entails a systematic methodology for gathering, examining, and interpreting data, resulting in dependable and implementable resolutions to complex issues.

Ontology, the discipline concerned with the investigation of existence and reality, and epistemology, the field dedicated to examining knowledge and the processes by which we acquire it, constitute the fundamental philosophical underpinnings upon which the entirety of the research enterprise is built. This discussion explores the profound importance of ontology and epistemology within research.

Moon et al. (2017) stated that ontology can be employed as a guiding framework for the planning, execution, analysis, and interpretation of studies across several disciplines, with a particular emphasis on the social sciences. Various ontological viewpoints can influence the selection of research methods, data-gathering techniques, data-processing approaches, and interpretation of findings. One illustrative instance involves the contrast between realist and relativist ontologies. Realist ontology posits the existence of a singular, objective reality that can be quantified and examined by researchers. Conversely, relativist ontology posits numerous subjective realities formed by human cognition and can solely be apprehended through interpretation.

Ontology is a branch of philosophy that explores inquiries about the fundamental nature of reality, the concept of existence (Al-Ababneh, 2020), and the underlying categories that structure our perception and understanding of the world. Business research impacts our cognitive understanding and delineation of the things and concepts that hold significance in our investigation. When examining organisational culture, one may encounter ontological considerations that revolve around whether culture should be perceived as an objective and quantifiable or as a subjective and socially produced phenomenon (Al-Ababneh, 2020). The ontological perspective influences the formulation of our research inquiries, the development of hypotheses, and the selection of methodologies employed for investigation.

As a branch of philosophy, epistemology investigates and comprehends the processes of acquiring, justifying, and disseminating knowledge (Wilson, 2018). The field of inquiry pertains to inquiries on the essence of knowledge, the origins of knowledge, and the standards by which the veracity of knowledge assertions is assessed. Epistemological concerns play a crucial role in business research as they inform research methods and the subsequent interpretation of findings (Mehdi and Moghimi, 2017). Researchers are faced with determining whether to take a positivist perspective, which prioritises using objective and quantitative data or to embrace an interpretive approach that places significance on subjective experiences and qualitative insights.

The interaction between ontology and epistemology holds significant importance. To maintain the coherence and rigour of their investigations, researchers must guarantee that their ontological and epistemological perspectives are aligned (Kant, 2014). An instance can be illustrated when a researcher who adheres to a positivist ontology that posits an objective world employs quantitative methodologies to collect and analyse data, focusing on achieving generalizability and replicability. On the other hand, a researcher who adopts a constructivist ontology, which recognises the existence of different socially constructed realities, may choose to utilise qualitative research methodologies to explore the subjective experiences of individuals inside an organisation.

Ontology and epistemology are abstract philosophical notions and practical frameworks guiding the research. Research topics, procedures, and the interpretation of findings are influenced by various factors, including the individuals involved in the research process. These individuals play a crucial role in shaping these aspects, determining the quality and usefulness of research outcomes within the ever-changing business. Comprehending and choosing suitable ontological and epistemological stances are essential prerequisites for significant and influential business research.

5.2.1 Ontology

Ontological philosophy covers two primary approaches that aim to conceptualise and categorise the fundamental nature of being and reality: positivism and subjectivism. These two positions present contrasting viewpoints regarding the existence and nature of entities, specifically within the domains of social and corporate phenomena.

Objectivism, a significant aspect of ontological philosophy, asserts that social and business entities have an intrinsic existence inside objective reality, regardless of the individuals or forces connected. Objectivism posits that the presence and importance of a societal phenomenon are independent of the behaviours and interpretations of individuals inside the social sphere. The viewpoint expressed in the statement is in close accordance with positivism. This philosophical paradigm perceives reality as a unified and objective entity independent of the researcher's personal convictions or subjective interpretations (Don-Solomon et al., 2018).

Positivism, as a methodological framework, places significant emphasis on implementing rigorous control and structure in the formulation of research inquiries, construction of hypotheses, and execution of investigations. The statement describes a structured framework that aims to verify or question assumptions using specified research procedures (Roth & Mehta, 2002). Positivism, as a theoretical framework, posits that the natural world may be thoroughly understood and observed without considering social actors' impact or interference.

Objectivism and positivism align fundamentally in their dedication to objective reality and empirical inquiry principles. Both perspectives emphasise entities' autonomous existence and the potential to discover universal truths through rigorous research methodologies. The correlation between Objectivism and positivism highlights their importance in influencing our comprehension of the world and the disciplines about existence and reality.

Subjectivism differs from objectivism and positivism as it strongly corresponds with the philosophical principles of social constructivism (Onwuegbuzie et al., 2009). Within the field of subjectivism, it is posited that there exists a close and complicated relationship between study and societal occurrences. As a result, subjectivism challenges the concept of pre-established and rigid study designs by acknowledging the intricate, diverse, and uncertain nature of perceived reality.

Within the framework of the subjectivist paradigm, researchers must uphold a receptive mentality throughout their study. This entails recognising the possibility of shifting viewpoints and acquiring novel information while they participate in rigorous data analysis. In contrast to positivism, subjectivism diverges from the pursuit of absolute facts or objective truths, prioritising the significance of interpretations arising from subjective perceptions instead.

Subjectivism, which originates in social constructivism, underscores the complex relationship between research and societal occurrences (Yilmaz, 2016). The statement promotes researchers embracing the complexities of human perception and experience, fostering an adaptable and open-ended approach to investigation. This approach prioritises the interpretations of participants rather than only pursuing objective truths.

5.2.2 Epistemology

Figure 5.1 visually shows the fundamental elements of research philosophies, highlighting the connection of ontology and epistemology within the research framework. This observation is of particular significance. Furthermore, Sutrisna (2009) emphasises the crucial importance of ontology and epistemology in social research, highlighting their position as fundamental principles that form the basis of the entire research framework. This highlights the lasting significance of these philosophical deliberations within social research.

Epistemology refers to the interplay between the researcher's belief in the existence of reality and the extent to which reality is apprehended or acknowledged (Schommer, 1994). Hence, epistemology plays a crucial role in determining the validity of knowledge in research, identifying the appropriate sources for acquiring knowledge and evaluating the acceptability of research findings. Once a researcher has made a deliberate choice regarding their epistemological stance, the subsequent selection of a research method becomes apparent. Epistemology includes two distinct philosophical theories, namely positivism and interpretivism. Positivism is mostly associated with an objectivist ontology, whereas interpretivism is primarily associated with a subjectivist ontology. Hence, it may be argued that epistemology and ontology include subjective and objective methodologies. While objective epistemology is typically associated with objective epistemology, it is worth noting that these assumptions are frequently challenged. It is not rare for the notion that objectivist ontology influences subjectivist (interpretivist) epistemology to be observed. For instance, when ontology and epistemology are founded on objective outcomes, the perspectives researchers acquire are their own (Mbanaso et al., 2023).

In contrast, when ontology adopts a subjective perspective and epistemology adopts an objective perspective, they represent the researchers' interpretations of their observations (Sutrisna, 2009). Similarly, when the ontology is considered objective, and the epistemology is based on a subjective approach, it can be inferred that the researcher's findings are determined by the researcher's assertions (Don-Solomon & Eke, 2018). In ontology and epistemology, adopting a subjective approach implies a discrepancy between the researcher's verbalised statements and their actual observations (Don-Solomon & Eke, 2018). Figure 5.1 illustrates the components comprising research philosophies. Nevertheless, according to Sutrisna (2009), the key components of social research are ontology and epistemology.

Figure 5.1. Research Paradigms Elements

5.3 Adopted Research Philosophy

Research philosophies cover core beliefs and underlying assumptions that serve as the bedrock for the execution of research endeavours. Žukauskas et al. (2017) assert that these guidelines are crucial in shaping researchers' methodologies in collecting, examining, and applying data to further enhance understanding within their domains. The ideologies above are of significant importance in influencing the research process, including the formulation of research inquiries, the choice of procedures, and the interpretation of findings (Gannon et al., 2022).

Epistemological, ontological, axiological, and doxological assumptions are fundamental constituents of research philosophies (Mingers, 2003). The assumptions above significantly impact a researcher's comprehension of the research inquiries, the selected research methodology, and the analysis of research results. Therefore, it is vital to carefully formulate a comprehensive set of assumptions when developing a research philosophy that effectively informs the selection of methods, strategies, data collecting, and analysis techniques (Easterby-Smith et al., 1993).

Within the management research, it is acknowledged by Saunders et al. (2009) that four fundamental research philosophies exist: positivism, realism, interpretivism, and pragmatism. Each philosophical framework presents a unique viewpoint regarding the inquiry methodology and knowledge generation.

As Friedman (1953) demonstrated, positivism aims to build a rational and empirical basis for research. This constrains the domain of human cognition to identify effective tools and methodologies for attaining particular objectives. Positivism places significant emphasis on the requirement for empirical and quantifiable evidence, prioritising objectivity and the ability to replicate observations. Nevertheless, the social sciences frequently criticise it due to its inherent limits in elucidating the fundamental causes and contextual factors (Saunders et al., 2020).

Interpretivism, in contrast to positivism, adopts a qualitative and subjective approach. The approach emphasises individual observations and examines social and contextual elements that affect research findings. Interpretivist scholars frequently utilise methodologies such as participant observation to acquire a profound understanding of the subjective encounters of persons (Saunders et al., 2020).

Whether in a positivist or interpretivist variant, realism recognises an objective reality independent of human perception. The objective of this study is to investigate and reveal the underlying truth utilizing research, with varying emphasis placed on empirical evidence (positivist realism) or subjective comprehension (interpretive realism) (Saunders et al., 2020).

Pragmatism is a comprehensive philosophical framework that integrates aspects of both positivism and interpretivism. The approach underscores the importance of practicality and the utilisation of methodologies most appropriate for addressing particular research inquiries, irrespective of whether they fall under the quantitative or qualitative paradigm (Saunders et al., 2020).

The selection of a research philosophy holds significant importance within the construction business, particularly concerning building project delays. The analysis of delay factors is substantially influenced by the ontological stance, which pertains to reality's subjective or objective nature, and the epistemological approach, which concerns the methods used to acquire information.

The study employs a dual methodology, integrating positivist and interpretivist realism elements. The primary objective of this hybrid method is to establish a comprehensive framework that enables the efficient creation of novel databases, promotes the exchange of information, and facilitates information retrieval to analyse delays in various building projects and regions. The framework's objective is to ascertain the delay factors generated by employers and their interplay with crucial success criteria from other stakeholders in construction projects.

To validate the proposed framework, statistical models will be utilised to examine and assess the ontological and epistemological assumptions. This process will serve to confirm or enhance the discovered delay causes. The visual representation in Figure 5.2 depicts the research philosophy summary and the research onion, demonstrating how these philosophical foundations effectively steer the research process and analysis thoroughly.

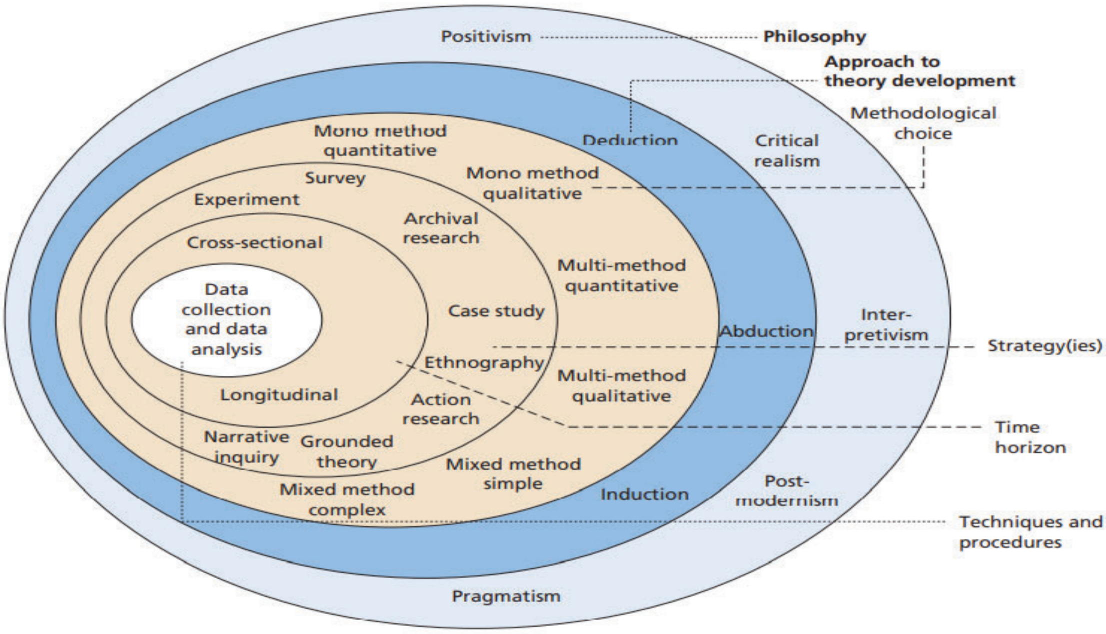

Figure 5.2. The Research Onion (Saunders et al., 2009)

5.4 Research Methodology and Design

Research methodology is the approach to obtaining knowledge through a proper scientific method. Walliman (2006) proposed that the methodology of research has the following main aspects: (1) it describes the elements of the research, (2) it identifies the research model and the relevant concepts and statements of the study, (3) it helps in the establishment of methods to apply in the research and (4) it defines the communication strategies. As usual in construction management research, this study began by reviewing past studies on delay, causes and success factors to form a detailed understanding of the research problem. The research problem and the detailed sub-problems must be identified and justified based on previous studies and empirical works. During the review of the present literature, despite a high number of studies evaluating the delay factors, fewer studies were found to have directly considered employer-initiated delay factors in a detailed manner. This main gap has been justified in detail in Chapters 2, 3, and 4.

However, it is important to note that the final developed survey questionnaire was distributed using an online platform, Qualtrics, for practitioners involved in construction projects in the study countries. The qualifications of the practitioners were selected carefully to ensure accurate data input. The sample size for the main study questionnaire was determined following a proper technical background check to ensure that the respondent size was sufficient. Xue et al. (2018) analysed the relationship between industrialised construction technology innovation organisations using a combined SNA and SEM approach. Their study used the sample size identified for SEM as applicable to the SNA method.

During the research process, following the period of data collecting, it becomes imperative to methodically analyse the acquired data to derive significant conclusions and properly address the research inquiries. The study employed an analytical approach to examine the data. It was guided by well-formulated hypotheses that addressed specific research questions related to ranking employer-initiated delay factors, critical success factors, and their relationships. This investigation focused on different types of projects and specific continents where limited prior research had been conducted. Various sophisticated analytical methods were utilised to investigate and comprehend the complex interconnections in the dataset. This study employed two main methodologies: Structural Equation Modelling (SEM) and conventional statistical approaches. Structural Equation Modelling (SEM) is a robust statistical methodology that enables researchers to investigate several correlations among variables concurrently. This approach extends beyond conventional statistical techniques as it evaluates the measurement model, which includes the connections between latent variables and their observable indicators, and the structural model, which includes the interconnections among latent variables. In the present study, Structural Equation Modelling (SEM) was utilised to examine and conceptualise the complex relationships among delay factors begun by employers, important success factors, and other variables of interest. Structural equation modelling (SEM) has the potential to offer a more comprehensive and nuanced comprehension of the intricate interplay between many components, hence enhancing the depth and sophistication of the research. Traditional (Non-BIM) statistical approaches were employed alongside structural equation modelling (SEM). The methods mentioned above comprise a variety of statistical techniques, including regression analysis, t-tests, and correlation analysis. These tools possess significant value in the analysis of particular relationships, the validation of hypotheses, and the derivation of statistical inferences from the collected data. These methodologies provide a more comprehensive examination of the information, facilitating the identification of particular insights into the determinants of employer-initiated delays and their associations with crucial success criteria.

In addition, the study made a substantial contribution to the area by developing an innovative methodology to tackle employer-initiated delay factors and their root causes effectively. The purpose of this framework is to construct a systematic strategy that is built upon the conceptual framework that has been previously developed. This technique is considered innovative as it identifies the elements contributing to delays and investigates the underlying causes, comprehensively comprehending the issue. Through a thorough analysis of the various elements contributing to delays in construction projects and their underlying causes, your research provides a solid basis for implementing an organised and proactive approach to mitigate these delays effectively. The framework presented in this study holds significant potential as a valuable asset for project managers, stakeholders, and decision-makers operating within the construction industry. It provides practical recommendations to enhance project management practises, improving project outcomes. The research included a comprehensive and pioneering examination of data utilising sophisticated statistical methodologies such as Structural Equation Modelling (SEM) alongside conventional approaches. Furthermore, developing an innovative framework derived from the conceptual framework presented contributes substantial value to the field of study. This framework offers a systematic approach to effectively tackle delay issues launched by employers and their underlying causes in construction projects spanning various project kinds and geographical regions.

This study employed a mixed methodologies approach to provide a comprehensive rationale for the chosen research methodology, as Creswell (2013) recommended. The methodology employed in this study involves incorporating both qualitative and quantitative research methodologies. Prominent instances of study utilising comparable methodologies include investigations carried out by Chan et al. (2004), Koushki et al. (2005), Olander and Landin (2005), and Assaf and Al-Hejji (2006).

In a study by Chan et al. (2004), a quantitative analysis was conducted by distributing an online survey. The study aimed to examine the important success determinants in partnering building projects, with a specific focus on the context of Hong Kong. In contrast, Koushki et al. (2005) conducted a qualitative investigation wherein they interviewed a sample of 450 individuals who were owners and developers of private residential projects in Kuwait. Their study aimed to identify the many factors contributing to project delays and cost escalation. Olander and Landin (2005) employed a comparable qualitative methodology, wherein they conducted case study studies to evaluate the impact of stakeholders on the implementation of construction projects. Although the studies mentioned above just utilised a singular research method, authors such as Creed et al. (2010) and Park and Papadopoulou (2012) have adopted a more diverse approach by integrating two or more research methodologies in their inquiries.

The mixed methods approach incorporates methodologies that are distinctive to both qualitative and quantitative research, enabling their sequential or simultaneous use, as delineated by Creswell and Clark (2007). The scholarly community has largely recognised the importance of this technique in the existing body of research. Robson (2011) emphasises the manifold benefits of utilising mixed approaches, including triangulation, completeness, illustration of data, refining the hypothesis question, etc.

5.4.1 Quantitative Method

Quantitative research holds significant importance in empirical inquiry, acting as a strong framework for examining the correlations between different variables and shedding light on the interactions among elements within a given system. The exploration of the significance of quantitative research methodologies can be undertaken by examining various essential variables. The examination of connections is a fundamental focus of quantitative research procedures, as emphasised by Robson (2011). These methodologies can dissect and scrutinise the ties and associations among various variables or aspects. Possessing analytical capability is essential for researchers who aim to comprehend the interconnectedness of different components inside a system and how they affect each other. Quantitative research provides a systematic and organised way to define the elements or variables being examined and their corresponding conclusions. The delineation of variables of interest by researchers is crucial for formulating hypotheses and the execution of robust statistical studies. The recognition of the value of distinct elements within a quantitative research system is emphasised by Creswell (2013). Every individual component has a significant role in enhancing the comprehensive comprehension of the phenomenon being investigated. Failure to consider any essential component might harm the research results, potentially resulting in incomplete or biased findings. The significance of sample size is emphasised by Babbie (2012) as one of the compelling arguments for utilising quantitative methodologies. The adequately large sample size is paramount in numerous study contexts within organisations. Including a larger and more diverse sample in research studies contributes to the increased credibility and generalizability of the findings. This allows researchers to make stronger and more reliable conclusions about the wider population from which the sample is selected. A well-defined and coherent study design is crucial in quantitative research, serving as a fundamental prerequisite before commencing data collection. The design phase of the research process includes identifying and formulating the research topic, carefully selecting relevant variables, and strategically planning data-gathering methods. One of the benefits of employing this methodology is that it facilitates researchers in establishing a more explicit definition of the scope and objectives of their study. Quantitative research is firmly rooted in a mathematical approach that includes gathering, analysing, and interpreting data. Mathematical modelling facilitates systematic data processing, statistical testing, and producing quantitative outcomes that can be objectively assessed and contrasted. The pilot study's evaluation ensures the research aligns with its intended aims. Pilot studies play a crucial role in quantitative research by validating the research design and data collection instruments. Mertens (2014) argues that identifying potential problems and refining the research approach is crucial in ensuring that the study effectively achieves its intended aims.

In summary, quantitative research plays a significant role in empirical investigation, especially when researchers aim to examine relationships, establish variables and outcomes, acknowledge the importance of components within a system, and maintain a reliable and systematic approach to gathering and analysing data. By adopting quantitative research approaches, scholars can enhance their ability to make well-informed decisions, derive strong findings, and provide useful insights into their academic disciplines.

5.4.2 Qualitative Method

Using information option treatment in research is a valuable methodology for comprehensively understanding individuals' principles, experiences, beliefs, and attitudes. The process needs to gather data that describes individuals' ideas and accounts of their experiences and perspectives (Sofaer, 2002). This methodology seems particularly advantageous in comprehending intricate human phenomena, exemplified by the occurrence of construction delays attributed to employers. The data-gathering methods linked with the information option treatment comprise a variety of qualitative methodologies, which include:

Comprehensive interviews refer to in-depth, individual interviews conducted by researchers to investigate participants' experiences, perspectives, and beliefs thoroughly. In-depth interviews yield extensive and complex data, presenting significant perspectives and insights on the research issue.

Semi-structured interviews aim to achieve a middle ground by combining open-ended and structured questions. The framework offered by interviewers allows for structured guidance during the interview process while permitting participants the freedom to expand upon their answers. Researchers frequently employ this methodology to promote coherence and participant engagement, ensuring uniformity in the data collection process while simultaneously facilitating the expression of diverse opinions.

Focus group interviews are a qualitative research method that involves the participation of a small group of individuals who engage in a guided discussion on a specific topic. This methodology enhances the dynamics of group interactions and has the potential to reveal both common viewpoints and divergent opinions among the participants. The utilisation of numerous opinions is advantageous in the exploration of a study subject. Task-based data-collecting approaches include the engagement of participants in the execution of specified tasks or activities that are directly relevant to the study topic. These tasks have the potential to yield useful insights regarding individuals' approaches and responses to real-life circumstances.

In the context of the research on construction delays attributed to employers, the analysis strategy appears to have adhered to an organized and structured process. The investigation commenced by conducting a comprehensive literature analysis, examining prior scholarly works in the relevant domain. This process aimed to identify areas where research has been lacking and highlight any concerns about delays imposed by employers. The preliminary stage of the investigation facilitated the establishment of a groundwork for the further gathering and examination of data.

The data-collecting process was carried out via the Qualtrics platform, including a preliminary pilot review and the primary questionnaire. The selection of the platform and the integration of pilot and main surveys exemplify a deliberate methodology for data gathering, ensuring the data's dependability and credibility.

The primary method employed for data analysis was Structural Equation Modelling (SEM) analysis, a robust statistical technique commonly employed for investigating intricate correlations between variables. Structural equation modelling (SEM) offers a systematic approach for hypothesis testing and modelling intricate phenomena. It is well-suited for examining the elements contributing to employer-initiated delays in construction projects.

To effectively address delays induced by employers, the research conducted included both traditional (Non-BIM) building projects and those utilising Building Information Modelling (BIM). This comprehensive approach demonstrates the study's broad breadth and relevance to construction practises. This strategy follows the imperative to modify research in response to evolving industry circumstances. The comprehensive research strategy is exemplified by incorporating qualitative and quantitative research methodologies proposed by Creswell (2013) and Robson (2011). The utilisation of a blended method offers several benefits in an academic context. These advantages include the practice of triangulation, which involves confirming findings using different data sources. Additionally, this strategy facilitates improved performance and comprehension of intricate phenomena and the explanation of data. Furthermore, it aids in the enhancement of research questions and hypotheses. By implementing this integrated approach, your study can offer a comprehensive and resilient comprehension of employer-induced delays in construction projects.

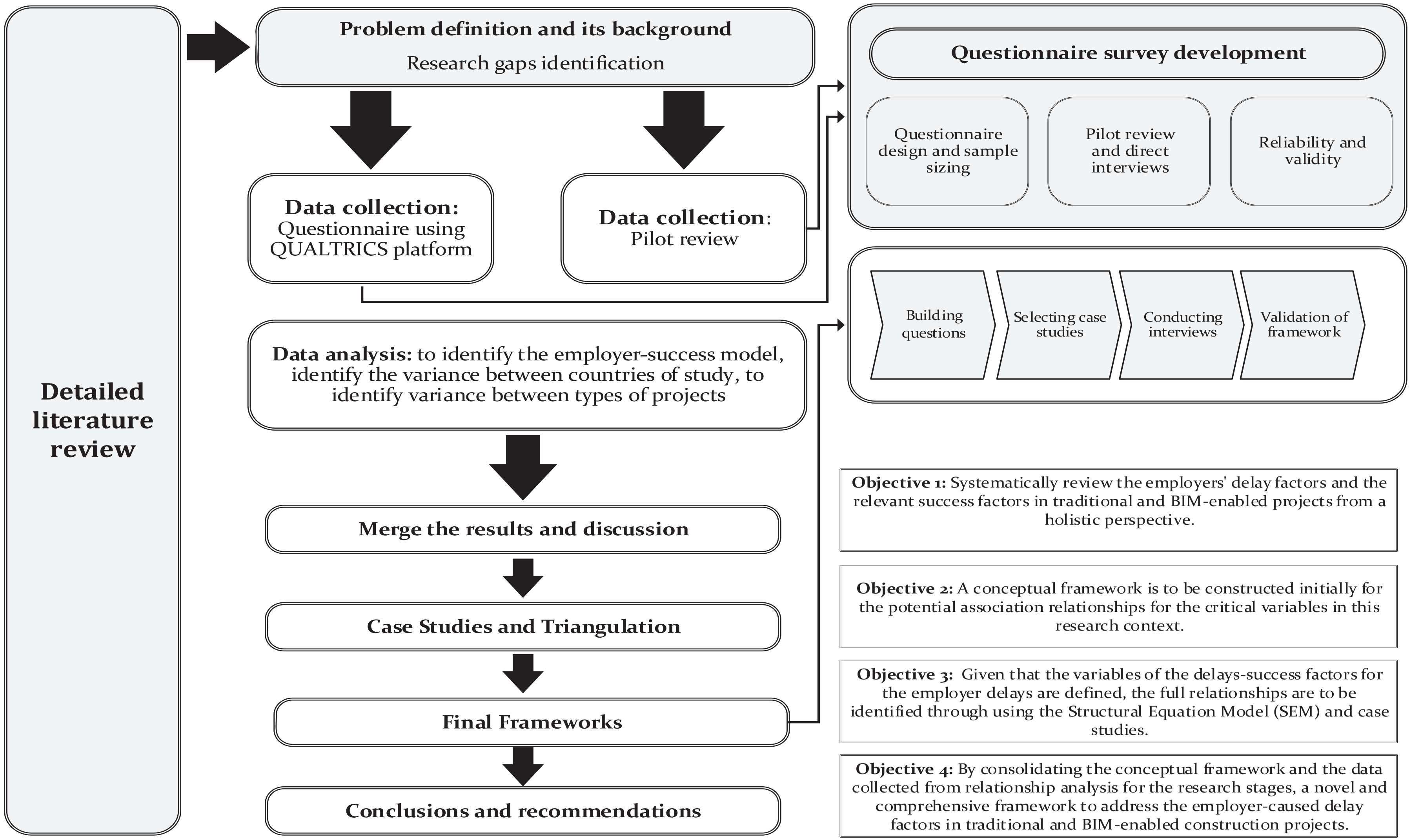

Figure 5.3. Research Design

5.5 Structural Equation Modelling

The research used Structural Equation Modelling (SEM) as the principal analytical approach, which provides a comprehensive framework for investigating causal links in the social sciences, with a special emphasis on qualitative analysis, as described by Cho et al. (2009). Like multiple regression equations, structural equation modelling (SEM) examines the underlying interrelationship structure using a sequence of mathematical equations. According to the research conducted by Hair et al. (2006), structural equation modelling (SEM) differentiates itself from other approaches of multivariate data analysis based on three fundamental properties. The structural equation modelling (SEM) technique is proficient at estimating multiple and interrelated dependent connections among variables. Structural Equation Modelling (SEM) can depict latent constructs that are not directly observable and remedy measurement mistakes while conducting the estimate procedure. Structural Equation Modelling (SEM) can construct a comprehensive model that elucidates the entirety of the relationships being examined. An increasing number of studies in the field of engineering and construction delays analysis have embraced the utilisation of Structural Equation Modelling (SEM) due to its inherent benefits (Dulaimi et al., 2005; Islam & Faniran, 2005; Molenaar et al., 2000; Nepal & Park, 2005; Wong & Cheung, 2005). Structural Equation Modelling (SEM) is a powerful statistical tool for analysing complex relationships among variables. This tool allows researchers to clarify potential connections between influential and underlying factors and the dependent variable. Moreover, structural equation modelling (SEM) enables the examination of measurement indicators in connection to latent variables, which are frequently conceptual and difficult to see. This methodology has been widely utilised in investigating causal linkages in many fields, such as education, management, and economics.

Structural equation modelling (SEM) is founded on a comprehensive set of statistical inference tests, which include various correlations, regressions, factor analysis, and route analysis techniques. The primary advantage of this approach is its ability to integrate all underlying variables and possible measurement inaccuracies into a model, providing a thorough representation of the interconnected connections being studied.

Structural Equation Modelling (SEM) assumes a critical role in identifying and analysing fundamental factors contributing to various challenges in construction-related research. This methodology has been utilised to ascertain pivotal elements for efficient project planning, analyse the correlation between project attributes and performance, evaluate the collaborative conduct of stakeholders in terms of timely project culmination, and assess the overall expenses of construction projects. One notable characteristic of structural equation modelling (SEM) is its capacity to depict the connection between observed (tangible) variables and unobserved (intangible) variables. The terminology "latent variables" denotes constructs not amenable to direct measurement owing to their abstract characteristics. On the other hand, measured variables are evaluated directly, typically through structured or semi-structured interviews. The theoretical underpinning of Structural Equation Modelling (SEM) asserts that multiple measurement variables can collectively represent a latent variable. The existence of this latent variable can also be supported by doing principal component analysis, wherein an Eigenvalue that is notably greater or lower than the Eigenvalues of other principal components serves as evidence.

Nevertheless, it is imperative that all components, including the latent variable, possess Eigenvalues that exceed one. Structural Equation Modelling (SEM) consists of two primary components, namely the Measurement Model (MM) and the Structural Model (SM). The MM (measurement model) investigates the associations between latent variables and latent constructs, whereas the SM (structural model) specifically examines the associations among these latent constructs.

In brief, structural equation modelling (SEM) is a robust analytical instrument that empowers researchers to examine intricate causal connections, rendering it especially advantageous in social sciences and construction-related studies. The capacity to represent both observable and unobservable variables, accurately account for measurement inaccuracies, and thoroughly comprehend interconnections renders it a fundamental component of contemporary research procedures. The MM in SEM is constructed as follows:

$$Y_{il} = r_{il} \times N_l + w_{il} \qquad \ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$X_{in} = D_{in} \times E_n + e_{in} \qquad \ldots\ldots\ldots\ldots\ldots \quad (4)$$

Y reflects that i observes the l latent construct indicator, and r is the correlation coefficient between Y_{il} and N_l. $\mathbf{N_l}$ represents the l latent construct. Likewise, X_{in} reflects that i observes the n latent construct indicator, and D_{in} is the correlation coefficient between X_{in} and E_n. E_n represents the l latent construct. In both the referred equations, e_{in} and w_{il} are the error terms.

The SM is expressed as $P = Q_p + T_Z + e$, where P is the endogenous variable, Z is the exogenous variable, Q represents the interaction between the endogenous variables, and T represents the coefficient matrix of the various exogenous variables on the endogenous variables. In contrast, e is the error term of the equation.

Within the structural equation modelling (SEM) framework, it is imperative to establish a clear distinction between endogenous and exogenous variables. Endogenous variables refer to delay factors that the employer initiates. In contrast, exogenous variables include delay factors that originate from other stakeholders, the specific type of construction project, the project's location, and the interactions among these exogenous variables. These interactions can define latent variables or introduce new exogenous variables. Conceptual models within the Structural Equation Modelling (SEM) framework include theoretical constructs that postulate hypothetical linkages and complicated interconnections between observable and latent variables. Structural Equation Modelling (SEM) is a highly valuable analytical process that identifies distinct cause-and-effect relationships underlying various data types, including qualitative and quantitative organised and unstructured data. Before doing structural equation modelling (SEM), it is customary to perform a Confirmatory Factor Analysis (CFA) to evaluate the reliability and validity of the chosen variables. The variables mentioned above function as fundamental components for later structural analysis.

The primary advantage of structural equation modelling (SEM) is its capacity to reveal causal connections between different underlying constructs that may not be readily apparent through methods such as in-depth interviews or traditional quantitative data analysis. The adequacy of an SEM model is assessed by examining goodness-of-fit indices, and the model with the greatest index is considered appropriate for further research. The process of refining the structural equation modelling (SEM) model may entail the removal of routes that exhibit non-significant correlation coefficients. This model simplification aims to establish more focused causal links between latent components, either corroborating or challenging the study hypotheses. Various software solutions can be utilised to do Structural Equation Modelling (SEM). The favoured selections are AMOS, LISREL, SMART PLS, and EQS. In a particular study, the researchers employed AMOS-23 software to develop a structural equation modelling (SEM) model to find the factors determining project costs in New Zealand construction projects. A total of 30 possible constructs, or influencing factors, were found from several sources. The impact of these factors on project costs was measured using data obtained from 283 replies to a semi-structured questionnaire. The research emphasised that market and industry circumstances are the main factors influencing construction project costs in New Zealand.

Additionally, it alluded to the possibility of constructing a novel ontology model to augment project cost performance by identifying and assessing cost drivers. The authors Zhao et al. (2019) offered recommendations about using standardised regression weights (SRW) to evaluate the convergent validity. A standardised response weight (SRW) exceeding 0.5 signifies a significant level of convergent validity. The researchers in their study depicted latent variables as a function of three observable factors, utilising rectangles to visually represent the observed variables, circles to symbolise measurement errors, and arrows to denote the direction of effects among constructs. This methodology is widely regarded as appropriate for identifying causal links to delay factors initiated by employers.

Creswell and Clark (2011) put out a systematic framework for analysing information, highlighting the significance of introducing, examining, evaluating, presenting, appraising, and verifying data. Structural Equation Modelling (SEM) is a fundamental method employed to analyse the data collected from online surveys, ensuring the research study's precision and validity. SPSS is often selected due to its efficacy in examining correlations between variables.

Cronbach's alpha is frequently utilised to evaluate gathered data's internal consistency and reliability. The construct validity of a measurement tool is determined by the degree to which various items intended to assess the same underlying concept produce reliable and consistent outcomes.

Inferential analysis allows researchers to make inferences and draw conclusions regarding a larger population by analysing data obtained from a smaller sample. An analytical technique facilitates identifying and examining connections and associations between several variables, enhancing the efficacy of addressing the research inquiries.

There are two predominant structural equation modelling (SEM) methodologies, namely Covariance-Based SEM (CB-SEM) and Partial Least Squares SEM (PLS-SEM). Confirmatory factor analysis-structural equation modelling (CB-SEM), a widely employed method in social sciences, assesses the validity or invalidity of theories through the rigorous examination of hypotheses. Utilizing software packages like MPLUS, AMOS, EQS, and LISREL is integral to the process.

On the other hand, Partial Least Squares Structural Equation Modelling (PLS-SEM) is particularly suitable for examining intricate models that include latent constructs and utilise several indicators indirectly. The primary objective of this approach is to estimate the associations between unobserved variables. It demonstrates notable efficacy in situations involving exploration and prediction and in depicting and assessing complex connections between latent variables and models.

Given the nature of the research problem, which involves the integration of soft theory and necessitates both exploratory and predictive analysis, employing Partial Least Squares Structural Equation Modelling (PLS-SEM) is deemed an appropriate approach for conducting quantitative analysis in the context of your thesis. The tool offers adaptability to collect and comprehend complex associations involving latent variables and models.

Covariance plays a crucial role in statistical investigations, serving as indices of the relationship between variables. Nevertheless, these findings' dependability may fluctuate according to the sample size. The literature has extensively documented that covariances tend to exhibit less stability when calculated from small samples, as Tabachnick and Fidell (2007) highlighted. Instability is a significant obstacle for statistical techniques like Structural Equation Modelling (SEM), as it heavily relies on covariance matrices to analyse complex associations between variables.

Determining the precise minimum sample size for structural equation modelling (SEM) is a topic that often causes varying perspectives and discussions among scholars. However, various factors need to be considered when estimating the necessary sample size for structural equation modelling (SEM).

According to Hair (2010), it is advised to have a minimum sample size of 200 to achieve a precise estimation of parameters. There exists a range of rules for determining the appropriate sample size in structural equation modelling (SEM), as suggested by various experts and scholars. As an example, Bollen (1989) advocated for a ratio of 3 to 5 participants per estimated parameter. Bentler and Chou (1987) proposed that a sample size of 5 to 10 participants per estimated parameter is appropriate. Quintana and Maxwell (1999) acknowledged the lack of unanimity on this matter and endorsed utilising the Bentler and Chou guidelines. Typically, when employing structural equation modelling (SEM), it is commonly deemed suitable to have a sample size ranging from 100 to 400 participants.

Further to the sample size determination in Chapter 4, another way is used to identify the minimum sample size to support the selection of a proper and sufficient sample size for the thesis. In this method, the determination of sample size is contingent upon several aspects, including the effect size, the statistical power, the desired p-value, and the number of observable and latent variables incorporated in the model. One example which used this method is a study by Bakker et al. (2020), which examined the effects of a 12-week exercise intervention on cognitive function in older adults. The authors used a power analysis to estimate the sample size needed to detect a medium effect size (d = 0.5) with a power of 0.8 and a significance level of 0.05 for a two-tailed independent t-test. They also considered the number of observable variables (cognitive tests) and latent variables (cognitive domains) in their model and applied a correction factor to account for multiple tests. They calculated that they needed at least 64 participants per group, or 128 participants in total, to achieve sufficient power and precision. The effect size is a measure that quantifies the magnitude of the link between variables inside a structural equation modelling (SEM) framework. The desired p-value is the predetermined degree of significance chosen for the investigation. In academic research, it is customary for researchers to employ a p-value threshold of 0.05, denoting a 5% probability of detecting the obtained results under the assumption of no genuine effect. Statistical power pertains to the likelihood of correctly identifying a genuine effect, should one indeed be there. Typically, researchers strive for a statistical power level of 0.80 or 80%, indicating that there exists an 80% probability of correctly identifying a genuine effect. A value of 0.3 will be sufficient to provide the necessary convergence in the structural model. Adopting the values above, considering the latent variables are seven and the observed variables are 30, the recommended minimum sample size will be 170. thus, 197 respondents are sufficient to be used in this study.

The objective of this study is to examine the influence of critical success criteria on employer-initiated delay factors while considering potential moderating factors in both Building Information Modelling (BIM)-enabled projects and traditional (Non-BIM) projects. It is vital to establish that the critical success elements in this study are considered independent variables (IV), whilst the employer-initiated delay factors are regarded as dependent variables (DV).

This study examines the concept of critical success factors, which are defined as the fundamental aspects or factors that are anticipated to have a substantial impact on the results or achievements of building projects. Moreover, this research also takes into account the existence of moderators, which are characteristics that could potentially impact the association between important success criteria and employer-initiated delay factors. The role of moderators in building projects, whether utilising Building Information Modelling (BIM) or following traditional (Non-BIM) methods, is significant since they have the potential to either enhance or diminish the connection between the independent and dependent variables. Moreover, moderators can offer useful insights into the intricacies and subtleties of these connections.

5.6 Sampling in Qualitative Study

This study utilised a combination of quantitative and qualitative methodologies to investigate the aim of this study thoroughly. The qualitative component of the inquiry sought to explore the research subject further and was carried out through semi-structured interviews focusing on four specific case studies. The research instrument has gained significant recognition for its efficacy in examining complex matters within a specific study field (Lincoln, 2009).

To ensure uniformity and achieve extensive coverage, a predetermined set of questions was created before conducting the interviews. Nevertheless, it is crucial to acknowledge that the participants in the study were explicitly prompted to provide additional insights beyond the preset interview questions as long as the information was considered relevant to the overall research framework (Hanson et al., 2011).

The main objective of these interviews was to collect the viewpoints of professionals regarding matters of construction delays within the nation. At the commencement of each interview, the participants were provided with an introduction to the overarching research aim and objectives. The interviews were done in person since this approach was selected to foster an atmosphere that would facilitate free and unconstrained dialogue regarding the subjects under investigation, enabling participants to fully articulate their perspectives (Polit and Beck, 2010).

The intended course of action involved the ongoing execution of interviews with construction practitioners who expressed interest in attaining data saturation. According to Glaser and Strauss (2009), data saturation is when no more interviews yield new or additional information. The saturation threshold was reached in this study following the completion of nine interviews, with the 10th participant failing to contribute novel insights (Malterud et al., 2016).

The recruitment of experts in these semi-structured interviews adhered to a purposeful or judgemental sampling approach. This methodology is founded on the purposeful identification of persons with expertise and information pertinent to the study subjects under investigation.

5.7 Questionnaire Development

The questionnaire was consciously designed to resolve the meaning and aims of the study. The survey aimed to collect empirical evidence on factors that had led to employer delays occurring and their corresponding critical success factors. The questionnaire consisted of closed-ended questions. Notably, closed-ended questions consist of pre-populated answer choices from which the respondents can choose. Respondents select from a distinct set of predefined responses, such as yes or no. These questions help generate a limited set of more accessible and faster responses to code. Thus, closed-ended questions were preferred in this study because they are easier, quicker to answer and more accessible to code. They also allow the respondents to answer questions about sensitive topics. Likewise, comparing answers to other respondents with closed-ended questions is easy. They are also more accessible, quick and inexpensive to analyse. However, closed-ended questions allow respondents to guess and provide answers even if they are unaware of the correct response.

The questionnaire was primarily created using the Likert scale, rated from '1' to '5'. A Likert scale is useful in gathering respondents' attitudes and opinions. Precisely, it assesses attitudes, opinions and behaviours quantitatively. In most cases, it is a 5-point scale that allows study participants to express how much they disagree or agree with a specific statement. The scale assumes that an attitude's intensity is linear, ranging from strongly agree to disagree. Notably, Likert scales are helpful in research because they enable the researcher to operationalise personality traits and perceptions.

The first area of the survey concentrated on participant demographics. This part asked about the participants' organisational type, functions, years of work experience, education level and typical project type. The demographic area allows researchers to gain background data on participants. This area's main advantage is that it helped develop the significance, dependability and representativeness of participant information for the survey. Obtaining participants' demographic information allows the researcher to describe their participants accordingly and analyse the collected data more effectively.

The second area of the survey collected preliminary information concerning the delayed projects, which formed the participants' responses. Closed-ended questions were used throughout this area to ensure the harmony of information collected and guaranteed essential measurements. A few of the questions presented to participants in this part were connected to the magnitude of delays, their experiences with construction delays, and project delays within the last ten years.

Areas three and four of the survey tried to generate details concerning the study participants' important role: delay factors caused by the employer in the project they were involved in for traditional (Non-BIM) and BIM-enabled projects and their critical success factors. The participants were asked about delays caused by the employer; the critical success factors expected to address these delays were also identified from the participants' answers.

Areas six, seven and eight concentrated on collecting data from the participants about the factors that moderated the critical success factors that influenced the relationships with delays caused by the employer. The participants' answers also determined success implementation factors and the success review tools. The full questionnaire text and data are provided in Appendix C.

5.8 Hypotheses and SEM Models Development

The idea concerning the correlation between employer-initiated delay factors and their corresponding crucial success elements was initially formulated and offered. This concept was formulated based on the classification of delay groups and critical success groups, as discussed in the extensive literature study published in Chapter 3. Based on the insights obtained from the literature review mentioned earlier, the categorisation process formed the basis for arranging and grouping employer-initiated delay factors and critical success factors. These factors were organised according to their specific nature and characteristics. This methodical categorization strategy is used for a systematic analysis of the potential interaction between delays initiated by employers and essential success criteria, which is fundamental to the overarching research goals of this investigation. Accordingly, the latent and the observed variables are identified and defined in the model, which helped to create the questionnaire formulation.

Consequently, to thoroughly examine the dynamics present in projects utilising Building Information Modelling (BIM), factors linked with techniques for implementing BIM and obstacles to its adoption were found. The factors under consideration in this study were derived based on insights obtained from prior empirical research conducted in the relevant field. Furthermore, moderators with a specific focus on traditional (Non-BIM) projects were also found, with particular attention given to factors about the project's external environment. Including these moderators within the research framework was undertaken to offer a comprehensive viewpoint on the various factors that impact employer-initiated delays and their interconnectedness with crucial success determinants. To enhance comprehension of the specific influence of these moderators on the intricate network of employer-induced delays and crucial determinants of success, the research applied Structural Equation Modelling (SEM). This statistical modelling technique facilitated a thorough investigation into the influence and interplay of various moderators within the specific framework of BIM-enabled projects. Through the utilisation of Structural Equation Modelling (SEM), this study aimed to reveal intricate connections and causal relationships, providing insights into the complex dynamics that influence project outcomes.

Chapter 2 of this research paper thoroughly detailed and extended the comprehensive approach for formulating hypotheses in the context of BIM-enabled projects. This chapter provides a clear articulation of the process of detecting delay factors launched by employers and the elements that contribute to the overall success of these initiatives. In addition, the essential function of moderators concerning Building Information Modelling (BIM) was outlined. The hypotheses in this study were carefully established after identifying and thoroughly examining these components, ensuring a strong foundation for the research approach. Similarly, Chapter 7 of this research elaborated on the approach employed for forming hypotheses within the context of traditional (Non-BIM) projects. Similar to BIM-enabled projects, this chapter provides a comprehensive definition of the methodology employed to identify delay factors and variables contributing to project success within traditional (Non-BIM) projects. Additionally, the document provided a comprehensive explanation of the methodology employed in identifying moderators specifically applicable to conventional project situations. The formulation of hypotheses in the traditional (Non-BIM) project context was based on a thorough literature analysis and empirical investigation, which provided clear and well-defined procedures. Through a thorough and systematic examination of the procedures involved in generating hypotheses in projects utilising Building Information Modelling (BIM) as well as those employing traditional (Non-BIM) methods, this study has established a methodologically rigorous and well-founded framework for exploring the diverse aspects that impact project results in both types of project environments. The research methodology employed in this study exhibits a high degree of clarity and accuracy, bolstering the findings' validity and reliability. Moreover, these methodological attributes make a valuable contribution to the existing body of knowledge within project management.

The formulation of the questionnaire had a crucial role in facilitating the acquisition of reliable data from individuals who possess knowledge of conventional and BIM-integrated projects. The questions were carefully crafted with the primary aim of investigating and offering responses to the presented hypotheses. Ensuring that the questionnaire includes a substantial and varied sample size is crucial to obtaining model convergence. By increasing the statistical power of the analysis and strengthening the generalizability of the findings to a wider range of projects and participants, the approach mentioned above boosts the overall validity and applicability of the study.

The subsequent stage of the study involved the initiation of the Structural Equation Modelling (SEM) procedure, which entailed the development of measurement models for the latent constructs being examined. Before proceeding with this stage, ensuring these constructs' dependability, trustworthiness, and validity was crucial. The task included evaluating the coherence and durability of the constructs over time and in various settings, guaranteeing that the measures employed to depict them were dependable and accurate indicators of the fundamental notions. After establishing the latent constructs' dependability, reliability, and validity, the research progressed to the third phase, which involved hypothesis testing utilising Structural Equation Modelling (SEM). Structural Equation Modelling (SEM) facilitated a comprehensive examination of the intricate connections among the constructs and offered a reliable statistical framework for evaluating the submitted hypotheses. This analytical methodology not only eased the evaluation of direct and indirect impacts but also allowed for investigating intricate causal connections among several variables.

It is crucial to elucidate how this research would accomplish the research hypothesis as outlined in Table 3.11, the researcher utilises a range of tactics and methodologies to test and confirm the theories. An established method involves hypothesis-driven research, where the methodology plays a critical role in differentiating between sound and flawed scientific practices (Rao, 2019).

This approach guarantees that grant reviewers are able to distinguish the calibre of research proposals, resulting in enhanced possibilities for financing. Furthermore, the validity of a hypothesis is crucial in research as it defines the degree to which study findings correspond with expectations drawn from theory (Wampold et al., 1990). Table 3.11 offers a comprehensive elucidation of the manner in which the assumptions have been formed from prior literature. In order to demonstrate how this study will validate the proposed hypotheses given in Table 3.11, the hypotheses were initially established by explicitly identifying all pertinent variables and their corresponding correlations.

These steps have already been executed and documented in this research. This study utilised a research style that combined both quantitative and qualitative methodologies. The qualitative component of the study involved conducting face-to-face interviews and a preliminary review. Conversely, the quantitative phase involved utilising an online structured questionnaire survey to collect data. Initially, a cohort of 29 individuals was selected for the pilot evaluation.

The main goal of the pilot review was to assess the appropriateness of the questions included in the questionnaire. In addition, the study analysed to examine the relationship between participants, using Cronbach's Alpha coefficient as the measure. The wording used in the questionnaire was improved by considering feedback and insights obtained during the pilot review process. The determination of sample size is an essential element in research methodology. In order to ascertain the suitable sample size for this study, the researcher employed the equation presented by Hogg and Tanis (2015).

The data gathered from the survey questions was analysed using a sophisticated analytical method known as Structural Equation Modelling (SEM). An analysis of the information and data was carried out utilising a two-step methodology. The first stage of the research involved creating measuring models for the underlying concepts. This stage was conducted after confirming the dependability, reliability, and validity of these constructs in the second phase. During the following phase, the research hypotheses underwent hypothesis testing using the utilisation of Structural Equation Modelling (SEM). Subsequently, the data were interpreted according to the explanations provided in the Thesis, confirming the associations proposed by the hypothesis, as well as the influence of moderators on these interactions.

5.9 Triangulation between Quantitative, Qualitative Studies and Literature Review

Noble and Heale (2019) suggest that research triangulation is a methodological approach employed to enhance the credibility and validity of the research. Research triangulation is a method utilised to assess the validity of study findings. Triangulation is a research approach that uses mixed approaches in order to validate study findings effectively. Triangulation pertains to the researcher's utilisation of multiple approaches within a study to obtain the necessary information and conduct a thorough analysis of the findings. This process serves to establish the validity and credibility of the research (Social Sciences Research Laboratories, 2018). Four notable projects around the world have been used as case studies in this thesis. The main aim of this analysis is to conduct a comprehensive cross-validation of the delay issues that are highlighted in this thesis from the quantitative point of view.

The purpose of this cross-validation is to analyse the employer-initiated delay factors along with the corresponding success factors in relation to the moderators in both BIM-enabled and traditional (Non-BIM) projects. The incorporation of practical projects is of utmost importance, as it offers the essential contextual depth needed to comprehend and tackle the difficulties being examined fully (Patton, 1999). In order to enhance the reliability of this investigation, a comprehensive methodology was utilised to collect relevant data and get valuable insights. This methodology involved the utilisation of documentary sources as well as conducting interviews (Yin, 2014). Interviews were performed with nine professionals who were actively involved in the execution of the case projects in order to obtain a deeper understanding of the delay concerns and the utilisation of critical success factors to address the delay issues (Silva et al., 2015). The interviews conducted played a vital role in obtaining primary knowledge and viewpoints, enhancing the study with valuable practical insights from professionals in the field (Creswell & Poth, 2018). To satisfy the objectives of this thesis, a triangulation of three research methods, a literature review, and quantitative and qualitative studies were undertaken. Triangulation, as employed in research techniques, functions as a robust mechanism to augment the credibility and validity of a study. This methodology involves the use of several data sources, hence mitigating various forms of biases and enhancing the dependability of research outcomes. In the subsequent discourse, we shall discuss the diverse sides of triangulation and its significance in the research. The utilisation of triangulation in research includes several distinct approaches, namely methodical triangulation, data triangulation, investigator triangulation, theoretical triangulation, environmental triangulation, and multiple triangulation. Methodical triangulation involves the application of different research methods, while data triangulation involves the utilisation of diverse data sources. Investigator triangulation entails the involvement of multiple researchers in the research process, while theoretical triangulation involves the consideration of different theoretical perspectives. Environmental triangulation takes into account the influence of different research settings, and multiple triangulation combines various forms of triangulation.

In summary, triangulation is a methodological strategy that prioritises the assurance of research findings' reliability and validity. This aspect holds significant value in providing information to stakeholders and decision-makers who depend on the results of research. Despite requiring significant time and knowledge, the utilisation of this instrument holds great appeal. It is considered vital in the researcher's resource due to its capacity to boost study quality, mitigate biases, and trust in researchers. However, the summary of the procedure adopted in this subject is as follows: (1) the analysis results pertaining to employer-initiated delays and their corresponding critical success factors were determined using the average ranking methodology and the SEM's analytical approach. These methodologies assigned rankings to both employer-initiated delays and critical success factors from a quantitative perspective, taking into account the strength of the relationship between these delays and factors using the analysis tools of SEM; (2) the qualitative analysis, conducted through case studies, involved the collection of qualitative data related to employer-initiated delay factors and critical success factors in both BIM-enabled and traditional (Non-BIM) projects, as per the questionnaire appended in the thesis appendix; (3) to ensure the validity and reliability of the obtained results, a triangulation approach is employed. This triangulation involves comparing and cross-referencing the quantitative results, qualitative findings, and insights gathered from the existing literature review for BIM-enabled and traditional (Non-BIM) projects; and (4) the data obtained from this triangulation process is integrated into the framework used to address employer-initiated delays, enhancing the effectiveness of strategies and solutions for mitigating these delays in both BIM-enabled and traditional (Non-BIM) projects.

5.10 Research Reliability and Validity

Research study dependability and credibility are critical aspects in quantitative and qualitative research, and efforts have been made to adapt these concepts from quantitative to qualitative research (Le Compte & Goetz, 1982; Mason, 2002). In the case of qualitative research, unique methods have been developed to establish dependability and credibility (Guba & Lincoln, 1994; Morse et al., 2008). However, it's worth noting that the application of reliability and validity concepts in mixed methodology research can be particularly complex, as Onwuegbuzie and Johnson (2006) pointed out.

Reliability and validity are fundamental concepts in research, referring to the consistency and accuracy of measurement or outcomes when using the same data collection instrument under consistent conditions and with the same subjects (Neuman & Robson, 2004). The dependability of a study questionnaire is established when the results obtained are consistent when the instrument is administered repeatedly under the same circumstances.

Reliability is closely tied to the replicability and repeatability of research results using the same instruments and under consistent conditions (Wolf, 1986). In quantitative research, reliability is broadly categorized into internal and external reliability, often assessed through test-retest methods (Morse et al., 2008). External (test-retest) reliability evaluates the ability to replicate research results using the same instrument on two separate occasions (Morse et al., 2008).

A specific procedure was followed to ensure internal and external reliability in this study, including adherence to the questionnaire design process, standardized administration procedures for the instrument, rigorous measurement protocols to ensure data stability and sound analytical techniques (De Vos et al., 2011). Enhancing the reliability of this research involved piloting it with a selected group of professionals in the construction industry. Cronbach's alpha was used to assess the reliability of the research instrument, a well-established method for evaluating the internal consistency of a questionnaire (Cronbach, 1946).

In summary, establishing dependability and credibility in qualitative research, especially within a mixed-methods context, requires careful attention to methodological rigour. Ensuring the reliability of research instruments, both internally and externally, is a critical step in maintaining the integrity of the research findings. Additionally, pilot testing and the use of established reliability measures like Cronbach's alpha contribute to the overall trustworthiness and quality of the research study.

5.11 Summary of Chapter 5

The research methodology employed in this study is underpinned by a well-defined ontology and epistemology, which have played a pivotal role in shaping the overall research approach. This methodological foundation has provided the necessary philosophical grounding for the research endeavour. The proposed methodology is particularly noteworthy for its innovative incorporation of objectivism and subjectivism within a new ontology. This approach seeks to balance these two contrasting philosophical perspectives to develop a comprehensive framework for understanding employer-initiated delay factors in construction projects across various continents and countries under investigation. Objectivism, in this context, emphasizes the existence of objective, external realities that can be studied and understood independently of human perspectives.

On the other hand, subjectivism recognizes the importance of individual and contextual subjectivities in shaping our understanding of these realities. By incorporating both perspectives into the research ontology, the methodology acknowledges the complexity of construction projects and the multifaceted nature of delay factors. A central component of this methodology is the utilization of Structural Equation Modeling (SEM). SEM is a powerful analytical tool that explores complex relationships between variables, making it particularly well-suited for the intricate web of factors influencing construction project delays. SEM enables the researcher to identify these factors and assess their interdependencies and causal relationships. In addition to SEM, the methodology harnesses the capabilities of traditional statistical analysis tools. These tools serve the crucial purpose of appraising and establishing connections between qualitative and quantitative data. Integrating both data types is essential in understanding the research topic comprehensively, as construction projects involve quantitative aspects such as timelines and budgets and qualitative elements like stakeholder interactions and project management practices.

The statistical analysis conducted within this methodology is designed to rigorously test the various hypotheses formulated as part of the research study. These hypotheses serve as the backbone of the study, providing a structured framework for investigating the complex dynamics of employer-initiated delay factors in construction projects.

In summary, the research methodology employed here represents a thoughtful and balanced approach that draws upon a robust ontology and epistemology. It integrates objectivism and subjectivism to create a comprehensive framework for understanding delay factors in construction projects. In addition, this chapter briefly presents the triangulation methodology, which involves a robust approach to research by combining quantitative, qualitative, and literature review methods to enhance the validity and reliability of the study's findings.

6 Pilot Review, Questionnaire, Data Collection, Data Analyses and Interpretations

6.1 Introduction

The data obtained from these questionnaires is subjected to a systematic compilation process prior to being sent for more comprehensive analysis and research objectives. The purpose of this analysis is to reveal complex trends, patterns, and the characteristics of both quantitative and qualitative data that have been collected during the survey. It is important to acknowledge that surveys that only inquire about the nature and frequency of work activities or the quality of work performed sometimes lack the necessary depth to provide a full and relevant analysis. In order to mitigate this constraint, our survey instrument has been strategically developed to provide supplementary data that is typically difficult to get, hence facilitating its seamless integration into the project's evaluation of delays. Consequently, the subsequent study can depend on the invaluable insights obtained directly from the perspectives spoken by the participants.

The analysis of survey findings is a complex undertaking due to a multitude of factors that can impact the results. Various factors can complicate the researcher's undertakings, including the duration of the survey, the demographic characteristics of the participants, their willingness to engage with previous questionnaires and the rates at which they react to different questions. However, modern survey instruments that possess sophisticated features can effectively address these difficulties, enabling researchers to make logical deductions from the survey data and conduct a comprehensive study of the total data. One example of a tool is Qualtrics, an online platform that is specifically built for the construction of survey questionnaires and the collection of data. By employing the Qualtrics platform, we distribute advanced survey links to enable participants to furnish comprehensive responses to our questionnaire.

Qualtrics is a highly adaptable database application that enables the efficient generation of survey questions using an internet-based platform. Within the framework of our research, the survey instrument has been carefully designed, predominantly comprising closed-ended questions presented on a Likert scale ranging from 1 to 5. This methodology not only streamlines the process of gathering data but also enhances uniformity and facilitates analysis, hence enabling us to derive significant insights from the collected information.

In addition, Building Information Modelling (BIM) initially yields a multitude of favourable outcomes within the domain of construction projects. The advantages mentioned by Wahab and Wang (2021) involve a range of benefits. These include improved information sharing, significant savings in cost and time, enhanced project quality, increased accountability and transparency in decision-making processes, and an overall enhancement in employer satisfaction. The revolutionary potential of Building Information Modelling (BIM) expands the scope of a project team's vision beyond conventional drawings, including essential elements such as cost analysis, sustainability assessment, and precise time management. In addition, Building Information Modelling (BIM) enhances decision-making processes and optimises maintenance operations, representing a notable advancement in the field of building project management.

Nevertheless, it is important to highlight that within the academic body, there is a lack of differentiation between projects utilising Building Information Modelling (BIM) and traditional (Non-BIM) construction projects in terms of essential success criteria and delays initiated by employers. Moreover, a lack of scholarly investigations exists regarding the evolutionary process of these differentiations within a range of projects, separate responsibilities within project teams, and diverse construction sites.

The focal point of this study centres on the assessment of discrepancies in time delays and key performance indicators between building projects that utilise Building Information Modelling (BIM) and those that rely on traditional (Non-BIM) methods. In order to obtain these insights, a thorough survey was undertaken, covering a wide range of respondents. The research investigated participants' viewpoints on the potential advantages of integrating Building Information Modelling (BIM) in construction projects. These benefits include the elimination of unforeseen modifications that are not accounted for in the budget, improved accuracy in estimating construction costs, and enhanced capabilities in detecting clashes between different elements of the project. Additionally, the research projected that the implementation of Building Information Modelling (BIM) would stimulate enhancements in on-site efficiency, a decrease in change orders, and an overall reduction in project durations, specifically during the cost estimation stage.

Despite the numerous advantages and the incorporation of Building Information Modelling (BIM) design automation tools for monitoring work, generating precise estimates, and enhancing safety measures, significant delays may still arise during projects that utilise BIM technology. The research also examined potential obstacles to the adoption of Building Information Modelling (BIM), including factors such as a lack of demand, a perception among employees that the advantages are insignificant, the high costs associated with implementation, and the difficulty of initiating cultural changes within organisations, as emphasised by Barqawi et al. (2021). The insights gathered from a diverse range of experts played a crucial role in clarifying the possible impact of a limited understanding of the benefits of Building Information Modelling (BIM) on its adoption within the industry.

Within the field of data analysis, Spearman's correlation has been identified as the preferred statistical tool for this particular study, mostly due to its appropriateness in analysing data sets that exhibit monotonic or curvilinear patterns. The selection of Spearman's coefficient was motivated by its ability to effectively represent data that exhibits non-linear relationships or consists of ordinal data pairs. It is worth mentioning that Spearman's coefficient addresses deviations that are not random by utilising a non-linear fit, thereby accurately capturing the extent of the association between variables (De Winter et al., 2016). Nevertheless, it is crucial to emphasise that the utilisation of Spearman's coefficient necessitates the presence of a noticeable inclination towards change in a particular direction. This chapter provides a detailed review and aspects determination for (a) pilot review, questionnaire and data collections, (b) an investigation into the extent of the most severe delays in projects that utilise Building Information Modelling (BIM) compared to traditional (Non-BIM) projects; (c) a ranking of the factors that contribute to delays attributed to employers, along with their corresponding critical success factors, in both BIM-enabled and traditional (Non-BIM) projects; and (d) a comprehensive analysis utilising Spearman's coefficient.

6.2 The Pilot Review

According to Polit et al. (2001), a pilot review functions as a concise interpretation of a comprehensive study or a preliminary test of the entire survey procedure. Additionally, it serves as a means of evaluating the practicality of the study undertaking. Moreover, this might be regarded as an essential preliminary testing stage for questionnaires or interviews. As a result, the pilot review carried out in this study fulfils two objectives: conducting a feasibility analysis and pre-testing to establish the validity and reliability of the gathered data. The pilot review conducted in this study was carried out with clearly defined key objectives. The primary objective of the pilot review was to compile accurate data regarding delay factors initiated by employers, particularly those that were not initially addressed in the questionnaire. The objective of the pilot evaluation was to evaluate and validate the terminology employed in delineating elements contributing to delays, with the purpose of enhancing clarity and precision. The definitions pertaining to different components of delay were thoroughly examined throughout the pilot review in order to ascertain their accuracy and clarity for easy understanding. The objective of the pilot review was to gather accurate and reliable data regarding essential success criteria, with a specific focus on those that were not initially incorporated in the questionnaire.

According to Connelly (2008), it is advisable to have a sample size for a pilot study that is equal to or greater than 10% of the total sample size of the parent model. However, the pilot sample size may need to be altered depending on the unique goals and requirements of the study in order to ensure that it effectively aligns with the research objectives. According to Isaac and Michael (1995), it has been proposed that a minimum sample size for pilot studies should range between 10 and 30 individuals. In accordance with the established rules, the researcher chose to utilise a sample size of 29 individuals for the pilot study in order to ensure the achievement of the objectives mentioned above.

In order to supplement the content validity of the questionnaire, the researcher initially administered it to a group of five construction experts who possessed extensive industry experience, each with a minimum of 20 years (Campbell & Stanley, 1963). This process covered a comprehensive examination of the substance and aims of the questionnaire, with particular attention given to aspects such as the clarity of the language, the structure of the questions, and the presence of any redundancies. The advice offered by experienced building professionals was thoroughly evaluated to guarantee the quality and efficacy of the questionnaire.

During this phase, all interviews were performed in person, allowing participants to fully engage with the research issue (Polit & Beck, 2010). The objective was to thoroughly examine the questionnaire with the participants, gathering significant insights and data regarding employer-initiated delays and crucial success elements in construction. It is worth mentioning that following the completion of ten interviews, the researcher concluded that the point of saturation had been attained. According to Malterud et al. (2016), it can be inferred that the stage at which additional significant knowledge could no longer be acquired has been reached.

Measurement stability, as conceptualised by Carmines and Zeller (1991), refers to the degree of consistency in the outcomes obtained when a test is administered to the same subject under comparable conditions. Different statistical techniques, such as the utilisation of Cronbach's alpha coefficient, are utilised in order to evaluate the stability of measurements, mostly concentrating on the internal consistency of items inside a questionnaire. After incorporating revisions based on the feedback received during the pilot evaluation, the researcher proceeded to administer the questionnaire to a sample of 29 participants. This sample was intentionally selected to include individuals with a wide range of experiences, involvement in various project kinds, and originating from different countries. The purpose of this stage was to assess the reliability of the questionnaire by calculating Cronbach's alpha coefficient and identifying any possible concerns or inconsistencies. Additionally, it functioned as a means to assess the extent to which the participants understood and accurately responded to the inquiries in the manner they were intended. Tables 6.1, and 6.2 show extensive details regarding the pilot respondents, incorporating their years of experience, roles, firm affiliations, and project kinds. These tables offer a full summary of the participant demographics. Table 6.1 covers years of experience for the pilot's respondents. 48.3% of the respondents had between 10 and 19 years of experience. Additionally, 24.1% of the respondents had between five and nine years of experience; 24.1% had at least 20 years of experience. Only 3.5% of the respondents had less than five years of experience. With this, it is evident that many respondents were highly experienced because only one respondent had very few years of experience. Further, five years of experience implies that a respondent is knowledgeable and can handle projects accordingly.

Table 6.1. Years of Experience for the Pilot Respondents

Years	**Number**	**Percentage (%)**
Less than 5	1	3.5%
5–9 years	7	24.1%
10–19 years	14	48.3%
20–Above	7	24.1%

Table 6.2 presents information about the roles of pilot respondents. Of these, 27.5% were site project managers. Most of these respondents played a significant role as site managers. Site managers are responsible for overseeing and supervising a project. With most respondents serving as site project managers, a project is likely to succeed by ensuring that the project's requirements and specifications are met. Also, there were design office managers, accounting for 6.9% each, and site engineers accounted for 17.1% of the respondents. Additionally, 10.3% of the respondents played the role of site construction manager; 10.3% of pilot respondents served as research or academic staff.

Table 6.2. Roles of Pilot Respondents

Role	Number	Percentage (%)
Site Project Director	2	6.9
Site Project Manager	8	27.5
Assistant Resident Engineer	1	3.5
Design Office Manager	2	6.9
Building Surveyor	1	3.5
Site Engineer	5	17.1
Site Construction Manager	3	10.3
Research/Academic Staff	3	10.3
Sr. QA/QC Coordinator	1	3.5
Sustainability Projects Manager	1	3.5
Others: Unspecified	1	3.5
Others: Construction Manager	1	3.5

Generally, all the pilot respondents played a significant role in ensuring the project was successful. Further, the resident assistant engineer, building surveyor, Senior QA/QC coordinator, sustainability projects manager and construction manager accounted for 3.5%. Unspecified roles were played by 3.5% of the participants.

This table presents a comprehensive summary of the varied group of persons who took part in the pilot project. The document emphasises the individuals' respective positions, levels of experience, and specialised knowledge within diverse domains associated with construction. In summary, the inclusion of a varied group of participants in the pilot project contributes to a diversified array of specialised knowledge and practical know-how, hence enhancing the depth and breadth of the study's findings pertaining to construction-related variables.

The pilot study participants agreed either in the direct interview or through answering the questionnaire that the questionnaire was suitable and reliable. Cronbach's alpha was used to measure the internal reliability of the research instrument. De Vos et al. (2011) state that Cronbach's alpha coefficient splits all questions differently and computes correlation values. The pilot data's reliability results using Cronbach's alpha are 0.899 for the traditional (Non-BIM) project and 0.94 for the BIM-enabled projects; these are considered acceptable.

It's crucial to emphasize the alterations implemented subsequent to the creation of the pilot survey. Several adjustments were made to enhance clarity and accuracy, ensuring the questions effectively conveyed their intended meaning. Firstly, textual revisions were undertaken to refine the wording, making the questions clearer and more comprehensible to the participants. This involved rectifying typographical errors and ambiguities that may have hindered understanding. Furthermore, the arrangement of the questions underwent modification to streamline the survey process and facilitate systematic responses from the participants. By reorganizing the questions, the survey was structured in a manner that facilitated ease of comprehension and straightforwardness in answering. These changes were aimed at optimizing the survey's effectiveness in eliciting meaningful and accurate responses from the participants, ultimately enhancing the quality and reliability of the data collected.

6.3 Data Collection and Sampling

In order to maintain the integrity of the data gathered on employer-initiated delay factors and their critical success factors, it is essential to implement a range of methods aimed at mitigating potential biases. The researcher has incorporated multiple criteria in order to minimise bias during the process of data collection. Initially, the researcher ensured confidentiality by assuring the participants that their names or emails would not be used. By assuring participants that their responses will remain anonymous, an atmosphere is established that promotes increased sincerity and transparency in the feedback provided. This methodology promotes a conducive environment for participants to express their perspectives without apprehension of negative consequences (Bryman, 2016).

The design of the questionnaire refrains from soliciting personal identifiers from participants. Ensuring the anonymity of participants and minimising potential bias arising from privacy or disclosure issues is a crucial measure in this process.

Before implementing the questionnaire on a larger scale, the researcher ran a pilot test with a limited number of participants. The initial testing step facilitates the detection of any concerns pertaining to the phrasing, organisation, or potential partiality of the questions. This allows for the option to enhance the questionnaire in order to guarantee clarity and impartiality. Bryan (2016) stressed the importance of the pilot review or pretesting when it comes to creating questionnaires. Basically, this is the step where you try out your questionnaire on a small group of people before using it on a larger scale. Bryan explained why this step is crucial in avoiding biased results; the way you ask a question can influence the answers you get. The pilot review helps you spot and fix any questions that might unintentionally push people to answer in a certain way. This makes your results more reliable and unbiased.

The construction of the questionnaire was conducted with great attention to detail in order to mitigate any biases. The survey utilises impartial language and refrains from using suggestive questions that could potentially influence participants towards particular answers.

Furthermore, the researcher conducted a Spearman's correlation study, which is elaborated upon in the subsequent section of this chapter. The correlation analysis examines the interrelationships among employers, contractors, consultants, and other pertinent parties. The presence of a high positive correlation in these associations implies that the influence of employers' responses as a source of bias in the data is unlikely to be substantial, especially since the correlation is happening between a wide spectrum of respondents.

The study team has implemented a variety of procedures in order to ensure the integrity of the data collection process. These preventive measures emphasise the dedication to acquiring impartial and dependable data for the research. Spearman's correlation analysis provides additional support for the credibility and dependability of the data, indicating that any potential bias resulting from employer replies has been successfully minimised. The implementation of this rigorous methodology serves to bolster the credibility of the study outcomes and guarantees the strength of the derived conclusions.

This study utilised both qualitative and quantitative methodologies to investigate the research inquiry thoroughly. The two methodologies mentioned in this context have separate and balancing objectives, and therefore, distinct data-gathering procedures were utilised to correspond with the specific aims of each strategy.

The qualitative methodology was employed with the aim of acquiring a more profound comprehension of the issue of delay and investigating the various factors and occurrences associated with it. The objective of this technique was to gain a comprehensive understanding of individuals' cognitive processes, viewpoints, personal encounters, dispositions, and convictions pertaining to delays inside the research framework (Sofaer, 2002). In order to accomplish this objective, the researchers implemented the subsequent data collection methodologies:

Semi-structured interviews were employed in this study, offering a combination of predetermined questions and the opportunity to explore specific themes in greater depth when they arose throughout the interview. The utilisation of this methodology facilitated a data collection process that was characterised by a more natural and investigative approach.

Researchers employ individual or non-participant observation as a means to directly observe and gather personal information pertaining to delays in various situations or occurrences. This methodology facilitated the acquisition of observational data, which has the potential to provide significant contextual information and insightful insights.

The study utilised task methodologies to get insights into people's approaches and strategies in addressing certain tasks or obstacles associated with delays. This methodology facilitated the examination of problem-solving techniques and the analysis of decision-making procedures by researchers.

The quantitative method, in contrast, places emphasis on the analysis of the delay problem through the use of numerical data that can be subjected to statistical examination (Robson, 2011). The predominant approach of collecting primary data in quantitative research often involves the utilisation of structured questionnaires or surveys, which are specifically designed to obtain data from a broader range of individuals. This methodology offers the quantitative data necessary for making statistical judgements and conducting hypothesis testing.

The significance of sampling cannot be overstated. Irrespective of the chosen method for data collection, the implementation of a robust sampling technique is essential to guarantee the dependability and credibility of the study (Kothari, 2004). The selection of participants, regardless of whether it is for qualitative or quantitative research, should align with the research aims and the intended population. The application of appropriate sampling strategies facilitates the process of extrapolating research findings to a wider population, hence minimising the likelihood of bias.

The integration of qualitative and quantitative methodologies in this study facilitated a thorough investigation of the issue of delay. Qualitative methodologies enabled a comprehensive comprehension of individuals' experiences and viewpoints, whilst quantitative methodologies furnished the requisite numerical data for statistical analysis. The selection of data collection methodologies and sample methods was determined by the particular objectives and criteria of each study strategy, thereby creating a comprehensive and robust research design.

The initial stage of this study was initiated by conducting a pilot survey comprising a sample of 29 experts from the international construction sector. The main aim of this pilot study was to evaluate the quality and pertinence of the questions incorporated in the questionnaire and implement any necessary enhancements in accordance with the recommendations of Teeline and Hundley (2001). The primary objective of this study was to identify the essential characteristics that contribute to employer-initiated delays in the construction sector at a global level. Furthermore, the study sought to evaluate the comparative significance of these characteristics. In addition, this study requires conducting a thorough analysis of the critical success factors linked to construction projects, as well as the moderators that impact the relationship between delays and critical success factors in various project contexts. Besides, investigates the correlation between employer-initiated delays and critical success factors. The primary objective of this research was to examine the correlations between delay factors and essential critical success criteria in distinct domains of study within the construction sector. The primary focus of the study was to examine a broad spectrum of individuals involved in the construction industry, such as employers, contractors, and consultants. The participants for the quantitative research study were chosen using a combination of random and convenience selection methods. Random sampling is a method of selecting individuals or items based on probability without the use of specific criteria to minimise bias (Komb & Tromp, 2006). This methodology guarantees that every individual within the population has an equitable opportunity to be selected for inclusion in the sample, hence augmenting the extent to which the findings can be applied to the broader community. The data collection process for the quantitative research study was conducted using a combination of various methodologies. Primary data was obtained through direct face-to-face interviews conducted with the respondents. This approach facilitated a more comprehensive examination of the responses and guaranteed a clear comprehension. Online questionnaire was chosen as the major method for data collection due to their ability to gather a substantial number of replies efficiently. This decision was made in consideration of the schedules of the intended respondents. The participants were given access to a questionnaire by either email or their LinkedIn profiles. The utilisation of this approach provided the benefit of expeditious data gathering and convenient availability for examination (Dillman, 2011). Considering the expectation of a response rate lower than 100%, a greater number of professionals were asked to partake in the survey, above the minimum needed threshold (Kline, 2007). The sample selection process was characterised by criteria covering characteristics such as extensive experience in the management of construction projects, possession of academic degrees and certifications, specialisation in certain areas of work, and participation in diverse types of construction projects.

Table 6.3 provides information for respondents based on their job titles in the project. The main job categories for this project include employer, consultant, contractor and others. This implies that the respondents played different roles in ensuring the project was successful. Any project consists of individuals playing various roles and contributing to its success, but they work together to attain the intended outcomes. In this project, Table 6.3 shows that most respondents were contractors, followed by consultants, other job titles, and finally, employers. According to the table, 10.15% of the pilot respondents were employers, 35.53% of the respondents were consultants, and 38.07% were contractors. We can see that 16.24% of the respondents were in other job categories, including subcontractors, project managers and unspecified roles. Based on the table, most respondents were contractors, implying that many were responsible for leading, planning, executing, supervising and inspecting the projects. Consultants accounted for a significant percentage of the pilot respondents. With 35.53% consultants, the project had as many consultants as contractors. With 10.15% of respondents serving as employers, it is evident that there were fewer employers than contractors and consultants. Also, many respondents were under other job titles, contributing to the project's success. Generally, the project had more contractors and consultants than other job title categories.

Table 6.3. Information for Respondents Based on their Job Title in Project

Job Title	Percentage (%)	No. of Respondents
Employer/Owner	10.15	20
Consultant/Engineer	35.53	70
Contractor/Subcontractors	38.07	75
Other disciplines	16.24	32
Total	---	197

To ensure the quality of the questionnaire, five experts in the construction field were interviewed to check the quality and completeness from the qualitative point of view. The participants were nominated using a purposive sampling technique. Berg (1989) states that 'certain individuals or persons displaying certain attributes' are usually selected in purposive sampling. Table 6.4 summarises these interviews, including their positions, locations and the interview method. The questions discussed with the experts mainly related to providing information about the questionnaire's quality and completeness: 'Are the construction delay factors addressed in the research in the construction field (delays caused by the employer) complete and covering the maximum spectrum?' 'are the critical success factors addressed in the research covering the whole aspects of construction for delays caused by the employer?' and 'Are the delay factors clear enough to be understood by the respondents?'

Table 6.4 presents fundamental descriptive statistics derived from the collected sample, providing valuable information regarding the participants' demographics and attributes. The inclusion of this extensive and diversified sample played a crucial role in assuring the production of strong and significant results throughout the quantitative research phase, effectively meeting the research objectives.

Table 6.4. Information for Respondents Based on their Demographic Area.

Interviewee Role	Interviewee Country	Method of Interviewing
Engineering Director	US	Online interview
Construction Manager	Australia	Online interview
Resident Engineer	Australia	Online interview
Project Engineer	UAE	Direct interview
BIM Manager	UAE	Direct interview

In addition, a comprehensive study was undertaken by Sanni-Anibire et al. (2020) on construction delays in the Gulf Cooperation Council nations, including Saudi Arabia, the United Arab Emirates, Kuwait, Bahrain, Oman, and Qatar. The primary objective of this study was to acquire a comprehensive understanding of the various elements that contribute to building delays within the selected countries. In order to achieve a comprehensive and inclusive sample, the researchers utilised a multi-layered strategy in the recruitment of participants. The recruitment process included a range of methods, such as reaching out to professional organisations, engaging in individual email communication, and conducting in-person administration of questionnaires at multiple tall building construction sites throughout the region. In the initial phase, a cumulative sum of 62 replies was obtained.

Nonetheless, a total of five replies were deemed unsuitable for analysis due to a range of factors, including incomplete or incorrectly filled out questionnaires, as well as their origin from experts located outside the Gulf Cooperation Council (GCC) region. As a result, the dataset employed in this investigation had 57 valid responses.

In order to evaluate the dependability and uniformity of the questionnaire survey, the researchers employed Cronbach's alpha, a well-established metric for assessing internal consistency. A remarkably high level of survey reliability was demonstrated by Cronbach's alpha score of 0.99. The outcome of this study provided further validation for the researchers' confidence in the reliability of their data, even though they utilised a single sample size across a wide range of countries. This confidence is strengthened by the sufficient level of consistency seen, as indicated by the measurement of Cronbach's Alpha. In addition, Mahdia and Soliman (2018) also did research on the topic of construction delays in the Arabic Gulf countries. The study centred on the identification and prioritisation of factors contributing to delays using qualitative methodologies. The researchers produced an exhaustive inventory of factors contributing to delays. Subsequently, they assigned a ranked order to these factors, taking into account their perceived level of importance across the Gulf Cooperation Council (GCC) nations. Additionally, they proposed a novel concept called the group effect index to assess the influence of collective variables on project delays. The utilisation of this index played a significant role in evaluating the impact of group dynamics on the occurrence of construction project delays within the countries of study. In order to conduct a more comprehensive examination of the data and assess the degree of similarity in the significance of delay reasons among the study nations, the researchers utilised the analysis of variance (ANOVA) test. This statistical method is appropriate for interval-level data and allows for parametric analysis. The statistical analysis facilitated the assessment of potential variations in the perceived significance of delay causes across the various nations within the Gulf Cooperation Council (GCC). The decision to utilise this approach was made in spite of the inherent ordinal nature of Likert scales due to its appropriateness within the research environment.

Furthermore, they employed Spearman's rank correlation coefficient to evaluate the level of concurrence in the prioritisation of delay causes. In this thesis, Cornbach's Alpha and Spearman coefficient tests have been conducted on the data collected to ensure the similarity and the reliability of the data collected for combined countries, which made this methodology feasible and consistent which made using one combined sample size for all countries is reasonable since the reliability and similarity is confirmed.

6.4 Participants' Demographic Characteristics

6.4.1 Participants' Role

Figure 6.1 shows the role of study participants. The respondents played various roles: site project directors, design office managers, resident engineers, technical office engineers, site construction managers, BIM managers and research staff.

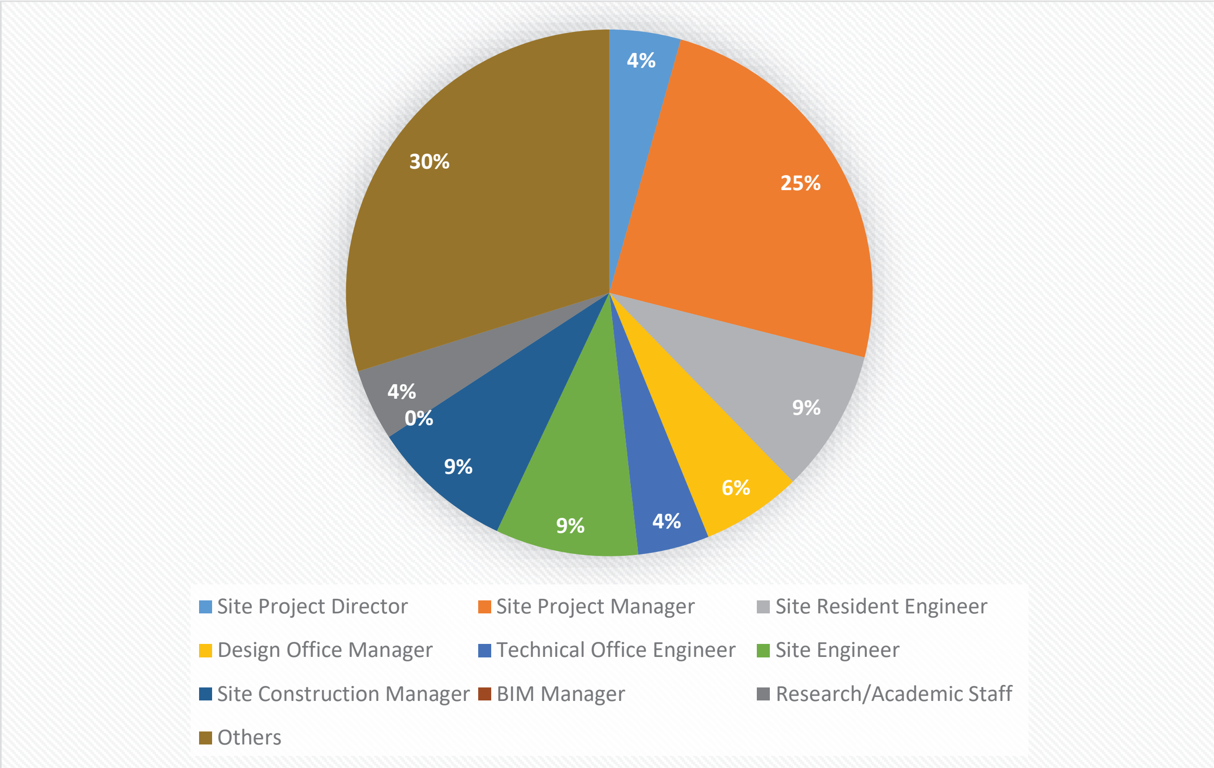

Figure 6.1. Participants' Roles

Notably, 4% of participants served as site project directors. Besides this, 25% of the respondents played the role of site project managers. Figure 6.1 also shows that 9% of the respondents were site resident engineers. Design office managers accounted for 6% of the study participants. On top of that, 4% and 9% of the respondents served as technical office and site engineers. Also, the study consisted of a site construction manager, accounting for 9% of the respondents; 4% of the respondents were research or academic staff. Finally, 30% of the participants played other roles. Technical office engineers, site directors and academic staff accounted for a minor percentage of the respondents at 4%. Design office managers followed them at 6%. Site resident engineers and site engineers accounted for 9% each.

6.4.2 Participants' Years of Experience

Table 6.5 provides an overview of the participants' years of experience. Precisely, 18.78% of the respondents had less than five years of experience; 21.83% of the participants had five to nine years of experience. Most participants, 41.62%, had 10 to 19 years of experience. Finally, 17.77% of the respondents had 20 years of experience. Based on the table, participants' years of experience ranged from five to more than 20 years.

Given that only 18.78% had less than five years of experience, it is evident that the project team comprised highly qualified and experienced members. Likewise, most participants had an experience of between 10 and 19 years, implying that no trainees or unqualified persons engaged in the project. All persons engaged in the project were experienced and capable of handling their specific roles as required. This increases the possibility of a project becoming successful. Also, five to nine years of experience enables individuals to acquire the necessary skills and knowledge to handle project-related tasks accordingly.

On top of that, with 17.77% of the respondents having at least 20 years of experience, the project team has enough experts to supervise and guide them to deliver their best effort and attain the intended project outcomes. Notably, a project's success depends on a team's ability to handle assigned tasks accordingly; thus, they need experience. Overall, this study identified highly qualified and experienced individuals to participate, increasing the possibility of the project's success.

Table 6.5. Overview of Participants' Years of Experience

Years of Experience	**Number of Respondents**	**Percentage (%)**
Less than 5	37	18.78%
5–9	43	21.83%
10–19	82	41.62%
20 or above	35	17.77%
Total	**197**	

6.4.3 Participants' Education Level

Table 6.6 displays the participants' educational levels. Notably, 49.75% of the participants had a Bachelor of Science (BSc). Also, 32.99% of the participants had a Master of Science (MSc). Only 3.05% had attained a PhD or higher; 14.21% of the participants had acquired other educational certifications.

Regarding educational achievement, most project team members must have a minimum of a B.Sc. degree. This is the minimum requirement to be involved in any project, ranging from the site manager, project manager, construction manager, and engineers. Having an M.Sc. degree is an added advantage.

However, project team members holding higher positions, such as site project directors, must have a higher level of education, such as an MSc, PhD or higher. This makes them qualified to ensure that a project is successful. Also, project team members can attain other certifications that may give an added advantage to handling tasks accordingly and contribute to the project's success. Having most participants with a BSc implies that qualified persons were engaged in the project. This indicates that most project team members had attained the minimum educational requirement to participate. A team with a high educational level and many years of work experience guarantee success. Besides, 32.99% of the respondents have attained an M.Sc., which is remarkable. With this, it is evident that many team members were qualified to hold higher positions, such as site project manager and perform the required roles and responsibilities. Even though the number of participants with a PhD or higher is relatively small, it is crucial to the project because it implies that highly qualified people guide the team members, especially those with slightly lower educational levels. Generally, the projects included participants with the required level of education.

Table 6.6. Participants' Educational Level

Level of Education	Number of Respondents	Percentage (%)
BSc	98	49.75%
MSc	65	32.99%

PhD or higher	6	3.05%
Others	28	14.21%
Total	**197**	

6.4.4 Participants’ Geographical Distribution

The study engaged participants from various countries, including the USA, the UK, Australia, Egypt, China, and the UAE. Table 6.7 shows the location of the respondents. Based on the table, 21.61% of the participants were from Australia, 6.96% and 2.93% of the respondents were from Egypt and China, 32.97% were from the UAE, 17.95% were from the UK, and 8.06% were from the US. Finally, 9.52% were from other countries. With this, it is evident that most of the participants were from the UAE. This was followed by Australia, which produced 21.61% of the participants. Besides, many participants were from the UK, as the country accounted for 17.95% of the study participants. Egypt and the US produced fewer participants, at 6.96% and 8.06%, respectively. Likewise, the number of participants from other unspecified nations was low. The study included participants from different countries globally; the project teams consisted of diverse individuals with different traits and backgrounds. Ensuring diversity in a project team is crucial because it allows input from people with specific cultures, skills and knowledge of handling projects. It is crucial to emphasize that the composition of the valid participants, totalling 197 individuals, differs from the number of participants in the geographical distribution due to the diverse geographical and international experiences they bring to the table. These participants have a unique characteristic that differentiates them from the original sample 197. This distinction arises from the valid participants' accumulated work experience in multiple countries and across different continents.

Table 6.7. Participants’ Geographical Distribution

Project Type	Percentage (%)	No. of Respondents
Australia	21.61	59
Egypt	6.96	19
China	2.93	8

UAE	32.97	90
UK	17.95	49
US	8.06	22
Others	9.52%	26
Total	**273**	---

6.4.5 Participants' Job Title

Table 6.8 displays the participants' job titles in this study. The projects have various job titles, including employer, contractor and consultant. Notably, different participants played distinct roles in contributing to their project's success. The table shows that 10.15% of the participants were employers, 35.53% were consultants, 38.07% were contractors, and 16.24% had other job titles. Based on this, most of the study participants were contractors. Notably, contractors are individuals or companies hired by another organisation to complete a project. They lead by providing the required materials and services to complete a project. Thus, with many contractors in a project, most focused on supplying the necessary resources to ensure project goals. Also, a considerable percentage of the participants were consultants. Both the contractor and consultant work closely to ensure project goals. Employers accounted for a minor percentage of participants at 10.15%. Further, other job titles, such as subcontractors and project management, formed 16.24% of the participants. The project participants had different job titles, with most of them being contractors, followed by consultants, then other titles, and finally, employers.

Table 6.8. Participants' Job Title

Job Title	No. of Respondents	Percentage (%)
Employer/Owner	20	10.15
Consultant/Engineer	70	35.53
Contractor/Subcontractors	75	38.07
Other Disciplines	32	16.24
Total	**197**	

6.5 Project Features

Table *6.9* provides information regarding the participants' project types. There are various projects that individuals can engage in, including airport, transportation, petroleum, commercial and residential, modular, power, water, industrial, sewer and waste, and hazardous waste projects. From the table, airport projects accounted for 16.95%. Also, 8.58% were transportation projects, while 2.51% were petroleum projects. In addition, 34.10%, 3.97% and 5.02% were commercial and residential building, modular, and power projects. Besides, industrial, water, sewer and waste, and hazardous waste accounted for 8.79%, 5.86%, 7.95% and 0.42%. Notably, most of the projects were commercial and residential, implying that many participants were engaged in building projects. There were also many airport projects, accounting for 16.95%. Industrial and transportation projects followed at 8.79% and 8.58%, respectively. There were very few hazardous waste projects, at 0.42%. Petroleum, modular, power and water projects accounted for 2.51%, 3.97%, 5.02% and 5.86%, respectively. Generally, participants worked on various projects, with commercial and residential buildings being the most common. It is crucial to emphasize that the composition of the valid participants, totalling 197 individuals, differs from the number of participants in the project types due to the diverse international experiences of the participants in different types of projects. These participants have multiple project types of experience that differentiate them from the original sample 197.

Table 6.9. Participant Project Types

Project Type	**No. of Respondents**	**Percentage (%)**
Airport Projects	81	16.95%
Transportation Projects (Not Airports)	41	8.58%
Petroleum Projects	12	2.51%
Commercial and Residential Building Projects	163	34.10%
Modular Projects	19	3.97%
Power Projects	24	5.02%
Industrial Projects	42	8.79%
Water Projects	28	5.86%
Sewer and Waste Projects	38	7.95%

Hazardous Waste Projects	2	0.42%
Total	**478**	

6.6 The Magnitude of Worst Delays

The administered survey involved participants who were asked to provide information on the frequency and magnitude of project delays experienced in their construction projects within the previous ten-year period. In the sample of participants involved in projects utilising Building Information Modelling (BIM), 1,229 projects were included. Of these projects, 699 were reported to have encountered delays, accounting for approximately 56% of the BIM-enabled projects. Within the context of traditional (Non-BIM) projects, the participants exchanged information about 3,801 projects, of which 2,384 experienced delays, constituting approximately 62% of the traditional (Non-BIM) initiatives. The data presented suggests that projects utilising Building Information Modelling (BIM) demonstrated a marginally reduced occurrence of delays compared to traditional (Non-BIM) projects.

Love et al. (2005) did a study examining the correlations between time and cost in the context of 161 projects in Australia, which is of particular significance. The researchers examined several procurement strategies, and the findings indicated that the average occurrence of time overruns was documented at a rate of 20.7%. The observed delay rates in the present research, for both BIM-enabled and traditional (Non-BIM) projects, are significantly higher than this proportion. Moreover, the study undertaken by Shebob et al. (2012) centred on examining delays within the building sector in the United Kingdom. The researchers' investigation revealed that the average delay value was approximately 9%, stressing that the delay rates observed in this present study, especially for traditional (Non-BIM) projects, exceed previous research findings.

Tables 6.10 and 6.11 provide a thorough dataset that demonstrates the notable delays experienced by professionals in projects utilising Building Information Modelling (BIM) as opposed to those following traditional (Non-BIM) project management approaches. In the context of traditional (Non-BIM) project scenarios, the observed delays varied from a minimum duration of one month to an astonishing maximum duration of 42 months. In contrast, projects that utilise Building

Information Modelling (BIM) demonstrate a more limited range of delays, ranging from a minimum worst-case delay of about 0.5 months to a maximum delay of 36 months.

Upon examination of the average durations of delays, it is evident that traditional (Non-BIM) projects encountered an average delay of roughly 10.7 months. Projects that integrated Building Information Modelling (BIM) exhibited considerably reduced average delays, with an average duration of around 5.35 months. The mean values presented in this analysis provide clear evidence that construction projects that employ Building Information Modelling (BIM) technology exhibit a lower likelihood of encountering delays, as well as shorter durations of delays when they do occur, in comparison to building projects that do not utilise BIM.

The presented data highlights the potential advantages of implementing Building Information Modelling (BIM) technology in construction endeavours, as it seems to facilitate improved project management and decreased instances of project delays. The results indicate that Building Information Modelling (BIM) has the potential to serve as a valuable instrument for optimising construction procedures and improving project schedules.

In order to enhance the comprehensiveness of the explanation pertaining to the extraction of data for Tables 6.10 and 6.11 from the questionnaire, it is imperative to explain that these tables specifically include data pertaining to the most substantial delay experienced by each participant within the framework of one project, regardless of whether it is a traditional (Non-BIM) construction project or one that integrates Building Information Modelling (BIM) technology.

During the administration of the questionnaire, participants were requested to provide a comprehensive account of their experiences pertaining to a particular project in which they possessed knowledge regarding both the anticipated (expected) duration and the factual duration of said project. The aforementioned crucial data enabled us to compute the proportion of delay for this specific undertaking, which signifies the most severe delay situation encountered throughout their professional contract.

It is noteworthy to mention that not all participants furnished data pertaining to this particular area of the survey. Certain participants may not have encountered any notable delays in their project, leading to their inability to provide data for this particular inquiry. In instances of this nature, the exclusion of their data from the dataset pertaining to these tables should not be seen as a deficiency in their involvement but rather signifies the absence of a significant delay in their project-related experience.

Tables 6.10 and 6.11 are essential resources for the analysis and comprehension of delay occurrences in construction projects, particularly those of a severe nature. These tables provide insights into the experiences of individuals involved in either traditional (Non-BIM) or BIM-enabled projects who have encountered such delays.

Table 6.10. Frequency of Worst Delays Experienced in BIM-Enabled Projects

Delay Percentages	Number of Respondents	Proportion	Cumulative Proportion
Delay between 0–25%	76	69.7%	69.7%
Delay between 26–50%	23	21.1%	90.8%
Delay between 51–75%	5	4.6%	95.4%
Delay between 76–100%	2	1.8%	97.2%
Delay over 100%	3	2.8%	100%

Table 6.11. Frequency of Worst Delays Experienced in Traditional (Non-BIM) Projects

Delay Percentages	Number of Respondents	Proportion	Cumulative Proportion
Delay between 0–25%	75	41.9%	41.9%
Delay between 26–50%	46	25.7%	67.6%
Delay between 51–75%	22	12.3%	79.9%
Delay between 76–100%	24	13.4%	93.3%
Delay over 100%	12	6.7%	100%

Figures 6.2 and 6.3 function as illustrative tools, providing valuable insights into the most severe delay values observed in both traditional (Non-BIM) and Building Information Modelling (BIM)-enabled approaches to project management. The data mentioned above provide significant insights into the distribution patterns of the delays mentioned above, facilitating a more profound comprehension of their inherent characteristics and ramifications for the field of project management.

Figure 6.2 displays the traditional (Non-BIM) project management strategy, wherein we can detect a distribution that is favourably skewed, as shown by a skewness value of 1.423. The presence of positive skewness suggests that the bulk of delay values are concentrated towards the lower end of the distribution, while a relatively small proportion of extreme delay values exert an influence on the rightward shift of the mean. As a result, the average delay value exceeds the middle value, indicating a right-skewed distribution on the graph. In addition, the kurtosis value observed for typical projects is 1.449, indicating a univariate distribution that closely approximates a normal distribution. In more accessible language, the distribution follows a fairly typical pattern and does not contain any notable extreme values.

Figure 6.3 exhibits a comparable positive skewness in the BIM-enabled projects but with a somewhat larger skewness value of 3.05. The observed high skewness indicates that projects utilising Building Information Modelling (BIM) demonstrate a greater concentration of delay values towards the lower end of the range, resulting in a higher rightward shift of the mean. In a manner similar to traditional (Non-BIM) projects, this suggests that BIM-enabled projects exhibit a mean delay value that exceeds the median, indicating a right-skewed distribution. However, a distinguishing characteristic of BIM-enabled projects is their significant kurtosis score of 11.3, which suggests a leptokurtic distribution. The observed kurtosis value indicates a higher occurrence of extreme values in the delay data for projects utilising Building Information Modelling (BIM) technology. A leptokurtic distribution is characterised by a higher probability of meeting extreme values or outliers, as a substantial proportion of values is concentrated in the tails of the distribution. On the other hand, the conventional methodology exhibits a rather balanced dispersion, characterised by a bell-shaped curve with a central peak of modest magnitude and a reduced occurrence of extreme values.

In brief, the analysis of Figures 6.2 and 6.3, along with the corresponding skewness and kurtosis measurements, offers significant insights into the delay distributions of both traditional (Non-BIM) and Building Information Modelling (BIM)-enabled projects. The results mentioned above highlight the significant differences in the distribution characteristics seen in the two project management methodologies. Projects that utilise Building Information Modelling (BIM) exhibit a notable clustering of delays towards the lower end of the range, as well as a higher likelihood of encountering exceptionally long delays. On the other hand, conventional projects exhibit a more equitable and measured allocation of delays, hence fostering a deeper comprehension of the dynamics inherent in various project management situations.

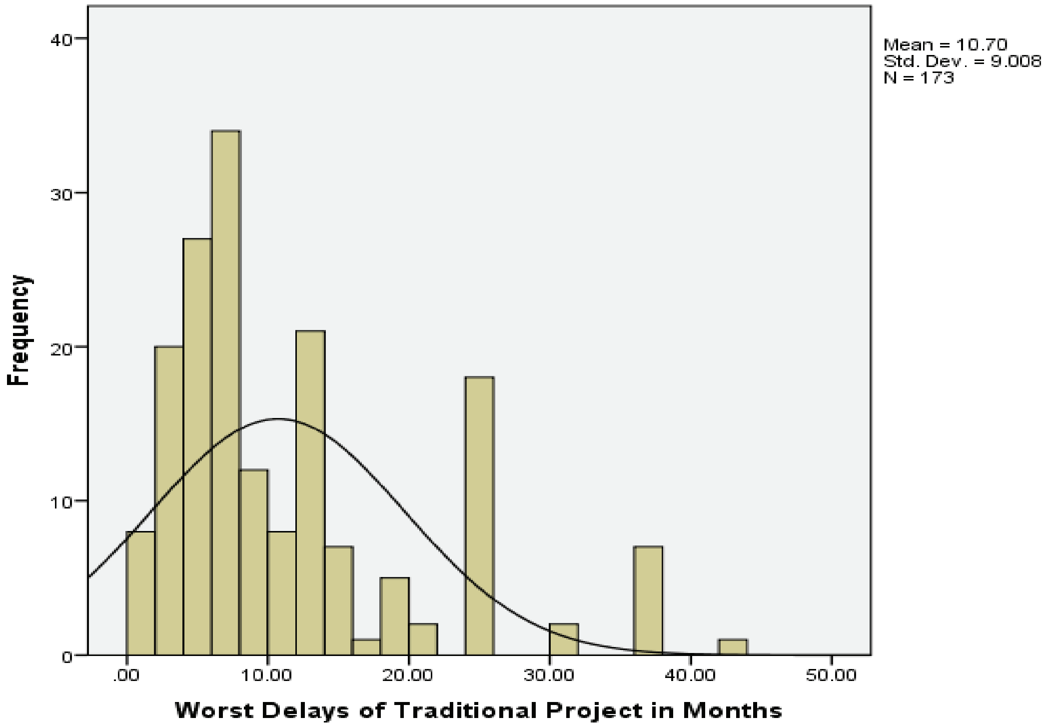

Figure 6.2.Worst Delay of Traditional (Non-BIM) Project in Months

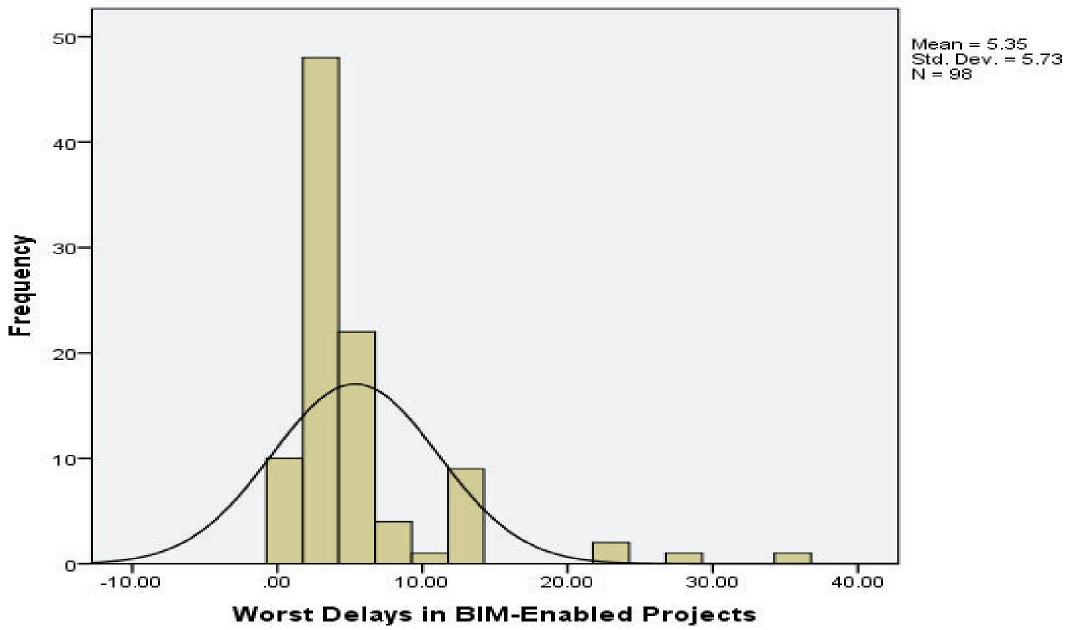

Figure 6.3.Worst Delay of BIM-Enabled Projects in Months

6.7 Ranking for Employer-Caused Delays and Critical Success Factors in Traditional (Non-BIM) and Building Information Modelling Type Projects

Tables 6.12 and 6.13 serve as comprehensive references that clarify the feedback collected from respondents, offering an informative perspective on the causes of construction delays. These tables present a ranking of responses, segregating them into traditional (Non-BIM) and BIM-enabled projects, thus facilitating a deeper understanding of the distinct challenges encountered in each context.

Table 6.12 dives into the details of delays within traditional (Non-BIM) projects. Evidently, respondents have located the approval process for work scope and specification changes as the most significant contributor to construction setbacks. This revelation implies that alterations and amendments to project plans and specifications often encounter bureaucratic obstacles or procedural bottlenecks, ultimately hindering project progress. The second most prevalent factor identified was the delay in processing claims, which suggests the existence of potential disputes and disagreements during construction that act as obstacles. Additionally, the delay in decision-making by the employer emerged as another substantial cause of delays, underscoring the critical nature of swift decision-making in construction management. Respondents also highlighted other factors such as delayed payments, underestimating project costs, challenges in creating accurate budgets, and excessive bureaucratic procedures. Although irregular attendance at weekly meetings emerged as a relatively less prominent factor, it still made a noteworthy contribution to project disruptions. Furthermore, the selection of the wrong construction site, including issues relating to infrastructure suitability and soil conditions, was cited as a less common but notable factor.

Table 6.13 shifts the spotlight onto BIM-enabled projects, revealing a different set of challenges. The most prominent issue identified by respondents in this context was the inadequacy of penalties for delays, indicating that the contractual mechanisms in place to address delays may have lacked sufficient punitive force or effectiveness. This shortcoming may have resulted in a negligent attitude towards meeting project timelines. Closely following this, respondents cited the imposition of unreasonable liabilities or penalties on contractors as a substantial factor, emphasizing the importance of equitable and well-balanced contract terms in BIM-enabled projects. Other contributors to delays in BIM-enabled construction projects included the late awarding of contracts, delays in compensation following the land acquisition, lags in site furnishings, organizational inefficiencies, and short contract durations.

Interestingly, improper investment initiatives and preliminary feasibility studies were ranked the lowest among the factors, suggesting that these aspects may have had a relatively minor impact on project delays. Similarly, the selection of the lowest bidders, represented by the term "wrong tendering systems," emerged as a less prominent factor affecting BIM-enabled projects.

In conclusion, Tables 6.12 and 6.13 serve as invaluable resources, shedding light on the unique challenges and underlying causes of delays within both traditional (Non-BIM) and BIM-enabled construction projects. These insights underscore the necessity of addressing specific issues and adapting project management strategies to the specific nature of the project, be it traditional (Non-BIM) or BIM-enabled, in order to mitigate delays effectively.

Table 6.12. Ranking of Employer-Initiated Delay Factors for Traditional (Non-BIM) Projects

Factor Code	Average	Rank
DMA1	4.27	1
DCA7	4.22	2

DMA3	4.22	3
DFA1	4.19	4
DFA2	4.18	5
DFA3	4.16	6
DFA4	4.04	7
DTA2	3.98	8
DMA4	3.95	9
DSA2	3.95	10
DCA2	3.89	11
DMA2	3.87	12
DSA1	3.72	13
DTA4	3.69	14
DTA3	3.53	15

Table 6.13. Ranking of Employer-Initiated Delay Factors for BIM-Enabled Projects

Factor Code	**Average**	**Rank**
DCA4	3.93	1
DCA5	3.84	2
DCA3	3.78	3
DCA6	3.77	4
DCA10	3.77	5
DCA9	3.61	6
DTA2	3.37	7
DMA10	3.32	8
DTA3	3.32	9
DSA2	3.31	10
DMA9	3.30	11
DFA3	3.30	12
DFA2	3.29	13

DMA8	3.27	14
DTA1	3.26	15
DSA1	3.25	16
DFA1	3.24	17
DMA7	3.20	18
DMA11	3.17	19
DFA4	3.15	20

Table 6.14 presents various factors that contributed to the success of projects that used traditional (Non-BIM) and BIM-initiated approaches. The participants attributed project success to competent consultants, proper planning and budget estimation, and extensive feasibility studies considering groundwork design and site conditions. The responses mapped out in Table 8.5 prove that addressing communication lags in traditional (Non-BIM) projects by requiring that regulations and design changes be relayed to contractors quickly is the surest way to guarantee success. Another highly effective approach is to plan the construction thoroughly while preparing for unexpected events. The least effective method is for employers to hasten their decision-making process or to fail to conduct regular site visits and meetings to enhance problem-solving.

Table 6.14. Ranking of Critical Success Factors for BIM-Enabled Projects

Factor Code	Average	Rank
SM03	4.13	1
SM09	4.12	2
ST01	4.11	3
ST02	3.98	4
SM04	3.93	5
SM10	3.90	6
SM02	3.78	7
SM08	3.75	8

Table 6.15 describes the critical success factors for construction sites that have adopted the BIM technique. The highest-ranked element was regular, successful meetings that included the relevant parties for problem-solving. Another highly ranked aspect was introducing a bonus scheme for all employees if they completed construction early. Other critical success factors mentioned by the

participants included owners speeding up decision-making, adequate budget allocation, close progress monitoring, approving/confirming design drawings, the construction concept and material selection before the building began. Effective value management ranked last while investigating site conditions, and groundwork design also ranked lowly.

Table 6.15. Ranking of Employer's Critical Success Factors for Traditional (Non-BIM) Projects

Factor Code	Average	Rank
SM02	3.69	1
SM07	3.66	2
SM09	3.63	3
SM06	3.60	4
SM01	3.59	5
SM08	3.59	6
SM04	3.56	7
SM05	3.54	8
ST01	3.38	9
ST02	3.36	10
SM12	3.31	11
SM10	3.28	12
SM11	3.23	13

6.8 Employer-Caused Delay and Critical Success Factors' Ranking for Project Parties, Project Countries and Project Types

Table 6.16 provides a thorough examination of the elements attributing to construction project delays arising from employer-initiated activities. This research examines the viewpoints of different stakeholders involved in these projects and integrates key factors necessary for attaining favourable results. Significantly, this study illuminates the complexities associated with project delays in the context of utilising Building Information Modelling (BIM) technology.

After carefully examining the feedback provided by various stakeholders, it becomes apparent that there is a disagreement in their perspectives on the issues that contribute to project delays.

Employers and contractors often underestimate the importance of defective tendering processes, perceiving them to have a relatively negligible effect on project delays. On the other hand, engineers and other professionals attribute project completion delays to incorrect investment strategies and insufficient feasibility standards, asserting that these factors have a diminished impact.

It is important to highlight that employers, contractors, and professionals all agree on the significant role that regular stakeholder meetings play in the success of a project. Nevertheless, engineers place significant emphasis on the effectiveness of a bonus incentive scheme as the most dependable vital success component for Building Information Modelling (BIM) projects. On the contrary, it is often perceived by all parties involved that the employer's efficient value management is of lesser importance for achieving success.

Tables 6.17 and 6.18 present a comprehensive examination of the delays that occur due to employer activities and the critical aspects contributing to success in different countries and continents. The tables mentioned above provide significant information regarding geographical variations in the dynamics of construction projects.

The primary factors contributing to building delays in Africa have been identified as disruptions in site furnishings and supply chains. Significantly, it was observed that three factors played a crucial role in enhancing project success in Africa. These factors covered the verification of job data accuracy in conjunction with project completion, the introduction of a bonus scheme aimed at incentivizing early completion, and the implementation of astute employer planning that incorporates adaptability to unforeseen challenges.

Insufficient contract durations have emerged as the predominant factor contributing to project delays in China, underscoring the significance of well-specified and feasible project timetables. In the Chinese setting, the attainment of project success was contingent upon the organisation of routine gatherings that included all pertinent stakeholders, as well as the implementation of analytical reasoning.

On the other hand, Australia had significant setbacks as a result of inadequate consequences for project delays, highlighting the necessity of strong contractual limitations to discourage such delays. Similar to China, Australia ascribed the achievement of project success to the regular convening of stakeholder meetings and the utilisation of analytical reasoning.

Insufficient investment plans and feasibility evaluations were deemed to have a lesser impact on project delays in the United Kingdom and Asia. These regions placed a higher emphasis on alternative success determinants, perceiving these aspects to have a lesser influence on delays. In the context of the United States, it was observed that faulty tendering techniques were perceived as a relatively inconsequential element in the overall causation of construction delays. This observation implies that tendering procedures in the United States may exhibit a lower susceptibility to delays in comparison to other geographical regions.

Table 6.16. Ranking for BIM-Enabled Projects by Project Parties

BIM-Enabled Projects-Parties																
N	Employer				Engineer				Contractor				Others			
	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank
1	DCA4	3.85	SM02	3.50	DCA4	3.94	SM07	3.69	DCA4	3.96	SM02	3.77	DCA4	3.88	SM02	3.72
2	DCA6	3.80	SM06	3.45	DCA5	3.86	SM02	3.64	DCA5	3.89	SM07	3.77	DCA5	3.78	SM01	3.56
3	DCA3	3.65	SM05	3.40	DCA3	3.79	SM09	3.63	DCA10	3.87	SM09	3.77	DCA10	3.75	SM04	3.53
4	DCA5	3.65	SM07	3.40	DCA10	3.77	SM08	3.61	DCA3	3.84	SM06	3.71	DCA3	3.69	SM07	3.50
5	DCA10	3.45	SM08	3.40	DCA6	3.76	SM06	3.60	DCA6	3.81	SM08	3.71	DCA6	3.69	SM09	3.50
6	DTA2	3.35	SM04	3.35	DCA9	3.63	SM01	3.59	DCA9	3.69	SM01	3.68	DCA9	3.56	SM06	3.47
7	DCA9	3.35	SM09	3.35	DTA2	3.51	SM04	3.57	DTA3	3.43	SM05	3.65	DSA2	3.22	SM05	3.38
8	DMA9	3.15	SM01	3.30	DMA10	3.41	SM05	3.53	DFA3	3.40	SM04	3.61	DMA8	3.19	SM08	3.38
9	DSA2	3.15	ST01	3.15	DMA9	3.39	ST01	3.43	DMA10	3.37	ST02	3.41	DMA9	3.19	ST01	3.38
10	DTA1	3.15	SM12	3.10	DSA1	3.37	ST02	3.41	DSA2	3.36	ST01	3.39	DTA1	3.19	SM10	3.25
11	DTA3	3.15	ST02	3.10	DMA8	3.36	SM12	3.40	DTA2	3.35	SM12	3.33	DFA2	3.19	ST02	3.25
12	DFA1	3.15	SM10	3.05	DSA2	3.36	SM10	3.33	DFA2	3.33	SM10	3.32	DMA10	3.16	SM12	3.22
13	DFA2	3.15	SM11	2.95	DTA3	3.36	SM11	3.30	DTA1	3.32	SM11	3.28	DFA1	3.16	SM11	3.16
14	DFA3	3.15			DFA2	3.34			DMA9	3.31			DTA2	3.13		
15	DMA10	3.10			DFA3	3.33			DFA1	3.31			DTA3	3.13		
16	DSA1	3.1			DMA11	3.29			DMA8	3.29			DFA3	3.09		
17	DMA8	3.05			DMA7	3.27			DMA7	3.27			DMA7	3.06		
18	DFA4	3.00			DTA1	3.27			DSA1	3.25			DMA11	3.06		
19	DMA7	2.95			DFA1	3.24			DFA4	3.21			DSA1	3.06		
20	DMA11	2.85			DFA4	3.17			DMA11	3.19			DFA4	3.03		

Table 6.17. Ranking for BIM-Enabled Projects by Project Countries

BIM-Enabled Projects-Countries												
N	Africa				China				Australia			
	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank
1	DFA8	10.4	SM06	4.20	DCA10	4.00	SM02	3.88	DCA4	3.88	SM02	3.69
2	DFA7	9.4	SM07	4.20	DCA4	3.88	SM01	3.75	DCA6	3.76	SM06	3.64
3	DFA6	8.4	SM09	4.20	DTA2	3.75	SM04	3.75	DCA5	3.71	SM07	3.63
4	DFA5	7.4	SM05	4.00	DCA5	3.75	SM07	3.50	DCA10	3.66	SM09	3.63
5	DFA4	6.4	SM08	4.00	DCA9	3.75	SM09	3.50	DCA3	3.61	SM05	3.59
6	DFA3	5.4	SM02	3.80	DTA1	3.63	ST02	3.50	DCA9	3.39	SM04	3.58
7	DCA4	4.4	SM04	3.60	DTA3	3.63	SM10	3.38	DTA2	3.34	SM08	3.58
8	DFA2	4.4	SM01	3.40	DCA3	3.63	SM11	3.38	DSA2	3.27	SM01	3.41
9	DCA5	4	SM10	3.40	DCA6	3.63	SM12	3.38	DFA2	3.27	ST01	3.31
10	DCA6	4	SM11	3.40	DMA7	3.50	ST01	3.38	DTA3	3.25	SM10	3.25
11	DCA10	4	SM12	3.40	DMA8	3.50	SM05	3.25	DFA3	3.25	ST02	3.20
12	DTA2	3.8	ST01	3.40	DMA9	3.50	SM06	3.25	DMA8	3.15	SM12	3.15
13	DCA3	3.8			DMA10	3.50	SM08	3.25	DMA9	3.14	SM11	3.08
14	DMA8	3.6			DFA1	3.50			DSA1	3.12		
15	DSA1	3.6			DFA3	3.50			DMA7	3.10		
16	DMA9	3.4			DSA1	3.38			DMA10	3.10		
17	DMA10	3.4			DSA2	3.38			DTA1	3.08		
18	DMA11	3.4			DFA2	3.25			DFA1	3.08		
19	DTA1	3.4			DMA11	3.13			DFA4	3.07		
20	DFA1	3.4			DFA4	3.00			DMA11	3.00		

Table 6.18. Ranking for BIM-Enabled Projects by Project Countries

BIM-Enabled Projects-Countries												
N	UK				Asia				US			
	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank
1	DMA7	3.05	SM01	3.49	DCA4	3.96	SM07	3.68	DCA4	3.87	SM02	3.70
2	DMA8	3.13	SM02	3.56	DCA5	3.84	SM02	3.67	DCA5	3.83	SM07	3.61
3	DMA9	3.22	SM04	3.44	DCA3	3.82	SM09	3.65	DCA6	3.83	SM08	3.61
4	DMA10	3.22	SM05	3.38	DCA10	3.79	SM06	3.64	DCA10	3.57	SM09	3.61
5	DMA11	3.04	SM06	3.45	DCA6	3.76	SM08	3.59	DCA3	3.48	SM04	3.48
6	DSA1	3.13	SM07	3.56	DCA9	3.62	SM01	3.58	DTA3	3.43	SM06	3.48
7	DSA2	3.25	SM08	3.53	DTA2	3.41	SM05	3.57	DFA3	3.43	SM01	3.43
8	DTA1	3.15	SM09	3.49	DMA10	3.36	SM04	3.57	DTA2	3.39	SM05	3.39
9	DTA2	3.38	SM10	3.18	DTA3	3.36	ST01	3.36	DSA2	3.35	SM10	3.30
10	DTA3	3.24	SM11	3.13	DMA9	3.36	ST02	3.36	DTA1	3.35	ST01	3.26
11	DFA1	3.15	SM12	3.24	DSA2	3.33	SM12	3.30	DFA1	3.35	SM12	3.22
12	DFA2	3.25	ST01	3.33	DFA3	3.33	SM10	3.25	DFA2	3.35	ST02	3.17
13	DFA3	3.24	ST02	3.29	DTA1	3.31	SM11	3.21	DCA9	3.35	SM11	3.09
14	DFA4	2.96			DFA2	3.30			DMA8	3.17		
15	DCA3	3.73			DSA1	3.30			DMA9	3.13		
16	DCA4	3.84			DMA8	3.29			DMA10	3.13		
17	DCA5	3.73			DFA1	3.28			DSA1	3.09		
18	DCA6	3.65			DMA7	3.25			DMA7	3.04		
19	DCA9	3.55			DMA11	3.17			DFA4	3.04		
20	DCA10	3.65			DFA4	3.14			DMA11	2.91		

Tables 6.19, 6.20, and 6.21 provide a comprehensive evaluation of diverse factors influencing distinct categories of construction projects facilitated by Building Information Modelling (BIM). The provided tables present significant insights into the factors that contribute to project delays and essential success characteristics that are unique to each project category.

Within the context of modular projects, it is evident that three key factors significantly obstruct progress: inadequate penalties, excessive contractor fines, and delayed contract awards. The concerns mentioned above underscore the need for formulated contractual provisions and quick contractual procedures in attaining punctual project finalisation. However, modular builds have been found to be significantly influenced by factors such as close progress monitoring and comprehensive validation of work data accuracy, particularly in relation to completion progress. This highlights the importance of thorough project monitoring and data validation in the context of modular construction.

In the context of construction activities, a set of eight characteristics were identified as being of considerable importance in relation to project delays. These considerations included various aspects such as irregular attendance at meetings, adherence to foreign quality control criteria, and difficulties in allocating budgetary resources. The findings mentioned above underscore the necessity for enhanced coordination, adherence to established quality standards, and efficient financial planning in the context of hazardous building projects. On the other hand, essential factors contributing to the achievement of hazardous sites included the implementation of frequent meetings, sufficient allocation of financial resources, the provision of incentive programmes, and the establishment of a strong and comprehensive project plan. These characteristics were considered crucial in guaranteeing the success of projects in the construction of hazardous buildings.

In the context of sewage projects, the involvement of contractors was found to have a substantial impact on project delays, primarily due to the presence of unjustified penalties and the absence of relevant incentives. This underscores the need for equitable contractual provisions and incentivization mechanisms in fostering motivation among contractors engaged in sewage development. The need for expeditious design and drawing approval was underscored in sewerage projects as a primary determinant of construction achievement.

The primary focus of industrial construction projects lies in the examination of contractor fines, which are deemed to be unjust, as a significant factor contributing to project delays. Efficient contractual arrangements and conflict resolution processes play a vital role in alleviating the challenges mentioned above encountered in industrial construction projects. Efficient value management was shown to be of relatively lower significance in both modular and industrial projects, indicating that these project types prioritise other facets of project management.

The biggest cause of delays in power, commercial, and transportation projects has been recognised as ineffective delay fines. These projects have underscored the necessity of clearly specified and enforceable contractual provisions. The failure to consider contractor incentives for early completion in petroleum projects has been found to be associated with delays in construction, underscoring the significance of matching incentives with project objectives.

Airport construction projects have also identified inefficient delay fines as a substantial factor contributing to construction delays. On the other hand, a significant contributing factor in water projects was the deliberate postponement of interim progress payments. The findings mentioned above highlight the significance of effective financial management and punctual payments in the context of these particular project categories.

The participants engaged in different forms of construction projects suggested that the most significant reasons contributing to delays were underestimated costs and short contract terms. This highlights the necessity for improved project planning and more accurate cost prediction. In contrast, water projects placed significant emphasis on the pivotal role of qualified consultants, highlighting the paramount significance of competence within this domain.

When considering minor yet noteworthy factors contributing to crucial success, airport projects have shown a preference for effective value management, whereas other project types prioritised timely consultant payments. Water projects have identified bonus programmes as the least crucial factor for achieving success, indicating that these projects may prioritise alternative incentives for attaining their objectives.

Table 6.19. BIM-Enabled Projects by Project Type

N	BIM-Enabled Project Type															
	Modular				Hazardous				Sewerage				Industrial			
	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank
1	DCA4	3.63	SM05	3.53	DTA1	4.00	SM02	4.50	DCA3	4.20	SM01	4.00	DCA5	3.83	SM01	3.60
2	DCA5	3.63	SM06	3.53	DTA3	4.00	SM04	4.50	DCA5	4.20	SM07	3.90	DCA3	3.79	SM07	3.55
3	DCA6	3.63	SM04	3.47	DFA1	4.00	SM07	4.50	DCA4	4.10	SM05	3.80	DCA4	3.79	SM02	3.52
4	DTA2	3.58	SM07	3.47	DFA3	4.00	SM09	4.50	DCA6	4.00	SM06	3.80	DCA9	3.69	SM06	3.52
5	DCA3	3.58	SM02	3.42	DCA4	4.00	SM01	4.00	DCA9	4.00	SM08	3.80	DCA10	3.67	SM09	3.50
6	DCA10	3.47	SM01	3.37	DCA5	4.00	SM05	4.00	DCA10	3.90	SM02	3.70	DCA6	3.64	ST02	3.50
7	DSA2	3.42	SM08	3.37	DCA6	4.00	SM06	4.00	DMA10	3.70	SM09	3.70	DSA2	3.45	SM08	3.48
8	DFA2	3.42	SM09	3.37	DCA10	4.00	SM08	4.00	DTA2	3.70	SM12	3.60	DFA2	3.40	SM04	3.45
9	DCA9	3.42	ST02	3.26	DSA1	3.50	SM10	4.00	DMA9	3.60	ST02	3.60	DTA3	3.38	SM05	3.45
10	DMA9	3.37	SM12	3.21	DSA2	3.50	SM11	4.00	DSA1	3.60	SM04	3.40	DTA2	3.36	ST01	3.43
11	DSA1	3.37	SM10	3.16	DTA2	3.50	SM12	4.00	DMA7	3.50	SM11	3.40	DMA9	3.33	SM12	3.38
12	DTA3	3.37	ST01	3.16	DFA2	3.50	ST01	4.00	DMA8	3.50	ST01	3.40	DFA3	3.33	SM10	3.31
13	DFA3	3.37	SM11	3.05	DFA4	3.50	ST02	4.00	DSA2	3.50	SM10	3.20	DMA10	3.31	SM11	3.31
14	DMA7	3.32			DCA9	3.50			DTA1	3.50			DSA1	3.29		
15	DMA8	3.32			DMA7	3.00			DTA3	3.50			DTA1	3.29		
16	DMA10	3.32			DMA8	3.00			DFA1	3.50			DMA7	3.24		
17	DFA4	3.21			DMA9	3.00			DFA2	3.50			DMA8	3.24		
18	DMA11	3.16			DMA10	3.00			DFA3	3.50			DFA1	3.24		
19	DTA1	3.05			DMA11	3.00			DMA11	3.40			DMA11	3.21		
20	DFA1	3.05			DCA3	3.00			DFA4	3.40			DFA4	3.19		

Table 6.20. BIM-Enabled Projects by Project Type

N	BIM-Enabled Project Type															
	Power				Commercial				Petroleum				Transportation			
	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank
1	DCA4	4.13	SM02	3.83	DCA4	3.93	SM07	3.67	DCA3	3.62	SM04	3.38	DCA4	3.85	SM09	3.83
2	DCA3	3.87	SM08	3.70	DCA5	3.86	SM02	3.67	DCA4	3.38	SM05	3.38	DCA5	3.80	SM07	3.80
3	DCA10	3.87	SM01	3.65	DCA3	3.82	SM06	3.64	DCA6	3.31	SM06	3.38	DCA6	3.78	SM06	3.73
4	DCA5	3.78	SM06	3.65	DCA10	3.79	SM09	3.63	DCA10	3.31	SM08	3.31	DCA3	3.75	SM02	3.70
5	DCA6	3.78	SM07	3.65	DCA6	3.75	SM01	3.60	DTA2	3.15	SM07	3.23	DCA10	3.75	SM08	3.65
6	DCA9	3.65	SM09	3.65	DCA9	3.65	SM08	3.60	DCA5	3.15	SM01	3.08	DCA9	3.55	SM04	3.63
7	DTA2	3.57	SM04	3.61	DTA2	3.39	SM04	3.59	DCA9	2.92	SM02	3.08	DTA3	3.40	SM05	3.63
8	DSA1	3.48	SM05	3.61	DMA10	3.32	SM05	3.57	DTA3	2.85	SM10	3.08	DFA3	3.40	ST02	3.55
9	DMA9	3.39	ST01	3.39	DTA3	3.31	ST01	3.37	DFA3	2.85	ST01	3.08	DTA1	3.35	SM01	3.48
10	DMA7	3.30	SM10	3.13	DMA9	3.30	ST02	3.36	DSA2	2.77	SM09	3.00	DTA2	3.35	ST01	3.45
11	DMA8	3.30	SM12	3.13	DSA2	3.30	SM12	3.29	DFA2	2.77	ST02	3.00	DFA1	3.35	SM12	3.38
12	DMA10	3.30	ST02	3.09	DFA3	3.28	SM10	3.27	DMA10	2.69	SM11	2.92	DMA9	3.30	SM10	3.28
13	DMA11	3.26	SM11	3.04	DMA8	3.27	SM11	3.20	DSA1	2.69	SM12	2.92	DMA10	3.28	SM11	3.28
14	DTA3	3.17			DFA2	3.27			DMA7	2.62			DSA2	3.25		
15	DFA3	3.13			DSA1	3.24			DMA9	2.62			DFA2	3.25		
16	DTA1	3.09			DTA1	3.23			DMA11	2.62			DSA1	3.23		
17	DSA2	3.04			DMA7	3.20			DTA1	2.62			DMA11	3.20		
18	DFA1	3.04			DFA1	3.20			DFA1	2.62			DMA7	3.18		
19	DFA2	3.00			DMA11	3.16			DMA8	2.54			DMA8	3.18		
20	DFA4	2.96			DFA4	3.12			DFA4	2.54			DFA4	3.08		

Table 6.21. BIM-Enabled Projects by Project Type

	BIM-Enabled Project Type											
N	Airports				Water				Others			
	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank
1	DCA4	3.94	SM07	3.80	DFA1	4.28	ST01	4.56	DFA2	4.07	SM08	4.34
2	DCA5	3.89	SM09	3.79	DCA10	4.15	SM12	4.44	DCA10	4.07	SM01	4.24
3	DCA6	3.84	SM06	3.74	DSA2	4.10	ST02	4.41	DFA1	4.03	ST01	4.24
4	DCA3	3.79	SM02	3.69	DMA11	4.03	SM01	4.28	DFA4	3.97	SM09	4.21
5	DCA10	3.75	SM08	3.68	DSA1	4.03	SM08	4.28	DCA6	3.97	SM10	4.21
6	DCA9	3.62	SM05	3.67	DFA2	4.03	SM09	4.21	DMA11	3.93	SM12	4.21
7	DTA2	3.44	SM04	3.62	DMA8	3.97	SM02	4.18	DSA1	3.93	SM07	4.17
8	DTA3	3.44	SM01	3.57	DTA2	3.95	SM10	4.18	DFA3	3.93	SM02	4.14
9	DFA3	3.43	ST02	3.43	DCA3	3.95	SM04	4.15	DSA2	3.90	SM11	4.14
10	DTA1	3.37	ST01	3.35	DCA6	3.95	SM05	4.15	DTA2	3.86	SM05	4.10
11	DFA1	3.37	SM12	3.32	DCA9	3.95	SM06	4.13	DCA9	3.83	SM04	4.07
12	DSA2	3.35	SM10	3.27	DTA1	3.92	SM11	4.03	DMA8	3.79	SM06	4.00
13	DFA2	3.35	SM11	3.22	DCA5	3.92	SM07	3.92	DCA5	3.76	ST02	3.93
14	DMA9	3.32			DFA3	3.90			DMA7	3.66		
15	DMA10	3.32			DMA9	3.87			DTA1	3.66		
16	DMA8	3.25			DMA7	3.85			DCA3	3.66		
17	DSA1	3.25			DMA10	3.85			DCA4	3.62		
18	DMA7	3.23			DFA4	3.85			DTA3	3.59		
19	DMA11	3.16			DCA4	3.77			DMA10	3.52		
20	DFA4	3.16			DTA3	3.74			DMA9	3.48		

Table 6.22 compares how employers, engineers, contractors and other site employees differ with delays in the traditional (Non-BIM) approach and critical success components rankings. Both engineers and other professionals considered claims issues the most impactful element to construction lags, while contractors ranked delays in approving scope and specification changes the highest. However, employers considered delays in approving scope changes, slow decision-making and lagged progress payments equally essential contributors to delays.

Engineers and other professionals also ranked irregular meeting attendance as a minor issue for the delay. Employers considered irregular meeting attendance and project bidding as the least significant components. In contrast, contractors noted that lags in acquiring land hardly affected construction delays. Employers and contractors ranked timely communication as the most significant critical success factor, but engineers considered competent consultants more influential. Other professionals selected wise planning, including unexpected events, as the highest critical success aspect. Although other professionals ranked regular stakeholder gatherings the lowest, employers, engineers and contractors selected speeding up employer decision-making as the least influential factor.

Tables 6.23 and 6.24 compare components across various regions. Table 6.23 compares how delay and critical success components for the traditional (Non-BIM) approach differ in their rankings across Africa, China and Australia. For instance, lags in acquiring land were Africa's most significant delay, but progress payment delays were most influential in China. In Australia, delays in approving scope changes affected construction delays the most. Also, although in Africa, wrong site selection delayed construction the least, irregular meeting attendance ranked lowest in China and Australia. Similarly, following the initial plan in Africa and China was essential to success, but competent consultants were the most important in Australia.

Table 6.24 compares how delay and critical success components for the traditional (Non-BIM) approach differ in rankings across the UK, Asia and the US. In the UK and US, lags in approving scope and specification changes were significant delay aspects, but in Asia, they selected lags in progress payments. Irregular meeting attendance was a considerable minor delay in all three regions. In Asia and the US, promptly relaying regulation changes to contractors contributed to construction success the most, while in the UK, following the initial plan was the most important. Speeding up the owner's decision-making process was the most trivial success in all three regions.

Table 6.22. Traditional (Non-BIM) Projects by Project Parties

Traditional (Non-BIM) Project Parties																
N	Employer				Engineer				Contractor				Others			
	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank
1	DMA1	4.50	SM03	4.20	DCA7	4.24	ST01	4.14	DMA1	4.35	SM03	4.25	DCA7	4.28	SM09	4.09
2	DMA3	4.50	SM09	4.15	DMA1	4.23	ST02	4.09	DMA3	4.31	SM09	4.23	DFA2	4.16	SM03	4.03
3	DFA1	4.30	ST01	4.00	DFA2	4.20	SM04	4.07	DFA1	4.28	ST01	4.15	DMA1	4.06	ST01	4.00
4	DSA2	4.15	SM04	3.95	DMA3	4.17	SM10	4.04	DFA2	4.27	ST02	4.01	DFA3	4.03	ST02	3.72
5	DMA4	4.05	ST02	3.95	DFA1	4.17	SM03	4.03	DCA7	4.27	SM04	3.92	DTA2	3.97	SM10	3.69
6	DFA3	4.05	SM10	3.90	DFA3	4.17	SM09	4.00	DFA3	4.23	SM02	3.87	DFA1	3.97	SM04	3.63
7	DFA4	4.00	SM02	3.70	DFA4	4.13	SM02	3.83	DFA4	4.09	SM10	3.87	DMA3	3.94	SM08	3.56
8	DMA2	3.90	SM08	3.65	DSA2	4.07	SM08	3.80	DCA2	4.01	SM08	3.81	DMA4	3.94	SM02	3.53
9	DCA7	3.90			DTA2	4.03			DTA2	3.97			DSA2	3.75		
10	DSA1	3.85			DMA2	3.99			DMA4	3.95			DFA4	3.72		
11	DTA2	3.85			DCA2	3.97			DMA2	3.88			DMA2	3.56		
12	DTA4	3.85			DMA4	3.93			DSA2	3.87			DSA1	3.56		
13	DFA2	3.85			DSA1	3.93			DTA4	3.77			DCA2	3.56		
14	DTA3	3.65			DTA4	3.74			DTA3	3.57			DTA4	3.28		
15	DCA2	3.65			DTA3	3.66			DSA1	3.56			DTA3	3.06		

Table 6.23. Traditional (Non-BIM) Projects by Project Countries

Traditional (Non-BIM) Projects-Countries												
N	Africa				China				Australia			
	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank
1	DSA1	4.60	SM04	4.20	DFA1	4.63	SM04	4.50	DMA1	4.51	ST01	4.12
2	DMA1	4.40	SM10	4.20	DMA1	4.38	SM02	4.38	DMA3	4.44	ST02	4.03
3	DSA2	4.40	ST01	4.00	DFA2	4.38	SM03	4.38	DFA2	4.25	SM09	4.00
4	DCA7	4.40	SM03	3.80	DFA3	4.38	SM08	4.25	DCA7	4.24	SM03	3.98
5	DMA3	4.20	SM09	3.80	DCA2	4.38	SM10	4.25	DFA3	4.15	SM10	3.92
6	DFA2	4.00	ST02	3.60	DMA3	4.25	ST01	4.25	DSA2	4.14	SM04	3.90
7	DFA3	4.00	SM02	2.40	DTA2	4.25	SM09	4.13	DFA1	4.12	SM02	3.80
8	DTA2	3.80	SM08	2.40	DFA4	4.25	ST02	4.13	DFA4	4.07	SM08	3.80
9	DTA3	3.80			DCA7	4.25			DTA2	4.05		
10	DFA1	3.80			DMA2	4.13			DMA2	4.00		
11	DMA4	3.60			DSA2	4.13			DMA4	3.93		
12	DFA4	3.60			DSA1	4.00			DSA1	3.90		
13	DMA2	3.20			DTA4	4.00			DTA4	3.88		
14	DCA2	3.20			DMA4	3.75			DCA2	3.78		
15	DTA4	2.80			DTA3	3.75			DTA3	3.51		

Table 6.24. Traditional (Non-BIM) Projects by Project Countries (Part 2)

Traditional (Non-BIM) Projects-Countries												
N	UK				Asia				US			
	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank
1	DMA1	4.47	SM04	4.00	DFA1	4.26	SM03	4.22	DMA1	4.61	SM03	4.17
2	DMA3	4.35	SM03	3.98	DFA3	4.25	ST01	4.19	DMA3	4.52	SM09	4.13
3	DCA7	4.24	ST01	3.96	DCA7	4.23	SM09	4.18	DFA1	4.52	SM04	4.09
4	DFA1	4.20	SM10	3.95	DMA1	4.20	ST02	3.99	DMA4	4.09	SM10	4.04
5	DFA2	4.07	SM02	3.93	DMA3	4.18	SM04	3.96	DCA7	4.09	ST01	4.00
6	DSA2	4.04	SM09	3.93	DFA2	4.15	SM10	3.91	DTA2	4.00	SM02	3.91
7	DMA2	4.02	ST02	3.91	DFA4	4.05	SM02	3.72	DTA4	4.00	ST02	3.91
8	DTA2	3.98	SM08	3.87	DMA4	3.99	SM08	3.67	DFA3	4.00	SM08	3.87
9	DCA2	3.98			DTA2	3.95			DSA1	3.96		
10	DFA3	3.96			DSA2	3.94			DFA2	3.96		
11	DSA1	3.95			DCA2	3.93			DCA2	3.96		
12	DFA4	3.95			DMA2	3.81			DMA2	3.91		
13	DMA4	3.87			DTA4	3.70			DFA4	3.91		
14	DTA4	3.76			DSA1	3.68			DSA2	3.87		
15	DTA3	3.67			DTA3	3.59			DTA3	3.87		

Tables 6.25 and 6.26 correlate distinct elements across various traditional (Non-BIM) projects. Table 6.25 compares how delay and critical success components for the conventional approach differ in their rankings across modular, hazardous, sewerage, industrial and power projects. Both sewerage and hazardous projects ranked disruptive communication the lowest, but other elements also ranked last in hazardous projects, including wrong site selection. Industrial and power projects ranked slow employer decision-making as the most significant contributor to construction lags. In contrast, in modular and hazardous projects, the delay was primarily attributed to cost underestimations and lags in approving scope changes. In contrast, sewerage builds selected claims issues as the most influential delay component. Modular and industrial sites ranked irregular meeting attendance as the lowest lag aspect, while power builds chose the wrong site selection.

Modular, hazardous and sewerage sites ranked prompt communication of new regulations as the most effective success. Both modular and sewerage projects also ranked following the initial plan equally. In contrast, competent consultants were considered the most crucial in industrial sites, while wise planning contributed the most to construction success in power and modular projects. Modular, hazardous, industrial, and power projects ranked regular stakeholder gatherings the least, but competent consultants and prompt progress payments were the most trivial for sewerage builds. Modular and hazardous projects also ranked speeding up decision-making lower as a critical success element. Table 6.26 compares how delay and critical success components for the traditional (Non-BIM) approach differ across communication, petroleum, transportation, airport, water and other project types. Communication, petroleum, transportation, airport and water projects considered lags in approving scope change the most significant delay factor, while this was slow owner decision-making for other sites. Water builds also shared the other sites' ranking for decision-making, while petrol construction also selected extensive bureaucracy as an equally significant delay factor. The lowest-ranked delay component was irregular meeting attendance for communication, transportation, water and other project types. Petrol, airport and water sites gave wrong site selection as a minor lag aspect. Petroleum construction also added project bidding as a lowly-ranked delay factor.

Prompt communication of new regulations was the most common critical success determinant in communication, petroleum and airport sites. However, following the initial project plan ranked highest in transportation projects, while for water builds, the two most significant elements were planning the project wisely and investigating site conditions. Airport projects also posted competent consultants as an essential critical success factor. Conversely, communication, petroleum, transportation and airport projects ranked speeding up the employer decision-making procedure as the lowest indicator of success. The least critical success factor for water sites was employing. Table 8.13 showed that the rankings of employers, engineers, contractors and other site employees varied with the traditional (Non-BIM) approach's delay and critical success components. A similar trend was observed in countries and project types. Although the professions, nations and project types examined by Barqawi et al. (2021) do not accurately match, the authors emphasise these variations, recognising and revealing that rankings of conventional delay elements and their nature vary based on these factors. They note that the variations were primarily due to differences in construction techniques, project size and type, availability of accurate construction specifications, construction funding methods, quality standards and culture. Few research papers have ranked employer-initiated delays and critical success factors using BIM. Btoush and Harun (2017) focused on investigating ways to reduce delays in Jordanian construction projects through BIM. They concluded that to address employer-initiated delays, it would be essential to recruit BIM specialists responsible for dividing the design phase to overcome poor design selections. Nevertheless, delay-causing factors were not sufficiently described in this research. Kubba (2017) rated employer-caused delay factors as poor communication, project scope changes, slow decision-making processes, delays in payments, contract errors, and defects.

Differences were evident in the ranking for employer-initiated delays and critical success factors between the two classes of projects. Variations can be seen in the above discussion. According to Kubba (2017), delay factors result from a functional approach and the two categories of management techniques used. Kubba (2017) highlights that traditional (Non-BIM) projects use standardised project management tools and follow a linear approach with predictable sequence processes and pre-planned stages. The general contractor generates the main construction plan, and the successive detailed plans grow with the subcontractors' and engineers' input. Therefore, the process inevitably results in poor communication and continuous changes in the schedule and budget. On the other hand, BIM-enabled projects are achieved more efficiently by creating and managing information regarding construction projects across their entire life cycle (Barqawi et al., 2021).

Table 6.25. Traditional (Non-BIM) Projects by Project Type

	Traditional (Non-BIM) Project Type																			
	Modular				Hazardous				Sewerage				Industrial				Power			
N	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank
1	DFA2	4.37	SM03	4.21	DMA1	5.00	SM03	5.00	DMA1	3.92	SM02	4.20	DMA3	4.37	ST01	4.23	DMA3	4.30	SM09	4.17
2	DMA1	4.26	SM04	4.21	DSA2	4.50	SM04	4.50	DMA2	3.89	SM03	4.20	DMA1	4.30	ST02	4.00	DMA1	4.26	SM03	4.13
3	DSA2	4.21	SM09	4.21	DTA2	4.50	SM02	4.50	DMA3	4.08	SM04	4.20	DFA3	4.30	SM09	3.93	DCA7	4.26	SM10	4.04
4	DFA3	4.21	SM10	4.21	DTA3	4.50	SM08	4.50	DMA4	4.28	SM08	3.90	DFA2	4.28	SM03	3.91	DSA2	4.22	ST01	4.04
5	DCA7	4.21	ST01	4.16	DFA1	4.50	SM09	4.50	DSA1	4.47	SM09	3.90	DTA2	4.14	SM10	3.84	DFA1	4.17	SM04	4.00
6	DFA4	4.16	ST02	4.11	DFA2	4.50	SM10	4.50	DSA2	4.65	SM10	3.80	DCA7	4.14	SM04	3.79	DFA2	4.17	ST02	4.00
7	DFA1	4.11	SM02	3.95	DFA3	4.50	ST01	4.50	DTA2	4.81	ST01	3.80	DFA1	4.07	SM08	3.70	DFA3	4.09	SM08	3.83
8	DMA3	4.05	SM08	3.95	DCA7	4.50	ST02	4.50	DTA3	5.00	ST02	3.80	DMA2	4.05	SM02	3.65	DFA4	4.04	SM02	3.78
9	DTA2	4.05			DMA2	4.00			DTA4	5.68			DSA2	4.02			DSA1	4.00		
10	DCA2	4.05			DMA3	4.00			DFA1	6.02			DFA4	4.02			DCA2	4.00		
11	DMA2	3.95			DMA4	4.00			DFA2	6.32			DMA4	3.98			DMA4	3.87		
12	DSA1	3.95			DSA1	4.00			DFA3	6.65			DCA2	3.81			DTA2	3.78		
13	DMA4	3.84			DTA4	4.00			DFA4	6.95			DSA1	3.72			DMA2	3.61		
14	DTA4	3.74			DFA4	4.00			DCA2	7.25			DTA4	3.56			DTA3	3.39		
15	DTA3	3.68			DCA2	4.00			DCA7	7.56			DTA3	3.44			DTA4	3.35		

Table 6.26. Traditional (Non-BIM) Projects by Project Type

Traditional (Non-BIM) Projects																							
Commercial				Petroleum				Transport				Airport				Water				Others			
Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank	Delay	Rank	Success	Rank
DMA1	4.31	SM03	4.19	DMA1	4.54	SM03	4.31	DMA1	4.35	SM04	4.13	DMA1	4.49	SM03	4.14	DMA1	4.62	SM09	4.03	DMA3	4.31	ST02	4.10
DFA1	4.23	SM09	4.17	DSA2	4.54	SM09	4.23	DCA7	4.35	SM03	4.10	DMA3	4.41	ST01	4.14	DMA3	4.62	SM10	4.03	DFA2	4.21	SM10	4.07
DCA7	4.22	ST01	4.12	DMA3	4.23	ST01	4.23	DMA3	4.25	ST01	4.08	DFA1	4.30	SM04	4.07	DFA1	4.33	SM03	3.95	DCA7	4.21	ST01	4.07
DMA3	4.22	ST02	3.97	DFA3	4.23	ST02	4.15	DSA2	4.10	SM10	4.03	DCA7	4.28	SM09	4.07	DTA2	4.21	SM04	3.95	DMA4	4.14	SM04	4.03
DFA3	4.17	SM04	3.95	DCA7	4.23	SM04	4.00	DFA2	4.10	ST02	4.03	DSA2	4.21	ST02	4.06	DSA2	4.18	SM08	3.95	DFA3	4.14	SM09	3.97
DFA2	4.14	SM10	3.92	DMA4	4.15	SM10	3.92	DFA1	4.08	SM09	4.00	DFA2	4.17	SM10	4.01	DCA7	4.18	ST01	3.92	DFA4	4.14	SM03	3.93
DFA4	4.02	SM02	3.81	DSA1	4.15	SM02	3.85	DFA3	4.08	SM02	3.78	DFA3	4.14	SM02	3.85	DFA2	4.10	SM02	3.87	DFA1	4.10	SM02	3.86
DTA2	3.98	SM08	3.78	DFA4	4.15	SM08	3.77	DFA4	4.05	SM08	3.70	DFA4	4.10	SM08	3.80	DMA4	4.05	ST02	3.85	DMA1	4.07	SM08	3.86
DSA2	3.96			DTA2	4.08			DSA1	4.03			DMA4	4.04			DSA1	3.97			DTA2	4.03		
DMA4	3.94			DMA2	3.92			DMA4	3.93			DSA1	4.04			DFA3	3.97			DCA2	3.93		
DCA2	3.93			DTA3	3.92			DMA2	3.88			DCA2	3.99			DMA2	3.87			DMA2	3.90		
DMA2	3.87			DFA1	3.85			DCA2	3.88			DMA2	3.98			DFA4	3.87			DSA1	3.86		
DSA1	3.72			DFA2	3.85			DTA2	3.80			DTA2	3.93			DCA2	3.87			DSA2	3.66		
DTA4	3.64			DTA4	3.69			DTA4	3.80			DTA3	3.72			DTA3	3.79			DTA4	3.66		
DTA3	3.58			DCA2	3.69			DTA3	3.55			DTA4	3.69			DTA4	3.79			DTA3	3.52		

6.9 Spearman's Coefficient and Data Correlation

Spearman's rank correlation is a nonparametric coefficient of statistical dependence between two variables. It measures the link between two variables that can be defined using a monotonic meaning. The value of Spearman's rank correlation ranges from +1 (perfect positive correlation) to 0 (no correlation) to –1 (perfect negative correlation). A perfect Spearman's correlation of +1 or –1 occurs when each variable is a perfect monotone function of the other. Equation no. 3 is used in the analysis for Spearman's coefficient.

$$\rho = \frac{6\sum d^2}{(n^2-n)} \tag{5}$$

Where ρ equals Spearman's rank correlation coefficient, d = difference between the ranks indicated by two parties, and n = number of records. Values of the Spearman coefficient between 0.60 and 0.90 are considered highly correlated. The project party correlation is generally within the acceptable range from moderate to high, with most values higher than 0.60.

Table 6.27. Spearman's Analysis for Parties-Traditional (Non-BIM) Projects

			Employer	**Engineer**	**Others**	**Contractor**
Spearman's Rho	**Employer**	Correlation Coefficient	1.000	0.594	0.608	0.662
	Engineer	Correlation Coefficient	0.594	1.000	0.775	0.825
	Others	Correlation Coefficient	0.608	0.775	1.000	0.830
	Contractor	Correlation Coefficient	0.662	0.825	0.830	1.000

Table 6.28. Spearman's Analysis for Parties-BIM-Enabled Projects

			Employer	**Engineer**	**Contractor**	**Others**
Spearman's Rho	**Employer**	Correlation Coefficient	1.000	0.956	0.962	0.903
	Engineer	Correlation Coefficient	0.956	1.000	0.993	0.976
	Contractor	Correlation Coefficient	0.962	0.993	1.000	0.970
	Others	Correlation Coefficient	0.903	0.976	0.970	1.000

6.10 Chi-Squared Test

In order to evaluate the potential presence of non-random response patterns among participants with diverse backgrounds, a non-parametric Chi-squared test was employed as an unbiased method of analysing distinct, independent samples. The selection of this particular test was based on its ability to accurately assess the distribution of replies among respondents with varying backgrounds in relation to their answers on the influence of stakeholders on project delays. Additionally, it aims to ascertain if these diverse backgrounds have a statistically significant impact on their responses. The Chi-squared test is an appropriate statistical method for evaluating the significance of variations among many independent groups where the study data includes frequencies within discrete categories, which may be either ordinal or nominal (Siegel, 1956).

The hypothesis for this experiment can be expressed as follows:

The null hypothesis (Ho) posits that the respondents from different backgrounds are not making random selections while providing their answers.

The alternative hypothesis (H1) posits that respondents from different backgrounds randomly make their answer choices.

The experiment was carried out independently for both conventional and BIM-enabled projects. The statistical analysis was conducted using software such as SPSS.

The Chi-squared test was conducted on the traditional (Non-BIM) project data, resulting in an Asymptotic Significance factor (2-sided) of 0.644. The observed value, which exceeds the predetermined significance level (α) of 0.05, results in the rejection of the null hypothesis. But, the data suggests that participants from diverse backgrounds did not reply to the survey haphazardly when it pertained to conventional initiatives.

Similarly, the Chi-squared test was conducted to analyse the BIM-enabled projects, yielding an Asymptotic Significance factor of 0.724. The obtained value, which exceeds the predetermined significance level of 0.05, results in the rejection of the null hypothesis for projects utilising Building Information Modelling (BIM) as well. Hence, the findings of the analysis indicate that the respondents' replies to questions pertaining to BIM-enabled projects were not randomly provided, as they exhibited a range of backgrounds.

In brief, the outcomes of the Chi-squared test reveal that the backgrounds of the respondents exerted a statistically significant impact on their responses while evaluating the role of stakeholders on project delays in both traditional (Non-BIM) and BIM-enabled projects. This discovery underscores the significance of taking into account the variety of backgrounds when analysing responses in surveys of this nature.

6.11 Structural Equation Modelling Analysis and Data Interpretation for Traditional (Non-BIM) Projects (Without Moderators)

In this part, we undertake an examination of the many elements that contribute to delays caused by employers in the context of traditional (Non-BIM) building projects. The focal point of our study revolves around the delays that arise as a result of activities or decisions made by employers, which are regarded as the dependent variable. In order to conduct a full analysis of these delays, we have deconstructed them into five unique dimensions: managerial, social, technological, financial, and contractual. Additionally, we have identified crucial determinants of success derived from relevant scholarly sources that serve as the independent variables intended to alleviate these delays. As a result, we have classified the variables that rely on other factors in our model as "Management, Organisation, and Financial Planning (SM)" and "Team (ST)."

Furthermore, we have integrated specific moderation variables to investigate their possible influence on the association between these essential determinants of success and delays caused by employers. The selected methodology for this study is Structural Equation Modelling (SEM), which is preferred due to its ability to provide a comprehensive multivariate data analysis approach. SEM is particularly useful for assessing linear and additive causal models that are supported by theoretical frameworks (Haenlein & Kaplan, 2004). SEM provides a means to visually depict the complex interconnections among the variables that are of interest to us.

Furthermore, this methodology is capable of accommodating the incorporation of latent variables that are unobservable and difficult to measure, rendering it very suitable for research conducted in the field of business. The structural equation modelling (SEM) framework in our study consists of two distinct sub-models. The first sub-model, known as the inner model, focuses on elucidating the relationships between dependent and independent variables. The second sub-model, referred to as the outer model, is responsible for specifying the linkages between latent variables and observable indicators. In this particular theoretical framework, we are presented with two distinct categories of variables: exogenous variables, which pertain to external elements, and endogenous variables, which are subject to influence from other variables, as indicated by arrows directed towards them. Although there are several different techniques for structural equation modelling (SEM), two of the most often utilised methods are CB-SEM and PLS-SEM. The use of CB-SEM is appropriate in cases where the model is accurately defined, taking into consideration all pertinent variables and where the data conforms to standard distribution assumptions (Vinzi et al., 2010). In contrast, Partial Least Squares Structural Equation Modelling (PLS-SEM) can be utilised without imposing strict assumptions regarding the distribution of data. Due to the lack of theoretical frameworks addressing the determinants of employer delays in construction projects within our particular contexts, our foremost focus pertains to the precision of predictions. Therefore, in this work, we have chosen to utilise Partial Least Squares Structural Equation Modelling (PLS-SEM). In order to support our Partial Least Squares Structural Equation Modelling (PLS-SEM) analysis, we employ Smart-PLS, a software tool developed by Ringle et al. (2005). The data collected from our survey is carefully handled, initially entered into an Excel spreadsheet, and then afterwards examined for any missing values and erroneous observations before being imported into Smart-PLS. The Structural Equation Modelling (SEM) framework utilises two distinct types of measuring scales, namely formative and reflecting scales. A formative measuring scale is utilised when the indicators are perceived as exerting a causal influence on the hidden variable.

On the other hand, a reflecting measuring scale is employed when the latent variable incorporates the indicators, wherein the indicators are interchangeable, exhibit high correlation, and reflect the underlying construct. Our work thoroughly evaluates the reliability and validity of our model in accordance with the established rules necessary for structural equation modelling (SEM). The measurement model (MM) depicted in Figure 6.4 of our research elucidates the impact of social media (SM) and social ties (ST) on clusters of employer-induced delays. It is important to highlight that, in the context of the MM analysis, specific crucial success variables and delay factors were deliberately omitted from the model in order to achieve convergence in accordance with recognised scientific principles.

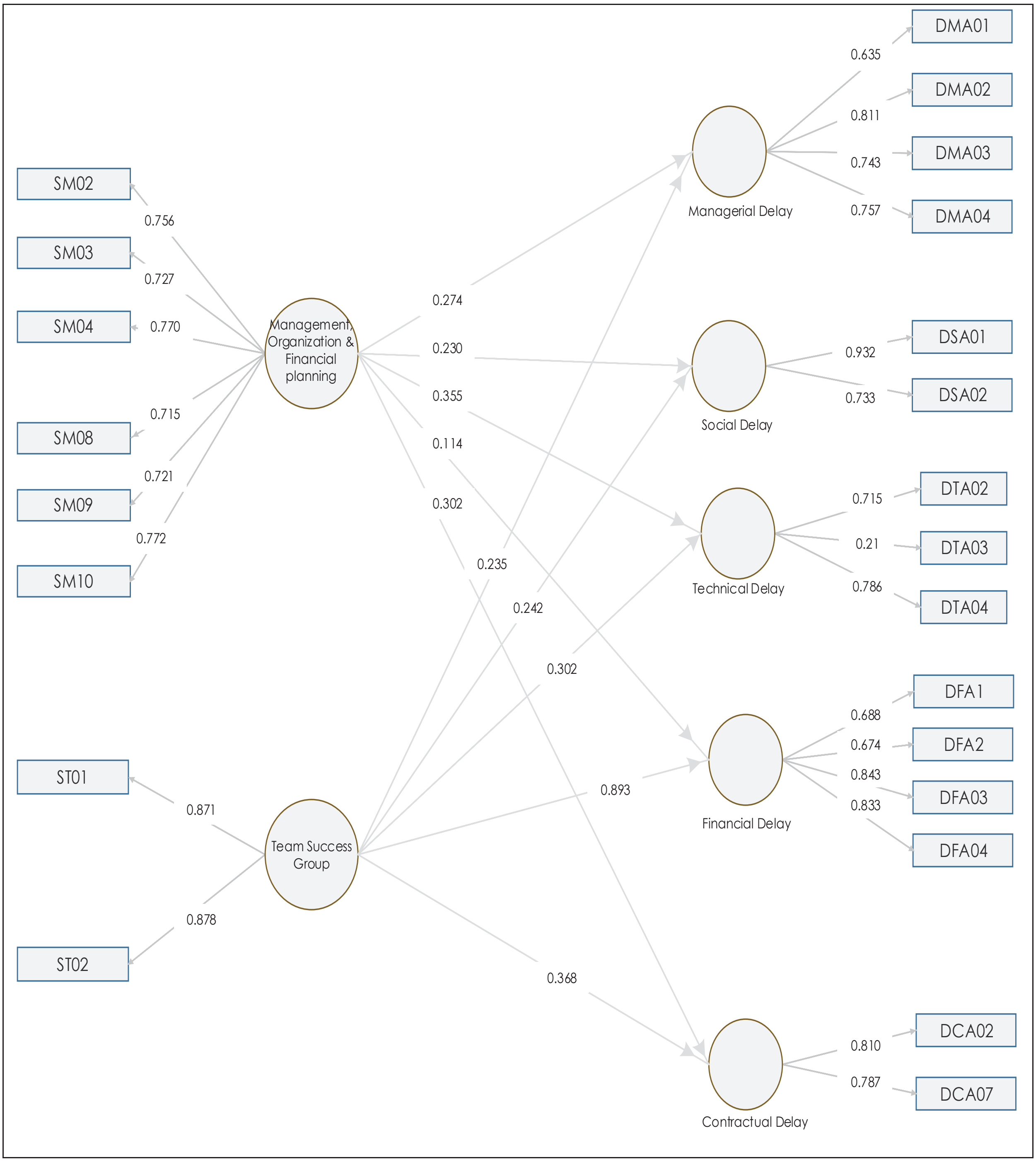

Figure 6.4. Impact of SM and ST on Delays without Moderators for Traditional (Non-BIM) Projects

Table 6.29 presents the R-square value (R^2), also known as the coefficient of determination. This is 0.297 for the contractual delay, implying that the latent variables SM and ST can explain a 29%

variance in contractual delay. Similarly, an 87% variance in financial delay, 17% variance in managerial delay, 14% variance in social delay and 35% variance in technical delay can be explained by these (SM, ST) latent constructs.

Table 6.29. R-square for Impact of SM and ST on Delays in Traditional (Non-BIM) Projects

Item	R-Squared	R-Squared Adjusted
DCA	0.297	0.290
DFA	0.875	0.874
DMA	0.171	0.162
DSA	0.147	0.138
DTA	0.350	0.343

The reliability and validity of the indicators were checked with the help of indicator reliability, internal consistency reliability and convergent and discriminant validity. The square of the outer loadings gives indicator reliability, and its preferred range is > =0.70 and >=0.40 for exploratory research (Hulland, 1999). Cronbach's Alpha and Composite Reliability (CR) were used to measure the internal consistency reliability of the indicators. However, Cronbach's alpha provides a conservative measurement in PLS-SEM; hence, composite reliability was used to verify the internal consistency reliability of the indicators. Composite reliability must be greater or equal to 0.7 to establish the internal consistency of the constructs (Bagozzi & Yi, 1988). It can be observed from Table 6.30 that the value of rho-A is larger than 0.707, which is considered acceptable. It can also be observed that Rho-A for all the latent constructs was more significant than 0.707 or close to 0.7. The indicator reliability was much more significant than 0.40 for all the indicators, and the composite reliability was more significant than 0.7 for all the constructs. Convergent validity was checked using each latent variable's average variance extracted (AVE), which must be greater than 0.5 (Bagozzi & Yi, 1988). The AVE values for all the latent constructs were greater than 0.5.

Table 6.30. Reliability and Validity for Impact of SM and ST on Delays in Traditional (Non-BIM) Projects

Factors	Loadings	Indicator Reliability	Cronbach's Alpha	Rho_A	Composite Reliability	AVE
Contractual Delay			0.733	0.733	0.779	0.638
DCA2	0.810	0.656				
DCA7	0.787	0.620				
Financial Delay			0.762	0.804	0.847	0.583
DFA1	0.688	0.474				
DFA2	0.674	0.454				
DFA3	0.843	0.710				
DFA4	0.833	0.694				
Managerial Delay			0.731	0.775	0.827	0.546
DMA1	0.635	0.403				
DMA2	0.811	0.658				
DMA3	0.743	0.552				
DMA4	0.757	0.572				
Social Delay			0.708	0.772	0.824	0.703
DSA1	0.932	0.868				
DSA2	0.733	0.538				
Technical Delay			0.668	0.680	0.818	0.601
DTA2	0.715	0.512				
DTA3	0.821	0.674				
DTA4	0.786	0.618				
Management, Organisation & Financial Planning			0.839	0.843	0.881	0.553
SM02	0.756	0.571				
SM03	0.727	0.528				
SM04	0.770	0.593				
SM08	0.715	0.511				
SM09	0.721	0.520				
SM10	0.772	0.596				
Team Success			0.692	0.692	0.866	0.764
ST01	0.871	0.758				
ST02	0.878	0.771				

Table 6.31 shows the Fornell-Larcker criterion, which states that 'the square root of AVE in each latent variable can be used to establish discriminant validity if this value is larger than other correlation values among the latent variables' (Fornell & Larcker, 1981), was used in the study to establish the discriminant validity of the constructs. The values along the diagonal of the Fornell-Larcker criterion table represent the AVE values. It can be observed that the square root of AVE values of all the constructs was more significant than the corresponding correlation values for each of the constructs.

Table 6.31. Fornell-Larcker Criterion for Impact of SM and ST on Delays in Traditional (Non-BIM) Projects

Factors	Contractual Delay	Financial Delay	Management, Organisation & Financial Planning	Managerial Delay	Social Delay	Team Success	Technical Delay
Contractual Delay	**0.799**						
Financial Delay	0.497	**0.763**					
Management, Organisation & Financial Planning	0.418	0.396	**0.744**				
Managerial Delay	0.333	0.356	0.348	**0.739**			
Social Delay	0.282	0.316	0.307	0.213	**0.839**		

Team Success	0.464	0.729	0.316	0.322	0.315	**0.874**	
Technical Delay	0.387	0.486	0.473	0.575	0.356	0.487	**0.775**

However, the bootstrapping approach was utilised in our study to determine the statistical significance of the structural routes within our Structural Equation Model (SEM). The utilisation of this statistical methodology is of paramount importance in evaluating the resilience and dependability of our research outcomes. The bootstrapping method entails the creation of T-statistics, which play a crucial role in assessing the statistical significance of the structural routes being examined. In order to achieve this objective, we employed a repetitive sampling technique from the initial dataset, hence permitting the inclusion of replacements to generate several subsamples. The utilisation of these subsamples allows for the computation of standard errors, which in turn provides vital T-values that are crucial for conducting significance tests on the structural routes.

Furthermore, the utilisation of bootstrapping techniques offers an estimation of the normal distribution of the data, enhancing the credibility and robustness of our statistical study. The results of the bootstrapping method are displayed in Figures 6.4 and Figure 6.5, providing vital insights into the relevance of the structural routes. The research findings emphasise the significant significance of thorough planning and efficient collaboration in guaranteeing the punctual completion of construction projects. In order to provide evidence for this claim, we conducted an observation and found that the T-values corresponding to the structural routes in question surpassed the critical value of 1.96. By utilising a two-tailed t-test with a significance level of 5%, it was determined that all path coefficients exhibited statistical significance. The presented evidence highlights the significant impact of "Management, Organisation, and Financial Planning (SM)" and "Team (ST)" factors on the delays caused by employers in building projects.

Our investigation has shown a number of significant elements that are contributing to these delays. The items mentioned above include: The occurrence of delays can frequently be attributed to inadequate communication and problem-solving procedures, which result from infrequent meetings and site visits. Contractors and developers frequently encounter disruptions in project development due to a lack of sufficient understanding regarding alterations in laws and regulations. Deviation from initial Intentions: The occurrence of projects deviating from their original intentions sometimes results in subsequent delays. The decision-making process of employers can have a substantial influence on project timeframes, especially when these decisions are made in a delayed manner or lack sufficient information. Insufficient site studies might lead to unanticipated difficulties and complexities, resulting in building delays. Concerns regarding the team's performance may also arise from factors such as the presence of insufficiently skilled advisors and inadequate coordination among representatives of businesses. Through the identification and recognition of these factors, our research not only emphasises the importance of proficient management and collaborative teamwork in construction projects but also offers valuable insights for stakeholders within the construction industry to confront and alleviate the delays caused by employers actively. Ultimately, this contributes to the achievement of more successful and punctual project outcomes.

Table 6.32. T-Values and P-Values for Traditional (Non-BIM) Project Relationships.

Critical Success/Delay Group Relationships	Sample Mean (M)	Standard Deviation	T-Statistics	P-Values
Management, Organisation & Financial Planning » Contractual Delay	0.306	0.077	3.896	0.000
Management, Organisation & Financial Planning » Financial Delay	0.112	0.035	3.161	0.002
Management, Organisation & Financial Planning » Managerial Delay	0.283	0.072	3.785	0.000
Management, Organisation & Financial Planning » Social Delay	0.239	0.086	2.688	0.007

Management, Organisation & Financial Planning » Technical Delay	0.362	0.064	5.517	0.000
Team Success » Contractual Delay	0.370	0.072	5.127	0.000
Team Success » Financial Delay	0.895	0.019	46.292	0.000
Team Success » Managerial Delay	0.241	0.086	2.732	0.006
Team Success » Social Delay	0.246	0.094	2.574	0.010
Team Success » Technical Delay	0.373	0.072	5.227	0.000

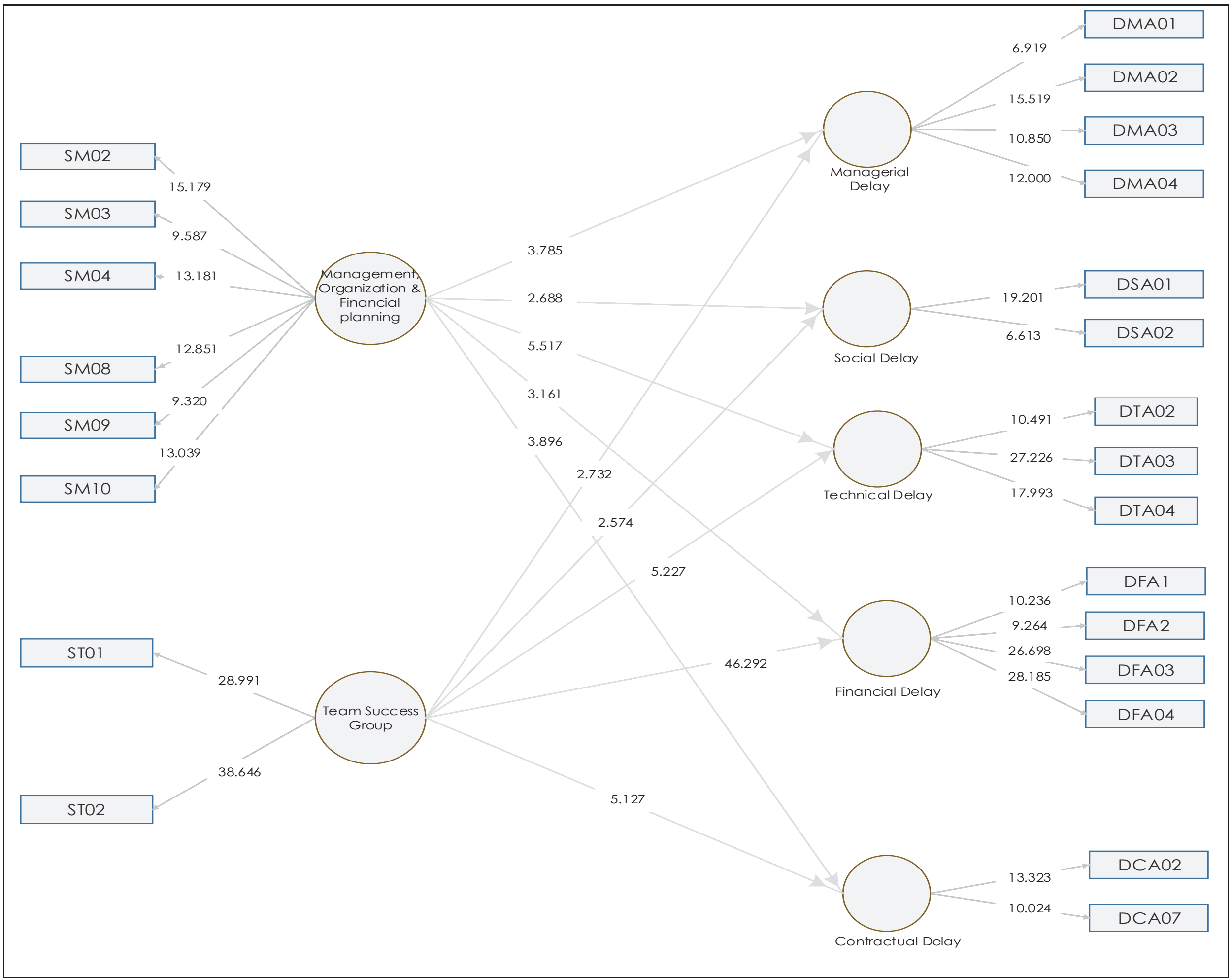

Figure 6.5. Bootstrapping Model—Impact of SM and ST on Delays in Traditional (Non-BIM) Projects

6.12 Structural Equation Modelling Analysis and Data Interpretation for Traditional (Non-BIM) Projects (Moderators Effects)

A moderator variable plays a pivotal role in research as it introduces a dynamic element into the relationship between independent and dependent variables. It is expected to alter or modify the impact of the independent variable on the dependent variable. Essentially, a moderator interacts with the predictor (independent variable) in a way that influences the outcome of the dependent variable. In the context of this study, the researchers have chosen to employ the product-indicator approach to investigate the effects of these moderators, as elaborated in Appendix H's definition of the moderators. The product-indicator approach is a widely accepted and conventional method used in regression-based analyses to explore and quantify these interactions. In this approach, each indicator representing the exogenous construct is systematically multiplied by each indicator representing the moderator variable, generating a set of interaction term indicators commonly known as product terms. These product terms serve as critical tools for scrutinizing how the moderator variable exerts its influence on the relationship between the predictor and the dependent variable. It's important to note that the product-indicator approach operates on the assumption that both the predictor indicators and the moderator indicators are derived from distinct construct domains and that both constructs are reflective. In the context of this study, where both constructs adhere to these reflective characteristics, the product-indicator approach was deemed to be a suitable choice for investigating the influence of moderators.

Turning our attention to the specific research context, the Partial Least Squares (PLS) algorithm was employed to analyze Project Characteristics (PC) in conjunction with Stakeholder Management (SM) in the context of traditional (Non-BIM) projects. In this analysis, Project Characteristics were considered as moderators, and their role in influencing the relationship between Stakeholder Management and project delays was explored. This complex relationship is visually represented in Figure 8.5, which provides a conceptual map for understanding how Project Characteristics factor into the interplay between Stakeholder Management and delays initiated by the employer in various project scenarios.

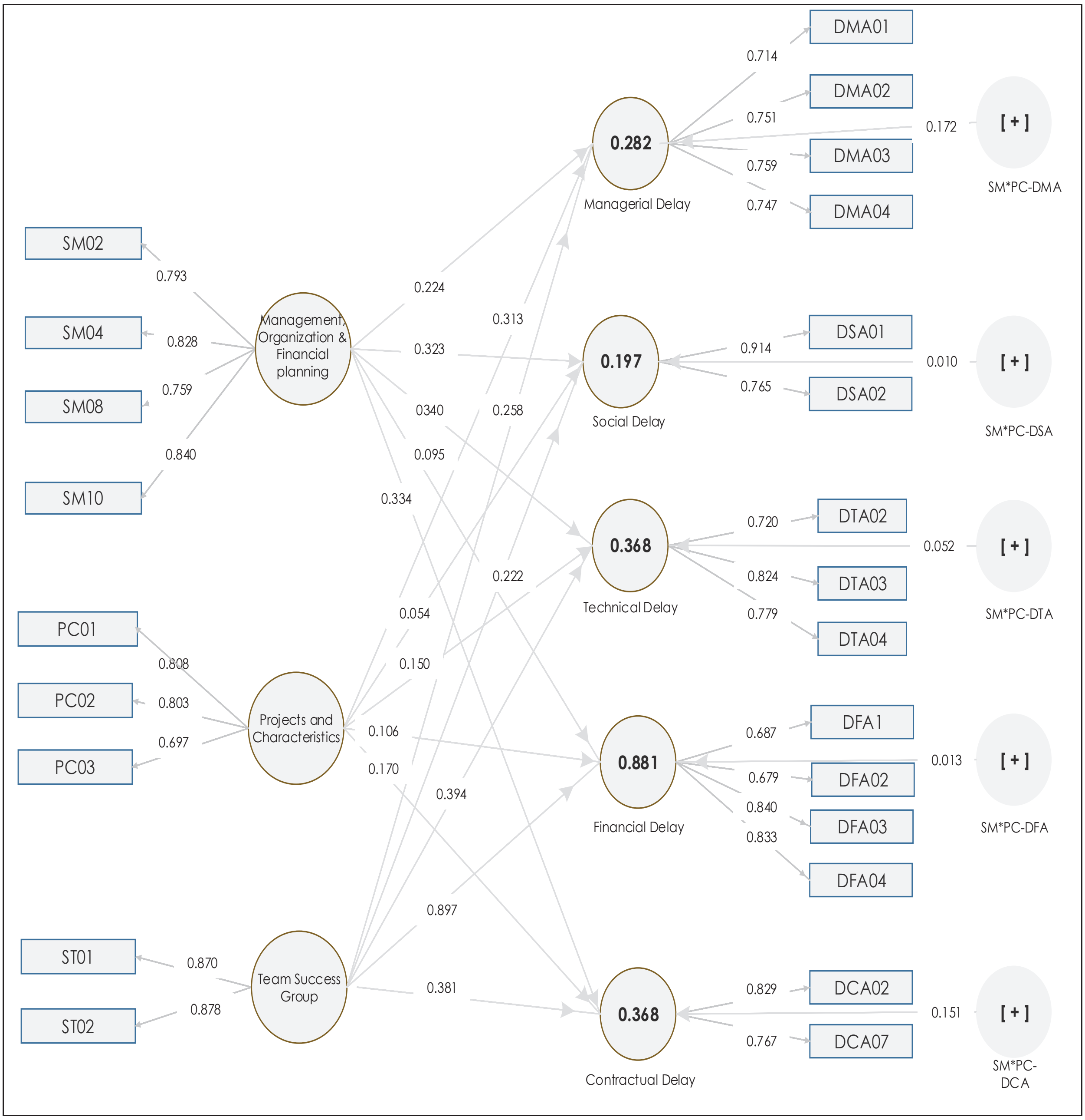

Figure 6.6. PLS Model—Impact of PC x SM on Delays in Traditional (Non-BIM) Projects

Table 6.33 shows that the indicator reliability was much more significant than 0.40 for all the indicators, and the composite reliability was more significant than 0.7 for all the constructs. The

AVE values for all the latent constructs were also greater than 0.5. Hence, the reliability and convergent validity of the constructs used in the model were established.

Table 6.33. Reliability and Validity for Impact of PC x SM on Delays in Traditional (Non-BIM) Projects

Factors	Loadings	Indicator Reliability	Cronbach's Alpha	Rho_A	Composite Reliability	AVE
Contractual Delay			0.733	0.738	0.778	0.637
DCA2	0.829	0.687				
DCA7	0.767	0.588				
Financial Delay			0.762	0.802	0.847	0.583
DFA1	0.687	0.472				
DFA2	0.679	0.460				
DFA3	0.840	0.706				
DFA4	0.833	0.693				
Managerial Delay			0.731	0.732	0.831	0.552
DMA1	0.714	0.510				
DMA2	0.751	0.564				
DMA3	0.759	0.576				
DMA4	0.747	0.558				
Social Delay			0.708	0.795	0.829	0.710
DSA1	0.914	0.835				
DSA2	0.765	0.585				
Technical Delay			0.668	0.680	0.818	0.601
DTA2	0.720	0.519				
DTA3	0.824	0.678				
DTA4	0.779	0.606				
Project Characteristics			0.671	0.695	0.814	0.594
PC_1	0.808	0.653				
PC_2	0.803	0.645				
PC_3	0.697	0.486				
Management, Organisation & Financial Planning			0.821	0.827	0.881	0.649
SM02	0.793	0.629				
SM04	0.828	0.686				
SM08	0.759	0.577				
SM10	0.840	0.706				

Team Success						
ST01	0.870	0.758	0.692	0.692	0.866	0.764
ST02	0.878	0.771				

Table 6.34 shows that the square root of the AVE values of all the constructs was more significant than the corresponding correlation values for each. Thus, the discriminant validity of the constructs was established. Figure 6.7 shows the bootstrapping results for the model of PC.

Table 6.34. Fornell-Larcker Criterion for the Impact of PC x SM on Delays in Traditional (Non-BIM) Projects

Factors	Contractual Delay	Financial Delay	Management, Organisation & Financial	Managerial Delay	Project Characteristics	Social Delay	Team Success	Technical Delay
Contractual Delay	**0.798**							
Financial Delay	0.496	**0.764**						
Management, Organisation & Financial Planning	0.420	0.341	**0.806**					
Managerial Delay	0.318	0.350	0.274	**0.743**				
Project Characteristics	0.212	0.139	–0.006	0.354	**0.771**			
Social Delay	0.282	0.316	0.384	0.205	0.060	**0.843**		
Team Success	0.462	0.728	0.273	0.312	0.040	0.313	**0.874**	
Technical Delay	0.393	0.486	0.442	0.560	0.173	0.355	0.487	**0.775**

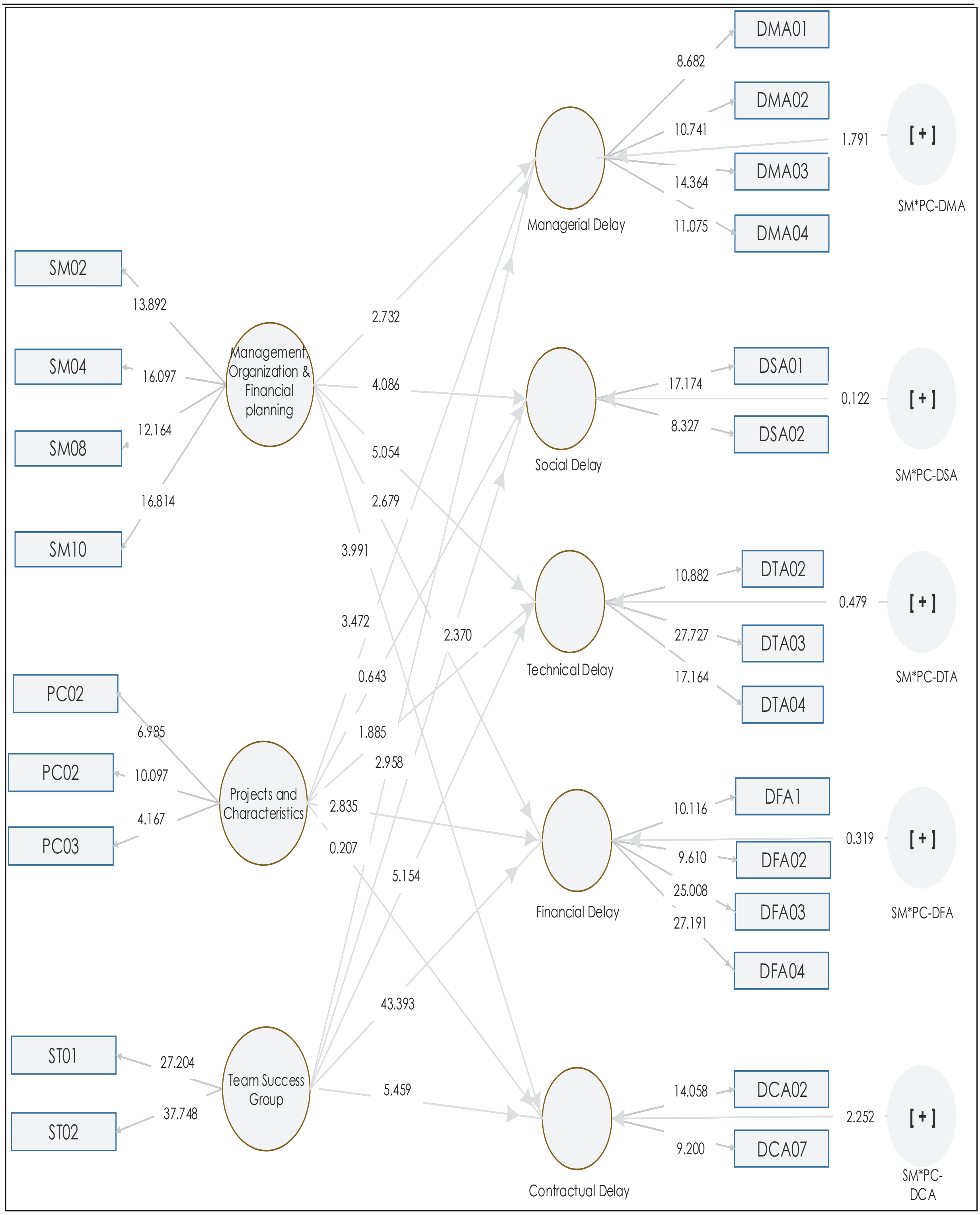

Figure 6.7. Bootstrapping Model—Impact of SM x PC on Delays in Traditional (Non-BIM) Projects

Table 6.35 shows that project characteristics significantly affect ($p < 0.05$) contractual, financial and managerial delays. However, the effect of the interaction terms on financial, managerial, social and technical delay was non-significant. The effect of the interaction terms on contractual delay alone was significant. This implies that PC moderates the influence of SM on contractual delays alone but has no moderating influence on other delays.

Table 6.35. T-Values and P-Values for Impact of PC x SM in Traditional (Non-BIM) Projects

Factors	Sample Mean	Standard Deviation	T-Statistics	P-Values
Management, Organisation & Financial Planning » Contractual Delay	0.335	0.084	3.991	0.000
Management, Organisation & Financial Planning » Financial Delay	0.095	0.035	2.679	0.007
Management, Organisation & Financial Planning » Managerial Delay	0.228	0.080	2.732	0.006
Management, Organisation & Financial Planning » Social Delay	0.329	0.079	4.086	0.000
Management, Organisation & Financial Planning » Technical Delay	0.342	0.067	5.054	0.000
PC » Contractual Delay	0.176	0.060	2.835	0.005
PC » Financial Delay	0.109	0.035	3.007	0.003
PC » Managerial Delay	0.316	0.092	3.472	0.001
PC » Social Delay	0.049	0.084	0.643	0.520
PC » Technical Delay	0.140	0.079	1.885	0.060
SM*PC-DCA» Contractual Delay	**–0.138**	**0.067**	**2.252**	**0.024**
SM*PC-DFA» Financial Delay	**0.010**	**0.045**	**0.319**	**0.750**
SM*PC-DMA» Managerial Delay	**–0.145**	**0.096**	**1.791**	**0.073**
SM*PC-DSA» Social Delay	**0.012**	**0.087**	**0.122**	**0.903**
SM*PC-DTA» Technical Delay	**–0.030**	**0.108**	**0.479**	**0.632**
Team Success » Contractual Delay	0.377	0.070	5.459	0.000
Team Success » Financial Delay	0.896	0.021	43.393	0.000
Team Success » Managerial Delay	0.259	0.086	2.985	0.003
Team Success » Social Delay	0.229	0.094	2.370	0.018
Team Success » Technical Delay	0.392	0.076	5.154	0.000

Furthermore, the PLS Algorithm for PC with ST was reviewed for the traditional (Non-BIM) projects in which the PC aspect was considered a moderator in the study, as well as its significance for the effect of ST. Figure 6.8 describes the MM for the effect of PC on the ST relationship with employer-initiated delay groups.

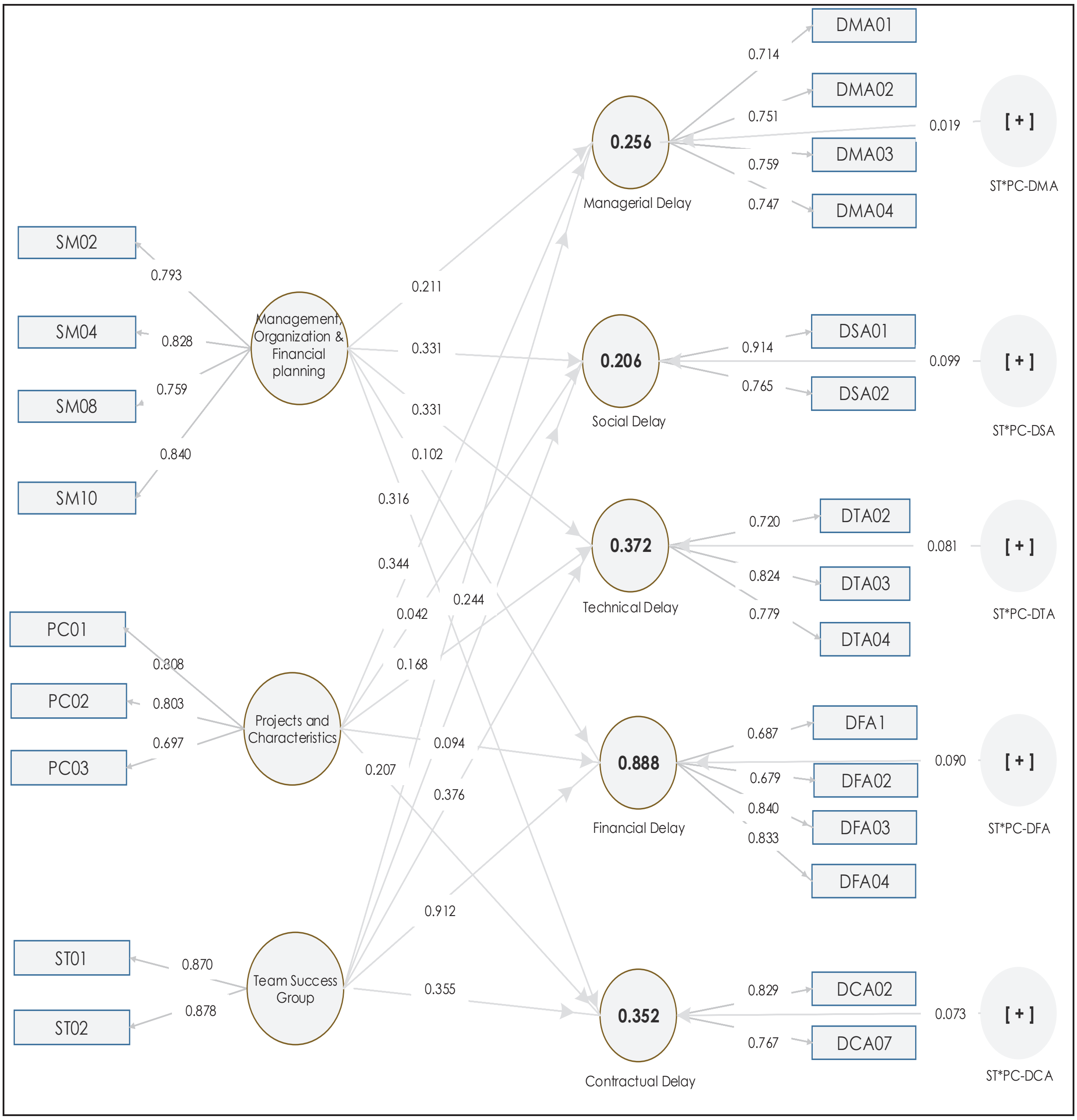

Figure 6.8. PLS Model—Impact of PC x ST on Delays in Traditional (Non-BIM) Projects

Table 6.36 shows that the indicator reliability was greater than 0.40 for all indicators, and the composite reliability was greater than 0.7 for all constructs. The AVE values for all latent constructs were also greater than 0.5. Hence, the reliability and convergent validity of the constructs used in the model were established.

Table 6.36. Construct Reliability and Validity for Impact of PC x ST on Delays in Traditional (Non-BIM) Projects

Factors	Loadings	Indicator Reliability	Cronbach's Alpha	Rho_A	Composite Reliability	AVE
Contractual Delay			0.733	0.738	0.778	0.637
DCA2	0.829	0.687				
DCA7	0.767	0.588				
Financial Delay			0.762	0.802	0.847	0.583
DFA1	0.687	0.472				
DFA2	0.679	0.460				
DFA3	0.840	0.706				
DFA4	0.833	0.693				
Managerial Delay			0.731	0.732	0.831	0.552
DMA1	0.714	0.510				
DMA2	0.751	0.564				
DMA3	0.759	0.576				
DMA4	0.747	0.558				
Social Delay			0.708	0.795	0.829	0.710
DSA1	0.914	0.835				
DSA2	0.765	0.585				
Technical Delay			0.668	0.680	0.818	0.601
DTA2	0.720	0.519				
DTA3	0.824	0.678				
DTA4	0.779	0.606				
Project Characteristics			0.671	0.695	0.814	0.594
PC_1	0.808	0.653				
PC_2	0.803	0.645				
PC_3	0.697	0.486				
Management, Organisation & Financial Planning			0.821	0.827	0.881	0.649
SM02	0.793	0.629				
SM04	0.828	0.686				
SM08	0.759	0.577				
SM10	0.840	0.706				
Team Success Group			0.692	0.692	0.866	0.764
ST01	0.870	0.758				
ST02	0.878	0.771				

Table 6.37 shows that the square root of the AVE values of all the constructs was greater than the corresponding correlation values for each construct. Thus, the discriminant validity of the constructs was established.

Table 6.37. Fornell-Larcker Criterion for the Impact of PC x ST on Delays in Traditional (Non-BIM) Projects

Factors	**Contractual Delay**	**Financial Delay**	**Management, Organisation & Financial Planning**	**Managerial Delay**	**Project Characteristics**	**Social Delay**	**Team Success**	**Technical Delay**
Contractual Delay	**0.798**							
Financial Delay	0.496	**0.764**						
Management, Organisation & Financial Planning	0.420	0.341	**0.806**					
Managerial Delay	0.318	0.350	0.274	**0.743**				
Project Characteristics	0.212	0.139	–0.006	0.354	**0.771**			
Social Delay	0.282	0.316	0.384	0.205	0.060	**0.843**		
Team Success Group	0.462	0.728	0.273	0.312	0.040	0.313	**0.874**	
Technical Delay	0.393	0.486	0.442	0.560	0.173	0.355	0.487	**0.775**

Figure 6.9 shows the bootstrapping results for the model of PC. Table 6.38 shows that ST significantly affects all the delays ($p < 0.05$). However, the effect of the interaction terms on contractual delay, managerial delay, and social and technical delays was found to be non-significant. The effect of the interaction terms on financial delay alone was significant. This implies that PC moderates the influence of ST on financial delays alone but has no moderating influence on other delays.

Table 6.38. T-Values and P-Values for Impact of PC x ST in Traditional (Non-BIM) Projects

	Sample Mean	**Standard Deviation**	**T-Statistics**	**P-Values**
Management, Organisation & Financial Planning » Contractual Delay	0.315	0.082	3.841	0.000
Management, Organisation & Financial Planning » Financial Delay	0.099	0.032	3.103	0.002
Management, Organisation & Financial Planning » Managerial Delay	0.213	0.074	2.777	0.006
Management, Organisation & Financial Planning » Social Delay	0.337	0.075	4.417	0.000
Management, Organisation & Financial Planning » Technical Delay	0.334	0.065	5.053	0.000
PC » Contractual Delay	0.205	0.068	3.029	0.002
PC » Financial Delay	0.095	0.038	2.487	0.013
PC » Managerial Delay	0.344	0.100	3.515	0.000
PC » Social Delay	0.044	0.078	0.537	0.591
PC » Technical Delay	0.164	0.089	1.890	0.059
ST*PC-DCA » Contractual Delay	0.079	0.079	0.928	0.354
ST*PC-DFA » Financial Delay	**–0.084**	**0.039**	**2.275**	**0.023**
ST*PC-DMA » Managerial Delay	–0.014	0.113	0.193	0.847
ST*PC-DSA » Social Delay	–0.096	0.105	0.939	0.348
ST*PC-DTA » Technical Delay	0.075	0.094	0.862	0.389
Team Success » Contractual Delay	0.356	0.074	4.779	0.000
Team Success » Financial Delay	0.908	0.030	30.861	0.000
Team Success » Managerial Delay	0.253	0.087	2.786	0.005
Team Success » Social Delay	0.250	0.096	2.493	0.013
Team Success » Technical Delay	0.384	0.073	5.149	0.000

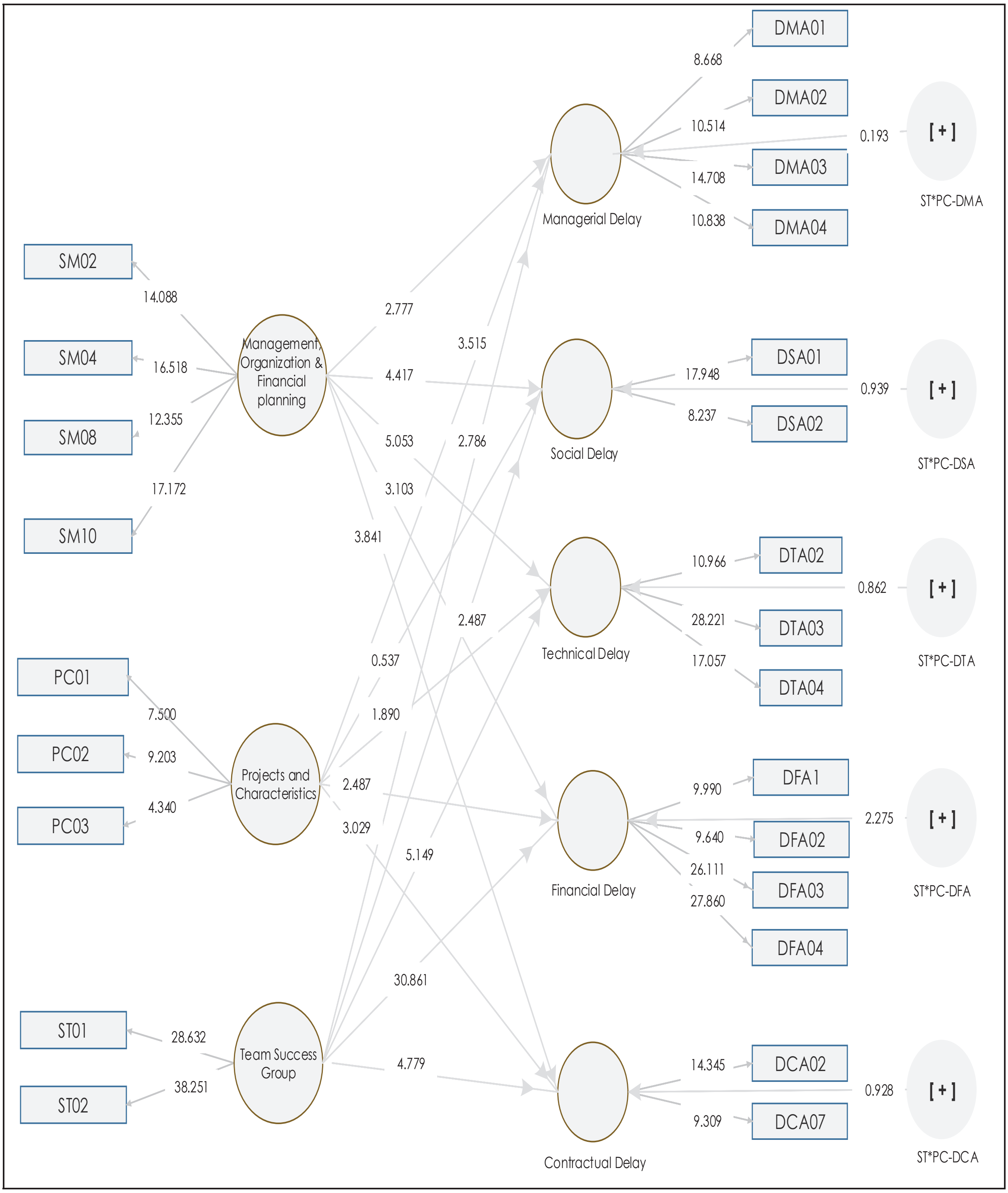

Figure 6.9. Bootstrapping Model—Impact of ST x PC on Delays in Traditional (Non-BIM) Projects

Following the effect of the PC analysis, the external environment of a project (PEE) was also considered a moderating variable in the study. The relationship between SM and project delays was studied. Interaction terms were created between Project External Environment (PEE) and SM. The model is shown in the following figure. Figure 6.10 describes the effect of PEE on the SM relationship with employer-initiated delay groups.

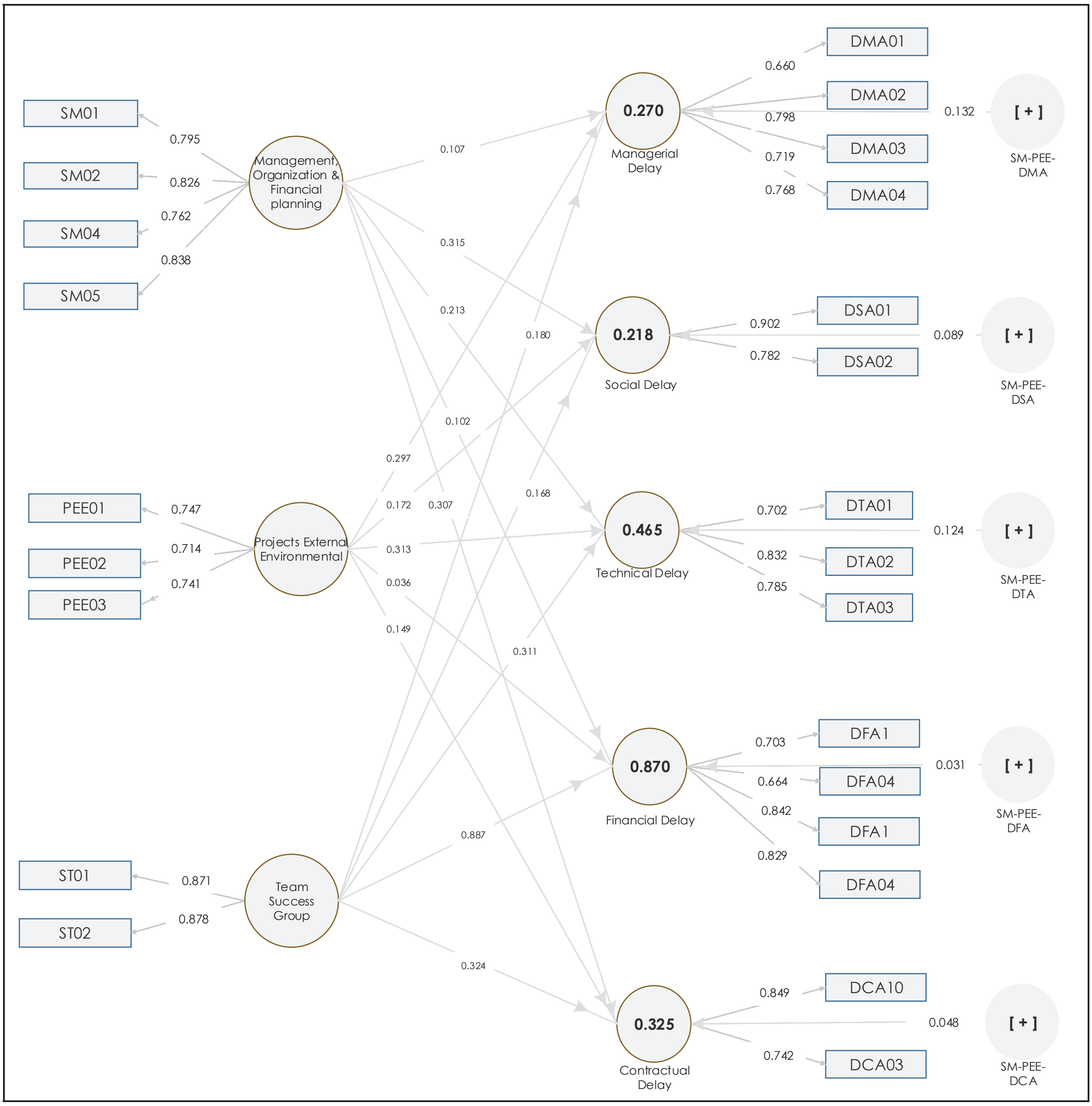

Figure 6.10. PLS Model–Impact of PEE x SM on Delays in Traditional (Non-BIM) Projects

Table 6.39 describes the indicator reliability, which was much greater than 0.40 for all the indicators, and the composite reliability was greater than 0.7 for all the constructs. The AVE values for all the latent constructs were also greater than 0.5. Hence, the reliability and convergent validity of the constructs used in the model were established.

Table 6.39. Construct Reliability and Validity for Impact of SM x PEE on Delays in Traditional (Non-BIM) Projects

Factors	**Loadings**	**Indicator Reliability**	**Cronbach's Alpha**	**Rho_A**	**Composite Reliability**	**AVE**
Contractual Delay			0.733	0.748	0.777	0.636
DCA2	0.849	0.721				
DCA7	0.742	0.550				
Financial Delay			0.762	0.800	0.847	0.583
DFA1	0.703	0.494				
DFA2	0.664	0.440				
DFA3	0.842	0.709				
DFA4	0.829	0.688				
Managerial Delay			0.731	0.759	0.827	0.545
DMA1	0.660	0.436				
DMA2	0.798	0.638				
DMA3	0.719	0.517				
DMA4	0.768	0.590				
Social Delay			0.708	0.763	0.832	0.713
DSA1	0.902	0.814				
DSA2	0.782	0.612				
Technical Delay			0.668	0.688	0.818	0.600
DTA2	0.702	0.493				
DTA3	0.832	0.692				
DTA4	0.785	0.616				
Project External Environmental			0.773	0.774	0.778	0.539
PEE01	0.747	0.559				
PEE02	0.714	0.510				
PEE03	0.741	0.549				
Management, Organisation & Financial Planning			0.821	0.826	0.881	0.650
SM02	0.795	0.632				
SM04	0.826	0.682				
SM08	0.762	0.580				
SM10	0.838	0.703				
Team Success Group			0.692	0.692	0.866	0.764
ST01	0.871	0.758				
ST02	0.878	0.771				

Table 6.40 shows that the square root of AVE values of all the constructs was greater than the corresponding correlation values for each construct. Thus, the discriminant validity of the constructs was established. Figure 6.11 shows the bootstrapping results for the model of the PEE effect.

Table 6.40. Fornell-Larcker Criterion for the Impact of SM x PEE on Delays in Traditional (Non-BIM) Projects

Factors	**Contractual Delay**	**Financial Delay**	**Management, Organisation & Financial Planning**	**Managerial Delay**	**Project Characteristics**	**Social Delay**	**Team Success**	**Technical Delay**
Contractual Delay	**0.797**							
Financial Delay	0.495	**0.763**						
Management, Organisation & Financial Planning	0.424	0.344	**0.806**					
Managerial Delay	0.333	0.357	0.299	**0.738**				
Project External Environmental	0.344	0.376	0.310	0.445	**0.734**			
Social Delay	0.282	0.317	0.380	0.218	0.297	**0.844**		
Team Success Group	0.460	0.727	0.274	0.322	0.361	0.312	**0.874**	
Technical Delay	0.398	0.487	0.443	0.570	0.538	0.358	0.487	**0.775**

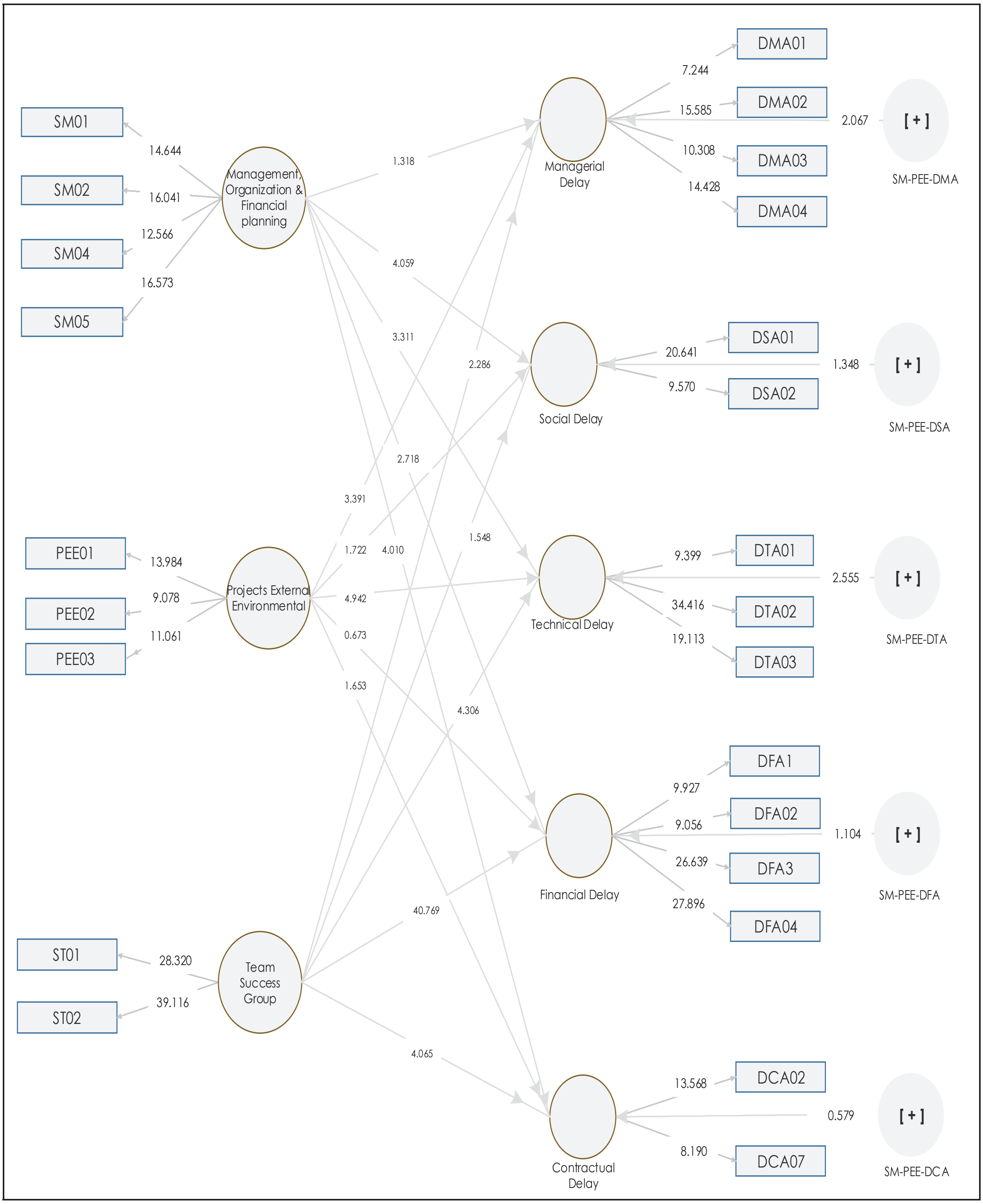

Figure 6.11. Bootstrapping Model—Impact of SM x PEE on Delays in Traditional (Non-BIM) Projects

Table 6.41 describes the PEE factors significantly affecting a project's technical and managerial delay. PEE moderates the relationship between SM and technical delay. It interacts with SM to significantly affect a project's technical delays. The interaction between PEE and SM did not affect other delays.

Table 6.41. T-Values and P-Values for Impact of PEE x SM in Traditional (Non-BIM) Projects

	Sample Mean	**Standard Deviation**	**T-Statistics**	**P-Values**
Management, Organisation & Financial Planning » Contractual Delay	0.303	0.077	4.010	0.000
Management, Organisation & Financial Planning » Financial Delay	0.100	0.036	2.718	0.007
Management, Organisation & Financial Planning » Managerial Delay	0.115	0.079	1.318	0.188
Management, Organisation & Financial Planning » Social Delay	0.326	0.078	4.059	0.000
Management, Organisation & Financial Planning » Technical Delay	0.217	0.065	3.311	0.001
PEE » Contractual Delay	0.146	0.090	1.653	0.099
PEE » Financial Delay	0.024	0.040	0.673	0.501
PEE » Managerial Delay	0.298	0.088	3.391	0.001
PEE » Social Delay	0.168	0.098	1.722	0.085
PEE » Technical Delay	0.317	0.063	4.942	0.000
SM*PEE-DCA » Contractual Delay	0.039	0.090	0.579	0.562
SM*PEE-DFA » Financial delay	0.032	0.028	1.104	0.270
SM*PEE-DMA » Managerial delay	–0.131	0.065	2.067	0.039
SM*PEE-DSA » Social delay	0.096	0.066	1.348	0.178
SM*PEE-DTA » Technical delay	–0.126	0.048	2.555	0.011
Team Success » Contractual Delay	0.334	0.080	4.065	0.000
Team Success » Financial Delay	0.896	0.022	40.769	0.000
Team Success » Managerial Delay	0.183	0.078	2.286	0.022
Team Success » Social Delay	0.170	0.109	1.548	0.122
Team Success » Technical Delay	0.307	0.072	4.306	0.000

Also, interaction terms were created between PEE and ST. The model is shown in the following figure. Figure 6.12 describes the MM for the effect of PEE on the ST relationship with employer-initiated delay groups.

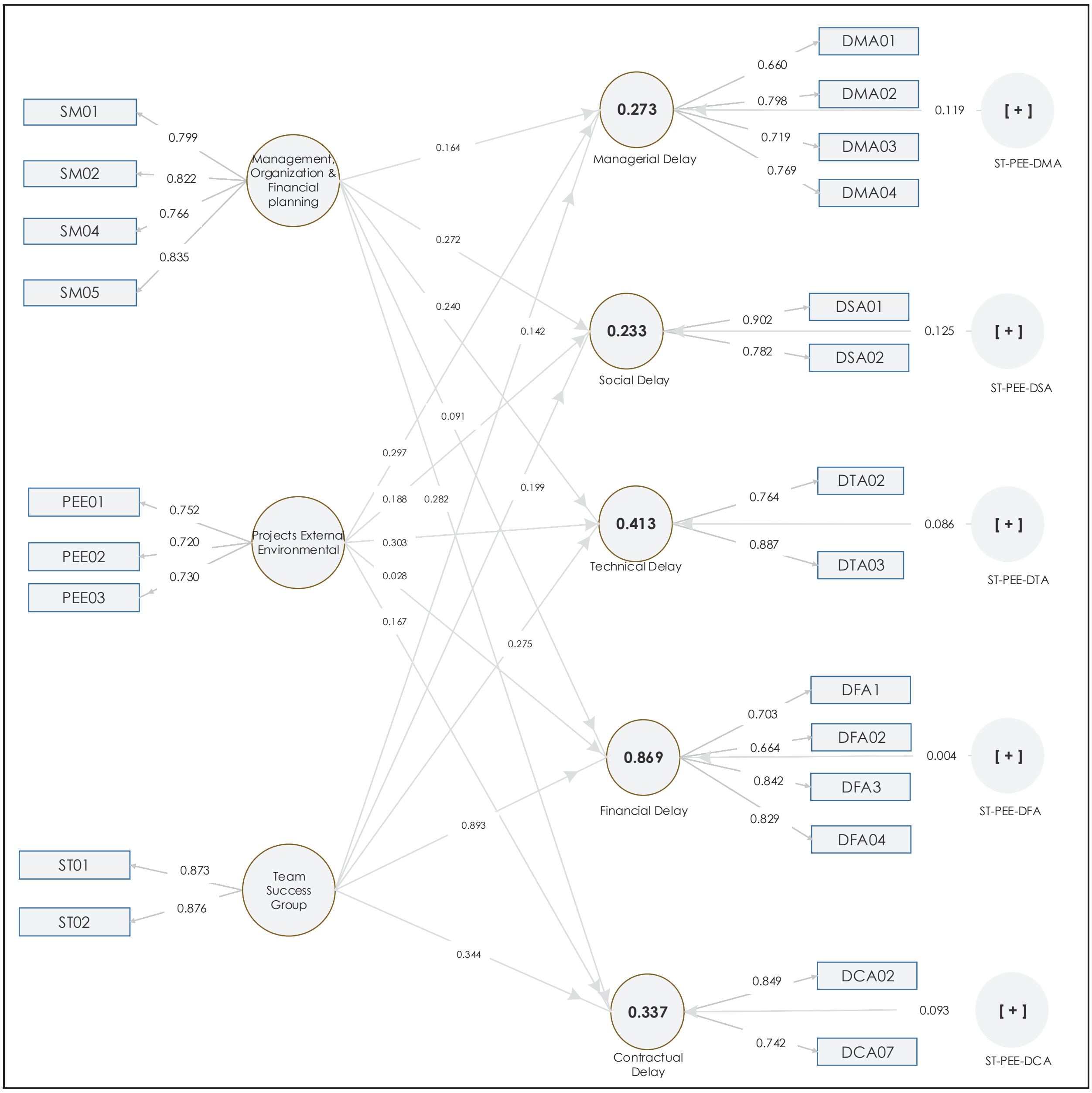

Figure 6.12. PLS Model—Impact of ST x PEE on Delays in Traditional (Non-BIM) Projects

Table 6.42 shows that the indicator reliability was greater than 0.40 for all the indicators, and the composite reliability was greater than 0.7 for all the constructs. The AVE values for all the latent constructs were also greater than 0.5. Hence, the reliability and convergent validity of the constructs used in the model were established.

Table 6.42. Construct Reliability and Validity for the Impact of ST x PEE on Delays in Traditional (Non-BIM) Projects

Factors	Loadings	Indicator Reliability	Cronbach's Alpha	Rho_A	Composite Reliability	AVE
Contractual Delay			0.733	0.748	0.777	0.636
DCA2	0.849	0.721				
DCA7	0.742	0.551				
Financial Delay			0.762	0.800	0.847	0.583
DFA1	0.703	0.494				
DFA2	0.664	0.441				
DFA3	0.842	0.710				
DFA4	0.829	0.687				
Managerial Delay			0.731	0.759	0.827	0.545
DMA1	0.660	0.436				
DMA2	0.798	0.637				
DMA3	0.719	0.517				
DMA4	0.769	0.591				
Social Delay			0.708	0.763	0.832	0.713
DSA1	0.902	0.814				
DSA2	0.782	0.611				
Technical Delay			0.749	0.789	0.812	0.685
DTA2	0.764	0.583				
DTA3	0.887	0.786				
Project External Environmental			0.773	0.774	0.778	0.539
PEE01	0.752	0.566				
PEE02	0.720	0.519				
PEE03	0.730	0.533				
Management, Organisation & Financial Planning			0.821	0.825	0.881	0.650
SM02	0.799	0.639				
SM04	0.822	0.676				
SM08	0.766	0.587				
SM10	0.835	0.697				
Team Success Group			0.692	0.692	0.866	0.764
ST01	0.873	0.762				
ST02	0.876	0.767				

Table 6.43 shows that the square root of AVE values of all the constructs was greater than the corresponding correlation values for each construct. Thus, the discriminant validity of the constructs was established.

Table 6.43. Fornell-Larcker Criterion for Impact of ST x PEE on Delays in Traditional (Non-BIM) Projects

Factors	Contractual Delay	Financial Delay	Management, Organisation & Financial Planning	Managerial Delay	Project Characteristics	Social Delay	Team Success	Technical Delay
Contractual Delay	**0.797**							
Financial Delay	0.495	**0.763**						
Management, Organisation & Financial Planning	0.424	0.344	**0.806**					
Managerial Delay	0.333	0.357	0.300	**0.738**				
Project's External Environmental	0.342	0.377	0.308	0.446	**0.734**			
Social Delay	0.282	0.317	0.379	0.218	0.294	**0.844**		
Team Success Group	0.460	0.727	0.273	0.322	0.362	0.312	**0.874**	
Technical Delay	0.366	0.468	0.412	0.578	0.510	0.355	0.470	**0.827**

Table 6.44 shows that ST has a significant effect ($p < 0.05$) on all the delays except managerial delays. However, the effect of the interaction terms on contractual delay and financial and social delay were non-significant. The effect of the interaction terms on managerial delay and technical delay alone was significant. This implies that PEE moderates the influence of ST on managerial and technical delays alone but has no moderating influence on other delays. Figure 6.13 shows the bootstrapping results for the PEE effect on the relationships between ST and the delays caused by the employer. The results suggest that managerial and technical delays in projects were not only a result of team success but also of the PEE.

Table 6.44. T-Values and P-Values for Impact of PEE x ST in Traditional (Non-BIM) Projects

	Sample Mean	**Standard Deviation**	**T-Statistics**	**P-Values**
Management, Organisation & Financial Planning » Contractual Delay	0.286	0.080	3.527	0.000
Management, Organisation & Financial Planning » Financial Delay	0.089	0.037	2.418	0.016
Management, Organisation & Financial Planning » Managerial Delay	0.171	0.072	2.235	0.025
Management, Organisation & Financial Planning » Social Delay	0.280	0.082	3.339	0.001
Management, Organisation & Financial Planning » Technical Delay	0.242	0.071	3.375	0.001
PEE » Contractual Delay	0.165	0.089	1.866	0.062
PEE » Financial Delay	0.018	0.035	0.546	0.585
PEE » Managerial Delay	0.300	0.089	3.347	0.001
PEE » Social Delay	0.185	0.095	1.950	0.051
PEE » Technical Delay	0.308	0.069	4.400	0.000
ST*PEE-DCA » Contractual Delay	0.081	0.067	1.432	0.152
ST*PEE-DFA » Financial Delay	0.006	0.024	0.250	0.803
ST*PEE-DMA » Managerial Delay	**–0.117**	**0.049**	**2.494**	**0.013**
ST*PEE-DSA » Social Delay	0.124	0.077	1.608	0.108
ST*PEE-DTA » Technical Delay	**–0.087**	**0.037**	**2.313**	**0.021**
Team Success » Contractual Delay	0.349	0.082	4.237	0.000
Team Success » Financial Delay	0.899	0.022	40.814	0.000
Team Success » Managerial Delay	0.148	0.080	1.765	0.078
Team Success » Social Delay	0.205	0.096	2.076	0.038
Team Success » Technical Delay	0.270	0.069	3.991	0.000

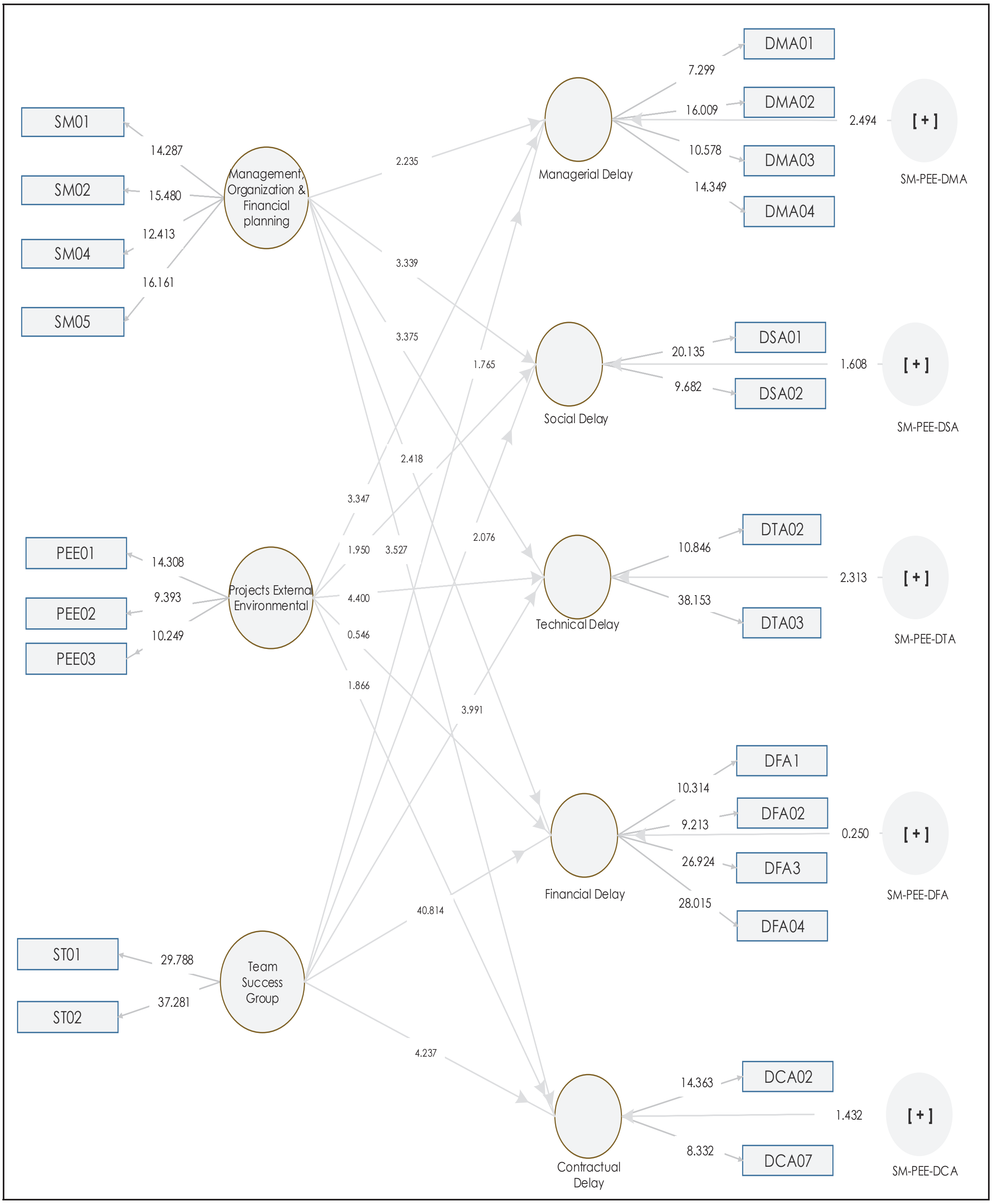

Figure 6.13. Bootstrapping Model—Impact of ST x PEE on Delays in Traditional (Non-BIM) Projects

6.13 Interaction Effects of Moderators on Employer-Initiated Delay and the Critical Success Factors Modelling

The analysis mentioned above offers a thorough examination, revealing various significant conclusions pertaining to the factors and dynamics that contribute to project delays in typical project settings. First and foremost, it is apparent that both SM and ST are crucial factors that contribute to project delays caused by employers. This highlights the significance of employing efficient stakeholder interaction and communication tactics within project management. Furthermore, the analysis of interaction effects provides complex insights into the underlying factors contributing to the occurrence of delays. Contractual delays can be attributed to various reasons, including individual elements as well as the interaction between Management Organisation and Financial Planning and Project Characteristics (PC). This emphasises the necessity of adopting a comprehensive approach to project management that takes into account both the organisational and financial dimensions. In a similar vein, it is important to note that financial delays in projects are not exclusively contingent upon the performance of the team but rather can be impacted by the complicated interplay between the effectiveness of the project team and the level of Project Characteristics (PC). This discovery underscores the importance of financial planning and its alignment with the unique project context. The occurrence of technical delays has been observed to arise from the interaction between SM and Project Environmental Elements (PEE) variables. This finding suggests that the broader project environment can significantly influence technical elements, implying that contextual considerations should be thoroughly evaluated while designing and implementing a project.

Moreover, the occurrence of managerial and technical delays can be attributed to the interplay between ST and PEE. This highlights the complex interplay between communication methods and the project environment, demanding a customised approach to tackle these difficulties effectively. Furthermore, it is worth noting that Figure 6.14 provides a visual representation of the impact of PC on the relationship between SM and DCA. The provided visual description underscores the significance of project complexity in moderating the impact of stakeholder management on delays, hence emphasising the necessity to adapt techniques in complex project scenarios. Figure 6.15 provides more evidence of the moderating influence exerted by Project Environmental Elements (PEE) on the enhancement of the association between DMA and SM. This implies that the project environment has the potential to augment the influence of milestone accomplishment on the effectiveness of stakeholder management. Figure 6.16 demonstrates that the moderator known as PEE mitigates the association between DTA and SM. The provided graphic representation highlights the potential for project circumstances to diminish the impact of task achievement on stakeholder management.

In conclusion, this extensive analysis offers valuable perspectives on the complex nature of project delays in conventional projects, emphasising the major influence of diverse elements and their complex interplay. The findings mentioned above highlight the significance of adopting comprehensive project management methodologies that take into account both individual variables and their interconnectedness within the project setting.

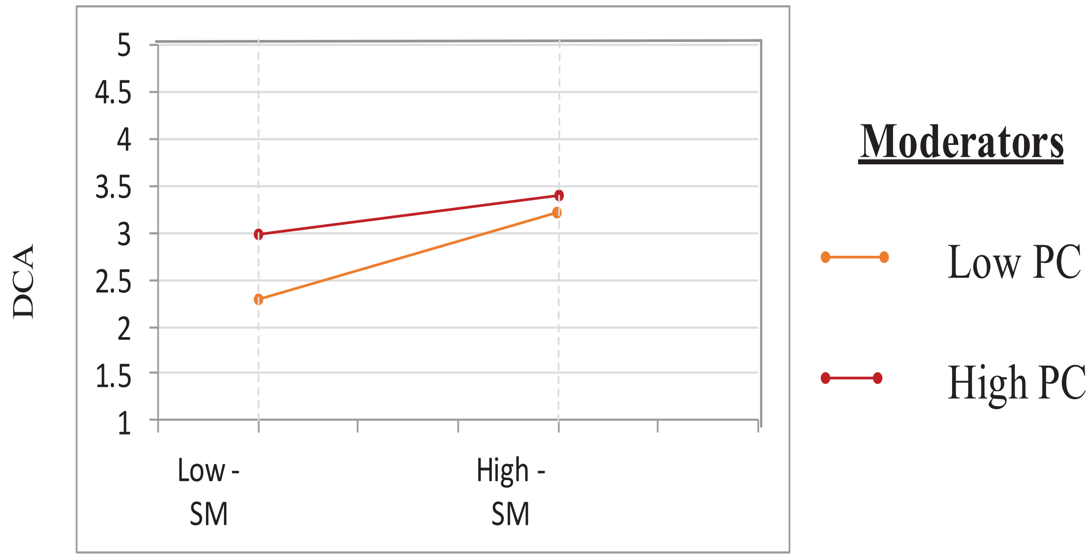

Figure 6.14. Interaction Influence for Variables DCA, SM and PC

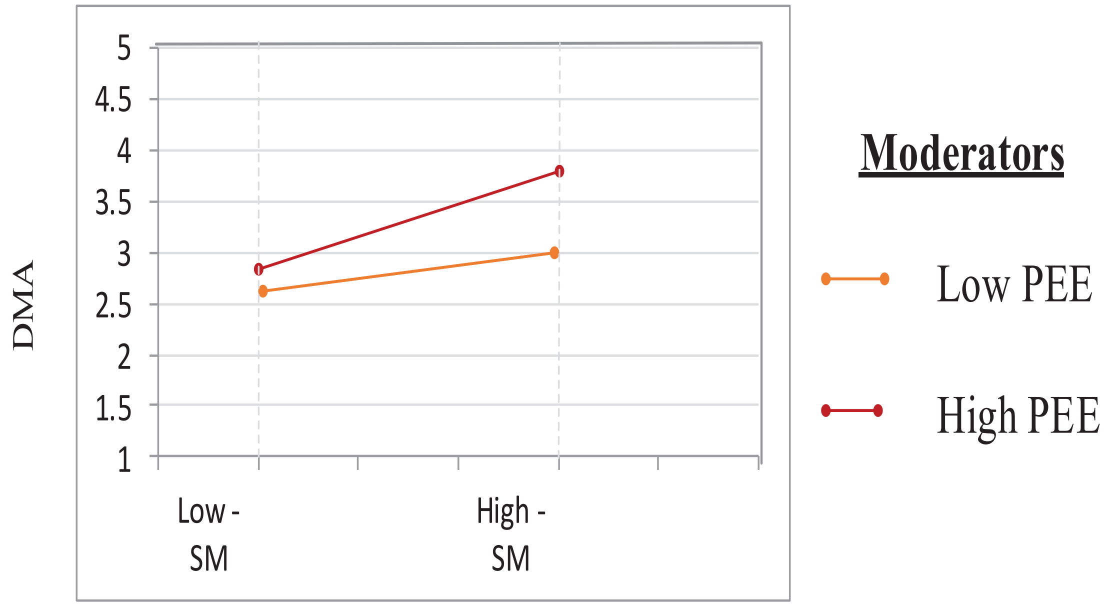

Figure 6.15. Interaction Influence for Variables DMA, SM and PEE

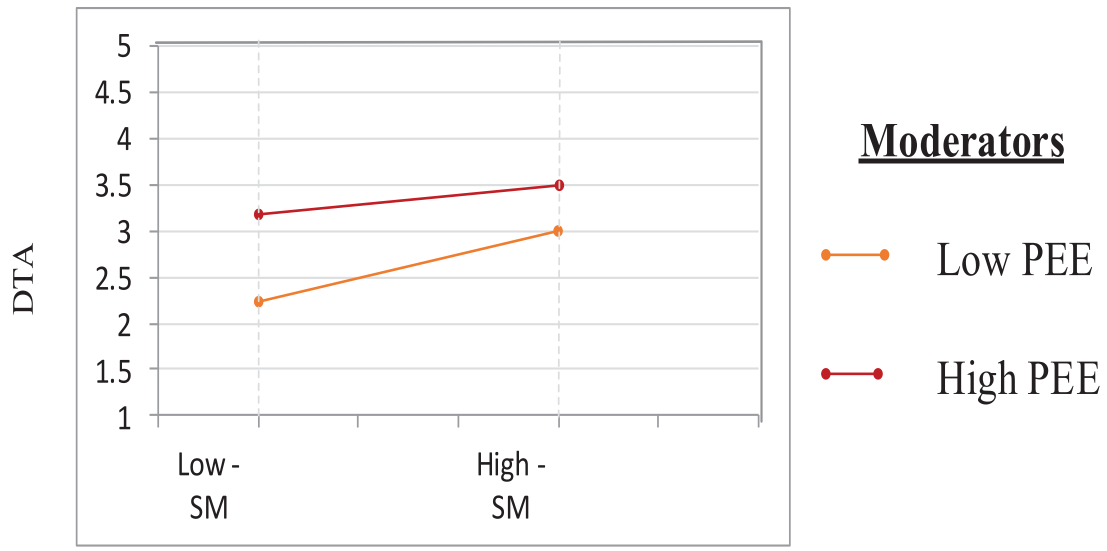

Figure 6.16. Interaction Influence for Variables DTA, SM and PEE

In addition to the above, Figure 6.17, Figure 6.18, and Figure 6.19 show that the PC dampens the positive relationship between ST and DFA, PEE dampens the positive relationship between ST and DMA, and PEE dampens the positive relationship between ST and DTA.

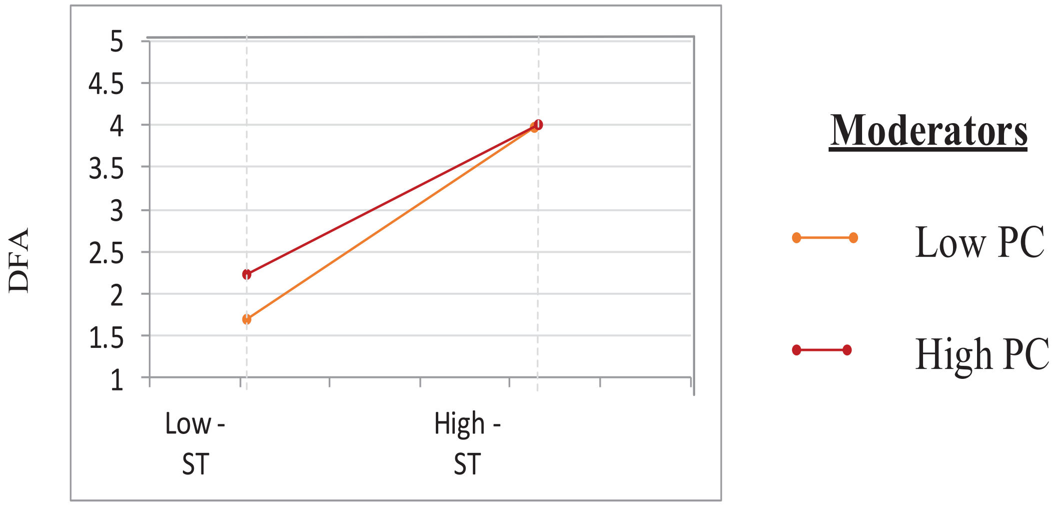

Figure 6.17. Interaction Influence for Variables DFA, SM and PC

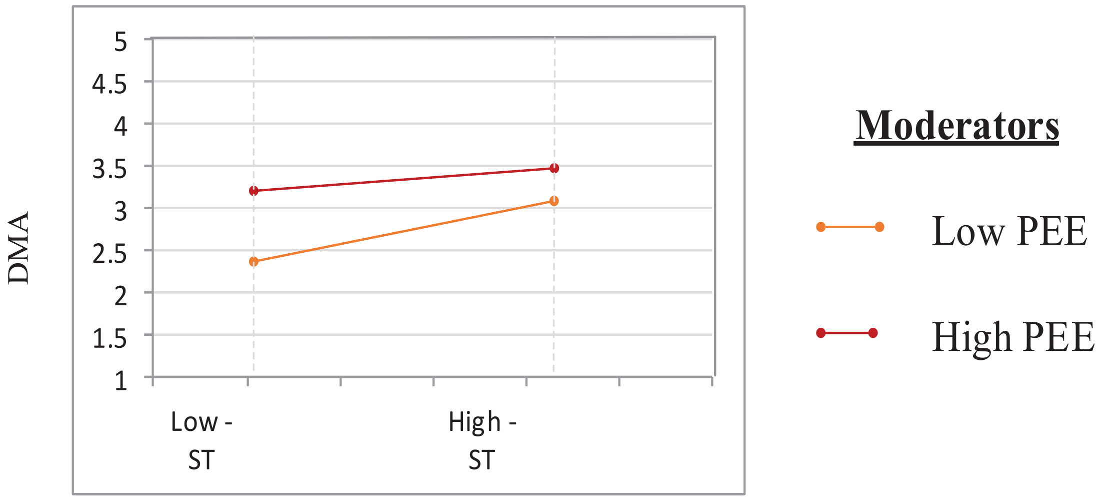

Figure 6.18. Interaction Influence for Variables DMA, ST and PEE

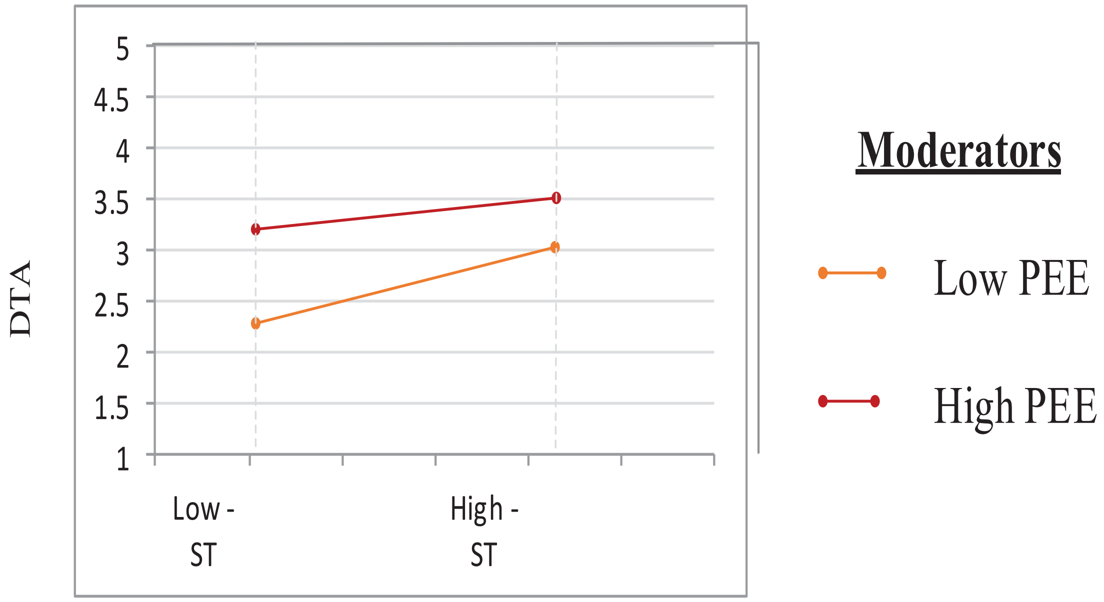

Figure 6.19. Interaction Influence for Variables DTA, ST and PEE

6.14 Summary Results for SEM Analysis for Traditional (Non-BIM) and BIM-Enabled Projects

Tables 6.45 and 6.46 provide comprehensive summaries of the analysis results, shedding light on the dynamics of project delays attributed to employers and the rankings of critical success factors in two project paradigms: traditional (Non-BIM) projects and Building Information Modelling (BIM)-enabled projects. The provided tables offer a comprehensive representation of the delays that can be linked to employers, which is a crucial factor in the field of project management. A comprehensive comprehension of the precise causes and their subsequent ramifications is of utmost importance in facilitating efficient project planning and execution. The provided tables display rankings for the top 10 important success elements, providing vital insights into the significant components that exert an effect on the success of a project. This unique insight is of great importance to project stakeholders who are striving to prioritise their efforts and allocate resources efficiently. The impact of moderators is explored in Tables 6.45 and 6.46, whereby the notion of external factors that affect the association between important success criteria and employer-induced delays is introduced. The factors included in this study are Project Characteristics (PC), Project Environmental Elements (PEE), BIM Implementation Factors (BIMS), and BIM Barriers Factors (BIMB). The tables provide clarification on the manner in which these moderators engage with the important success elements. This observation provides an understanding of whether external factors serve to enhance or diminish the influence of important success elements on delays caused by employers. Comprehending these relationships is crucial for customising project management solutions to particular settings. The type of effect, whether dampening or strengthening, is clearly indicated in Tables 6.45 and 6.46, providing explicit information regarding the moderators' impact. The provision of this information enables project managers and stakeholders to make well-informed decisions in relation to the identified important success criteria and their corresponding modifiers. One of the primary advantages of these tables is their capacity to facilitate a comparative analysis of the outcomes observed in traditional (Non-BIM) projects against those enabled by Building Information Modelling (BIM). A comparative examination of several project approaches assists stakeholders in identifying the distinct problems and advantages associated with each strategy. In brief, Tables 6.45 and 6.46 function as comprehensive resources that incorporate essential project management ideas. The provided analysis presents a comprehensive perspective on project delays, covering the various elements that contribute to their occurrence, as well as the ways in which external influences can either exacerbate or mitigate their consequences. This understanding enables those involved in a project to improve their decision-making processes and eventually improve project outcomes in both conventional and BIM-enabled project environments.

Table 6.45. Results Summary for Traditional (Non-BIM) Projects

Items	Rank for Employer-Initiated Delay Factors	Rank for Critical Success Factors	Summary/Conclusion
First Ten Factors	DMA1 DCA7 DMA3 DFA1 DFA2 DFA3	SM03 SM09 ST01 ST02 SM04 SM10	Managerial (DMA) and Financial (DFA) employer-initiated delay factors form 70% of the first ten factors leading to delays in traditional (Non-BIM) projects. Besides,

	DFA4 DTA2 DMA4 DSA2	SM02 SM08 SM01 SM05	80% of the critical success factors are from the SM group.
T-Values for Relationships Between Critical Success and Employer-Initiated Delay Groups (First Five Relationships)- **Without Moderators**	ST to DFA; T = 46.292 SM to DTA; T = 5.517 ST to DTA; T = 5.227 ST to DCA; T = 5.127 SM to DCA; T = 3.896 SM to DMA; T= 3.785 ST to DMA; T= 2.732		ST and SM, groups of critical success factors, have all been proven (without considering the moderators) to influence employer-initiated delay factors; however, ST was proven to have the most positive effect on the DFA delay factors.
PC Moderator's Impacts on Delays Caused by the Employer and Critical Success Factors Relations	SM-PC-DCA and ST-PC-DFA are the only valid relationships when the moderator PC is considered in the SEM model with a t-value of 2.252, p-value of 0.024 and t-value of 2.275 and p-value of 0.023, respectively		The moderator PC dampens the positive relationship between DCA and SM. The moderator PC dampens the positive relationship between DFA and ST.
PEE Moderator's Effects on Delays Caused by the Employer and Critical Success Factors Relations	SM-PEE-DMA, SM-PEE-DTA, ST-PEE-DMA and ST-PEE-DTA are valid relationships when the PEE is considered in the SEM model SM-PEE-DMA; T-value = 2.067; p-value = 0.039 SM-PEE-DTA; T-value = 2.555; p-value = 0.011 ST-PEE-DMA; T-value = 2.494; p-value = 0.013 ST-PEE-DTA; T-value = 2.313; p-value = 0.021		The moderator PEE dampens the relationship between DMA and SM. The moderator PEE dampens the relationship between DTA and SM. The moderator PEE dampens the positive relationship between DMA and ST. The moderator PEE dampens the positive relationship between DTA and ST.

Table 6.46. Results Summary for BIM-Enabled Projects

Item	Rank for Employer-Initiated Delay Factors	Rank for Critical Success Factors	Summary/Conclusion
First Ten Factors	DCA4 DCA5 DCA3 DCA6 DCA10 DCA9 DTA2 DMA10 DTA3 DSA2	SM02 SM07 SM09 SM06 SM01 SM08 SM04 SM05 ST01 ST02	Contractual (DCA) employer-initiated delay factors form 60% of the first ten factors leading to the delay in the BIM-enabled projects. Besides, 80% of the success factors are from the SM group.
T-Values for Relationships Between Critical Success and Employer-Initiated Delay Groups (First Five Relationships)- **Without Moderators**	SM to DCA; T = 14.875 SM to DMA; T = 5.213 SM to DSA; T = 4.705 SM to DTA; T = 3.928 SM to DFA; T = 2.899		SM group of critical success factors is proven (without considering the moderators) to affect employer-initiated delay factors; however, SM was proven to have the most positive effect on the DCA delay factors.
BIMS Moderator's Effects on Employer-Initiated Delays and Critical Success Factors Relationships	BIMS affected delays caused by the employer relations with the critical success factors of SM-DSA, SM-DCA and SM-DTA.		Refer to Chapter 4.
BIMB Moderator's Impacts on Employer-Initiated Delays and Critical Success Factors Relationships	BIMB affected delays caused by the employer relations with the critical success factors of SM-DSA, SM-DTA and SM-DFA.		Refer to Chapter 4.

6.15 Summary of Chapter 6

This chapter offered a detailed summary of this study's sample size, the pilot review, the questionnaire development and the methods used in data collection. In general, the researcher referred to previous similar studies about SEM, providing evidence of the convenient sample size used in this research. Besides, this chapter provided a brief description of the pilot review conducted either by direct interview to ensure that the questionnaire was clear and sufficient for the respondent to understand or by collecting pilot responses from 29 persons to measure the validity of the questionnaire. The questionnaire development procedure was defined. Detailed descriptions of the data collected from the respondents' roles, years of experience, education level, geographical distribution, job title and project features have been presented in this chapter in a detailed manner.

This chapter offered a detailed summary of the data results and interpretations for the traditional (Non-BIM) and BIM-enabled projects regarding the magnitude of the worst delay data results and discussions, employer-initiated delay factors ranking, critical success factors ranking, traditional (Non-BIM) project SEM data analysis, results and interpretation. It also provided a useful summary of the data results for both projects covered in this study. The data analysis evaluated how delays and critical success parameters differ between BIM-enabled and traditional (Non-BIM) projects. This study sought several respondents for various surveys to investigate this phenomenon. The study also used Spearman's correlation and Chi-squared coefficient to represent a nonparametric alternative often used for data items that follow monotonic, curvilinear patterns. Therefore, it presented a beneficial correlation measure because the data used did not have a straight-line relationship or comprise ordinal data pairs.

7 Case Studies and Triangulations Results

7.1 Introduction

Case studies have been widely employed in numerous academic fields throughout history. Qualitative research techniques are widely used in the social sciences, as they enable researchers to examine real-life situations and establish a basis for the formulation and implementation of theories and procedures. A case study is a form of empirical research that examines some current phenomena within its natural environment. However, a contentious discussion persists regarding the efficacy of the case study methodology. Several critics argue that analysing a limited number of cases lacks the essential foundation for establishing reliability or universal principles.

On the other hand, case studies possess essential value as instruments for exploration and validation. They highlight the ongoing efficacy of this approach in carefully designed investigations that delve into authentic scenarios, difficulties, and concerns.

The objective of this review is to establish the foundation for the formulation of frameworks designed to address and reduce delays caused by employers through conducting a triangulation between the quantitative and qualitative results and the case studies. Through a comprehensive analysis of actual projects, this assessment provides a deep contextual comprehension of the difficulties being examined. The assessment of these case studies has four fundamental elements: The objectives of this study include providing a thorough analysis of each project, determining the factors that contribute to delays initiated by employers, evaluating the success factors for mitigating employer-induced delays, and investigating the influence of moderating factors on both traditional (Non-BIM) and Building Information Modelling (BIM)-enabled projects. During performing these case studies, interviews played a crucial role. In each case study, a total of two interviews were carried out, with two interviews dedicated to traditional (Non-BIM) projects and another two interviews dedicated to projects utilising Building Information Modelling (BIM). The selection of study sites for these case analyses included China and the United Arab Emirates for the traditional (Non-BIM) projects and the United Kingdom and the United Arab Emirates for the projects utilising Building Information Modelling (BIM).

In order to support ethical standards in the research conducted, the participants involved in the case studies were furnished with two crucial documents. The initial document included a concise overview of the research study's thesis, whilst the subsequent document aimed to obtain the participants' informed consent for their involvement in the research. Both forms were granted clearance by the Ethics Department at Curtin University, as indicated by the approval number HRE2018-356. The Appendices provide copies of the approved ethical forms for reference purposes.

The occurrence of construction delays can exert a substantial influence on the timetables, budgets, and overall success of a project (Perera & Dewagoda, 2021). Case studies serve as a helpful study methodology for comprehending the benefits associated with the examination of construction delays (Perera & Dewagoda, 2021). Researchers can get insights into the common causes, repercussions, and management solutions pertaining to construction delays by analysing unique projects and their corresponding delays (Perera & Dewagoda, 2021).

A benefit inherent in the utilisation of case studies for construction delay analysis is its capacity to enhance the precision of existing research findings and assemble a comprehensive inventory of causes, repercussions, and methods for effective management (Perera & Dewagoda, 2021). Case studies offer a qualitative methodology for comprehending the details associated with building delays, enabling researchers to acquire comprehensive data and valuable insights from actual projects (Perera & Dewagoda, 2021).

Researchers can achieve triangulation in their research by integrating the outcomes derived from the analysis of case studies, conducting in-depth structured interviews, and engaging in actual fieldwork investigations (Rahman et al., 2022). Triangulation enhances the depth and breadth of comprehension regarding the research subject by integrating diverse viewpoints and data sources (Rahman et al., 2022). The practice of triangulation within case studies needs the use of many approaches for data collecting, including the examination of case studies, conducting in-depth structured interviews, and undertaking actual fieldwork investigations. By integrating these methodologies, scholars have the potential to augment the dependability, authenticity, and comprehensiveness of their research outcomes. Triangulation facilitates the process of validating and cross-verifying data, hence enhancing the comprehensiveness and reliability of the research findings pertaining to the chosen subject of study.

In summary, the incorporation of case studies in this research fulfils an essential role, namely, to authenticate and corroborate the conclusions drawn from quantitative data analysis and prior empirical investigations. The utilisation of a multidimensional method contributes to the enhancement of the robustness and reliability of the study outputs. The use of case studies in this study serves to enhance the comprehensiveness and contextual understanding of the quantitative data. Furthermore, it boosts the general dependability and validity of the study's findings by aligning them with qualitative evidence and proven empirical research.

7.2 Case Studies' Selection Approach: A Detailed Overview

Selecting case studies is a vital phase in the field of case study research, one that strongly affects the validity, generalizability, and practical significance of the findings gained. The choice of case selection strategies should fit with the specific research topic, the overarching objective of the study, and its overall design. In this thesis, the four case studies are considered typical and influential. The typical case study is a research strategy applied to get comprehensive insights and a thorough understanding of a particular environment or event. This approach comprises an extensive examination and analysis of one or more individual situations to reveal the underlying variables, processes, and results linked with them (Irasuegi et al., 2021). Case studies have proven beneficial across a wide array of domains, such as industrial engineering and management, sustainability, civil and mechanical engineering, geodesy, power quality estimates, and computational fluid dynamics. Researchers performing typical case studies delve into the nuances of their chosen setting, providing significant insights and understanding of the dynamics at play. These case studies are beneficial in different applications, including the study of theoretical concepts, the assessment of methodological procedures, the quantification of parameter fluctuations, the validation of instrument characteristics, and the examination of fluid flow characteristics. Ultimately, they contribute greatly to increasing knowledge and refining procedures in their respective sectors. The influential case study, as proven by Li et al. (2017), tries to discover important, influential components within a given domain, notably addressing human behaviour or complex systems. The key aims of such case studies are establishing linkages between these influential components and specific outcomes and displaying the capabilities of these models through actual case examples. Li et al. (2017), for instance, conducted an influential case study focusing on inhabitants' energy usage characteristics within a building environment. They wanted to investigate how numerous factors influenced energy habits, design a prediction model, and prove its application using a real-world building case study. The study underscored the need to take into account psychological elements and aesthetics when examining energy consumption behaviours in constructed environments. This seminal case study is a noteworthy scholarly contribution due to its provision of a comprehensive conceptual framework for comprehending and forecasting energy utilisation behaviours. Moreover, it offers practical insights that may be utilised to influence and potentially mitigate energy consumption. The results have broad relevance in various domains, including architectural design, energy administration, and policy development, ultimately advancing the implementation of energy efficiency and sustainability.

Initially, the case studies utilised in this thesis were typical as they provided highly valuable crucial facts and information that aid in the validation of quantitative analysis findings. Quantitative analysis, while having considerable efficacy, frequently acts at a conceptual level, relying on statistical patterns and interconnections. Researchers can effectively bridge the difference between abstract findings and the practical circumstances they seek to depict by integrating example case studies. These cases provide a tangible and comprehensive perspective on certain instances or circumstances within the wider scope of the study field. By analysing these representative cases, researchers may validate the alignment between their quantitative findings and the real-life experiences and behaviours seen in the field. In addition, they are involved with highly knowledgeable specialists through the means of interviews. These individuals possess a substantial amount of expertise, valuable perspectives, and pragmatic wisdom that they provide to the research endeavour. The inclusion of expert interviews in research not only enhances the quality of the qualitative data gathered but also adds a human element to the study. Professionals possess the ability to clarify intricate facets of the topic, furnish a historical framework, and present interpretations that may not be readily apparent solely from quantitative data. The contributions made by the individuals enhance the comprehensiveness and reliability of the research outcomes.

Additionally, the case studies of this thesis are also considered influential as they are involved in traditional (Non-BIM) building procedures as well as in Building Information Modelling (BIM)-enabled practises; significant case studies can shed light on the contrasting nature of both approaches. Also, the inclusion of diverse geographic contexts is of significant importance in conducting research, particularly cross-cultural studies; prominent case studies conducted in nations such as China and the United Kingdom provide a valuable avenue for examining the impact of distinct contextual elements on the phenomenon being investigated. Moreover, while examining case studies in both traditional (Non-BIM) and BIM-enabled projects, it becomes apparent that interviewees constantly assert that the employer notably impacts their projects. The influence mentioned above holds significant importance and exerts a central role in the process of selecting projects. The influence of the employer on these initiatives is of significant importance since it holds considerable control over multiple facets of project implementation and achievement. This observation highlights the influential role of employers in determining project dynamics and emphasises their importance in the decision-making process for project selection.

The case studies were conducted in person for traditional (Non-BIM) projects, whilst for BIM-enabled projects, except for the one undertaken for the UK, the interviews were conducted online. Professionals engaged in these projects, such as project managers, construction managers, quantity surveyors, and site engineers, were interviewed. The interview procedure began with a concise summary of the study and a clear explanation of the reasoning for its implementation. The need to gather qualitative data on delay issues begun by employers and their associated important success elements was highlighted. In addition, an examination was conducted to determine the factors that influenced the moderation of this data. The purpose was to utilise this qualitative knowledge to triangulate alongside the quantitative data analysis. Before the interviews, the individuals being interviewed were sent the interview documents by email. The interviews had a duration of 15 to 20 minutes on average, during which a complete discussion occurred to guarantee a clear comprehension of the questions. The objective of this strategy was to produce replies that would make a valuable contribution to the study. The focus on clarity and collaboration aimed to extract insights that would improve the overall quality and reliability of the collected data for further analysis.

7.3 Traditional (Non-BIM) Project in China Study 1

7.3.1 Case Study Description

The focus of this case study pertains to a notable construction effort located in Tianjin, China. Tianjin is a significant administrative division situated in the northern region of China, strategically positioned adjacent to the coastal areas of the Bohai Sea. This city is recognised as one of the nine national centre cities in Mainland China and is home to a significant population of roughly 13,866 inhabitants. The primary focus of this case study project revolved around the development of a commercial structure with a significant overall expenditure totalling 10,000,000 US dollars. The time frame for any project is the time which is originally stipulated in the contract. For this project, the contractual time frame was established as 1,460 days. Nevertheless, a significant delay was encountered, extending for around 400 days over the initially projected timeframe. To gain a complete comprehension of the shades and challenges associated with this project, interviews were held with two important participants who represent the contractor's team. The initial participant took on the position of a Quantity Surveyor’s engineer, with a total of three years of professional experience in the industry. The second participant assumed the role of a technical manager and contributed a substantial amount of knowledge and competence, having accumulated ten years of experience during the project's construction phase. The inception of the project can be dated to the mid-1994 period, signifying the initiation of its preliminary phases. The handover phase was completed in 2001, marking the conclusion of this significant undertaking. One salient feature of this case study pertains to the involvement of the employer in the project. The employer played an active role in coordinating the consultant's services, granting the contractor the flexibility to conceptualise the project and supervise its implementation throughout the construction stage. The extent of this engagement included the oversight of multiple aspects of the project, such as its advancement, the calibre of its design, and the consultant's performance within the established parameters. In the given case study, the consultant's primary function entailed assuming comprehensive responsibility for overseeing the principal activities involved with the project throughout the building phase. The establishment of distinct roles and duties among the employer, contractor, and consultant is an essential framework for comprehending the details involved in this intricate undertaking.

7.3.2 Findings of the Case Study

The interviews conducted with the two participants in this case study have provided valuable insights into the key reasons that contribute to delays caused by employers. Additionally, these interviews have identified the success aspects that can potentially improve these delays. Based on the viewpoints expressed by the participants, it was evident that delays attributed to the employer held significant significance. The participants firmly believed that the implementation of specific success elements, as described during the interviews, could successfully mitigate these delays. The case study interview data revealed two significant project delays caused by the employer, which were labelled as DFA01 and DMA03. The participants considered these delays to be of considerable importance, highlighting their influence on the timeframe and development of the project.

On the other hand, the success elements that were discussed during the interviews were perceived as valuable strategies to address these delays. The participants emphasised the efficacy of success factors ST01 and SM08 in mitigating the delays caused by the employer. The identified success elements were deemed crucial in effectively mitigating the negative impacts caused by delays attributed to the employer on the project.

In addition, the participants also took into account project characteristics elements as moderators, which have an impact on the association between success factors and the settlement of delays caused by employers. Specifically, it was determined that variables PC01, PC02, and PC03 exerted a detrimental influence on the efficacy of the success factors in mitigating employer-induced delays. This implies that specific attributes of a project may present difficulties in effectively harnessing the effectiveness of success factors in addressing delays caused by employers.

In brief, the integration of qualitative interviews and quantitative analysis yields a holistic comprehension of the determinants impacting employer-induced delays and the associated elements contributing to their resolution. The adoption of a multi-faceted strategy enhances the depth of understanding in the research. It offers a more nuanced viewpoint on the complexities of project delays and their potential remedies within the specific environment under investigation.

To guarantee dependence on traditional (Non-BIM) construction methods in this case study rather than Building Information Modeling (BIM) techniques, this case study purposefully chose to focus on an older construction project in China. This case study is important since it follows pure traditional (Non-BIM) building construction methods. China was selected as the study site because it is thought that there haven't been many previous studies conducted there as noted previously in the literature review. Two interviewees participated in the study and provided a wealth of information and insights into employer-initiated delay factors, success factors, and their relative importance during in-person meetings. The respondents discussed how important success elements could lessen the impact of these delay causes. As moderator factors were discussed in depth, it became clear that DFA01 and DMA03 had the greatest influence in this case study. Furthermore, the addition of ST01 and SM08 was crucial in enhancing the study's output and allowed the researcher to make comparisons with a related study carried out in the United Arab Emirates (case study 2). Triangulating results was made easier by this comparison method, Structural Equation Modeling (SEM) analysis, and knowledge from earlier empirical research. In order to provide the abundance of data in an organized manner, Table 7.1 was created, which summarizes the results of in-person interviews with the two engineers directly involved in the project. This table was the starting point for creating Table 7.2, which shows the triangulation procedure. The careful selection of this case study guaranteed conformity with important aspects of traditional (Non-BIM) or non-BIM projects, including its age, China location, employer-caused delays, interviewees' fluency in English, and their thorough comprehension of construction nuances.

7.4 Traditional (Non-BIM) Project in the United Arab Emirates Study 2

7.4.1 Case Study Description

This case study focuses on a significant construction project located in Dubai, United Arab Emirates (UAE). Dubai, a city widely recognised for its distinctive skyline and thriving real estate industry, provides the setting for this notable undertaking. The project entails the construction of two separate structures, with one intended for residential use and the other specifically allocated for office utilisation. Furthermore, the property has a ground-floor retail area, thereby enhancing its overall mixed-use nature. The project possesses considerable financial significance, as evidenced by its overall construction cost of a huge sum of 100,000,000 US dollars. The significant expenditure highlights the intricate nature and magnitude of this development. The project's original contractual construction period was determined to be 545 days, which was indicative of the ambitious timeframe specified at the inception of the project. Nevertheless, the project had significant delays, resulting in a time extension of approximately 500 days beyond the initially planned date of completion. The delays mentioned above indisputably have extensive ramifications for the parties involved in the project and its overall level of achievement. As part of this case study, two key participants were interviewed to obtain a full understanding of the project's dynamics and the causes that have contributed to its delays. Both individuals served as representatives of the contractor's team and possessed a considerable amount of expertise. The initial participant adopted the position of a project manager, showcasing a substantial 15-year background in project management. The individual in question assumed the role of a manager responsible for Mechanical, Electrical, and Plumbing (MEP) matters. They had a notable professional history spanning more than two decades in this specific domain during the period when the project was being developed.

Within the framework of this particular case study, the employer had a crucial role in arranging the various services provided by the consultant. The active participation of the employer played a crucial role in ensuring that the project's scope of work included both the design phase and the subsequent supervision during the building phase. In addition, the employer engaged in active monitoring of many facets of the project, including its advancement, the calibre of its design, and the consultant's performance inside the established parameters. The present case study demonstrates the interdependent dynamics and multifaceted relationships among the employer, contractor, and consultant, highlighting the complex network of obligations and interactions inherent in the project. This case study examines the complexities of a significant construction project in Dubai, United Arab Emirates, which includes the development of residential and office buildings, as well as a retail area on the ground level. The project exhibits a significant financial magnitude, as seen by its overall construction cost of 100,000,000 US dollars. Notwithstanding the originally stipulated construction period of 545 days, the project encountered substantial delays. The useful viewpoints on the issues encountered throughout the execution of the project are derived from the insights obtained from two significant participants from the contractor's side. The inclusion of both the employer and the consultant in the project enhances the comprehension of its dynamics, rendering it a valuable case study for the examination of construction-related matters within this particular context.

7.4.2 Findings of the Case Study

The significance of employer-induced delays was underscored by the two participants in the study, who identified these delays as a crucial concern. They attributed these delays to both the actions of the employer and the efficacy of specific essential success criteria that were mentioned during the interviews. It was believed by the individuals that the crucial success elements that were found could potentially have a significant impact in reducing or preventing these delays. Based on the analysis of the case study interview data, it became apparent that the participants recognised some delay reasons initiated by the employer as significant contributors to project delays. The criteria considered in this study included DMA1, DCA07, DFA01, and DMA03. Concurrently, the researcher identified several critical success factors, notably SM09, ST01, SM02, and SM03, which possess the capacity to mitigate the delays caused by employers efficiently. In addition, it has been identified that SM03 exhibits the most potential as a success factor in effectively addressing delays arising from the employer. When considering the parameters related to project characteristics (PC), which serve as moderators in traditional (Non-BIM) projects, the participants expressed the belief that these aspects had a disadvantageous impact on the effectiveness of success factors in mitigating delays imposed by employers. The study identified PC01, PC02, and PC03 as the primary elements that significantly obstruct the association between critical success factors and delays caused by employers. During the discussion on the external environmental variables (PEE) for their impact on traditional (Non-BIM) projects, the interview participants highlighted that the element with the greatest potential to obstruct the success factors' ability to solve employer-initiated delays, in general, was PEE03. It is important in this case study that a deliberate focus on traditional (Non-BIM) construction methods is assured rather than Building Information Modeling (BIM) techniques, this case study has been selected consciously to be using traditional (Non-BIM) or non-BIM construction methods to ensure the purpose of this study is achieved. The respondents engaged in discussions highlighting the significance of success elements in mitigating the impact of delay causes. The study delved into moderators influencing traditional (Non-BIM) projects, including project characteristics and the external project environment, shedding light on their influence on the interplay between employer-initiated delay factors and critical success factors. The collected data from this study have been summarized in Table 7.1 and triangulated in Table 7.2, showcasing the valuable insights gained. The face-to-face interviews were recorded for future reference, ensuring the preservation of the rich data collected during this insightful exploration.

7.5 Summary of Results for Traditional (Non-BIM) Projects' Case Studies and the Data Triangulation

The findings from the case studies conducted in China and the UAE indicate that participants consistently affirmed that delays caused by employers had a significant and adverse effect on the advancement of traditional (Non-BIM) projects. The recognition of the importance of delays initiated by employers served as a critical context for the ensuing analysis. Table 7.1 presents a concise overview of the outcomes obtained from these case studies within the framework of traditional (Non-BIM) projects. The table presents a comprehensive overview of the primary variables causing delays in projects as identified by employers. Among these factors, DMA01, DCA07, DMA03, DFA01, and DFA02 have been found to be particularly significant contributors to project delays. Concurrently, the text mentioned above underscores the critical success factors for traditional (Non-BIM) initiatives, namely SM03, SM09, and ST01.

Table 7.1. Summary of Case Study Results for Traditional (Non-BIM) Projects.

Item	Delays Initiated by the Employer	Critical Success Factors
Case Study 1 China-Traditional (Non-BIM)	DFA01 and DMA03 were considered the most critical employer-initiated delay factors; however, participants noted that the list of employer-initiated delay factors is influential from the perspective of being caused by the employer.	ST01 and SM08 were the most critical employer's success factors; however, participants noted that the list of the employer's success factors is influential and can address the employer delays, as listed in the interview participant statement.
Case Study 2 UAE-Traditional (Non-BIM)	DMA01, DCA07 and DMA03 were the most critical employer-initiated delay factors; however, participants noted that the list of employer-initiated delay factors is influential from the perspective of being caused by the employer.	SM09, ST01, SM02 and SM03 were the most critical employer's success factors; however, participants noted that the list of the employer's success factors is influential and can address the employer delays, as listed in the interview participant's statement.

When examining the question posed during the interviews about the feasibility and value of applying critical success factors to tackle employer-initiated delays, it becomes evident that team-related critical success factors can indeed exercise a substantial influence in addressing these challenges. Specifically, they can play a crucial role in dealing with financial, technical, and contractual aspects associated with such delays. In addition to the importance of team-related success factors, it's clear that management and organizational critical success factors also have an essential role to play in mitigating employer-induced delays. These factors, when effectively implemented, can contribute significantly to addressing not only the financial, technical, and contractual dimensions but also other aspects of employer-initiated delays.

Table 7.2 assumes a crucial function within our research effort as it serves to illustrate the procedure of triangulation, a fundamental strategy employed to safeguard the validity and dependability of the findings generated from this particular investigation. Triangulation includes the examination of a research subject using a multi-layered approach, incorporating both quantitative and qualitative data and leveraging insights derived from prior empirical investigations. This methodology has been developed with the intention of enhancing and substantiating the results that have been acquired. The structure of this table has been designed with the intention of fulfilling certain specific objectives.

In a specific section of the table, ranking for the delays initiated by employers, along with their corresponding critical success factors, were triangulated. Then, the results of relationships between the employer-initiated delays and their critical success factors were also triangulated in both the presence and non-presence of the moderators. The results of the study extend beyond basic exposition and make a valuable contribution to a comprehensive theoretical framework. The model mentioned above serves as a significant instrument for efficiently managing employer-initiated delays within the project management.

From the perspective of the employer-initiated delay factors ranking, and the factors which are the most critical and influential factors from a triangulation point of view (local triangulation from the perspective of the ranking). Table 7.2 reveals that within traditional (Non-BIM) projects, particular delay causes launched by employers, namely DMA01, DCA07, DMA03, and DFA01, have been identified as the primary drivers of project delays. This evaluation incorporates both quantitative rankings and qualitative studies. Significantly, these findings are in accordance with the consensus established in multiple prior empirical investigations. In a research conducted by Erzaij et al. (2021), it was found that the extended process of approving changes to a project's scope of work and specifications was a notable factor leading to project delays within the construction sector in Iraq. The component mentioned above is inherently interconnected with the role and obligations of the employer in the context of the project. The potential effects of this factor on the project include multiple dimensions, such as its timeline, cost, and quality. Wang et al. (2018) conducted a study titled "Construction Disputes in the UAE: Causes and Resolution Methods," which provides valuable insights into the factors contributing to construction disputes and the approaches employed to resolve them in the United Arab Emirates (UAE). The study utilised a mixed-methods approach, incorporating both questionnaire surveys and interviews with professionals in the construction industry, in order to collect data and conduct an analysis of the findings. One of the causes of construction disputes in this particular scenario is notably attributed to adjustments introduced by the employer. Among the 25 identified factors, this particular component held the fourth position in terms of relevance, as indicated by its mean score of 4.13 out of 5. Modifications implemented by the employer have the potential to exert substantial influence on various aspects of the project, including its scope, schedule, cost, and quality. Consequently, such alterations frequently give rise to arguments and conflicts among the parties involved.

From the perspective of the critical success factors ranking and the factors which are the most influential and critical from a triangulation point of view (local triangulation from the perspective of the ranking). According to the essential success factors ranking, triangulation is employed to validate that the three most crucial success elements for mitigating employer-initiated delay factors are SM03, SM09, and ST01. Famiyeh et al. (2017) presented a comprehensive risk assessment methodology tailored to the context of mining ventures in Ghana. The researchers in this study have delineated seven critical success factors (CSFs) that are important for the effective governance of risks inherent in mining projects. One crucial determinant of success that is particularly noteworthy is active engagement and effective communication with stakeholders. This element underscores the significance of actively engaging and informing all pertinent stakeholders of potential risks, their consequences, and the strategies devised to alleviate these risks. The emphasis focused on stakeholder involvement and communication stems from its potential to mitigate employer-induced delays, including disagreements and legal proceedings. By actively engaging developers and contractors, the mining project may successfully address emergent difficulties, therefore fostering a collaborative environment that reduces conflicts and accelerates their resolution. In addition, Shen et al. (2017) contend that effective project management necessitates practical project planning by the employer. The authors contend that the act of planning is of utmost importance in establishing the project's scope, objectives, deliverables, timetable, budget, and quality standards. Additionally, it is believed that the process of planning can facilitate the identification and mitigation of potential hazards, as well as enable the efficient allocation of resources and the clear communication of expectations to stakeholders. It is recommended that the employer choose a planning approach that is flexible and adaptive, capable of accommodating changes and uncertainties within the project environment. It is concluded by Shen et al. (2017) that proper and early planning by the employer can address the delay factors of DMA01, DCA07, DMA03, and DFA01.

In the context of the comprehensive triangulation approach applied to the data presented in Table 7.2, it was of utmost importance to accurately examine and compare the findings outlined in the conclusion sections. This comparative analysis aimed to establish a robust and universally applicable triangulation framework capable of effectively addressing employer-initiated delay factors. The investigation focused on a select subset of four employer-initiated delay factors, namely DMA01, DCA07, DMA03, and DFA01. Through the diligent application of triangulation techniques, it became evident that certain critical success factors played a pivotal role in mitigating the impact of these employer-initiated delay factors. Specifically, the most influential factors in addressing these delays were identified as SM03, SM09, and ST01. By taking into account the employer-initiated delay factors and the critical success factors that emerged from the triangulation process, the subsequent Structural Equation Model (SEM) analysis revealed a refined network of significant relationships. Within this refined model, three primary connections stood out as the most pertinent: ST to DFA, ST to DCA, and SM to DCA. Furthermore, when considering the influence of the PC moderator on these relationships, the SEM analysis was further streamlined to focus on two significant connections: SM to DCA and ST to DFA. This perspective highlighted the specific dynamics at play when the PC moderator was introduced. Similarly, when examining the SEM analysis in the context of the PEE moderator, it also led to the identification of two significant connections: SM to DMA and ST to DMA. This highlighted the unique impact of the PEE moderator on the relationships between critical success factors and employer-initiated delay factors.

Table 7.2. Summary of Triangulation between Quantitative, Qualitative and Empirical Studies for Traditional (Non-BIM) Projects.

Items	Quantitative Analysis	Qualitative Analysis	Previous Empirical Studies	Triangulation's Summary
Employer-Initiated Delay Factors Ranking	**DMA01** **DCA07** **DMA03** **DFA01**	DFA01, DMA03, DMA01, and DCA07 are the most critical employer-initiated delay factors in traditional (Non-BIM) projects.	Erzaij et al. (2021); Wang et al. (2018); Alshihri et al. (2022); Mahamid (2017); Fashina et al. (2021); Aisheh & Issa (2021); Hoque et al. (2021); Nikjow et al. (2021); Mbatha et al. (2022); Sauden et al. (2022); Karimi & Piroozfar (2022); and Ismail et al. (2019.)	By considering a triangulation technique, it becomes apparent that the most significant delay causes launched by employers in this study are DMA01, DCA07, DMA03, and DFA01. It is crucial to emphasise that these characteristics have been methodically ranked using a thorough quantitative examination.
Critical Success Factors Ranking	**SM03** **SM09** **ST01**	**ST01**, SM08, **SM09**, SM02, and **SM03** are the most critical success factors in addressing employer-initiated delays in traditional (Non-BIM) projects.	Kashyap & Raghuvanshi (2020); Famiyeh et al. (2017); Adhi & Muslim (2023); Jitpaiboon et al. (2019); Shen et al. (2017); Hamad et al. (2021); Winch & Leiringer (2016); and Abdel-Haq et al. (2018.)	By considering a triangulation technique, it becomes apparent that the most significant critical success factors that may address the employer-initiated delay factors are SM03, SM09, and ST01.
SEM Analysis for Relationship between Employer-initiated Delays and Critical Success Factors	**ST to DFA; T = 46.292;** SM to DTA; T = 5.517; ST to DTA; T = 5.227; **ST to DCA; T = 5.127; SM to DCA; T = 3.896; SM to DMA; T= 3.785** **ST to DMA; T= 2.732**	The interviews suggest that critical success factors, particularly those related to team dynamics and management/organization, offer a promising avenue for addressing employer-initiated delays. By incorporating	El-Sayegh et al. (2020); Naji et al. (2022); Sauden et al. (2022); Perera et al. (2021); Prasetya & Adnyana (2022); Matseke & Khatleli (2021); Ibraheem & Mahjoob (2021); Waty & Sulistio (2022); Yap et al. (2016); Maganić (2021); and Manda et al. (2019.)	Based on the employer-initiated delay factors and the critical success factors that have been triangulated, the Structural Equation Model (SEM) analysis relationships can be narrowed down to only three significant connections: ST to DFA, ST to DCA, SM to

		these factors into project planning and execution, construction teams can better navigate the challenges posed by financial, technical, and contractual matters, ultimately leading to more successful project outcomes and reduced delays.		DCA, SM to DMA, and ST to DMA.
SEM Analysis for Relationship between Employer-Initiated Delays and Critical Success Factors in the Presence of the PC Moderator.	**SM-PC-DCA** and **ST-PC-DFA** are the only valid relationships when the moderator PC is considered in the SEM model; however, the moderator PC dampens the positive relationship between DCA and SM; the moderator PC dampens the positive relationship between DFA and ST.	The study identified PC01, PC02, and PC03 as the primary elements that significantly obstruct the association between critical success factors and delays caused by employers.	Ma & Fu (2020); Luo et al. (2017); Luo et al. (2020); Bjorvatn & Wald (2018); Cleary & Lamanna (2022); Nikolić & Cerić (2022); Butler et al. (2019); and Rodríguez-Rivero et al. (2020.)	Based on the employer-initiated delay factors and the critical success factors that have been triangulated, the Structural Equation Model (SEM) analysis relationships in consideration with the PC moderator can be narrowed down to only two significant connections: SM to DCA and ST to DFA.
SEM Analysis for Relationship between Employer-initiated	**SM-PEE-DMA**, SM-PEE-DTA, **ST-PEE-DMA** and ST-PEE-DTA are valid relationships when the PEE is considered in the SEM model.	During the discussion on the external environmental variables (PEE) for their impact on traditional (Non-BIM) projects, the interview	Durdyev (2020); Seddeeq et al. (2019); Sohu et al. (2018); Sohu et al. (2018); and Alshihri et al. (2022.)	Based on the employer-initiated delay factors and the critical success factors that have been triangulated, the Structural Equation Model (SEM) analysis relationships in

Delays and Critical Success Factors in the Presence of the PEE Moderator.	However, the moderator PEE dampens the relationship between DMA and SM.	participants highlighted that the element with the greatest potential to obstruct the success factors' ability to solve employer-initiated delays, in general, was "Economic and financial problems (PEE03)."		consideration with the PEE moderator can be narrowed down to only two significant connections: SM to DMA and ST to DMA.

7.6 Building Information Modelling-Enabled Project in the United Arab Emirates Study 3

7.6.1 Case Study Description

Located in the vibrant business sector of Dubai, this recently constructed hotel exemplifies sophistication and innovation. With a total of 1,042 units, each providing panoramic views of the Arabian Gulf, this hotel holds the title of the tallest in the world based on its architectural height. The project was skillfully executed by a highly regarded firm based in London, known for its innovative and modern design principles. Upon arrival at this establishment, individuals will be immersed in an ambience characterised by extravagance and grandeur, owing to the particular selection of interior designs and lavish furnishings that are bound to make a lasting impact on both inhabitants and guests. The utilisation of Building Information Modelling (BIM) has been integral to the entirety of the project, serving as the principal tool throughout the construction process. This technology not only enabled efficient coordination of operations but also had a significant impact in preventing conflicts, optimising the generation of accurate shop drawings, and closely monitoring the progress of project activities. Therefore, this project serves as a notable demonstration of the potential afforded by Building Information Modelling (BIM) in the construction sector.

The financial investment required to realise this ambitious undertaking amounts to a significant sum of approximately 160 million US dollars. Initially scheduled to be finished within 38 months, the project had unanticipated difficulties, which led to a total delay of 189 days up until the time of these interviews. Within the framework of this illuminating case study, three primary participants were interviewed in order to provide insight into the diverse facets of the project. The sample of participants consisted of a senior resident engineer who possessed a notable 20 years of professional experience and who played a crucial position within the consultant's team. The inclusion of the second participant, who served as the project director representing the contracting team, proved to be highly advantageous due to their excellent insights. The inclusion of the project manager as the third stakeholder provided a comprehensive viewpoint of the complexities involved in overseeing this ambitious endeavour. It is noteworthy to mention that the employer also exerted a substantial influence on this initiative. The individuals in question were accountable for coordinating the services provided by the consultant, guaranteeing the unity of the project's design, and supervising its implementation throughout the construction period. The employer vigilantly monitored the advancement of the project, the calibre of its design, and the consultant's effectiveness, thereby conscientiously supervising the established scope of this undertaking. In this particular instance, the consultant assumed the primary role of overseeing the principal undertakings throughout the construction stage, guaranteeing the seamless progression of the project in accordance with its ambitious objectives.

7.6.2 Findings of the Case Study

The insights collected from the interviews with the three participants shed light on the complex web of factors contributing to delays in this BIM-enabled project. Delays attributed to the employer's actions were identified as a pivotal concern by the participants, who considered them to be of utmost significance. In their view, the critical success factors they highlighted during the interviews were seen as potent tools to mitigate and overcome these employer-induced delays. From the data gathered in the case study interviews, it was evident that certain delay factors stood out as particularly significant in the context of the project. DCA06, DCA07, DSA02, and DTA02 were pinpointed as the leading delay factors instigated by the employer in BIM-enabled projects. These factors played a substantial role in causing disruptions to the project's timeline. On the flip side, the participants found solace in the identification of success factors that were deemed effective in addressing delays stemming from the employer's actions. SM01, SM07, and SM09 were regarded as the most promising success factors for tackling these challenges head-on. Their integration into the project's framework was seen as a constructive step towards mitigating the impact of employer-initiated delays.

In general, the interview participants suggested that critical success factors, particularly those related to management and organization, offer a promising avenue for addressing employer-initiated delays in BIM-enabled projects. By incorporating these factors into project planning and execution, construction teams can better navigate the challenges posed by financial, technical, managerial, and contractual matters, ultimately leading to more successful project outcomes and reduced delays. The BIM implementation factors, considered moderator factors, were evaluated for their potential to strengthen the effectiveness of the identified success factors in mitigating delays caused by the employer. Participants concurred that specific BIM implementation factors played a crucial role in enhancing the success factors. BIMS07, BIMS11, and BIMS10 emerged as the essential BIM implementation factors, contributing positively to the success factors' ability to address employer-induced delays. Participants acknowledged that BIM barrier factors could have a detrimental impact on the effectiveness of success factors in countering employer-initiated delays. BIMB04, BIMB07, BIMB03, and BIMB02 were recognized as the most influential barrier factors, hindering the success factors' capacity to efficiently manage and mitigate delays resulting from the employer's actions.

In summary, the insights gathered from the interviews underscore the dynamic interplay between a range of delay factors, success factors, BIM implementation factors, and BIM barrier factors in the context of this BIM-enabled project. The participants' perspectives provide a comprehensive view of the multifaceted challenges and opportunities involved in managing and mitigating delays attributed to the employer.

7.7 Building Information Modelling-Enabled Project in the UK Study 4

7.7.1 Case Study Description

The subject of analysis in this academic case study is the One Crown Place project, situated in London, the esteemed capital city of England. London, boasting a population of 8.982 million, holds the distinction of being the largest city in both England and the United Kingdom. The city is renowned for its plethora of attractions, which include notable historical edifices, including Buckingham Palace, the British Museum, Tower Bridge, and Big Ben. One Crown Place is a commercial tower that has been developed to accommodate a total of 235 residential units, distributed across two buildings measuring 30 and 34 stories in height, respectively. The developer has allocated a seven-story platform for the purpose of accommodating office space, street-level businesses, and an underground electrical plant situated within a double basement. The project was contracted by the employer in April 2018, with a contract value of £513 million. The project experienced a delay of 23 months, primarily attributed to planning issues, resulting in its commencement being initiated in April 2018. The original contractual agreement stipulated that the project would conclude by the conclusion of 2020. Nevertheless, due to unforeseen circumstances, the project encountered a delay of five months and was ultimately finalised in May 2021.

This case study examines the complexities of the One Crown Place project, which commenced development in the United Kingdom in 2018. This ambitious endeavour sought to harness the revolutionary potential of Building Information Modelling (BIM) with the goal of reconfiguring the construction industry's landscape. Nevertheless, notwithstanding its use of state-of-the-art technology, the project experienced setbacks that varied from its original estimated schedule. In order to have a thorough comprehension of the elements that contribute to both the achievements and challenges of Building Information Modelling (BIM) deployment in this particular setting, two primary participants were interviewed. The participants were assigned the responsibility of responding to two predetermined inquiries, thus providing their unique thoughts and opinions. These responses were afterwards evaluated and graded to emphasise their significance. The examination of the participants' feedback resulted in noteworthy observations regarding the difficulties and successes related to the use of Building Information Modelling (BIM) in the One Crown Place project. It is worth noting that a significant factor leading to delays in BIM projects was the tardy issuance of contracts. The initiation of the project was postponed, resulting in a cascading impact on future stages, frequently leading to substantial setbacks in the project's progress.

Conversely, the impact of bureaucratic procedures within employer organisations on the project's timeline was determined to be rather insignificant. The achievement of success within the framework of this Building Information Modelling (BIM) project was contingent upon two critical elements: proficient inventory management and the fostering of constructive engagements through meetings and on-site visits with pertinent stakeholders. The proactive approach to problem-solving and teamwork played a crucial role in effectively addressing difficulties within a reasonable timeframe, hence aiding in the reduction of delays' impact. Remarkably, meticulous observation of the project yielded the most negligible impact on the overall success of the Building Information Modelling (BIM) project. This implies that, although it held value, it did not serve as the key catalyst for success in this particular instance. The findings mentioned above are in accordance with previous studies conducted in the sector, which have continuously emphasised the importance of collaboration as a critical factor impacting Building Information Modelling (BIM) projects. The imperative to develop effective connections and establish transparent channels of communication with stakeholders has emerged as a prevalent and recurring subject. Additionally, the study highlights the significance of promptly securing contracts in influencing the overall outcome of a Building Information Modelling (BIM) project, underscoring the value of effectively organised project commencement and procurement procedures.

In summary, the One Crown Place project in the United Kingdom serves as an interesting subject of analysis, explaining the details associated with the adoption of Building Information Modelling (BIM). This case study offers significant contributions to the understanding of the determinants that can either facilitate or hinder the triumph of similar endeavours, thereby enhancing the existing body of knowledge within the domains of construction technology and project administration.

7.7.2 Findings of the Case Study

The respondents in this study placed significant emphasis on the late contract award (DCA06) as the most influential factor that adversely affected the timely delivery of the project. This observation was grounded in practical evidence, as the case study revealed a staggering 23-month period for the employer to complete the contract awarding process. Subsequently, the Mace team was left with only one month to prepare and initiate the project. This substantial delay was a pivotal factor in pushing the project's estimated completion date from the end of 2020 to May 2021. DCA06 was, therefore, an undeniable bottleneck in the project's timeline.

Furthermore, respondents highlighted DCA03 as another key factor impacting the project's delivery schedule. Additional causative factors contributing to BIM-related delays included DCA04, DTA03, DCA05, and DCA09. On the other hand, the least determinative factors were DTA02 and DSA02, indicating that they had a comparatively lesser impact on project timelines. In their assessment of factors contributing to the success of the BIM project, respondents stated that regular meetings (SM02) emerged as the most vital factor for effectively coordinating the project, ensuring that all stakeholders were aligned and informed. Timely approval (SM01) was also important, emphasizing the importance of swift decision-making and responsiveness in the project environment. Besides, wise project planning and the ability to anticipate and manage unexpected events during construction (SM09) are considered vital as well. These major determinants were recognized as key drivers of project success. Factors such as employers sticking rigidly to the initial plan (SM04) and close work monitoring (SM05) were considered of lesser significance in the overall success of the BIM project. In general, the interview participants suggested that critical success factors, particularly those related to management and organization, offer a promising avenue for addressing employer-initiated delays in BIM-enabled projects.

7.8 Summary of Results for BIM-Enabled Projects' Case Studies and Data Triangulation

Choosing a project for a case study that fully integrates Building Information Modeling (BIM) is a difficult task since it requires the project to use BIM from the beginning of the planning stage to the end of the defect liability period. Interviewees' affirmation that the project experienced thorough BIM modeling during all stages of its lifecycle—planning, design, and construction—is one of the selection criteria for this case study. This selection criterion involves active use of BIM to monitor construction progress, identify clashes, promote speedy decision-making for employers, and more, going beyond simply having a model to prevent design and construction clashes. This particular case study was quite helpful in showing that, in contrast to typical projects, BIM-enabled projects offer different situations with regard to employer-initiated delay factors and crucial success elements. The project's full use of BIM, from planning to the defect liability period, gave rise to a sophisticated understanding of how BIM affects different aspects of project management, facilitating better decision-making and possibly reducing employer-initiated delays. This deliberate choice was made with the intention of providing thorough insights into the distinct dynamics of BIM-enabled projects, differentiating them from traditional (Non-BIM) projects.

The findings from the BIM-enabled project case studies conducted in the United Arab Emirates (UAE) and the United Kingdom (UK) are summarised in Table 7.3. In the case studies conducted in the UAE and the UK for the BIM-enabled projects, it was verified by the participants that delay factors introduced by the employer indeed impacted the development of the projects. Table 7.3 presents the most influential employer-initiated delay factors. The most critical success factors of the BIM-enabled projects were identified. The impact of success factors related to SM on project delays induced by the employer has been substantiated through case studies conducted in the context of Building Information Modelling (BIM)-enabled projects. The integration of quantitative analysis (specifically structural equation modelling and ranking by average) and qualitative review (specifically case studies) has yielded novel insights. Firstly, the study has successfully identified the validity of the connections between employer-initiated delay factors and success factors. Secondly, the utilisation of ranking by average has effectively determined the most significant employer-initiated delay factors and success factors, both in a general sense and within each country. Lastly, the study has shed light on the nature of the relationship between success and employer-initiated delay factors, specifically whether it acts as a dampening or strengthening force.

From the perspective of the employer-initiated delay factors ranking in BIM-enabled projects, and the factors which are the most critical and influential factors from a triangulation point of view (local triangulation from the perspective of the ranking). Table 7.4 reveals that within BIM-enabled projects, particular delay causes launched by employers, namely DCA04, DCA05, DCA03, DCA06, and DCA10, have been identified as the primary drivers of project delays. This evaluation incorporates both quantitative rankings and qualitative studies. Significantly, these findings are in accordance with the consensus established in multiple prior empirical investigations.

From the perspective of the critical success factors ranking and the factors which are the most influential and critical from a triangulation point of view (local triangulation from the perspective of the ranking). According to the essential success factors ranking, triangulation is employed to validate that the four most crucial success elements for mitigating employer-initiated delay factors are SM02, SM07, SM09, and SM01.

In the context of the comprehensive triangulation approach applied to the data presented in Table 7.4, it was of utmost importance to accurately examine and compare the findings outlined in the conclusion sections. This comparative analysis aimed to establish a robust and universally applicable triangulation framework capable of effectively addressing employer-initiated delay factors. The investigation focused on a select subset of five employer-initiated delay factors, namely DCA04, DCA05, DCA03, DCA06, and DCA10. Through the diligent application of triangulation techniques, it became evident that certain critical success factors played a pivotal role in mitigating the impact of these employer-initiated delay factors. Specifically, the most influential factors in addressing these delays were identified as SM02, SM07, SM09, and SM01. By taking into account the employer-initiated delay factors and the critical success factors that emerged from the triangulation process, the subsequent Structural Equation Model (SEM) analysis revealed a refined network of significant relationships. Within this refined model, two primary connections stood out as the most pertinent: SM to DCA. Furthermore, when considering the influence of the BIMS moderator on these relationships, the SEM analysis was further streamlined to focus on one significant connection: SM to DCA. This perspective highlighted the specific dynamics at play when the BIMS moderator was introduced. Similarly, when examining the SEM analysis in the context of the BIMS moderator, it led to the identification of two significant connections: SM to DCA and SM to DTA.

Table 7.3. Summary of Case Study Results for BIM-Enabled Projects

Item	Delays Caused by the Employer	Critical Success Factors
Case Study 3 UAE (BIM-Enabled)	DCA06, DCA07, DSA02 and DTA02 were the most critical employer-initiated delay factors; however, participants noted that the list of employer-initiated delay factors is influential from the perspective of being caused by the employer. It is important to note that DCA07 has been eliminated from the models for moderators.	SM01, SM07 and SM09 were the most critical employer's success factors; however, participants noted that the list of the employer's success factors is influential and can address the employer delays as listed in the interview participant statement.
Case Study 4 UK (BIM-Enabled)	DCA06, DCA03, DCA04, DTA03, DCA05 and DCA09 were the most critical employer-initiated delay factors in BIM-enabled projects.	Respondents stated that regular meetings are vital in successfully coordinating the BIM project (SM02); also, timely approval is crucial to the project's success (SM01) is critical to address the employer-initiated delay factors; then the factor of wisely planning the project and considering unexpected events during the construction (SM09).

Table 7.4. Summary of Triangulation between Quantitative, Qualitative and Empirical Studies for BIM-Enabled Projects.

Items	Quantitative Analysis	Qualitative Analysis	Previous Empirical Studies	Triangulation's Summary
Employer-Initiated Delay Factors Ranking	**DCA04** **DCA05** **DCA03** **DCA06** DCA10 **DCA09** **DTA02**	DCA06, DSA02, DTA02, DCA06, DCA03, DCA04, DTA03, DCA05 and DCA09 were the most critical employer-initiated delay factors.	Liao et al. (2020); Ahmed (2018); Gledson & Greenwood (2017); Babatunde et al. (2020); and Oraee et al. (2019.)	By considering a triangulation technique, it becomes apparent that the most significant delay causes launched by employers in this study for BIM-enabled projects are DCA04, DCA05, DCA03, DCA06, DCA09, and DTA02. It is crucial to emphasise that these characteristics have been methodically ranked using a thorough quantitative examination.
Critical Success Factors Ranking	**SM02** **SM07** **SM09** SM06 **SM01** SM08 SM04 SM05 ST01 ST02	SM01, SM07, SM09, and SM02.	Singh et al. (2021); Oraee et al. (2021); Olbina & Elliott (2019); Antwi-Afari et al. (2018); Hosseini et al. (2018); and Disney et al. (2022.)	By considering a triangulation technique, it becomes apparent that the most significant critical success factors that may address the employer-initiated delay factors in BIM-enabled projects are SM02, SM07, SM09, and SM01.
SEM Analysis for Relationship between Employer-	**SM to DCA; T = 14.875;** SM to DMA; T = 5.213; SM to DSA; T = 4.705; **SM to DTA; T = 3.928**;SM to DFA; T = 2.899	The interviews suggest that critical success factors, particularly those related to team dynamics and management/organization,	Zuo et al. (2018); Ouyang & Chen (2019) Mbatha et al. (2022); and Osei-Kyei et al. (2017.)	Based on the employer-initiated delay factors and the critical success factors that have been triangulated, the Structural Equation Model

initiated Delays and Critical Success Factors		offer a promising avenue for addressing employer-initiated delays in BIM-enabled projects. By incorporating these factors into project planning and execution, construction teams can better navigate the challenges posed by financial, technical, managerial, and contractual matters, ultimately leading to more successful project outcomes and reduced delays. It is essential to mention here that the interview participants considered the team's critical success factors as not that important to address the delays of employees in BIM-enabled projects.		(SEM) analysis relationships can be narrowed down to only three significant connections: SM to DCA, and SM to DTA,
SEM Analysis for Relationship between Employer-Initiated Delays and	SM-DSA, **SM-DCA,** and SM-DTA, with T-statistic values of 5.904, 3.542, and 3.235 and p-values of 0.000, 0.000, and 0.001, respectively.	The interview participants stated BIM implementation success factors are going to help the employer to address his delays in BIM-enabled projects, specifically,	Bean et al. (2019); Noviani et al. (2022); Boyacioglu et al. (2022); (Al-Hazim & abusalem (2015.).	Based on the employer-initiated delay factors and the critical success factors that have been triangulated, the Structural Equation Model (SEM) analysis relationships in consideration with the BIMS

Critical Success Factors in the Presence of the BIMS Moderator.	However, it is important to note that the moderator BIMS strengthens the relationship between DCA and SM while it dampened the SM and DTA	BIMS07, BIMS11, and BIMS10.		moderator can be narrowed down to only one significant connection: SM to DCA.
SEM Analysis for Relationship between Employer-initiated Delays and Critical Success Factors in the Presence of the BIMB Moderator.	SM-DSA, **SM-DTA**, and SM-DFA, **SM-DCA** relationship with t-statistics values of 3.780, 3.769, 3.540, 2.559 and p-values of 0.000, 0.000, and 0.000, 0.011 respectively.	The interview participants stated BIM barriers are going to hinder the employer from addressing his delays in BIM-enabled projects; specifically BIMB04, BIMB07, BIMB03, and BIMB02.	Fan et al. (2018); Moreno et al. (2019); Alwee et al. (2023); Jamil & Fathi (2018); Alqahtani et al. (2022.)	Based on the employer-initiated delay factors and the critical success factors that have been triangulated, the Structural Equation Model (SEM) analysis relationships in consideration with the BIMB moderator can be narrowed down to only two significant connections: SM to DCA and SM to DTA.

7.9 Summary of Chapter 7

This chapter presents a thorough examination of the data findings and their corresponding analyses in relation to traditional (Non-BIM) and Building Information Modelling (BIM) facilitated project case studies carried out in three distinct nations: China, the United Arab Emirates (UAE), and the United Kingdom (UK). These case studies utilised a combination of both face-to-face and online interviews to collect significant information. The UK case study utilised online interviews as a research method, through which participants provided their insights on elements that contribute to delays instigated by employers and characteristics that lead to successful outcomes. These viewpoints took into account several aspects, including relationships, impacts, and the most significant drivers. The utilisation of qualitative data played a crucial role in confirming and substantiating the findings obtained through quantitative research.

The study employed a comprehensive approach of full triangulation, which involved the integration of the results obtained from the analysis of Structural Equation Modelling (SEM), the examination of case studies, and the review of previous empirical research. The purpose of this triangulation endeavour was to improve the accuracy and dependability of the findings, hence guaranteeing the strength and trustworthiness of the data outputs. The purpose of this systematic approach was to integrate all pertinent data into the proposed novel frameworks, which have been specifically devised to tackle the complex matter of employer-initiated delays in building projects.

The outcomes observed in BIM-enabled projects exhibit a significant different compared to traditional (Non-BIM) construction projects, as evidenced by the results obtained through triangulation. The comparison mentioned above highlights the importance of taking into account the unique dynamics and effects present in these two types of projects, hence emphasising the necessity of customised tactics and solutions to address delays introduced by employers.

8 Discussions and Conclusions

8.1 Introduction

Its dynamic nature and demanding requirements essentially characterise the process of project implementation. It often encounters unwelcome and detrimental delays that can greatly hinder the achievement of project objectives. A notable feature of these initiatives is their inherent complexity, necessitating the involvement of multiple stakeholders and including a diverse range of interconnected operations. This thesis aimed to comprehensively examine the elements that contribute to delays caused by employers in both Building Information Modelling (BIM)-enabled and traditional (Non-BIM) projects, including several continents and countries. The primary aim of the study was to identify key factors that contribute to delays caused by employers and to examine the implementation of success factors in resolving these difficulties.

The research consisted of multiple discrete stages, each strategically devised to accomplish the broad objectives of the investigation. The study began by conducting a thorough examination of the available literature. This process had two main objectives: first, to identify any existing gaps in current knowledge, and second, to establish a conceptual framework for understanding the various elements that contribute to delays caused by employers and their impact on performance at a worldwide level.

After conducting a comprehensive assessment of the existing literature, a quantitative survey study was undertaken to methodically capture and evaluate the different elements contributing to delays and the existence of factors leading to success within the context of delays caused by employers. The quantitative research yielded data that was utilised to inform the subsequent phase of the study, which involved conducting in-depth case studies across multiple nations as part of a qualitative examination. Triangulation was done between the quantitative analysis and the qualitative analysis in line with the existing empirical studies, and the summary of triangulation formed the main part of the proposed frameworks used in BIM-enabled and traditional (Non-BIM) projects. The case studies provided useful insights into the actual difficulties associated with delays caused by employers and the effectiveness of success factors in reducing them. Through the integration of the outcomes derived from the extensive examination of existing literature, the collection of quantitative data through surveys, and the analysis of qualitative case studies, this study successfully constructed comprehensive frameworks with the objective of mitigating delays caused by employers in various project environments.

In conclusion, this thesis explored the complex domain of project implementation, providing insights into the ongoing problem of employer-induced delays. The study employed a systematic and comprehensive methodology, incorporating a combination of literature review, quantitative data gathering, and qualitative case studies to enhance comprehension of these delays and offer practical solutions by leveraging success drivers. The findings derived from this research possess the capacity to exert a beneficial influence on project management methodologies within diverse sectors and across different geographic regions.

8.2 Methodology for the Development of the Frameworks

The frameworks developed to address delays arising from employer-initated concerns in both traditional (Non-BIM) and BIM-enabled construction projects have been methodically established based on a strong basis of quantitative and qualitative data, which has been further strengthened through triangulation. The preceding chapters have provided a thorough analysis and investigation, which has established the foundation for these frameworks. In a general sense, these two frameworks have been accurately constructed with the objective of demonstrating essential tactics that can be utilised to either mitigate or efficiently resolve employer-initiated delays. These solutions analyse the complex network of interactions and connections between delays caused by employers and the relevant factors that contribute to achieving successful resolution. This method is supported by an extensive examination of the current literature, information obtained from interviews conducted with pertinent parties, and insights generated from practical case studies.

In order to construct frameworks that are not only robust but also practical and highly valuable for end users, a detailed methodology has been devised. This methodology is designed to ensure that the resulting frameworks are not just theoretical constructs but tools that can be readily applied in real-world scenarios. Below, we present a comprehensive roadmap for creating these frameworks, meticulously crafted to meet the needs of end users:

1. The creation of two frameworks stems from the acknowledgement that BIM-enabled projects and traditional (Non-BIM) projects possess distinct characteristics that vary. The contrast mentioned above highlights the significance of implementing distinct frameworks that are specifically designed to cater to the distinct demands of each type of project.
2. The framework offers the findings of the investigation, specifically highlighting the top 10 elements contributing to the success and causes causing delays that employers initiate. The first phase in this process is of utmost importance for individuals who will be utilising it, as it provides a foundation for recognising possible risks of delays related to employers and the corresponding elements that contribute to success. Subsequently, individuals can choose the delay reasons and success variables that are most pertinent to their particular project circumstances.
3. The approach proceeds to uncover the major causes causing delays initiated by employers through a rigorous process of analysis and triangulation. The identification of project delays is intricately connected to the essential success criteria, necessitating their joint consideration in order to address them successfully.
4. The methodology for success factors is developed based on a comprehensive analysis of prior empirical studies, allowing for a thorough and detailed approach to each success element. This methodology provides end users with a complete comprehension of the importance of delay causes initiated by employers and presents specific remedies. The solutions mentioned above are based on action plans designed to execute success factors, which will be further expounded upon in the subsequent chapter.
5. In the event that a user desires to include other employer-initiated delay factors that were originally listed in step 2, it is crucial to acknowledge that this undertaking would require extra study and additional research.
6. The approach incorporates the examination of moderators, distinguishing between their impact on BIM-enabled projects and traditional (Non-BIM) projects. The act of separating these moderating aspects inside the framework's context enables end users to properly utilise their managerial talents by comprehending how to handle them.

7. In order to ascertain the efficacy of the framework, a comprehensive review plan has been incorporated into its design. This aspect has been developed using information obtained from previous empirical research and plays a crucial role in confirming the effectiveness of the framework in achieving its intended objectives.
8. This thorough methodology offers the groundwork for the development of two practical frameworks, which allow end users to navigate the intricate employer-initiated delays in construction projects effectively. This approach is characterised by a rigorous analytical and empirical base, ensuring its effectiveness and reliability.

8.3 Understanding How Frameworks Work: A Detailed Overview

Figures 8.1 and 8.2 represent the summary of the novel frameworks proposed by this research to address the employer-initiated delay factors in both traditional (Non-BIM) and BIM-enabled projects, considering the effect of the possible moderators. In accordance with the principal methodology outlined above, a set of frameworks has been accurately developed, each tailored to address distinct aspects and requirements of the subject matter. These frameworks have been carefully structured and organized in the following specific areas or particulars, each serving a unique purpose and providing a comprehensive structure for addressing various aspects of the subject:

1. Legend is an essential element in frameworks, as it serves the function of including all variables that have not yet been named or stated as the following:
   Sx: Main findings of the frameworks used to address the employer-initiated delay factors;
   Sx-x: Path of Solution for each finding component;
   RxS: Ranking for critical success factors;
   RxD: Ranking for employer-initiated delay factors;
   DMA: Delay managerial aspect;
   DSA: Delay social aspect;
   DTA: Delay technical aspect;
   DCA: Delay contractual aspect;
   SM: Management, organisations, and financial success group of factors;

ST: Team critical success group of factors;

PC: Project characteristics moderator factors;

PEE: Project external environmental moderator factors;

MRxx: Review plans for the implementation of the success factors;

Mxx: Action plans for Implementation of the success factors;

BIMS: Building Information Modeling implementation;

BIMB: Building Information Modelling barriers.

2. From S1 (as noted in the frameworks) and in the context of traditional (Non-BIM) projects, there is a pre-established set of delay factors that employers initiate ranked based on their mean values. The parts included in this set are DMA1, DCA7, DMA3, DFA1, DFA2, DFA3, DFA4, DTA2, DMA4, and DSA2. The components mentioned above are systematically organised within the traditional (Non-BIM) project framework, where they are assigned and prioritised based on analytical results. Similarly, the framework includes crucial success variables that have been assigned names according to their ranking derived from the study. The elements under consideration are labelled as SM02, SM09, SM06, SM08, SM04, SM05, ST01, and ST02. The criteria mentioned above for success are, after that, classified and interrelated with the employer-initiated delays. This interconnection facilitates a comprehensive examination of all these components by end-users, enabling them to determine the need for incorporating additional aspects pertaining to delay beyond what was derived from the SEM analysis and triangulation or success factors (S2) that are tailored to their specific project. Therefore, these variables exhibit interconnections with the integration of success factors, facilitating the formulation of a solution matrix derived from the action plan for the efficient implementation of these components. Within this particular framework, S1-1, S1-2, S1-3, and S1-4 function as indicators that provide insight into the selection of variables that contribute to delays caused by the employer and relevant aspects that contribute to the success of the project. These indicators serve as a guiding framework that directs attention towards the essential action plans needed for successful implementation. The careful execution of this particular procedure is crucial in order to avoid any oversight by the framework about significant elements that could potentially lead to delays or successes, which

may not have been explicitly indicated in the triangulated outcomes of the structural equation modelling-partial least squares analysis. Similarly, this procedural phase is of significance within the framework of projects enabled by Building Information Modelling (BIM). These projects include a wide range of important success factors and employer-initiated delay causes; each assigned a distinct priority and level of importance. Therefore, this procedure guarantees that the framework can efficiently adjust to the unique characteristics of projects allowed by Building Information Modelling (BIM).

3. The triangulation process in the S2 (as noted in the frameworks) flow incorporates the integration of data derived from the study of structural equation modeling-partial least squares (SEM-PLS), qualitative research, and case studies triangulation. The primary objective of this comprehensive method is to enhance and streamline the identification of elements that impact both traditional (Non-BIM) and Building Information Modelling (BIM)-enabled projects, as illustrated within the established frameworks. It is imperative to underscore that the architecture of the framework sheds light on the relative importance of linkages between refined employer-initiated delay factors and the corresponding success variables, as observed through the lens of delay-success interactions by showing the level of importance for each valid relationship between the delay and the success in the body of the proposed frameworks.
4. In the context of S3 (as noted in the frameworks), the flowchart primarily focuses on illustrating the influence of moderators on the connections between employer-initiated delay factors and critical success factors. These moderators play a pivotal role in shaping how delays initiated by the employer impact the overall success of the project. The success factors and delay factors, once identified and assessed by the project team, are crucial components that need to be addressed effectively. These factors, whether they pertain to positive project outcomes or potential hindrances, should be seamlessly integrated into an action plan aimed at implementing the critical success factors. In essence, the flowchart serves as a visual representation of the complex interplay between various elements in S3, shedding light on how moderators influence the relationship between employer-initiated delays and critical success factors. Moreover, it emphasizes the importance of proactively managing both critical success and delay factors by incorporating them into a comprehensive action plan to ensure the project's overall success.

5. It is presumed that concise summaries of S1, S2, and S3, which likely represent critical components or phases within a project or system, are categorized under the action plan aimed at implementing the identified success factors. The action plan plays a pivotal role in organizing and prioritizing the various tasks and strategies necessary to achieve these critical success factors. Based on the rankings assigned to the items within the action plan, the project team will then proceed to adopt the appropriate action plan. This decision-making process hinges on a thorough assessment of the potential impact and feasibility of each action or strategy outlined in the plan. In essence, the ranking system serves as a guide for determining which actions should be given higher priority and attention. This particular aspect of the project management process is crucial, forming the core solution for effectively achieving the project's objectives. However, it is important to emphasize and clarify this step in more detail, as it represents the essentials of the project.
6. The matrix of solutions is anticipated to be included in the action plan subsequent to their categorization by the project into three primary classifications.

   Matrix 1: The first matrix includes supplementary delay causes and critical success factors that are found by the project team through the examination of flowchart S1. Within this matrix, the project team will define the many aspects that exert an influence on the advancement of the project.

   Matrix 2: The present matrix includes a refined compilation of delay factors launched by employers and their corresponding critical success factors, which have undergone prioritisation (through the strength of the relationships) through the use of Structural Equation Modelling (SEM) analysis. The usage of an analytical method facilitates the identification and examination of the interconnections among various components, hence emphasising their importance.

   Matrix 3: Present a concise compilation of delay factors begun by employers, together with their associated important success variables, while considering the influence of moderating effects. The purpose of this matrix is to discern the precise aspects that are essential for the achievement of the project while taking into account any potential moderating influences and prioritisation (through the strength of the relationships.)

7. After the creation and population of Matrix 1 and Matrix 2 with the respective data, it is advisable to merge them into a consolidated matrix denoted as "Matrix 1-2." The integration of this matrix will yield a thorough analysis, including both the delay causes launched by the employer and the corresponding critical success elements, establishing a robust basis for the project's action plan. Ultimately, the end-user will possess two separate collections of matrices, denoted as **Matrix 1-2** and **Matrix 3**, each fulfilling a unique role within the project's structure. Matrix 1-2 and Matrix 3 will be dealt with in accordance with the action plan.
8. It has been concluded for the traditional (Non-BIM) and BIM-enabled projects that the priority matrix, the project and the management control and the staff responsibility matrix are the top tanked methods which can be used to implement success in the project. Tools and strategies exist that can be employed to guarantee the achievement of project objectives. The priority matrix, project control, and the staff responsibility matrix are three tools that are considered essential in this context. The priority matrix is a valuable tool utilised by project managers to effectively prioritise tasks and make informed decisions by considering their respective levels of importance and urgency. The two-dimensional matrix classifies jobs into four quadrants based on their level of urgency and importance: urgent and important, important but not urgent, urgent but not important, and neither urgent nor important. The utilisation of the priority matrix enables project managers to effectively distribute resources and concentrate on work that possesses both urgency and significance while assigning or removing jobs that lack both urgency and significance (Ktaish & Hajdu, 2022). Project control is a crucial element of project management that significantly contributes to the achievement of project objectives. Project management includes the systematic oversight and regulation of multiple facets within a project, including but not limited to scope, time, cost, and quality. The implementation of project control enables project managers to detect variances from the project plan and implement corrective measures in order to realign the project with its intended trajectory. Additionally, the process encompasses the monitoring of project advancement, the evaluation of project effectiveness, and the implementation of well-informed choices to guarantee the achievement of the project (Thapa & Shrestha, 2018). The staff responsibility matrix, commonly referred to as the RACI matrix, is a technique utilised to provide clarity regarding the roles and duties assigned to members of a project team. The statement mentioned above

delineates the individuals or entities that bear responsibility, accountability, consultation, and information dissemination for every task or deliverable inside the project. The utilisation of the staff responsibility matrix enables project managers to ascertain that all jobs are allocated to suitable team members and that there exists a distinct sense of responsibility for each task. According to Iriarte and Bayona-Oré (2021), the aforementioned practises aid in the prevention of misunderstandings, mitigation of disagreements, and facilitation of efficient execution of project tasks. By integrating these three instruments, project managers may proficiently regulate and oversee projects, resulting in favourable project outcomes. The utilisation of a priority matrix facilitates the process of prioritising tasks and making well-informed decisions. Additionally, project control measures are implemented to ensure that the project remains on schedule and that any deviations from the plan are promptly addressed. Furthermore, the staff responsibility matrix serves the purpose of clarifying roles and responsibilities within the project team, thereby promoting effective collaboration and accountability. It is suggested that these three methods are combined to create a proper method statement to implement the critical success factors as indicated in the proposed frameworks.

9. The present study aims to assess and prioritise the most efficient approaches for evaluating and monitoring the execution of essential success elements. Nevertheless, it is crucial to acknowledge that the scope of this study was limited to the ranking element, with the detailed methodology being deferred for future research endeavours. To clarify, the study primarily concentrated on evaluating the efficacy of various approaches but did not extensively examine the specific intricacies of their execution or implementation. This issue is suggested to be explored more comprehensively in future research endeavours.

   In order to fully grasp the technique, let's examine a virtual example that makes it easier to understand. Within the framework of traditional (Non-BIM) projects, see an end user manoeuvring through Figure 8.1. The objective is to utilise this figure to reduce delays created by the employer during different stages of the project. After a thorough evaluation, the end user chooses DFA02 (underestimation of the project cost or value) as an example only, which holds the fifth position in Figure 8.1 according to quantitative analysis; this choose is assumed by the end user as it is missing in the concluding list of the employer-initiated delay factors (through quantitative analysis) and based also on his extensive work experience, the project requirements and the ranking provided for this construction delay factor. This strategy considers the measurable measures used thoroughly in Figure 8.1, guaranteeing that the framework is not only skilled but also capable of fixing any possible deficiencies that may occur throughout its implementation. Subsequently, the end user integrates this component with additional factors, maybe more, into the S2 matrix. The outcome of this process is that the end user possesses a consolidated matrix consisting of DMA01, DCA02, DMA02, DFA01, and DFA02 as employer-initiated most critical delay factors. The critical success factors of SM09, SM03, and ST01 are concurrently recognised as the most efficient approaches for mitigating these issues causing delays. Upon analysing the two matrices, the end user identifies the direct influence of success factors on employer delay factors. Specifically, the occurrence of ST impacts DFA, DCA, and DMA, whereas SM just impacts DMA, resulting in the respective matrix.

Within the action plan, the end user designates the priority matrix, project control, and staff responsibility matrix as the foremost tools for implementing the first devised matrix. Based on extensive management expertise, the end user begins implementing the matching matrix in the project, focusing on aspects that have been validated through this study.

When considering the impact of moderators, the end user should observes that the PC moderator reduces the influence of SM on DCA and ST on DFA. Maintaining constant vigilance is essential in effectively handling this vital issue. In addition, the PEE moderator dampens the impact of SM on DMA. With this knowledge, the end user includes a review plan matrix that identifies MR01, MR03, and MR06 as the most efficient methods for monitoring the implementation of the action plan. This methodology can be applied to all stages of a project, however it primarily emphasises the construction phase.

8.4 Theoretical Contribution

The objective of this study was to discover and comprehend the delays created by employers in particular continents or nations where previous research was insufficient. The study has made noteworthy additions to the current body of literature in the subsequent manners:

a) The study primarily aimed to identify project delays caused by employers in continents or nations that had not been widely investigated before. Furthermore, it has been found that there are correlations between these delays and the particular success characteristics that are necessary to ease them. This represented a deviation from previous research actions that approached the topic of delays more broadly and abstractly, failing to establish a direct correlation with specific aspects contributing to success.

b) The present study contributes to the existing literature by conducting a systematic investigation into the efficacy of success factors in mitigating delays attributed to employers. The analysis progressed by acknowledging the complex interplay among many sets of variables contributing to these delays and their connection to elements associated with success. The utilisation of Structural Equation Modelling (SEM) was employed to achieve this outcome in both the setting of BIM-enabled projects and traditional (Non-BIM) projects. Prior studies frequently examined these components in isolation, offering solely subjective accounts of delays and factors contributing to success.

c) Another significant contribution of this study involved the creation of a comprehensive analysis and action plan for the effective implementation of success factors in both projects utilising Building Information Modelling (BIM) and those following traditional (Non-BIM) approaches. Previous scholarly investigations have predominantly neglected the pivotal element of ascertaining the most productive approaches for assessing the execution of these determinants of achievement and the requisite measures to actualize them.

d) The study made notable progress in enhancing the methodologies employed in prior scholarly works about delays induced by employers. This was achieved by offering a comprehensive framework that effectively tackles and mitigates such delays. Previous research has mostly concentrated on the identification of the causes accountable for these delays. However, the present study not only clarifies these aspects but also offers comprehensive strategies for mitigating their consequences. The comprehensive nature of this methodology establishes a significant model for future research on this particular topic. It presents a practical framework for effectively managing project delays attributed to employers across diverse project environments.

e) The proposed frameworks offer a substantial improvement in resolving delay causes introduced by employers and their associated critical success elements by providing simple and meaningful data results. Unlike previous research that mostly focused on ranking delay factors, including those caused by employers, these two frameworks present a new methodology. They surpass simple rankings by offering a thorough method for identifying the most crucial elements that could cause delays in both traditional (Non-BIM) and BIM-enabled projects. For example, in the traditional (Non-BIM) projects' framework 1, the framework exhibits a significant component throughout phases S2 and S3. These procedures provide a concise and deep connection between the most reliable solutions and the moderating elements that influence these solutions. This dimension has not been investigated in previous studies. This novel technique enhances our comprehension of the dynamics associated with mitigating factors that cause delays related to employers. In addition, the frameworks include a comprehensive matrix that enhances the most important interconnections and elements after analysis and triangulation. This improved matrix enhances our understanding of the complex network of relationships between delay causes, leading to a more nuanced and precise depiction of project difficulties. An important achievement in the proposed framework is the implementation of a comprehensive strategy for incorporating crucial success variables into an action plan. The action plan specifies that the most effective technique for attaining success in the project is to use a combination of the priority matrix, project and management control, and the staff responsibility matrix. The combination of several approaches highlights the importance of a comprehensive and collaborative strategy in dealing with and resolving the obstacles caused by employer-induced delays.

8.5 Practical Implications

Proposals have been formulated to address diverse concerns pertaining to the implementation of construction projects in the continents or countries being examined. These ideas hold significant importance not only for employers but also for other key players involved in building projects. The primary objective is to address and mitigate delays caused by the employer and improve the tactics implemented across the whole project distribution cycle, spanning from the initiation of the project to the final stage of handover. The recommended shift is moving away from inflexible problem-solving techniques towards a more adaptable strategy that actively solicits input from all those involved in the project. By incorporating the findings of this study, informed decisions can be made, and proactive measures may be taken to mitigate challenges, such as delays caused by employers.

According to the proposed frameworks, it is recommended that practitioners develop a comprehensive matrix of solutions that explicitly target the reduction of delays induced by the employer. It is imperative to conduct periodic evaluations of these solutions in order to maintain their efficacy and currency. This strategy can be applied to all stakeholders involved in a project, covering contractors, consultants, and employers. It is recommended that employers incorporate these frameworks into their project management procedures, starting from the initiation of the project to its conclusion. Additionally, employers should adopt consistent techniques for implementation and review to address any delays for which they have responsibility effectively.

Furthermore, it is imperative for project teams to consistently utilise these tactics in order to evaluate the effective application of aspects that impact project advancement. The continuous evaluation process is crucial in order to maintain control over delays caused by the employer, preventing them from escalating into unmanageable disruptions to the project.

It is crucial to implement a comprehensive task control system that is specifically developed to assess unanticipated occurrences commonly encountered in construction projects. Recognising the inherent uncertainty associated with building projects, experts and stakeholders must exercise caution in presuming that all challenges can be anticipated solely through rigid administrative approaches. Alternatively, it is advisable to anticipate probable obstacles that could impede the advancement of a project.

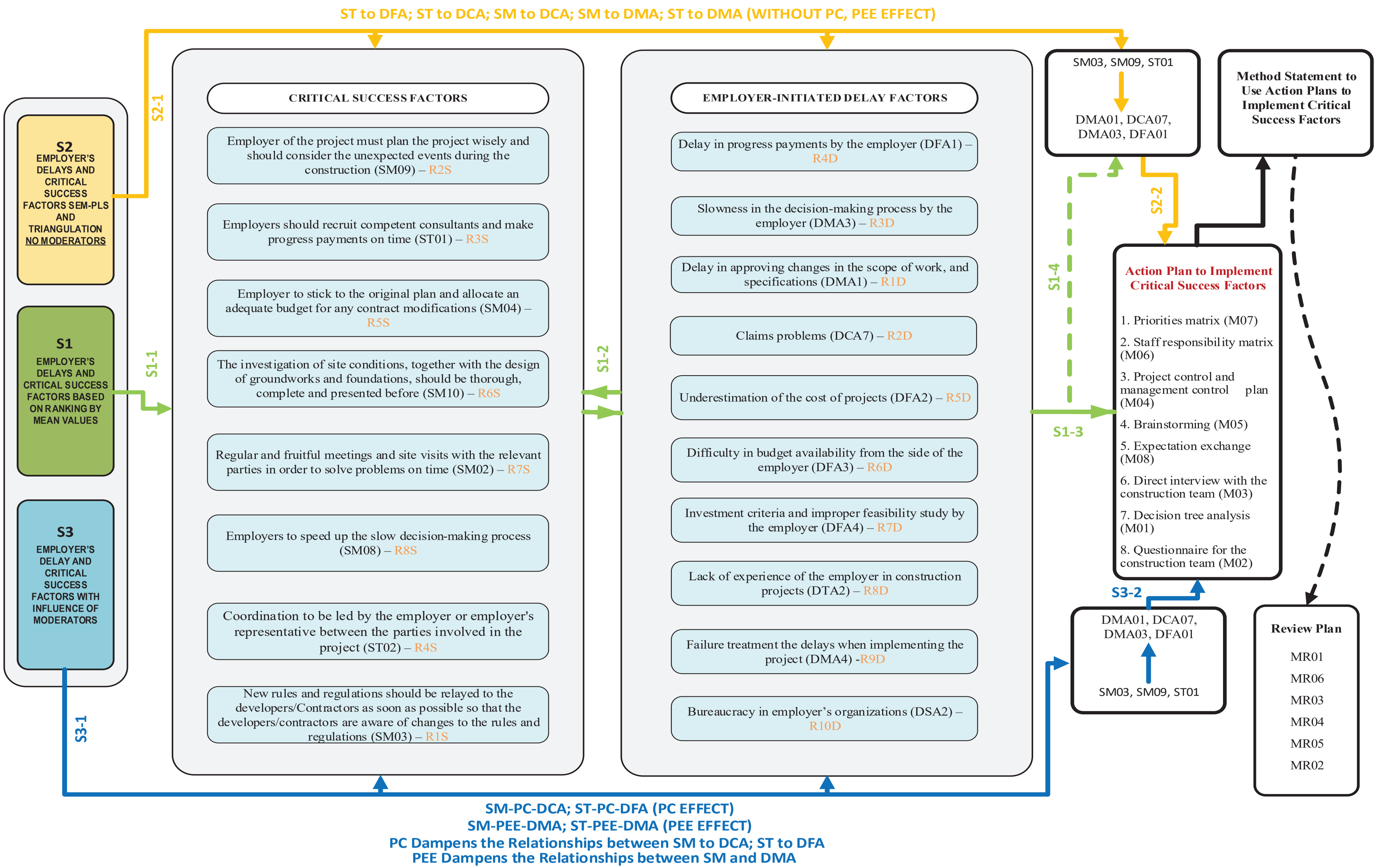

Figure 8.1. Framework to Address Employer-Initiated Delays in Traditional (Non-BIM) Projects

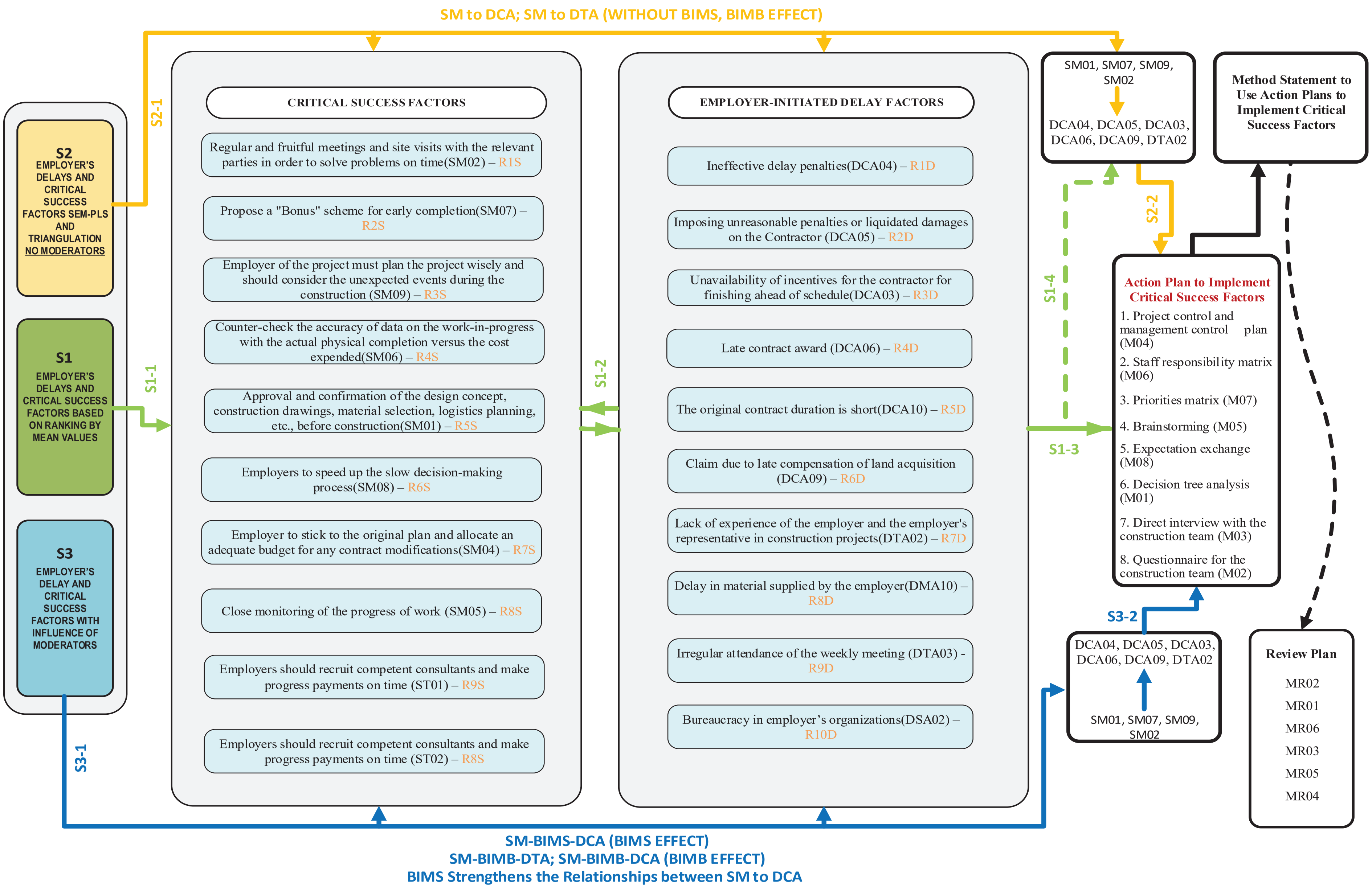

Figure 8.2. Framework to Address Employer-Initiated Delays in BIM-Enabled Projects

8.6 Study Limitations and Suggested Directions for Future Work

Also, though an extensive evaluation of the applications of success elements and employer delays has been conducted in this research study, some spaces continue to demand to be better examined. Further evaluation of ongoing projects can be carried out in a different study to boost the understanding of success and delays caused by the employer and thus address them. It will be interesting to execute a separate research study for each continent or country with even more feedback and information (bigger example dimension for each continent/country) collected for the survey in this study.

Further studies are required to improve the understanding of delays caused by the employer and their success factors. Consequently, the following suggestions are presented regarding future work:

a) More studies are necessary to settle the understanding of this problem and propose other efficient monitoring methods to face this difficulty. In this regard, various research study designs and methods can be used in this present study to boost the understanding of delays caused by the employer.
b) More research can concentrate on various other project administration strategies to stop delays caused by employers in the construction industry. For example, such investigations might analyse better-suited project management tools and techniques to resolve different types of delays inherent in public construction tasks. The outcomes from these suggested research studies might improve decision-making for affected projects.
c) Based on the frameworks for traditional (Non-BIM) and BIM-enabled projects, it is recommended to build an ontology matrix using software such as Protégé and Studio. Employers can use this ontology to address their delays in easier ways.
d) The present study, which assesses several action plans for the execution of essential success criteria, does not extensively explore the operational details pertaining to the implementation of these top-ranked action plans. The comprehensive methodologies for executing these highly regarded action plans have not been discussed within the confines of this study. However, this particular feature is left to be explored in future research endeavours that seek to offer a more

thorough comprehension of the actual procedures and approaches required to implement these action plans successfully.

e) The fundamental objective of this study is to evaluate and prioritise crucial success variables, and it is imperative to provide clarification on this matter. The comprehensive methodologies for examining these elements have not been investigated within the scope of this study. This study recognises that there is a need for further research on the complex methodologies and approaches used to perform thorough examinations of crucial success determinants. Hence, the precise methodologies for conducting such reviews have not been encompassed within the existing body of research; however, they are regarded as a significant domain warranting additional investigation.

8.7 Summary of Chapter 8

A summary of the findings associated with each of the chapters in this thesis was presented in this concluding chapter. Several suggestions were made for current practitioners based on the research findings. In addition, the research's theoretical contributions were presented, as was their practical significance. Suggested directions for future work and the current limitations of this study were presented. This study not only presents proposed frameworks for addressing employer-initiated delay causes but also offers a full and extensive exposition of these frameworks. The objective is to provide the end-user with a comprehensive comprehension of the operational mechanisms of these frameworks and to offer guidance on their efficient application for the purpose of enhancing project development. This study provides a comprehensive examination of the proposed frameworks, revealing their underlying mechanisms and operational processes. Engaging in this practice, it discusses authority and capability upon project stakeholders, including employers, project managers, and team members, by equipping them with the necessary information and discernment to effectively navigate and harness these frameworks to their utmost benefit. The inclusion of such comprehensive information guarantees that individuals utilising these frameworks can engage with them clearly and assuredly.

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APPENDICES

Appendix A-Ethics Approval

Curtin University

Office of Research and Development

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Facsimile +61 8 9266 3793
Web research.curtin.edu.au

14-Jun-2018

Name: Heap-Yih (John) Chong
Department/School: Department of Construction Management
Email: Heap-Yih.Chong@curtin.edu.au

Dear Heap-Yih (John) Chong

RE: Ethics Office approval
Approval number: HRE2018-0356

Thank you for submitting your application to the Human Research Ethics Office for the project **A Novel Employer-Oriented Framework for Delay Causes in the Construction Industry**.

Your application was reviewed through the Curtin University Low risk review process.

The review outcome is: **Approved**.

Your proposal meets the requirements described in the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research (2007)*.

Approval is granted for a period of one year from **14-Jun-2018** to **13-Jun-2019**. Continuation of approval will be granted on an annual basis following submission of an annual report.

Personnel authorised to work on this project:

Name	Role
Barqawi, Mohammad	Student
Chong, Heap-Yih (John)	CI

Approved documents:

Document

Standard conditions of approval

1. Research must be conducted according to the approved proposal
2. Report in a timely manner anything that might warrant review of ethical approval of the project including:
    - proposed changes to the approved proposal or conduct of the study

- unanticipated problems that might affect continued ethical acceptability of the project
- major deviations from the approved proposal and/or regulatory guidelines
- serious adverse events

3. Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an amendment is undertaken to eliminate an immediate risk to participants)
4. An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion report submitted on completion of the project
5. Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
6. Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
7. Changes to personnel working on this project must be reported to the Human Research Ethics Office
8. Data and primary materials must be retained and stored in accordance with the Western Australian University Sector Disposal Authority (WAUSDA) and the Curtin University Research Data and Primary Materials policy
9. Where practicable, results of the research should be made available to the research participants in a timely and clear manner
10. Unless prohibited by contractual obligations, results of the research should be disseminated in a manner that will allow public scrutiny; the Human Research Ethics Office must be informed of any constraints on publication
11. Approval is dependent upon ongoing compliance of the research with the Australian Code for the Responsible Conduct of Research, the National Statement on Ethical Conduct in Human Research, applicable legal requirements, and with Curtin University policies, procedures and governance requirements
12. The Human Research Ethics Office may conduct audits on a portion of approved projects.

Special Conditions of Approval

None

This letter constitutes low risk/negligible risk approval only. This project may not proceed until you have met all of the Curtin University research governance requirements.

Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at hrec@curtin.edu.au or on 9266 2784.

Yours sincerely

Catherine Gangell
Manager, Research Integrity

Appendix B-Updated Ethics Approval

Curtin University

Research Office at Curtin

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Facsimile +61 8 9266 3793
Web research.curtin.edu.au

26-Aug-2020

Name: Heap-Yih (John) Chong
Department/School: Department of Construction Management
Email: Heap-Yih.Chong@curtin.edu.au

Dear Heap-Yih (John) Chong

RE: Amendment approval
Approval number: HRE2018-0356

Thank you for submitting an amendment request to the Human Research Ethics Office for the project **A Novel Employer-Oriented Framework for Delay Causes in the Construction Industry**.

Your amendment request has been reviewed and the review outcome is: **Approved**

The amendment approval number is HRE2018-0356-03 approved on 26-Aug-2020.

The following amendments were approved:

Amendments to the pilot review forms and the to the main questionnaire

It is the responsibility of the Chief Investigator to ensure that any activity undertaken under this project adheres to the latest available advice from the Government or the University regarding COVID-19.

Any special conditions noted in the original approval letter still apply.

Standard conditions of approval

1. Research must be conducted according to the approved proposal
2. Report in a timely manner anything that might warrant review of ethical approval of the project including:
    - proposed changes to the approved proposal or conduct of the study
    - unanticipated problems that might affect continued ethical acceptability of the project
    - major deviations from the approved proposal and/or regulatory guidelines
    - serious adverse events
3. Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an amendment is undertaken to eliminate an immediate risk to participants)
4. An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion report submitted on completion of the project
5. Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
6. Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
7. Changes to personnel working on this project must be reported to the Human Research Ethics Office
8. Data and primary materials must be retained and stored in accordance with the Western Australian University Sector Disposal Authority (WAUSDA) and the Curtin University Research Data and Primary Materials policy
9. Where practicable, results of the research should be made available to the research participants in a timely and clear manner
10. Unless prohibited by contractual obligations, results of the research should be disseminated in a manner that will allow public scrutiny; the

Human Research Ethics Office must be informed of any constraints on publication

11. Ethics approval is dependent upon ongoing compliance of the research with the Australian Code for the Responsible Conduct of Research, the National Statement on Ethical Conduct in Human Research, applicable legal requirements, and with Curtin University policies, procedures and governance requirements
12. The Human Research Ethics Office may conduct audits on a portion of approved projects.

Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at hrec@curtin.edu.au or on 9266 2784.

Yours sincerely

Amy Bowater
Ethics, Team Lead

Appendix C-Ethics Approval for Case Studies' Interviews

Curtin University

Research Office at Curtin

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
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Web research.curtin.edu.au

13-Jun-2022

Name: Heap-Yih (John) Chong
Department/School: Department of Construction Management
Email: Heap-Yih.Chong@curtin.edu.au

Dear Heap-Yih (John) Chong

RE: Amendment approval
Approval number: HRE2018-0356

Thank you for submitting an amendment request to the Human Research Ethics Office for the project **A Novel Employer-Oriented Framework for Delay Causes in the Construction Industry**.

Your amendment request has been reviewed and the review outcome is: **Approved**

The amendment approval number is HRE2018-0356-09 approved on 13-Jun-2022.

The following amendments were approved:

The addition of a new form for the case studies; a guideline for interviews, required to validate the results of the research.

Conditions of Approval
Please note the special conditions of approval and send through to ROC-ethics@curtin.edu.au at your earliest convenience. It is the responsibility of the CI to meet the special condition of approval and ensure that the ethics office hold a final version of all documents relating to this approval.

1. Participant Information Statement
a.) In the paragraph about the data being re-identifiable, please remove the reference to "your child's name", as it is not relevant to your project.

2. It is the responsibility of the Chief Investigator to ensure that any activity undertaken under this project adheres to the latest available advice from the Government or the University regarding COVID-19.

Any special conditions noted in the original approval letter still apply.

Standard conditions of approval

1. Research must be conducted according to the approved proposal
2. Report in a timely manner anything that might warrant review of ethical approval of the project including:
    - proposed changes to the approved proposal or conduct of the study
    - unanticipated problems that might affect continued ethical acceptability of the project
    - major deviations from the approved proposal and/or regulatory guidelines
    - serious adverse events
3. Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an

amendment is undertaken to eliminate an immediate risk to participants)

4. An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion report submitted on completion of the project
5. Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
6. Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
7. Changes to personnel working on this project must be reported to the Human Research Ethics Office
8. Data and primary materials must be retained and stored in accordance with the Western Australian University Sector Disposal Authority (WAUSDA) and the Curtin University Research Data and Primary Materials policy
9. Where practicable, results of the research should be made available to the research participants in a timely and clear manner
10. Unless prohibited by contractual obligations, results of the research should be disseminated in a manner that will allow public scrutiny; the Human Research Ethics Office must be informed of any constraints on publication
11. Ethics approval is dependent upon ongoing compliance of the research with the Australian Code for the Responsible Conduct of Research, the National Statement on Ethical Conduct in Human Research, applicable legal requirements, and with Curtin University policies, procedures and governance requirements
12. The Human Research Ethics Office may conduct audits on a portion of approved projects.

Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at hrec@curtin.edu.au or on 9266 2784.

Yours sincerely

Amy Bowater
Ethics, Team Lead

Appendix D-Questionnaire Body Format (9 Pages)

Curtin University

WHAT IS THE SURVEY ABOUT?

The primary purpose of this survey is to obtain opinions of construction experts about the most prevalent causes of delay by the employer in traditional and BIM-enabled projects in order to develop a framework that applying available success factors, tools, techniques and methodologies to minimize delays. The research will be seeking solutions for employer-oriented delay factors. The following questions have been developed after an exhaustive review of literature worldwide on the subject topic and the questions are a direct result of that review. The questionnaire estimated time is 20 minutes to complete.

Participation is completely voluntary and the data collected from you or your cooperation can be non-identifiable. This means that we don't need to collect individual names or information. No one, even the research team will be able to identify your information if you would prefer to participate anonymously. Any information collected and used during this research will be treated as confidential. The research project is supervised by Dr. Heap-Yih (John) Chong and he can be contacted on heap-yih.chong@curtin.edu.au. The research questionnaire has been approved by the Curtin University Human Research Ethics Committee. The Ethics approval number is HRE2018-0356.
Your efforts and time are highly appreciated for answering the questionnaire below.

I agreed to share in this questionnaire and return it to the researcher.

○ Yes, I consent

○ No, I don't consent

→

What is your company role in a construction project?

- ◯ Contractor
- ◯ Employer, Client or Owner
- ◯ Engineer/Consultant
- ◯ Project Management Company
- ◯ Subcontractor (i.e.; MEP subcontractor, facade subcontractor, etc.)
- ◯ Material supplier
- ◯ Governmental authority
- ◯ Others, please specify:

What is your position in the company you are working in?

- ◯ Site Project Director
- ◯ Site Project Manager
- ◯ Site Resident Engineer
- ◯ Design Office Manager
- ◯ Technical Office Engineer
- ◯ Site Engineer
- ◯ Site Construction Manager
- ◯ BIM Manager
- ◯ Research/Academic Staff
- ◯ Others, please specify:

What is your education level?

- ◯ B.Sc.
- ◯ M.Sc.
- ◯ Ph.D. or Higher
- ◯ Others, please specify:

How many years of experience in construction?

- ◯ Less than 5
- ◯ 5-9
- ◯ 10-19
- ◯ 20 or Above

What are your main project type's experience (you can tick more than one box)?

- ☐ Airport Projects
- ☐ Transportation Projects (Not Airports)
- ☐ Petroleum Projects
- ☐ Commercial and Residential Building Projects
- ☐ Modular Projects
- ☐ Power Projects
- ☐ Industrial Projects
- ☐ Water Projects
- ☐ Sewer and Waste Projects
- ☐ Hazardous Waste Projects
- ☐ Others, please specify:

Where are your most places of experience located (You can tick more than one box)?

- ☐ Australia
- ☐ Egypt
- ☐ China
- ☐ United Arab Emirates
- ☐ United Kingdom
- ☐ United States of America
- ☐ Others, please specify:

How many construction projects have you involved in the last 10 years?

No. of projects for traditional types	
No. of projects for BIM-enabled types	

How frequent have you experienced delays within construction projects out of what you have involved in the last 10 years?

Project delayed out of no. projects you involved for traditional types	
Project delayed out of no. projects you involved for BIM-enabled types	

Can you please provide a specific example of the worst delay you have experienced?

	Planned Project duration (months)	Final/Actual Project duration (months)
Project duration In (months) for traditional projects		
Project duration In (months) for BIM-enabled projects		

From your experience in projects, have you completed project earlier than planned? if yes, Please provide example for the shortest duration. Otherwise, Please choose "No"

If yes, answer the adjacent questions		Project duration in (months) for traditional projects		Project duration in (months) for BIM-enabled projects	
Yes	No	Plan project duration (months)	Actual project duration (months)	Plan project duration (months)	Actual project duration (months)
○	○				

How much do you agree that the following employer-caused delay factors are majorly caused by the following factors? (managerial delay aspect)
(Please tick all the boxes)

	Traditional projects					BIM-enabled projects				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
DMA1: Delay in approving changes in the scope of work and specifications.	○	○	○	○	○	○	○	○	○	○
DMA2: Lack of communication's capacities between the employer and the the the employer's representative.	○	○	○	○	○	○	○	○	○	○
DMA3: Slow decision-making process by the employer or unauthorized employer's representative	○	○	○	○	○	○	○	○	○	○
DMA4: Weak managerial capacities by the employer or the employer's representative to treat the delay caused by the employer	○	○	○	○	○	○	○	○	○	○
DMA5: Suspension of work by employer.	○	○	○	○	○	○	○	○	○	○
DMA6: Unreasonable constraints by the employer.	○	○	○	○	○	○	○	○	○	○
DMA7: The poor organizational structure of the employer's organization	○	○	○	○	○	○	○	○	○	○
DMA8: Delay to furnish and deliver the site to the contractor by the employer.	○	○	○	○	○	○	○	○	○	○
DMA9: Lack of capabilities to early plan for the project.	○	○	○	○	○	○	○	○	○	○
DMA10: Delay in material supplied by the employer	○	○	○	○	○	○	○	○	○	○
DMA11: An improper tendering system such as selecting the lowest bidder	○	○	○	○	○	○	○	○	○	○

How much do you agree that the following employer-caused delay factors are majorly caused by the following factors? (social delay aspect)
(Please tick all the boxes).

	Traditional projects					BIM-enabled projects				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
DSA1: Delays in acquiring land from citizens.	○	○	○	○	○	○	○	○	○	○
DSA2: Bureaucracy in employer's organizations	○	○	○	○	○	○	○	○	○	○

How much do you agree that the following employer-caused delay factors are majorly caused by the following factors? (technical delay aspect)
(Please tick all the boxes).

	Traditional projects					BIM-enabled projects				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
DTA1: Application of quality control based on foreign specifications.	○	○	○	○	○	○	○	○	○	○
DTA2: Lack of experience of the employer and the employer's representative in construction projects.	○	○	○	○	○	○	○	○	○	○
DTA3: Irregular attending of weekly meeting.	○	○	○	○	○	○	○	○	○	○
DTA4: Improper selection of the site location by the employer such as non-availability of infrastructure, location or requirements for soil works	○	○	○	○	○	○	○	○	○	○
DTA5: Difficulties in defining project requirements	○	○	○	○	○	○	○	○	○	○

How much do you agree that the following employer-caused delay factors are majorly caused by the following factors? (financial delay aspect)
(Please tick all the boxes).

	Traditional projects					BIM-enabled projects				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
DFA1: Delay in interim progress payments by the employer	○	○	○	○	○	○	○	○	○	○
DFA2: Underestimation of the cost of projects.	○	○	○	○	○	○	○	○	○	○
DFA3: Difficulty in budget availability from the side of the employer.	○	○	○	○	○	○	○	○	○	○
DFA4: Improper Investment criteria and improper feasibility study by the employer.	○	○	○	○	○	○	○	○	○	○

How much do you agree that the following employer-caused delay factors are majorly caused by the following factors? (contractual delay aspect)
(Please tick all the boxes).

	Traditional projects					BIM-enabled projects				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
DCA1: Contract modifications, change in specifications. change in material, general site changes by the employer	○	○	○	○	○	○	○	○	○	○
DCA2: Improper type of project bidding and awarding	○	○	○	○	○	○	○	○	○	○
DCA3: Unavailability of incentives for contractor for finishing ahead of schedule	○	○	○	○	○	○	○	○	○	○
DCA4: Ineffective delay penalties	○	○	○	○	○	○	○	○	○	○
DCA5: Imposing unreasonable penalties or liquidated damages on the Contractor	○	○	○	○	○	○	○	○	○	○
DCA6: Late contract award	○	○	○	○	○	○	○	○	○	○
DCA7: Claims and disputes due to changes by the employer	○	○	○	○	○	○	○	○	○	○
DCA8: Delay in approval of completed work by the employer (i.e., stage passing or milestone)	○	○	○	○	○	○	○	○	○	○
DCA9: Claim due to late compensation of land acquisition	○	○	○	○	○	○	○	○	○	○
DCA10: Original contract duration is short	○	○	○	○	○	○	○	○	○	○

From your experience, how much do you agree that the following success factors can address the employer delays (management, organization, and financial planning aspects)?
(Please tick all the boxes).

	Traditional projects					BIM-enabled projects				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
SM01: Approval and confirmation of the design concept, construction drawings, material selection, logistics planning, etc., prior to construction	○	○	○	○	○	○	○	○	○	○
SM02: Regular and fruitful meetings and site visits with the relevant parties in order to solve problems in time	○	○	○	○	○	○	○	○	○	○
SM03: New rules and regulations should be relayed to the developers/Contractors as soon as possible so that the developers/contractors are aware of changes to the rules and regulations	○	○	○	○	○	○	○	○	○	○
SM04: Employer to stick to the original plan and to allocate an adequate budget for any contract modifications	○	○	○	○	○	○	○	○	○	○
SM05: Close monitoring for the progress of work	○	○	○	○	○	○	○	○	○	○
SM06: Counter-check the accuracy of data on the work-in-progress with the actual physical completion versus the cost expended	○	○	○	○	○	○	○	○	○	○
SM07: Propose a "Bonus" scheme for early completion	○	○	○	○	○	○	○	○	○	○
SM08: Employer to speed up the slow decision-making process	○	○	○	○	○	○	○	○	○	○
SM09: Employer of the project must plan the project wisely and should consider the unexpected events in the construction	○	○	○	○	○	○	○	○	○	○

	Traditional projects					BIM-enabled projects				
SM10: The investigation of site conditions, together with the design of ground works and foundations, should be thorough, complete and clearly presented before	○	○	○	○	○	○	○	○	○	○
SM11: Proper Value management techniques to be deployed by the employer	○	○	○	○	○	○	○	○	○	○
SM12: Employer should give special attention to pay the contractors on time	○	○	○	○	○	○	○	○	○	○

From your experience, how much do you agree that the following success factors can address the employer delays (team aspect)?
(Please tick all the boxes).

	Traditional projects					BIM-enabled projects				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
ST01: Employer should recruit competent consultants and make progress payment on time	○	○	○	○	○	○	○	○	○	○
ST02: Coordination to be lead by the employer or employer's representative between the parties involved in the project	○	○	○	○	○	○	○	○	○	○
ST03: The roles and responsibilities of those involved in the project team should be clearly defined	○	○	○	○	○	○	○	○	○	○

From your experience, how much do you agree the following project's characteristics influences negatively the effectiveness of the success factors towards addressing employer-caused delay factors?
(Please tick all the boxes).

	Traditional project					BIM-enabled projects				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
PC01: High value of project	○	○	○	○	○	○	○	○	○	○
PC02: Large size of project (team numbers involved and number of deliverables to be produced)	○	○	○	○	○	○	○	○	○	○
PC03: Complexity and uniqueness of project activities	○	○	○	○	○	○	○	○	○	○
PC04: The urgency of project outcome	○	○	○	○	○	○	○	○	○	○
PC05: The type of project (new, existing, maintenance)	○	○	○	○	○	○	○	○	○	○

From your experience, how much do you agree the following project's external environmental factors influences negatively the effectiveness of the success factors towards addressing employer-caused delay factors?

	Traditional project					BIM-enabled projects				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
PEE01: Natural climates problems like winds, rains, high humidity and high temperature	○	○	○	○	○	○	○	○	○	○
PEE02: Social and cultural interference (population demographics, rising educational levels, norms and values, language and attitudes)	○	○	○	○	○	○	○	○	○	○
PEE03: Economic and financial problems (price, local currency value, etc.)	○	○	○	○	○	○	○	○	○	○

From your experience, to what extent the following tools and methods can help for a proper implementation of the success factors in addressing employer delays?

	Traditional project					BIM-enabled projects				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
M01: Decision tree analysis										
M02: Questionnaire for construction team										
M03: Direct interview with the construction team										
M04: Project control and management control plan										
M05: Brainstorming										
M06: Staff responsibility matrix										
M07: Priorities matrix										
M08: Expectation exchange										

From your experience, to what extent, which of the following tools helps in measuring and reviewing the success in implementation of success factors to address employer delays?

	Traditional project					BIM-enabled projects				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MR01:Budget and Cost										
MR02: Time and Schedule										
MR03: Employer satisfaction										
MR04: Environmental impact										
MR05: Readiness for Future										
MR06: Quality and Safety										

From your experience, how much do you agree that the following BIM implementation factors can influence positively the success factors to address the employer delays in BIM-enabled projects?
(Please tick all the boxes).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
BIMS01: Implementing BIM by the employer to avoid design clashes using 3D BIM.					
BIMS02: Implementing BIM by the employer for early warning for the employer delays using 4D BIM (i.e., 4D BIM can monitor the critical path of the project and thus enables the employer for better understanding of delay risk and how to resolve the constraints at an early stage.)					
BIMS03: Implementing BIM by the employer to reduce disputes using 4D BIM.					

BIMS04: Implementing BIM by the employer for construction planning and project management using 4D BIM. Time constraints can be viewed and resolved.	○	○	○	○	○
BIMS05: Implementing BIM by the employer to reduce claims by utilizing a combination of claims' causes responsibility matrix and a 5D BIM model for visualizing and foreseeing projects' areas of claims or even a potential of claims.	○	○	○	○	○
BIMS06: Implementing BIM by the employer for schedule visualization using 3D and 4D BIM.	○	○	○	○	○
BIMS07: Implementing BIM to support proper decision making for any anticipated changes using 4D BIM.	○	○	○	○	○
BIMS08: Implementing BIM by the employer to reduce the project duration.	○	○	○	○	○
BIMS09: Implementing BIM by the Employer to use algorithmic procedures to learn from previous issues and proactively identify the same/similar issues later on the project.	○	○	○	○	○
BIMS10: Implementing BIM 4D to analyse employer delay's events using 4D visual interface.	○	○	○	○	○
BIMS11: BIM 4D can create (what-if) scenario to monitor/control the employer delays.	○	○	○	○	○
BIMS12: Using BIM-Last planner system (LPS) to monitor/control the employer delays.	○	○	○	○	○

From your experience, how much do you agree the following BIM barriers can influence negatively the success factors to control the employer delays in BIM-enabled projects?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
BIMB01: Legal and contractual challenges (ownership of data, and traditional procurement methodology.)	○	○	○	○	○
BIMB02: Cost implications of BIM implementation pertaining to purchase of software license, hardware upgrade, and training cost and time.	○	○	○	○	○
BIMB03: Uncertainty regarding benefit, and return on investment.	○	○	○	○	○
BIMB04: Lack of contractual arrangements.	○	○	○	○	○
BIMB05: Lack of BIM specialist.	○	○	○	○	○
BIMB06: Difficulties in managing changes in BIM.	○	○	○	○	○
BIMB07: Drastic changes in organizational chart, and workflow because of BIM implementation.	○	○	○	○	○

If you are willing (optional) to share in further online interview, questionnaires or discussion in regards to the research in concern; please provide your email address

Appendix E-Permission Statement (Paper 1)

MB

MelJean Berenguer <help@hindawi.com>

To: Mohammad Barqawi

Mon 3/10/2022 12:10 PM

Dear Dr. Barqawi,

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If I can assist you with anything else, please let me know.

Best regards,

MelJean

Appendix F-Permission Statement (Paper 2)

tjcm20:Effects of critical success factors, BIM implementation strategies, and barriers on employer-initiated delays [ref:_00D0Y35Iji._5007R3PCAmv:ref]

20/10/2022

Dear Mohammad Barqawi,

Mohammad Barqawi, Heap-Yih Chong & Robert Lopez (2022): Effects of critical success factors, BIM implementation strategies, and barriers on employer-initiated delays, International Journal of Construction Management, DOI: 10.1080/15623599.2022.2097041

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Appendix G-Statement of Author's Contributions (Paper 1)

To Whom It May Concern,

I, **Mohammad Tawfiq Barqawi**, contributed 90% to the publication:

Barqawi, M., Chong, H. Y., & Jonescu, E. (2021). A review of employer-caused delay factors in traditional and building information modelling (BIM)-enabled projects: A research review. *Advances in Civil Engineering*, *2021*, 6696203, https://doi.org/10.1155/2021/6696203.

Specifically, I contributed the following: Abstract, introduction, literature review, methodology, coordination, data collection and analysis, conceptualisation and design, writing of the original draft, revising and editing, discussion on overall project performance, conclusions and references.

Mohammad Tawfiq Barqawi

---------------- ------------ (10.03.2023)

I, as a co-author, endorse that this level of contribution by the candidate indicated above is appropriate.

Assoc. Prof Heap-Yih Chong

---------------------------------- (10.03.2023)

Appendix H-Statement of Author's Contributions (Paper 2)

To Whom It May Concern,

I, **Mohammad Tawfiq Barqawi**, contributed 90% to the publication:

Barqawi, M., Chong, H. Y., & Lopez, L. (2022). Effects of critical success factors, BIM implementation strategies, and barriers on employer-initiated delays. *International Journal of Construction Management*, 1-16, https://doi.org/10.1080/15623599.2022.2097041.

Specifically, I contributed the following: Abstract, introduction, literature review, methodology, coordination, data collection and analysis, conceptualisation and design, writing of the original draft, revising and editing, discussion on overall project performance, conclusions and references.

Mohammad Tawfiq Barqawi

---------   ----------- (10.03.2023)

I, as a co-author, endorse that this level of contribution by the candidate indicated above is appropriate.

Assoc. Prof Heap-Yih Chong

----------------------------------- (10.03.2023)

Appendix I-SEM Model Variables Codes and Definitions for Traditional (Non-BIM) and BIM-Enabled Project Models

Variables Code	Factors Definition
DMA1	Delay in approving changes in the scope of work and specifications.
DMA2	Lack of communication capacities between the employer and the employer's representative.
DMA3	Slow decision-making process by the employer or authorised employer's representative.
DMA4	Weak managerial capacities by the employer or the employer's representative to treat the delay caused by the employer
DMA5	Suspension of work by the employer.
DMA6	Unreasonable constraints by the employer.
DMA7	The poor organisational structure of the employer's organisation.
DMA8	Delay in furnishing and delivering the site to the contractor by the employer.
DMA9	Lack of capabilities to early plan for the project.
DMA10	Delay in material supplied by the employer.
DMA11	An improper tendering system, such as selecting the lowest bidder.
DSA1	Delays in acquiring land from citizens.
DSA2	Bureaucracy in employer's organisations.
DTA1	Application of quality control based on foreign specifications.
DTA2	Lack of experience of the employer and the employer's representative in construction projects.
DTA3	Irregular attendance of the weekly meeting.
DTA4	Improper selection of the site location by the employer, such as non-availability of infrastructure, location or requirements for soil works.
DTA5	Difficulties in defining project requirements.
DFA1	Delay in interim progress payments by the employer.
DFA2	Underestimation of the cost of projects.
DFA3	Difficulty in budget availability from the side of the employer.
DFA4	Improper Investment criteria and improper feasibility study by the employer.
DCA1	Contract modifications and changes in specifications. Material change and general site changes by the employer.
DCA2	Improper type of project bidding and awarding.
DCA3	Unavailability of incentives for the contractor to finish ahead of schedule

DCA4	Ineffective delay penalties.
DCA5	Imposing unreasonable penalties or liquidated damages on the Contractor
DCA6	Late contract award.
DCA7	Claims and disputes due to changes by the employer.
DCA8	Delay in approval of completed work by the employer (i.e., stage passing or milestone).
DCA9	Claim due to late compensation of land acquisition.
DCA10	The original contract duration is short.
SM01	Approval and confirmation of the design concept, construction drawings, material selection, logistics planning, etc., before construction.
SM02	Regular and fruitful meetings and site visits with the relevant parties to solve problems on time.
SM03	New rules and regulations should be relayed to the developers/Contractors as soon as possible so that the developers/contractors know the changes to the rules and regulations.
SM04	Employer to stick to the original plan and allocate an adequate budget for contract modifications.
SM05	Close monitoring of the progress of work.
SM06	Countercheck the data accuracy on the work-in-progress with the actual physical completion versus the cost expended.
SM07	Propose a "Bonus" scheme for early completion.
SM08	Employer to speed up the slow decision-making process.
SM09	The employer must plan the project wisely and consider unexpected construction events.
SM10	The investigation of site conditions and the design of groundworks and foundations should be thorough, complete and presented before.
SM11	Proper Value management techniques to be deployed by the employer.
SM12	Employers should give special attention to paying the contractors on time.
ST01	Employers should recruit competent consultants and make progress payments on time.
ST02	Coordination is to be led by the employer or employer’s representative between the parties involved in the project.
ST03	The roles and responsibilities of those involved in the project team should be clearly defined.
PC01	A high value of the project.
PC02	The large size of the project (team numbers involved and number of deliverables to be produced).
PC03	Complexity and uniqueness of project activities.
PC04	The urgency of the project outcome.

PC05	The type of project (new, existing, maintenance).
PEE01	Natural climate problems like winds, rain, high humidity and high temperature.
PEE02	Social and cultural interference (population demographics, rising educational levels, norms and values, language and attitudes).
PEE03	Economic and financial problems (price, local currency value, etc.).
BIMS01	Implementing BIM by the employer to avoid design clashes using 3D BIM.
BIMS02	Implementing BIM by the employer for early warning for the employer delays using 4D BIM (i.e., 4D BIM) can monitor the project's critical path and thus enables the employer to understand delay risk better and how to resolve the constraints early.).
BIMS03	Implementing BIM by the employer to reduce disputes using 4D BIM.
BIMS04	Implementing BIM by the employer for construction planning and project management using 4D BIM. Time constraints can be viewed and resolved.
BIMS05	Implementing BIM by the employer to reduce claims by utilising a combination of claims causes a responsibility matrix and a 5D BIM model for visualising and foreseeing projects' areas of claims or even a potential of claims.
BIMS06	Implementing BIM by the employer for schedule visualisation using 3D and 4D BIM.
BIMS07	Implementing BIM to support proper decision-making for any anticipated changes using 4D BIM.
BIMS08	Implementing BIM by the employer to reduce the project duration.
BIMS09	Implementing BIM by the Employer uses algorithmic procedures to learn from previous issues and proactively identify identical/similar issues later in the project.
BIMS10	Implementing BIM 4D to employee events using a 4D visual interface.
BIMS11	BIM 4D can create a (what-if) scenario to monitor/control employer delays.
BIMS12	Using BIM-Last planner system (LPS) to monitor/control employer delays.
BIMB01	Legal and contractual challenges (ownership of data).
BIMB02	Cost implications of BIM implementation pertaining to purchase of software license, hardware upgrade, and training cost and time.
BIMB03	Uncertainty regarding benefit and return on investment.
BIMB04	Lack of contractual arrangements.
BIMB05	Lack of BIM specialists.

BIMB06	Difficulties in managing changes in BIM.
BIMB07	Drastic changes in an organisational chart and workflow because of BIM implementation.

Appendix J-Variable Codes and Definitions for Tools and Methods for Proper Implementation of Critical success factors & Variable Codes and Definitions for Reviewing the Critical success factors Implementation

Variables Code	Factors Definition
[redacted]	
M01	Decision tree analysis
M02	Questionnaire for the construction team
M03	Direct interview with the construction team
M04	Project control and management control plan
M05	Brainstorming
M06	Staff responsibility matrix
M07	Priorities matrix
M08	Expectation exchange
[redacted]	
MR01	Budget and Cost
MR02	Time and Schedule
MR03	Employer satisfaction
MR04	Environmental impact
MR05	Readiness for Future
MR06	Quality and Safety

Appendix K-Guideline Questions for Case Study's Interviews

Guideline Questions for Interview
(For the use of the interviewer only)

Position in the organisation:...
Nature of the organisation:...
Business address:...
Years of experience: ________ year(s)

- How do you consider the employer a source of delay in this project? Why?
- What could project processes best be employed to minimise employer-initiated delays in this project? Why?
- What do you think about the following employer-initiated delay factors in BIM-enabled projects? Do you agree that these factors are the main factors causing delay by the employer in this project? How do you consider these factors about the other factors caused by other project parties (i.e., contractor and consultant)? What is your opinion?

Employer-Initiated Delay Factors in BIM Projects
Ineffective delay penalties
Imposing unreasonable penalties or liquidated damages on the Contractor
Unavailability of incentives for the contractor to finish ahead of schedule
Late contract award
Claim due to late compensation of land acquisition
Lack of experience of the employer and the employer's representative in construction projects.
Irregular attendance of the weekly meeting.
Bureaucracy in employer's organisations

- What do you think about the following critical success factors in BIM-enabled projects? Do you agree that these factors significantly affect addressing the above employer-initiated delay factors? What is your opinion?

Employer's Success Factor in BIM Projects
Regular and fruitful meetings and site visits with the relevant parties to solve problems on time
Propose a "Bonus" scheme for early completion.
The project's employer must plan the project wisely and consider unexpected events during the construction.

Countercheck the data accuracy on the work-in-progress with the actual physical completion versus the cost expended.
Approval and confirmation of the design concept, construction drawings, material selection, logistics planning, etc., before construction
Employer to speed up the slow decision-making process.
Employer to stick to the original plan and allocate an adequate budget for contract modifications.
Close monitoring of the progress of work
Employers should recruit competent consultants and make progress payments on time.

- What do you think about the following employer-initiated delay factors in traditional (Non-BIM) projects? Do you agree that these factors are the main factors causing delay by the employer in this project? How do you consider these factors about the other factors caused by other project parties (i.e., contractor and consultant)? What is your opinion?

Employer-Initiated Delay Factors in Traditional (Non-BIM) Projects
Delay in approving changes in the scope of work and specifications
Claims problems
Slowness in the decision-making process by the employer
Delay in progress payments by the employer
Underestimation of the cost of projects
Difficulty in budget availability from the side of the employer
Investment criteria and improper feasibility study by the employer
Lack of experience of the employer in construction projects
Failure treatment the delays when implementing the project
Bureaucracy in employer's organisations

- What do you think about the following critical success factors in traditional (Non-BIM) projects? Do you agree that these factors significantly affect addressing the above employer-initiated delay factors? What is your opinion?

Employer's Success Factor in Traditional (Non-BIM) Projects
New rules and regulations should be relayed to the developers/Contractors as soon as possible so that the developers/contractors know the changes to the rules and regulations.
The employer must plan the project wisely and consider unexpected events during the construction.
Employers should recruit competent consultants and make progress payments on time.
Employer to stick to the original plan and allocate an adequate budget for contract modifications.
The investigation of site conditions, together with the design of groundworks and foundations, should be thorough, complete and presented before
Regular and fruitful meetings and site visits with the relevant parties to solve problems on time
Employer to speed up the slow decision-making process.

- Do you agree that the following BIM implementation factors positively influence some critical success factors' effects on employer-initiated delay factors in BIM-enabled projects? What is your opinion?

BIM Implementation Factors
Implementing BIM to support proper decision-making for any anticipated changes using 4D BIM.
Implementing BIM 4D to analyse employer delay events using a 4D visual interface.
BIM 4D can create a (what-if) scenario to monitor/control employer delays.

- Do you agree that the following BIM barrier factors have a negative impact on some critical success factors' effects on employer-initiated delay factors in BIM-enabled projects? Please describe your experience. What is your opinion?

BIM Barrier Factors
Cost implications of BIM implementation include the purchase of software license, hardware upgrades, and training costs and time.
Uncertainty regarding benefit and return on investment.
Lack of contractual arrangements.
Drastic changes in an organisational chart and workflow because of BIM implementation.

- Do you agree that the following project characteristics significantly influence some critical success factors' effects on employer-initiated delay factors in traditional (Non-BIM) projects? What is your opinion?

Project Characteristics Factors
A high value of the project
The large size of the project (team numbers involved and number of deliverables to be produced)
Complexity and uniqueness of project activities

- Do you agree that the following project's external environmental factors significantly affect some critical success factors' effects on employer-initiated delay factors in traditional (Non-BIM) projects? Please describe your experience. What is your opinion?

Project External Environmental Factors
Natural climate problems like winds, rain, high humidity and high temperature
Social and cultural interference (population demographics, rising educational levels, norms and values, language and attitudes)
Economic and financial problems (price, local currency value, etc.)

- From your experience with this project, do you think applying critical success factors to address employer-initiated delays is worth the stress? Why?