POLITEKNIK UNGKU OMAR

ANALYZING KEY DELAY FACTOR IN RAILWAY CONSTRUCTION: AN EMPIRICAL APPROACH USING RELATIVE IMPORTANCE INDEX AND MULTIPLE REGRESSION ANALYSIS

ANUM JUITA BINTI KAPPER @ KEPPER

(01BCT21F3022)

CIVIL ENGINEERING DEPARTMENT

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A project report/thesis submitted in partial fulfilment of the requirement for the award of the Bachelor of Civil Engineering Technology with Honours

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STATEMENR OF AUTHENTICITY AND PROPRIETARY RIGHTS

ANALYZING KEY DELAY FACTOR IN RAILWAY CONSTRUCTION: AN EMPIRICAL APPROACH USING RELATIVE IMPORTANCE INDEX AND MULTIPLE REGRESSION ANALYSIS

SESSION II 2023/2024

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ABSTRACT

Construction delays encompass a multitude of factors that can impede the progression of projects, particularly in railway construction, which plays a pivotal role in economic development and transportation infrastructure. Despite their importance, railway construction projects frequently encounter substantial delays, presenting challenges to stakeholders and communities alike. Within this context, the purpose of this study is to comprehensively analyze and understand the factors of railway construction delays, prioritize the critical delay factors using the Relative Importance Index (RII) method, and examine the relationships between these factors and project outcomes through multiple regression analysis. Data were collected from 53 employees, chosen through simple random sampling, via a questionnaire survey that included 39 critical delay factors categorized into 5 major groups. The findings indicated that several significant factors contributed to the delays, such as adverse weather conditions (RII = 0.968) and the delays in paying suppliers or subcontractors (RII = 0.960). Additionally, the regression examines showed that while material, contractor, client, and consultant exhibited non-significant individual contributions, external factors strongly predicted delays (B=0.788, p=0.007). The broader implications of these findings highlight the potential for significant cost reductions and improvements in efficiency by addressing these critical delay factors in railway construction projects. This study emphasizes the importance of comprehending and mitigating the various causes of delays in railway construction to enhance project management techniques and ensure timely project completion. However, the study is limited by its sample size and geographic scope, which may affect the generalizability of the results.

ABSTRAK

Kelewatan dalam pembinaan merangkumi pelbagai faktor yang boleh menghalang kemajuan projek, terutama dalam pembinaan landasan kereta api. Walau bagaiamanpun, projek pembinaan landasan kereta api sering menghadapi kelewatan yang ketara, memberikan cabaran kepada pihak berkepentingan dan komuniti. Tujuan kajian ini adalah untuk menganalisis dan memahami faktor-faktor kelewatan pembinaan landasan kereta api secara komprehensif, mengutamakan faktor-faktor kelewatan kritikal menggunakan kaedah Indeks Kepentingan Relatif (RII), dan meneliti hubungan antara punca dan kesan melalui analisis regresi berganda. Data dikumpulkan daripada 53 pekerja, yang dipilih melalui persampelan rawak mudah, melalui tinjauan soal selidik yang merangkumi 39 faktor kelewatan kritikal yang dikategorikan kepada 5 kumpulan utama. Hasil kajian menunjukkan bahawa beberapa faktor yang penting menyumbang kepada kelewatan, seperti punca keadaan cuaca (RII = 0.968) dan kelewatan dalam pembayaran kepada pembekal atau subkontraktor (RII = 0.960). Selain itu, analisis regresi menunjukkan bahawa faktor material, kontraktor, pelanggan, dan perunding tidak menunjukkan hubungan, namun faktor luaran sangat mempengaruhi kelewatan (B=0.788, p=0.007). Kajian ini menekankan kepentingan memahami dan menangani pelbagai sebab kelewatan dalam projek pembinaan landasan kereta api untuk memperbaiki teknik pengurusan projek dan berjaya mengurangkan kelewatan. Kajian ini juga menekankan pentingnya memahami dan mengurangkan pelbagai sebab kelewatan dalam pembinaan keretapi untuk memperbaiki teknik pengurusan projek dan memastikan penyelesaian projek tepat pada masanya. Walau bagaimanapun, kajian ini terhad terhadap saiz sampel dan skop geografi, yang mungkin mempengaruhi keberkesanan hasil.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

α	alpha
β	Beta
ϵ	error value
e	margin of error
Σ	total sum
η	sample size
N	total of population
p	significant
R	correlation coefficient
W	weighting
X	independent Variable
Y	dependent Variable

LIST OF ABBREVIATION

TEN-T	Trans-European Transport Network
GDP	Gross Domestic Product
RII	Relative Importance Index
DEMATEL	Decisive Modelling and Evaluation Laboratory
SD	System Dynamics
IR 4.0	Industrial Revolution 4.0
PDO	Project Delay Occurrence
ACC	Annual Citation Count
Akh	Awash-Kombollcha-Haragbyia
SPSS	Statistical Package for the Social Sciences
QAQC	Quality Assurance and Quality Control
M&E	Mechanical and Electrical
MLR	Multi Liner Regression
SD	Standard Deviation
SEM	Structural Equation Modelling
ANN	Artificial Neutral Networks

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

Railway construction plays a pivotal role in the economic development and growth of nations worldwide. An efficient and well-connected railway network facilitates the movement of goods, services, and people, thereby enhancing economic activities and fostering regional integration (Campos et al., 2019). Recent initiatives underscore the critical role of railways in regional connectivity and economic cooperation, such as the European Union's Trans-European Transport Network (TEN-T) and China's ongoing development of its high-speed rail network. In the United States, the Infrastructure Investment and Jobs Act (2021) reflects renewed emphasis on railway infrastructure with significant funding allocations aimed at improving rail services. Moreover, railways are increasingly recognized for their lower environmental impact compared to air and road travel, aligning with global sustainability goals.

The economic impact of delays in railway construction projects is substantial. According to the World Bank (2014), delays in infrastructure projects, including railways, can lead to significant economic losses, potentially amounting to 1% of a country's Gross Domestic Product (GDP) annually. These delays ripple across sectors such as manufacturing, logistics, and trade, impacting national competitiveness in the global market (Cantarelli et al., 2012). Addressing construction delays in the railway sector is, therefore, not only a technical challenge but a critical economic imperative.

Moreover, delays in railway construction projects can stem from a multitude of factors, ranging from logistical challenges and financial constraints to regulatory hurdles and stakeholder conflicts (Hwang et al., 2017). Identifying and understanding these delay factors is crucial for project managers and stakeholders to devise effective strategies and implement mitigation measures. Numerous studies have been conducted to explore the causes of delays in construction projects, providing valuable insights into the underlying issues (Aziz & Abdel, 2016; Larsen et al., 2016). Better project planning and execution can result from these insights, which will eventually lessen the negative effects of such delays on the economy and operations. This research intends to add to the body of knowledge by concentrating on the particular context of railway construction and provides workable suggestions for enhancing project timeliness and efficiency.

Delays in railway construction projects can stem from various factors, including logistical challenges, financial constraints, regulatory hurdles, and stakeholder conflicts (Hwang et al., 2017). Understanding these delay factors is crucial for project managers and stakeholders to devise effective strategies and implement mitigation measures. While numerous studies have explored delays in construction projects broadly, there remains a gap in comprehensive research specifically focused on the railway industry (Aziz & Abdel, 2016; Larsen et al., 2016). This study aims to fill this gap by concentrating on the unique context of railway construction, providing actionable insights to enhance project timeliness and efficiency.

Additionally, delays in railway projects have significant environmental implications, contributing to ecosystem disruptions, increased pollutants, and heightened resource utilization (Fernandez-Sanchez et al., 2010; Hwang et al., 2017). Addressing these delays through effective project management not only mitigates economic losses but also supports sustainable development goals. By promoting resource efficiency and environmental responsibility, this research contributes to building a more sustainable future for railway infrastructure.

As a final semester student, my decision to investigate the causes and consequences of delays in railway construction projects is driven by personal motivation and a unique opportunity gained through an internship in a company involved in railway projects. This study seeks to bridge the gap in the literature by providing a detailed examination of delay factors specific to the railway industry. This study focuses specifically on railway projects within the Kempas Baru area under YTL Construction. This regional focus allows for a contextualized analysis within a specific geographical boundary, ensuring relevance and applicability of the findings to the local railway construction context. The study also considers delays and their impacts within a defined time frame, ensuring consistency and relevance of the data used in the analysis. These geographical and temporal boundaries provide clarity on the scope of the study and help readers understand the specific context within which the research findings are situated.

1.2 PROBLEM STATEMENT

The railway sector plays a pivotal role in a nation's economic development and social progress, facilitating enhanced connectivity, reduced transportation costs, and increased economic activities. However, delays in railway construction projects persist as a significant challenge, undermining project efficiency and impacting stakeholders across various sectors (Flyvbjerg, 2014). These delays lead to cost overruns, schedule disruptions, and diminish public trust in infrastructure initiatives, thereby hindering overall economic growth (Ahsan & Gunawan, 2010).

Despite numerous studies on construction delays, research specifically focused on the railway industry remains insufficient (Larsen et al., 2015). Existing literature often overlooks the intricate logistical requirements, specialized equipment, and stringent regulatory frameworks unique to railway projects (Hwang et al., 2017). Previous research, such as that by Alaghbari et al. (2007), Mahamid (2013), and Rahman (2013), has identified factors like poor site management, escalating material costs, and inadequate planning as contributors to delays and cost overruns in various regions. However, there is a lack of comprehensive understanding regarding the interrelationships between these factors and their impacts on project outcomes (Aziz & Abdel, 2016).

To address this gap, there is an urgent need for in-depth exploration into the causes and effects of delays in railway construction projects. Stakeholders must gain a profound understanding of the critical challenges impeding project progress through systematic identification and prioritization of delay factors (Larsen et al., 2016). By elucidating the connections between these delay causes and their effects, stakeholders can develop targeted strategies to mitigate delays effectively and enhance project success (Hwang et al., 2017).

This study adopts a multidimensional approach to fill existing research gaps and provide comprehensive insights into delays in railway construction projects. The primary objective is to analyze the causes of delays comprehensively, prioritize critical delay factors using the Relative Importance Index (RII) method, and examine their relationships with project outcomes through multiple regression analysis. Through these efforts, the study aims to inform stakeholders and policymakers with actionable insights to improve the efficiency and effectiveness of railway construction projects.

1.3 OBJECTIVE

i. To identify the causes of railway construction delays using past studies and questionnaires.

The primary aim of this study is to identify the causes of delays in railway construction projects. This will be accomplished through a comprehensive review of past studies and the administration of questionnaires to stakeholders involved in railway construction projects. By synthesizing existing literature and gathering insights directly from industry experts, the study intends to provide a comprehensive understanding of the various factors contributing to project delays.

ii. To rank these delay factors using Relative Important Index (RII) method

This objective involves applying the RII method to quantitatively assess the significance of identified delay factors. By integrating performance metrics such as cost overruns, schedule delays, and impact on project quality, the study seeks to prioritize interventions that can yield the most substantial improvements in project outcomes. This approach ensures that resources are allocated efficiently to address the most critical factors contributing to delays.

iii. To examine the relationships between delay factors and their effects

This objective focuses on analyzing how delay factors interact with project outcomes, including their effects on cost, time, and quality. By understanding these relationships through statistical analysis, the study aims to develop targeted strategies for mitigating delays. These strategies will be informed by data-driven insights, facilitating the implementation of effective measures to improve project efficiency and timeliness. The ultimate goal is to derive actionable recommendations that can be integrated into project management practices to minimize delays in railway construction projects.

1.4 HYPOTHESES

The hypothesis for this study are as follows:

i. Client-related factors
   a. Rationale: The client decisions and approvals are critical milestones in project timelines. Delays in decision-making, changes in project scope, or inadequate project funding from clients can disrupt project schedules.
   b. Null Hypothesis (H_0): Client-related factors do not significantly contribute to project delays.
   c. Alternative Hypothesis (H_1): Client-related factors significantly contribute to project delays.

ii. Contractor-related factors
   a. Rationale: Contractor performance, including resource allocation, workforce management, and adherence to project schedules, directly impacts project timelines. Poor management practices or subcontractor delays can lead to project delays.
   b. Null Hypothesis (H_0): Contractor-related factors do not significantly contribute to project delays.
   c. Alternative Hypothesis (H_1): Contractor-related factors significantly contribute to project delays.

iii. Consultant-related factors
   a. Rationale**:** Consultants provide technical expertise, design coordination, and project oversight. Delays in providing accurate designs, resolving technical issues, or communicating effectively with stakeholders can prolong project durations
   b. Null Hypothesis (H_0): Consultant-related factors do not significantly contribute to project delays.
   c. Alternative Hypothesis (H_1): Consultant-related factors significantly contribute to project delays.

iv. Material-related factors

a. Rationale: Timely availability and quality of materials are crucial for project progress. Delays in material delivery, shortages, or poor quality can halt construction activities, causing project delays.

b. Null Hypothesis (H_0): Material-related factors do not significantly contribute to project delays.

c. Alternative Hypothesis (H_1): Material-related factors significantly contribute to project delays.

v. External factors

a. Rationale: External factors such as weather conditions, regulatory changes, or economic fluctuations can disrupt project schedules beyond the control of project stakeholders. These factors often introduce uncertainties that impact project timelines.

b. Null Hypothesis (H_0): External factors do not significantly contribute to project delays.

c. Alternative Hypothesis (H_1): External factors significantly contribute to project delays.

1.5 SCOPE OF STUDY

This study will focus exclusively on railway construction projects, utilizing data and insights obtained from various stakeholders involved in these initiatives, including consultants, owners, and contractors. By narrowing the scope to the railway sector, the research aims to provide targeted and actionable findings that are directly applicable to the unique challenges and complexities associated with railway construction (Flyvbjerg et al., 2003). This focused approach will enable a comprehensive understanding of the industry-specific factors contributing to delays and their subsequent impacts, facilitating the development of tailored strategies for mitigating these issues.

To achieve a holistic perspective, the study will employ a mixed-methods approach, combining a thorough review of past studies and literature with primary data collected through comprehensive questionnaires administered to key stakeholders (Aziz & Abdel-Hakam, 2016). This multi-faceted approach will ensure that the research captures both theoretical insights and practical experiences, enhancing the validity and applicability of the findings.

The identified delay factors will be quantitatively ranked using the Relative Importance Index (RII) method, a widely recognized technique for assessing the relative significance of various factors (Hwang et al., 2017). This ranking will enable stakeholders to prioritize interventions and allocate resources effectively, focusing on the most critical issues contributing to delays. Furthermore, statistical analyses will be conducted using SPSS software to explore the relationships between delay factors and their effects on project outcomes, such as cost overruns and schedule delays (Larsen et al., 2016). By quantifying these relationships, the study will provide valuable insights into the causal mechanisms underlying delays, empowering stakeholders with data-driven decision-making capabilities.

While the research aims to generate findings with broad applicability, practical limitations necessitate the establishment of geographical and temporal boundaries. The study will focus on railway projects within Kempas Baru under YTL Construction, determined by data availability and relevance to the study objectives (Aziz & Abdel-Hakam, 2016). Additionally, the data will be collected over a period from February to April, ensuring consistency and relevance in the analysis of delays and their impacts within this defined time frame. These boundaries will enable the research to maintain a focused scope while still providing meaningful and actionable insights for stakeholders operating within the specified context.

1.6 SIGNIFICANCE OF STUDY

Railway construction projects are essential for economic development and transportation infrastructure, yet they often face significant delays, posing challenges for stakeholders and communities alike. By systematically identifying the causes of these delays, this study has the potential to address longstanding issues within the industry, enhancing project efficiency and reducing costs.

Moreover, the application of the Relative Importance Index (RII) method to rank delay factors provides a structured approach to prioritize interventions, enabling stakeholders to allocate resources effectively and mitigate risks. The insights gained from this analysis can inform policy decisions, leading to the formulation of regulations and guidelines aimed at reducing delays. By integrating these data-driven insights into strategic planning and project management practices, policymakers can develop targeted strategies to enhance project outcomes and foster a more efficient and reliable rail construction sector.

Additionally, the findings of this research can contribute to the development of innovative policies and regulations aimed at reducing delays, thereby supporting sustainable infrastructure development and economic growth. Emphasizing the adoption of new technologies and innovative project management techniques can further drive improvements in project efficiency. Overall, this research has the potential to make a significant contribution to improving project efficiency, informing policy decisions, and developing rail infrastructure for a healthy and sustainable future.

1.7 LIMITATION OF THE STUDY

One of the primary limitations of this study is the availability and quality of data obtained from stakeholders. The accuracy and reliability of the findings heavily depend on the completeness and truthfulness of the responses provided in the questionnaires, as well as the comprehensiveness of historical data related to railway construction projects (Larsen et al., 2016). Incomplete or inaccurate data can potentially introduce biases or skew the results, limiting the study's ability to fully capture the complex reality of delays in railway construction. To mitigate this limitation, future studies could employ multiple data collection methods, such as interviews and direct observations, to cross-verify the information obtained from questionnaires.

While the study aims to provide valuable insights specifically tailored to the railway construction sector, the findings may not be fully generalizable to other types of construction projects or to railway projects undertaken in regions with vastly different socio-economic conditions (Hwang et al., 2017). The unique characteristics of railway construction, such as specialized equipment, complex logistics, and stringent regulatory frameworks, may limit the transferability of the results to other contexts. Enhancing external validity can be achieved by conducting similar studies across diverse geographical regions and varying project types, thus allowing for comparative analysis and broader applicability of the findings.

Delays in construction projects are often influenced by a complex interplay of factors, some of which may be subtle or difficult to quantify. Despite the study's rigorous approach to identifying and ranking delay factors, there is a possibility that certain underlying variables or nuanced relationships may not be fully captured or understood (Aziz & Abdel, 2016). This limitation highlights the need for continuous research and refinement of the findings as new data and insights emerge. Incorporating qualitative research methods, such as case studies and expert interviews, can provide deeper insights into these complex relationships and improve the understanding of subtle factors influencing delays.

This study reliance on statistical methods, such as correlation and regression analysis, inherently carries certain limitations. While these techniques are widely accepted and employed in quantitative research, they may not fully account for all nuances or complexities in the relationships between delay factors and their impacts (Cantarelli et al., 2012). The robustness of the statistical analysis is contingent upon the quality and representativeness of the available data, as well as the assumptions and constraints of the chosen statistical models. Future research should consider using advanced statistical methods and machine learning techniques to enhance the robustness and predictive power of the analyses.

1.8 RESEARCH FRAMEWORK

Figure 1.1 illustrates the intricate relationships between various causes of delays in railway construction projects and their subsequent effects. This framework aims to provide a structured approach to understanding how different categories of delay factors contribute to specific project outcomes.

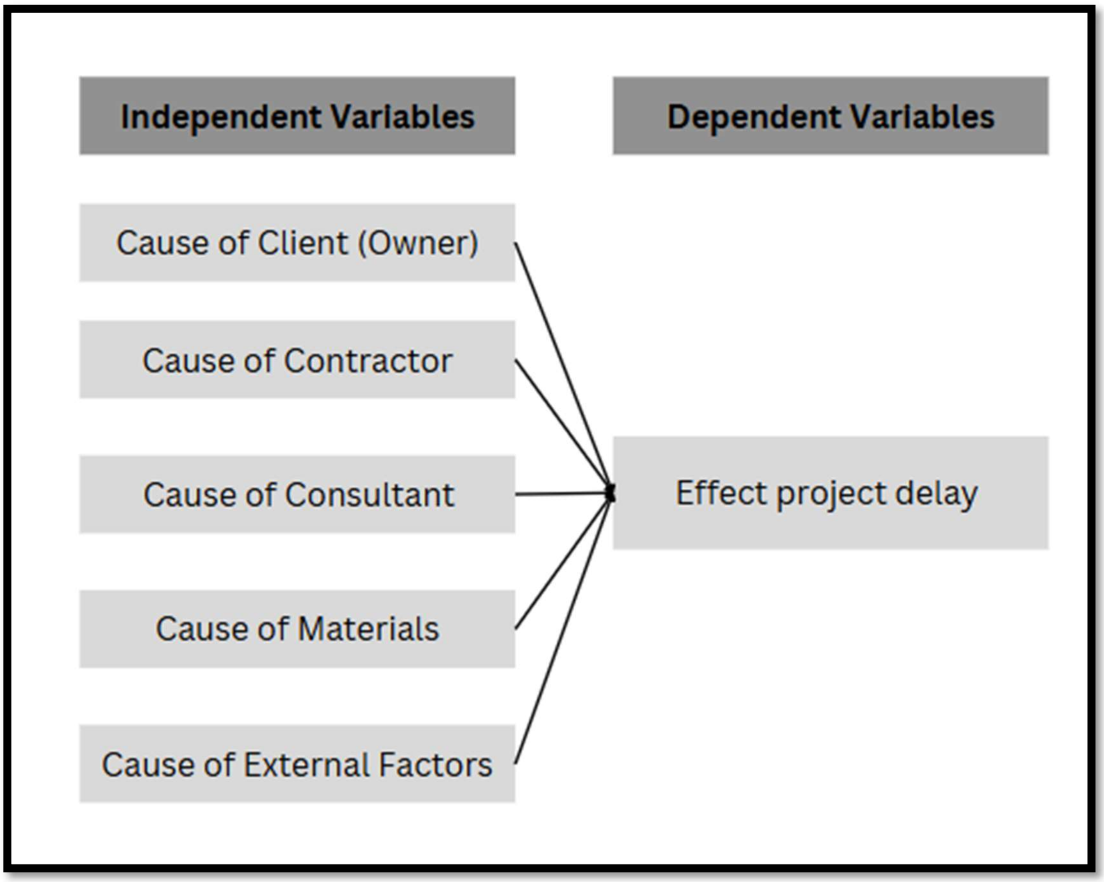


Figure 1.1: Research Framework for Analyzing Delay Causes and Effects in Railway Construction Projects

1.9 ORGANIZATION OF THE STUDY

This study is divided into five sections. The first part shows the background of research, problem statement, research objectives, importance, scope and limitations of studies. The second part shows literature reviews from various researchers and general explanations about cause-and-effect construction delays. The third section describes the research method, design, research sources and research ethics during data collection and analysis. The fourth chapter shows results and discussions about important and common topics and the effect of delay. In the fifth chapter is about the conclusion and future recommendation.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter offers a basic guideline on the central root causes and fallout of railway project delays. The first section, identified the reasons and consequences of construction delays, contextualized with many factors that contribute to these delays in railway construction projects. This chapter also examined the role of railway construction stakeholders on delays. The two sections therefore cover the relationship between two issues and the research gap identified by many studies, thus confirming the focus of my study.

2.2 THEORETICAL LITERATURE REVIEW

The sector comprehensive role in the economic growth of countries cannot be denied. Hwang & Low (2012) found that the economy of Singapore developed significantly throughout the construction sector. Consequently, it is critical that the country continues to excel in project delivery in order to ensure that its economy moves at the desired rate. There are various aspects involved in ensuring that a projects delivery is successful, among them being; design, planning, resource execution, availability, acquisition, and implementation, among others. However, the construction sector has had one primary problem that causes delays to projects.

It is important to address some of the backlogs to ensure forests can recover and projects can be implemented in the future to avoid the trap of failed construction projects. An action or situation that extends the time required for the performance of a contractual obligation constitutes a delay. Typically, delays are reflected in additional work days or postponed start dates for certain activities (Sweis et al., 2008). The reasons for the delay in the construction of the project are many projects that have a significant impact on the short-term financial and financial situation. According to

Fashina et al., (2021), cost overruns are considered an important factor that can lead to premature suspension or termination of a project.

2.3 DEFINITION OF CONSTRUCTION DELAYS

The definition of construction delay includes a variety of factors that can hinder the progress of a construction project. These factors include financial problems such as late payments of contractors, design changes, incomplete designs, and lack of resources (Alemu & Thakur, 2021; Shahsavand et al., 2018). Additionally, poor planning and scheduling, poor management of surveys and inspections, inexperienced contractors and lack of workers are considered the main factors of construction. Additionally, the effects of disruptions on construction delays have been highlighted, emphasizing the importance of understanding and addressing these disruptions to reduce delays (Kowalczyk et al., 2018).

Not only that, but inappropriate construction materials can cause delays, highlighting the need for accurate and efficient material management (Indhu & Yogeswari, 2021). The impact of delays on project management is emphasized, emphasizing the importance of identifying and evaluating the main causes of delays in construction projects (Gordon, 2023). Regional and cultural influences on the impact of construction delays have also been identified, suggesting that understanding this impact can help determine deadlines and avoid unnecessary changes to project schedules (Derakhshanfar et al., 2019). Therefore, construction delays are common and can arise from a variety of sources, including financial, planning, and resource issues. Understanding the causes of these delays and their impact on project management is crucial to effective strategies to reduce and successfully complete the project.

2.4 TYPES OF PROJECT DELAY

According to Theodore (2009), procrastination can be divided into four basic categories:

i. Critical or non-critical
ii. Excusable or non-excusable

iii. Compensable or non-compensable
iv. Concurrent or non-concurrent

An overview of the differences between delayed and one-time types is given in the table in Figure 2.1. This summary Table expands the discussion below.

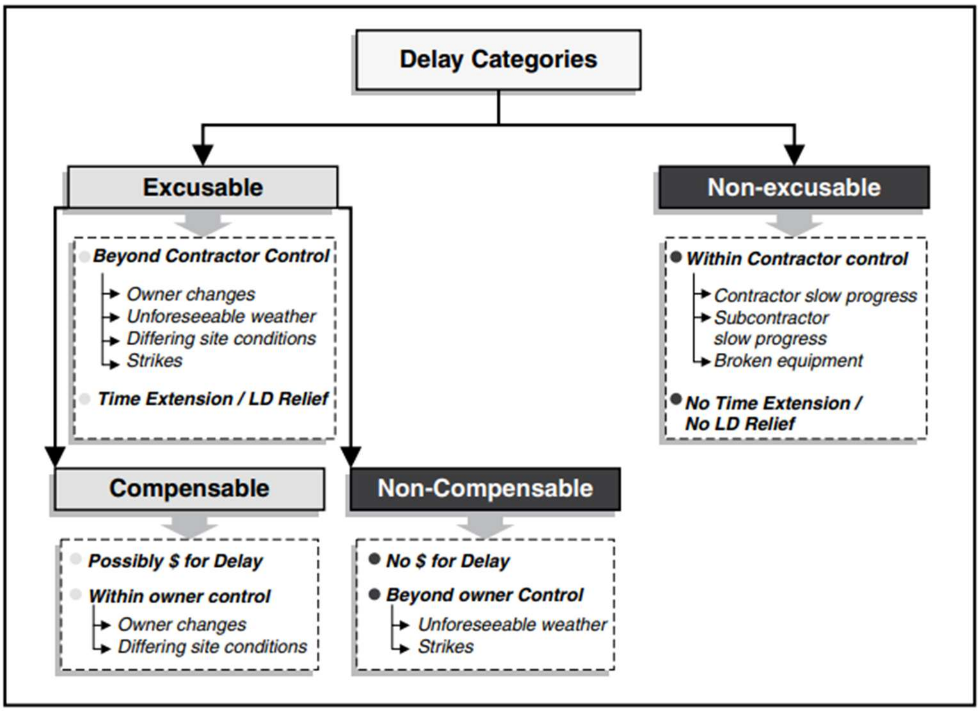


Figure 2.1: Delay Categories

2.4.1 Critical Versus Non-Critical Delays

Critical delays in construction projects refer to delays that have a significant impact on the overall project completion or deadlines and can lead to significant delays in project delivery (Haas & Markovič, 2021). This delay is important because it can affect the duration of the project, lead to financial consequences and disruptions in subsequent stages (Tafesse, 2021). Moreover, there are often significant delays regarding the completion of the project and the definition of the contract for the preparation of the project (Haas and Markovič, 2021). Based on Tafesse (2021), minor delays are delays that occur in construction projects and do not have a significant impact on the completion date or deadlines. Although minor delays may affect certain activities in a project, they do not have a significant impact on the overall performance or delivery of the project.

The distinction between critical and non-critical delays is important for project management and contract objectives. By understanding the nature of delays, project partners can prioritize efforts to address significant delays that are key to project delivery, while also addressing early issues to ensure successful completion of the project (Haas and Markovıč, 2021).

2.4.2 Excusable versus Non-Excusable Delays

Excusable delays in construction projects are beyond the control of the parties involved and are often unpredicTable, such as extreme weather conditions, natural disasters or government actions. These delays are considered valid reasons for extending the project duration and may relieve the parties from delay liability. Extraordinary delays are addressed in construction contracts through special clauses stating that delay is considered a cause and time or a means of granting compensation.

In general, according to the general provisions in the government definition, delays caused by the following factors are often considered as reasons Trauner et al. (2009):

i. General strike
ii. Fever
iii. Flood
iv. Works of God
v. Owner-managed changes
vi. Errors and inaccuracies in programs and descriptions
vii. Parsing the structure of a location or hidden object
viii. Special weather forecast
ix. Assistance from external organizations
x. Inaction of government agencies such as building inspection agencies.

On the other hand, irreversible delays are caused by factors within the stakeholders' control, such as inadequate project management, labor disputes, material shortages, or contractor performance. Delays are generally not considered a valid reason for extension of time and may be attributed to the at-fault party.

2.4.3 Compensable or Non-Compensable

According to Callahan et al., (1992); Kartam (1999) and Mubarak (2005), these delays are often caused by factors beyond the contractor's control, such as changes in the scope of work, design changes, or unexpected site conditions. Delays in payment may result in additional labor, equipment or material costs and overhead, and parties are entitled to seek compensation for these additional costs.

On the other hand, payment is deferred if the injured party is not entitled to additional compensation above the original contract amount. These delays are often within the contractor's control or are due to the contractor's contractual obligations. Many scholars, including Barrie and Paulson (1992) and Mubarak (2005), argue that delays are irreversible compensations for wars, national conflicts, floods, fires, labor strikes, natural disasters, and extreme weather events that we spend too much time on. There is no control over the owner or contractor. Knowing the difference between recoverable and non-recoverable delays is important in controlling project costs and resolving potential problems or disputes on construction projects. By clearly defining late payments and non-payment in the contract, parties can create a framework for dealing with delays and associated costs and reduce the financial impact of late payments on the project.

2.4.4 Concurrent or Non-Concurrent

According to Mubarak (2005), concurrent delays in construction projects occur when multiple delays affect the project schedule in time and lead to a significant impact on the project schedule. These delays can occur for a variety of reasons, including design changes, unexpected site conditions, or labor shortages, and can occur simultaneously, increasing the overall impact on the project schedule. Jointly identifying and analyzing delays is important to accurately assess the impact of on project completion and determine the distribution of responsibilities among stakeholders.

On the other hand, discrete delays that affect the timing of projects that do not occur simultaneously are known as inconsistent delays, also called sequential delays. Instead, delays occur one after another. Inconsistent delays can be caused by factors such as project changes, production requirements or equipment delays. Understanding inappropriate delays is important to evaluate their impact on the project schedule and determine how they affect project management and contractual obligations.

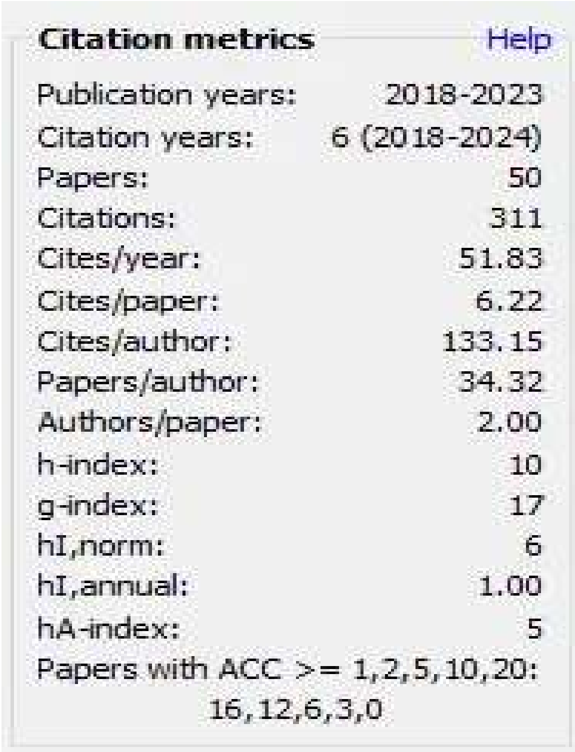
It is important to distinguish between late integration and non-integration in order to accurately assess its impact on construction projects and assign responsibilities to the parties involved. By characterizing delays as normal or inconsistent, project partners can better manage their impact on the project schedule and reduce potential disputes or claims arising from delays.

2.5 REFERENCE MEASURE IN CONSTRUCTION SECTOR

2.5.1 Reference Measure for Project Delays in General Construction Project

The provided Figure 2.2 is a citation metrics report generated from analyzing a set of research papers related to the topic of "project delay" in the construction domain. The analysis was conducted using Harzing's Publish or Perish software, which is a citation analysis tool that retrieves and analyzes academic citations from various online sources, including Google Scholar Web.

The report presents various metrics that provide insights into the impact and influence of the analyzed research papers. The citation metrics suggest that the research area of "project delay" in construction is relatively recent but has gained traction within the past 6 years. Not only that, but citation metrics also showed that the topic of project delays is worthy of coverage and is not a new topic for publishers to use. While the number of papers is modest, the citation count and impact metrics indicate a moderate level of recognition and influence within the research community. The analysis also highlights the presence of a core group of authors contributing multiple papers on the topic, with a few highly cited papers driving a significant portion of the overall citation count.



Citation metrics	Help
Publication years:	2018-2023
Citation years:	6 (2018-2024)
Papers:	50
Citations:	311
Cites/year:	51.83
Cites/paper:	6.22
Cites/author:	133.15
Papers/author:	34.32
Authors/paper:	2.00
h-index:	10
g-index:	17
hI,norm:	6
hI,annual:	1.00
hA-index:	5
Papers with ACC >= 1,2,5,10,20:	16,12,6,3,0

Figure 2.2: Citation metric for project delay in general construction

2.5.2 Reference Measure for Project Delays in the Railway Project

The given Figure 2.3 shows the citation metrics for a particular collection of research articles with the subject "project delay railway." Harzing's Publish or Perish software was utilised for the investigation. It is capable of retrieving and analysing academic citations from several web sources, including Google Scholar Web. Only 4 papers were included in the analysis, suggesting a niche or highly specialized research area within the broader topic of project delays in the railway sector as shown in Table 2.1.

Table 2.1: Lists papers that are specifically related to project delays in the railway sector.

Author	Title
(Badshe, 2020)	Causes And Effect of Delay in Ethiopian Railway Construction Project in Case of Awash-Kombollcha-Haragbyia (Akh) Railway Project
(Ramli et al., 2021)	Ranking of Railway Construction Project Delay Factors in Malaysia by using Relative Importance Index (RII)
(Sowkasem & Kirawanich, 2021)	A Deliverable Delay Management of Software Development in Railway Project using an OKR-Based Scrum Process

(Yenealelm, 2020)	Determine of infrastructure project delay and cost escalations: The case of federal road and railway construction projects in Ethiopia.

Therefore, the study field of the project delay railway is at a very early stage, with only a few recently published papers and little colour so far. The topic of study on construction delays in the railway sector is worth investigating due to the large number of publications produced this year. The small number of authors and the limited ability of authors to present a unique concept or empirical study may be considered an impact in the future as the number of increases.

Citation metrics	Help
Publication years:	2020-2021
Citation years:	4 (2020-2024)
Papers:	4
Citations:	12
Cites/year:	3.00
Cites/paper:	3.00
Cites/author:	5.80
Papers/author:	2.70
Authors/paper:	2.25
h-index:	2
g-index:	3
hI,norm:	2
hI,annual:	0.50
hA-index:	1
Papers with ACC >= 1,2,5,10,20:	2,1,0,0,0

Figure 2.3: Citation metric for project delay in railway contsruction

2.6 CAUSE OF DELAY IN GENERAL CONSTRUCTION

As highlighted by various research studies, such as those produced by Frimpong & Oluwoye, (2003), the global construction industry faces industry faces delays in project completion for various reasons. Muhwezi et al., (2014) found that that negotiator-related delays have the highest impact in Uganda. In Taiwan, there have been 35 instances of construction delays stemming from modifications in client specifications (Yang & Wei, 2010). Similarly, Seddeeq et al., (2019) also proved that the most significant factor contributing to delays in Saudi Arabia is clients making changes to the design and scope during the construction process. In Ghana, the most frequently recorded issues pertain to delayed payment to contractors or suppliers (Amoatey et al., 2015).

Major causes of delays in Jordan encompass contractor financial challenges, problems with subcontractors, and apprehensions regarding the quality of the contractor's performance (Sweis et al., 2008). Chen et al., (2019) reported that the lack of sufficient equipment is noTable cause of delays in the developed country of China. When discussing factors contributing to delays related to construction managers, Islam et al., (2015) observed that a significant issues in Bangladesh is the absence of experienced professionals in this field. A similar situation has been encountered in Malaysia, where delays are attributed to factors such as the delayed issuance of instructions, incomplete drawings, revisions of design documents taking longer than expected, and design inadequacies (Mydin et al., 2014).

Furthermore, general conditions such as adverse weather, issues related to law and order, and overall economic conditions can become significantly severe, resulting in project completion delays. Prolonged periods of bad weather can lead to project delays as construction activities may need to be halted until conditions improve, affecting project timelines and budgets. This situation has been corroborated by studies conducted in Malaysia by Mydin et al., (2014), in Indonesia by Wiguna & Scott (2005), and Vietnam by Luu et al., (2009). Moreover, the complexity of construction projects has increased with the introduction of new tools, equipment, technology, and innovations. To provide precise projections of project timelines, construction companies commonly employ standardized quantitative tools for analyzing delay risks.

2.7 CAUSE OF DELAY IN RAILWAY CONSTRUCTION

Rail transport in Malaysia is an important product of the modern revolution and has grown rapidly. Wherever it is located, it is an important part of the economic and social development of countries. Developed as private companies have public works that provide profits to the owner and services in between Theis usually medium transport for both personal mobility and transportation of goods (Aswathi & Thomas, 2013).

According to the Table 2.2, the causes of construction delays can be classified into several main areas: client, contractor, consultant, material, equipment, labor, external factors, and design. There are top 5 main causes that may be most relevant for this research that focused on railway construction is owner (client), contractor, consultant, material and external factor.

Table 2.2: Causes of delay factors in railway construction project

Groups		Reason of delays
Client	i.	Delay payment to supplier/subcontractor (Asmi et al., 2019; Asmi & Djamaris, 2021; Fashina et al., 2021; Kog, 2019)
	ii.	Payment delays from the client (Farid et al., 2020; Yap et al., 2021; Yaseen et al., 2020)
	iii.	Delays in decision-making (Gondia et al., 2020; Said Al Hinai Student et al., 2020; Yap et al., 2021; Yaseen et al., 2020)
	iv.	Inadequate project funding (Said Al Hinai Student et al., 2020)
	v.	Owner financial problems (Yaseen et al., 2020)
	vi.	Choosing an inefficient design team (Kog, 2019; Yaseen et al., 2020)
	vii.	Inadequate project planning by client (Gondia et al., 2020; Kog, 2019; Yap et al., 2021)
	viii.	Delays in site delivery to contractor (Gondia et al., 2020)
	ix.	Change orders during construction (Fashina et al., 2021; Kog, 2019)
	x.	Changes in project requirements (Yap et al., 2021)
Contractor	i.	Lack of experience of the construction manager (Rivera et al., 2020)
	ii.	Incompetent subcontractors (Asmi & Djamaris, 2021)
	iii.	Poor project management (Abbasi et al., 2020; Said Al Hinai Student et al., 2020; Yap et al., 2021)
	iv.	Delays in mobilizing equipment and manpower (Said Al Hinai Student et al., 2020)
	v.	Contractor's financial difficulties (Abbasi et al., 2020)
	vi.	Delays in payments to subcontractors (Abbasi et al., 2020)
	vii.	Delay in material delivery (Yap et al., 2021; Yaseen et al., 2020)
	viii.	Labor-related issues (Yaseen et al., 2020)
	ix.	Poor contractor coordination with subcontractors (Gondia et al., 2020)
	x.	Delays in sub-contractor's work (Fashina et al., 2021)
Consultant	i.	Lack of coordination between consultants (Fashina et al., 2021; Said Al Hinai Student et al., 2020; Yap et al., 2021)
	ii.	Changes in design requirements (Said Al Hinai Student et al., 2020; Yap et al., 2021)
	iii.	Delays in design approvals (Asadi et al., 2015; Said Al Hinai Student et al., 2020)
	iv.	Delays in reviewing and approving design documents (Gondia et al., 2020; Yap et al., 2021)
	v.	Inadequate consultant experience (Fashina et al., 2021; Gondia et al., 2020; Kog, 2019)
Material	i.	Changes in material specification and type (Asmi & Djamaris, 2021)
	ii.	Delays in material procurement (Abbasi et al., 2020; Fashina et al., 2021; Yap et al., 2021)
	iii.	Inflation affecting material prices (Abbasi et al., 2020; Fashina et al., 2021)
	iv.	Errors during construction (Fashina et al., 2021)
	v.	Late delivery (Asadi et al., 2015; Kog, 2019; Yap et al., 2021)
	vi.	Poor quality of materials (Gondia et al., 2020; Yap et al., 2021)

External factor	i.	Weather Factors (Fashina et al., 2021; Panchal et al., 2023; Yap et al., 2021)
	ii.	Delays in the mandatory monitoring, evaluation, and project inspection (Ogbeifun & Pretorius, 2022)
	iii.	Environmental issues (Yaseen et al., 2020)
	iv.	Economic factors affecting the construction industry (Yaseen et al., 2020)
	v.	Delay in securing permits (Fashina et al., 2021; Kog, 2019)
	vi.	Land acquisition problems (Kog, 2019)
	vii.	Congested construction site (Gondia et al., 2020; Yap et al., 2021)
	viii.	Different nationalities of the workforce (Asadi et al., 2015)

2.8 EFFECT OF PROJECT DELAY

Construction delays can have significant and multifaceted effects on construction projects. According to Amoatey et al., (2015), these effects include time overrun, cost overrun, disputes, arbitration, litigation, and total abandonment as shown in Figure 2.4. Delays are common in various construction projects and cause considerable losses to project parties (Aziz, 2013). Studies have shown that delays in construction projects can lead to an increase in the original estimated cost of the projects (Oyegoke & Kiyumi, 2017). Additionally, delays can result in loss of productivity, late project completion, disruption of work, disputes between parties, third-party claims, and termination of the project. Furthermore, delays not only affect project duration but also increase costs and reduce construction quality (Yılmaz, 2019). The effects of delays are not only limited to the construction industry but also have implications for the overall economy of countries (Mydin et al., 2014).

It is evident that construction delays have far-reaching consequences, impacting various aspects of a project including time, cost, quality, and relationships between project parties. These effects can lead to financial losses, legal disputes, and overall negative impacts on the economy. Therefore, it is crucial for stakeholders in the construction industry to address and mitigate the causes of delays to minimize their detrimental effects.

2.8.1 Time Overrun

Overtime on construction projects is a major problem that can lead to cost overruns and other negative consequences. Insufficient contract duration established by clients, poorly defined projects, projects initiated by clients, failure to compare project costs by consultants, and weak control/oversight of projects by consultants (Famiyeh et al., 2017; Soomro et al., 2019). Additionally, Saputro & Wiguna, 2021 noted the consequences of delays in the construction of projects, such as overtime, cost overruns, conflicts, negative social impacts, arbitration, abandonment, lawsuits, and enrichment.

Eltoukhy & Nassar (2021) discussed the important factors of overtime such as financial problems with the owner, financial problems with the contractor, late control, late decision making, lack of equipment, poor site management, lack of equipment, construction defects and delays in the delivery of materials. Moreover, Salunkhe (2014) stated that project failure is mostly related to the problems and failures of the contractor and owner, which leads to more time and cost.

2.8.2 Cost Overrun

The effect of project delays on cost overruns in construction projects is a critical concern that has been extensively studied. Research has identified various factors contributing to cost overruns as shown in Figure 2.4, including estimating errors (32%), flawed estimates (27%), delivery delays (12%), field productivity issues (11%), higher than anticipated costs (9%), contracting approach (6%) and commissioning & start up scope (3%) (Osman & Mohamud, 2022). Additionally, it has been established that cost overruns are more likely to occur in more expensive projects, leading to significant delays (Adam et al., 2017).

Furthermore, delays in construction projects have been found to result in cost overruns and project losses (Rauzana et al., 2022). In the context of infrastructure projects, inflation, inaccurate cost estimates, variations, economic conditions, and escalation of material prices have been identified as top risk factors leading to cost overruns (Melaku Belay et al., 2021). Moreover, delays have been shown to have a damaging economic effect, ranging from allocative inefficiency of scarce resources to contractual disputes, claims, litigation, and even project failure and total abandonment (Gbahabo & Samuel , 2017).

The impact of delays on cost overruns has been studied in various countries, including Ghana, Algeria, Vietnam, and Bahrain, highlighting the global significance of this issue (Fugar & Agyakwah-Baah, 2010; Roumeissa, 2019; Vu et al., 2015). The correlation between inexcusable delays and cost overruns has been found to be significant, emphasizing the direct relationship between delays and increased project costs (Amanya et al., 2022) Additionally, delays have been associated with negative financial and social impacts on all parties involved in construction projects (Wali & Ali, 2019). The critical effects of delays have been identified as cost overruns, time overruns, litigation, lack of continuity by the client, and arbitration (Amoatey et al., 2015). Furthermore, inadequate planning at the early stages of projects has been highlighted as important for minimizing delay and cost overruns, particularly in developing countries with relatively unskilled workers (Fugar & Agyakwah-Baah, 2010).

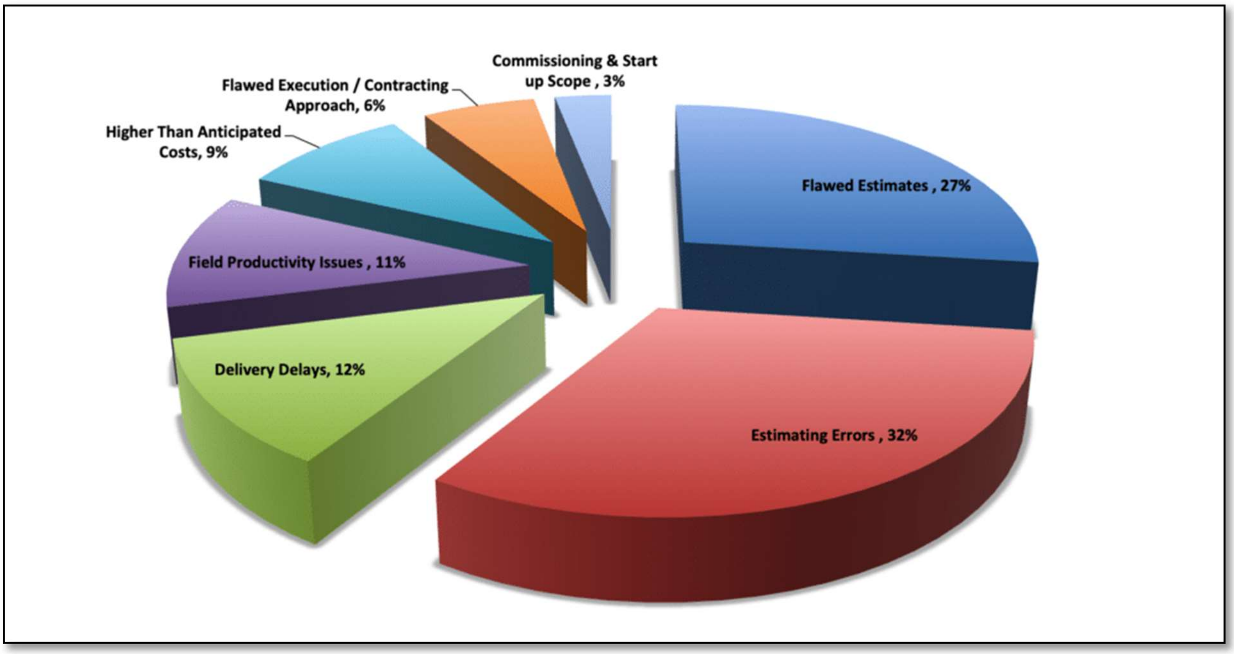


Figure 2.4: Top reasons for Cost Overruns in Major Construction Projects (Source: Osman & Mohamud, 2022)

2.8.3 Disputes

The effect of project delays on disputes in construction projects has been a subject of extensive research. Delays have been identified as a significant factor leading to disputes, with various studies highlighting the detrimental impact of delays on project outcomes and relationships between project participants Sambasivan & Soon (2007) found that construction delays lead to disputes, including time overrun, cost overrun, arbitration, litigation, and total abandonment. Additionally, Kathpalia & Jhamb (2022) emphasized payment delays as a major cause of disputes in construction projects, leading to cost and time overruns Atanasov et al., (2022) examined disputes arising from delays in construction projects, emphasizing the significant transaction cost associated with such disputes. Furthermore, Mohammed et al., (2021) highlighted that construction delays are a common cause of disputes in construction projects..

The literature also indicates that disputes resulting from delays can have far-reaching effects, including increased project costs, time overruns, and damage to relationships between project participants. K. Kim (2020) pointed out that to compensate for delays, additional time and cost may be required, leading to disputes between project participants. Atanasov et al., (2022) and K. Kim (2020) highlighted that construction delay claims are a leading cause of disputes in the construction sector. Moreover, delays in road construction projects have been found to lead to disputes, cost overruns, time overruns, and litigation (Alfakhri et al., 2018). The negative impact of disputes resulting from delays has been further emphasized by Mishra & Aithal (2022) who highlighted the risks associated with unresolved conflicts, including cost and time overruns in projects.

In addition, the effects of disputes resulting from delays have been found to include loss of productivity, cost and time overruns, damage to company reputation, and strained relationships between project participants (Mashwama et al., 2019). Furthermore, disputes have been associated with increased project duration, costs, and delay claim disputes between parties in construction projects (Kamandang et al., 2017). The detrimental impact of disputes on project completion within the desired cost, time, and quality has also been highlighted (Irlayici Çakmak, 2016).

2.8.4 Litigation

The impact of project delays on litigation in the construction industry has been extensively researched. Sambasivan & Soon (2007) found that construction delays lead to disputes, including litigation, which can have significant implications for project outcomes and relationships between project participants. Similarly, Atanasov et al., (2022) examined disputes arising from delay in construction projects, emphasizing the significant transaction cost associated with such disputes, including litigation. Furthermore, Jagannathan & Delhi (2023) highlighted that litigation is often expensive, uncertain, and prone to delays, indicating the challenges associated with resolving disputes through legal means.

The literature also indicates that disputes resulting from delays can have far-reaching effects, including increased project costs, time overruns, and damage to relationships between project participants. Amoatey et al., (2015) identified time overrun, cost overrun, dispute, arbitration, and litigation as the six main effects of construction delays. Additionally, Alfakhri et al., (2018) found that delays in road construction projects widely lead to cost overrun, time overrun, litigation, and disputes.

The detrimental impact of disputes on project completion within the desired cost, time, and quality has also been highlighted. Tummalapudiet et al., (2022) mentioned that delays affect the contractor, as final payments take longer than expected, which has an impact on the contractor's bonding capacity and sometimes leads to claims and litigation, further delaying the closeout as projects typically cannot be closed with unresolved claims.

2.8.5 Arbitration

The impact of project delays on arbitration in the construction industry has been extensively researched. Sambasivan & Soon (2007) found that construction delays lead to disputes, including arbitration, which can have significant implications for project outcomes and relationships between project participants. Similarly, Chan & Suen (2005) emphasized arbitration as the most popular method, after negotiation, for resolving disputes in international construction projects in China. Additionally, Webb & Wagar (2024) mentioned that the arbitration process was initially instituted to combat the delays and costs experienced in the courts. Mishra & Aithal (2022) recommended studying the effectiveness of arbitration for resolving disputes, indicating the significance of arbitration in addressing the challenges posed by project delays.

Overall, the literature provides substantial evidence of the impact of project delays on arbitration in construction projects. Delays have been consistently linked to disputes, arbitration, and their implications for project resolution, emphasizing the need for effective dispute resolution mechanisms and proactive delay management strategies.

2.9 MITIGATION MEASURE OF CONSTRUCTION DELAYS

Based on the provided references, several mitigation measures for construction delays can be identified. Sweis et al., (2008) highlighted the importance of assessing the perceptions of consultants, contractors, and owners to measure differences in collective perspectives and address popular misconceptions or prejudices regarding delay causes. Gunduz & Al-Naimi (2022) emphasized the need for integrated balanced scorecard and quality function deployment to mitigate construction project delays. Arantes & Ferreira (2020) stressed the decisive role of the owner/developer in mitigating delay causes in construction projects. Additionally, Sarki et al., (2021) pointed out the need for specific and in-depth mitigation measures to control delays effectively.

Furthermore, Sutisna et al., (2022) emphasized the essentiality of mitigating construction procurement delays to avoid potential losses. Kammouh et al., (2022) introduced an open-source software, MitC, for construction project control and delay mitigation. Soliman & Alrasheed (2021) highlighted the importance of predicting and identifying problems in the early stages of construction to implement appropriate procedures for delay effect mitigation. Tummalapudi et al., (2022) provided recommendations for state DOTs to mitigate closeout delays and ensure timely finalization of highway construction projects.

2.10 EMPIRICAL REVIEW

Numerous empirical studies have been conducted to investigate the causes and effects of delays in construction projects, particularly in the railway sector. A study by BADSHE (2020) focused on the Awash-Kombollcha-Haragbyia (Akh) Railway Project in Ethiopia, identifying causes of delays such as ineffective project management, poor scheduling, and lack of skilled labor. Similarly, Ramli et al., (2021) conducted a study in Malaysia, ranking delay factors in railway construction projects using the Relative Importance Index (RII) method. Their findings highlighted issues like late payments, design changes, and material procurement delays as significant contributors to project delays.

In another study, Sowkasem & Kirawanich (2021) explored delay management in software development for railway projects, proposing an OKR-Based Scrum Process to address deliverable delays. Yenealelm (2020) investigated infrastructure project delays and cost escalations in federal road and railway construction projects in Ethiopia, shedding light on the impact of delays on project costs and timelines.

Several empirical studies have also been conducted in the broader construction industry, providing insights into delay causes and mitigation strategies. For instance, Hoque et al., (2023) analyzed construction delays in Bangladesh, identifying factors like payment delays, rework due to mistakes, and lack of skilled labor as major contributors. Ajayi & Chinda (2022b) employed a DEMATEL-System Dynamics modeling approach to understand the dynamics of delay factors and their impact on project schedules in the Thai construction sector.

Furthermore, Abera (2022) investigated the causes and effects of construction delays in Koye Feche Condominium Houses in Addis Ababa, Ethiopia, highlighting material, client, and contractor-related causes. Ajayi & Chinda (2022a) utilized a DEMATEL-SD analysis to examine pertinent delay variables in the Thai construction sector, emphasizing the importance of project design and management for overall performance. These empirical studies provide valuable insights into the challenges faced by construction projects, particularly in the railway sector, and offer potential mitigation strategies to address delays effectively.

2.11 PREVIOUS STUDIES ON PROJECT DELAYS

Table 2.3 shows a compilation of studies published in recent years focusing on the issue of project delays in the construction industry, especially from 2023 (Gordon, 2023; Hoque et al., 2023; Ajayi & Chinda, 2022b; Seman et al., 2023; SA'AD et al., 2020; ABERA, 2022; Ajayi & Chinda, 2022a; DEJENE, 2022; Romzi & Ing, 2022; Soliman & Alrasheed, 2021). The fact that the project is still an issue and is being worked on.

As for the methods used in this study, the general method includes the use of interviews and surveys (Gordon, 2023; Hoque et al., 2023; ABERA, 2022; SA'AD et al., 2020). Many researchers distributed surveys to construction industry officials such as engineers, project managers, and contractors to collect information about potential delays, their consequences, and strategies to mitigate their impacts. Statistical analysis techniques including correlation coefficients, Cronbach's alpha, and SPSS software were commonly used to analyze the collected data (Gordon, 2023; Hoque et al., 2023).

Additionally, some studies have used advanced methods such as DEMATEL (Decisive Modeling and Evaluation Laboratory) and System Dynamics (SD) to demonstrate how to understand the complex relationship between different delay factors and their effects during the project (Ajayi and Chinda, 2022b; Ajayi and Chinda, 2022a). The table also shows that project delays are an issue that deserves further research in the future. Many studies have focused on identifying the causes of delays, their impact on project performance, and possible mitigation strategies (Seman et al., 2023; Abera, 2022; Dejene, 2022; Romzi and Ing, 2022; Soliman and Alrasheed, 2021). The impact of delays on project schedules, budgets and overall quality is a recurring theme and highlights the importance of tackling this problem effectively.

Due to the importance of project delays and their far-reaching consequences, the table shows that project delays may be an important and useful topic for future research in the construction industry. Researchers can build on existing knowledge, look for emerging technologies or methods to reduce delays, or explore limitations and unique factors that contribute to delays in specific regions or project types

Table 2.3: Past Studies on Project Delays

Author	Title	Purpose	Method	Results
(Gordon, 2023)	Investigating The Causes of Project Delay and Its Effects on The Project Management in Construction Projects	To examine the causes of project delays in construction projects and assess their impact on the performance of project management offices.	The reliability of the questionnaire was confirmed using Cronbach's alpha technique, and statistical tests through SPSS software.	The results indicated that addressing and mitigating these delay factors is crucial for improving the efficiency and effectiveness of project management in construction projects
(Hoque et al., 2023)	Analysis of construction delay for delivering quality project in Bangladesh	This study has investigated the views of engineers, project managers and contractors on the causes of delay during a construction phase to identify potential delay factors, negative effects on project delivery and prioritize the delay factors.	The final questionnaire was designed with 40 potential delay factors, and a total of 102 valid Bangladeshi construction stakeholders and responded the result was analysed by the relative importance index.	Among the 40 delay factors, the top five most influencing delay factors are “delay in progress payments,” “rework due to mistakes during construction,” “lack of skilled labour,” “poor monitoring and control of activities” and “delays in the making of a decision.”

(Ajayi & Chinda, 2022a)	Impact of Construction Delay-Controlling Parameters on Project Schedule: DEMATEL-System Dynamics Modelling Approach	To provide insights that can help in mitigating construction delays and improving project management practices.	Data collected from experts in the Thai construction industry and secondary sources were used for the analyses. The DEMATEL analysis helped examine the importance and influence of each key factor.	The research highlights the significant influence of delay factors on each other and demonstrates how the SD model can be used to explore the dynamics of these factors based on their established influence weights and relationships
(Seman et al., 2023)	Causes and effects of project delay in public construction projects in Ethiopia	To identify the factors leading to delays in construction projects and understand the impact of these delays on the overall project outcomes.	The research adopted a descriptive research design, which helps to describe the variables or conditions in a situation.	The last finding of the paper emphasizes that the effects of project delays are significant and frequently occur due to delays in projects, with time overrun and cost overrun being the most prevalent issues.
(Haris et al., 2022)	The Delay Issues in The Malaysian Construction Industry and Benefits of Industrial Revolution 4.0 (IR 4.0) to Mitigate Issues for Project Managers	The study aims to identify the factors contributing to delays in construction projects and assess the potential benefits of incorporating I.R 4.0 solutions to enhance project management efficiency	Questionnaires were distributed to 150 respondents from the construction background in Klang Valley, Malaysia. Out of these, 36 respondents provided their feedback through Google Forms and hardcopies.	The research findings suggest that educating construction teams on the significance of I.R 4.0 tools is crucial for enhancing project efficiency and addressing the performance gap between virtual design and real-world construction.
(ABERA, 2022)	Causes And Effects of Construction Delay in Koye Feche Condominium Houses in Addis Ababa: Project O8 Branch Office	The aim of this project is to investigate the causes and effects of construction delay in Project 08 Branch Office.	A structured questionnaire in Likert scale was used in data collection. 114 project team members filled the questionnaire and 6 of them took part in the interview.	This indicated that the majority of construction delay occurred due to materials, client and contractor related causes.
(Ajayi & Chinda, 2022b)	Dynamics of Pertinent Project Delay Variables in the Thai Construction Sector: Mathematical Analysis	The study aims to go beyond simply identifying delay factors and focuses on understanding how these factors interact and influence project timelines in the construction sector in Thailand.	The method use is a hybrid mathematical system that combines the DEMATEL (Decision Making Trial and Evaluation Laboratory) analysis and System Dynamics (SD) modelling.	The study contributes to the field by using DEMATEL-SD analysis to understand and analyze delay-controlling factors in construction projects, emphasizing the importance of project design and management in

				overall project performance.
(Dejene, 2022)	Assessment on the Causes and Effects of Road Construction Project Delay: Case of Addis Ababa City Road Authority	To identify the causes and effects of delay causing factors in Addis Ababa City Road Authority Road construction projects	The study adopted a descriptive research design. A purposive sampling method was used in this study.	The study recommends the payments to be made on time by the client, the design documents should be reviewed and approved by the consultant on time and the contractor should select an experienced sub-contractors and work hand in hand to complete the project with the allocated budget and time.
(Romzi & Ing, 2022)	Underlying causes of construction project delay: A review	To highlight the significance of construction delays as a global issue that can impact project completion, budgeting, and quality.	The paper provides a comprehensive overview of the factors contributing to delays in construction projects	The study identifies various factors contributing to construction project delays, such as slow decision-making, poor site management, shortage of labour, changes in scope of work, and delays in revising and approving design documents.
(Soliman & Alrasheed, 2021)	Model for construction project delay occurrence (PDO)	To propose a theoretical model that explains how delays manifest in construction projects, focusing on the root causes, resource availability, and the dynamic nature of construction projects.	The proposed theoretical model is verified through interview questionnaires with construction experts in two rounds. The Delphi method and statistical analysis is used in this study.	The Delphi results validate the principles of the theoretical model, indicating a strong correlation between the identified root delay causes and their effects on project delays and resource availability.

CHAPTER 3
METHODOLOGY

3.1 INTRODUCTION

The railway sector plays an important role in the global transportation network, facilitating the efficient movement of goods and passengers. However, the timely completion of railway construction projects is often hampered by various delays, which leads to economic and financial problems. Understanding the causes and consequences of these delays is important to improve project management efficiency and the efficient operation of railway infrastructure.

This topic aims to provide an in-depth investigation of the causes and consequences of delays in the railway sector. It requires a methodological approach that includes identifying the factors that cause delays, analyzing the relationships between them, and evaluating their impact on efficiency. This study, which investigates the main causes and consequences of delays, aims to provide useful information to stakeholders involved in railway construction projects.

Therefore, this thesis undertakes an in-depth investigation of the causes and consequences of delays in the railway sector, using a critical thinking approach to generate practical knowledge to improve project performance and stakeholders' decision-making. Through an in-depth investigation into the nature of delay processes, this study aims to provide evidence-based strategies to reduce delays and improve railway infrastructure performance.

3.2 RESEARCH APPROACH

In order to provide a thorough grasp of the study subject, the research methodology combines mixed techniques, which incorporate components of quantitative and qualitative research approaches (Harrison et al., 2020). This methodological pluralism, often referred to as eclecticism, typically results in more robust and superior research outcomes compared to using a single research approach (Johnson and Onwuegbuzie, 2004). A wide range of academic areas have acknowledged the benefits of mixed-methods research. For instance, in the fields of public health (Mills et al., 2012), pharmacy practice Hadi et al., (2012), health psychology Bishop (2014), and accounting Otieno et al., (2023). Therefore, by combining qualitative and quantitative procedures, mixed-methods research offers researchers a useful and efficient way to achieve a more thorough knowledge of complicated research problems.

3.3 RESEARCH DESIGN

Figure 3.1 illustrates the research procedure for this study. This study uses survey and explanation methods to investigate the causes and effects of delays in railway construction in order to achieve its purpose. In order to perform research that focuses on documenting a phenomena or condition as it exists, without changing variables, this study used a descriptive research approach. It places a focus on obtaining information in natural environments, applying inductive reasoning, and comprehending the viewpoints of the subjects (Magilvy and Thomas, 2019). This method seeks to give a thorough and in-depth explanation of the topic being studied by providing a detailed account of a particular phenomenon or experience from the perspective of people involved (Nurhamidah et al., 2018). Using a descriptive research design has the advantage of offering a comprehensive and in-depth description of a specific event or circumstance. Without imposing preconceived assumptions or preconceptions, researchers can obtain a greater grasp of the topic by concentrating on characterising the qualities of the subject under examination(Youngblood, 1990). This design is particularly useful for producing detailed data that can guide further research projects, including creating theories or models for instructional design (Kahlke, 2014). Descriptive study design is, in reality, a useful tool for researchers who want to give in-depth explanations of events or circumstances without changing any factors.

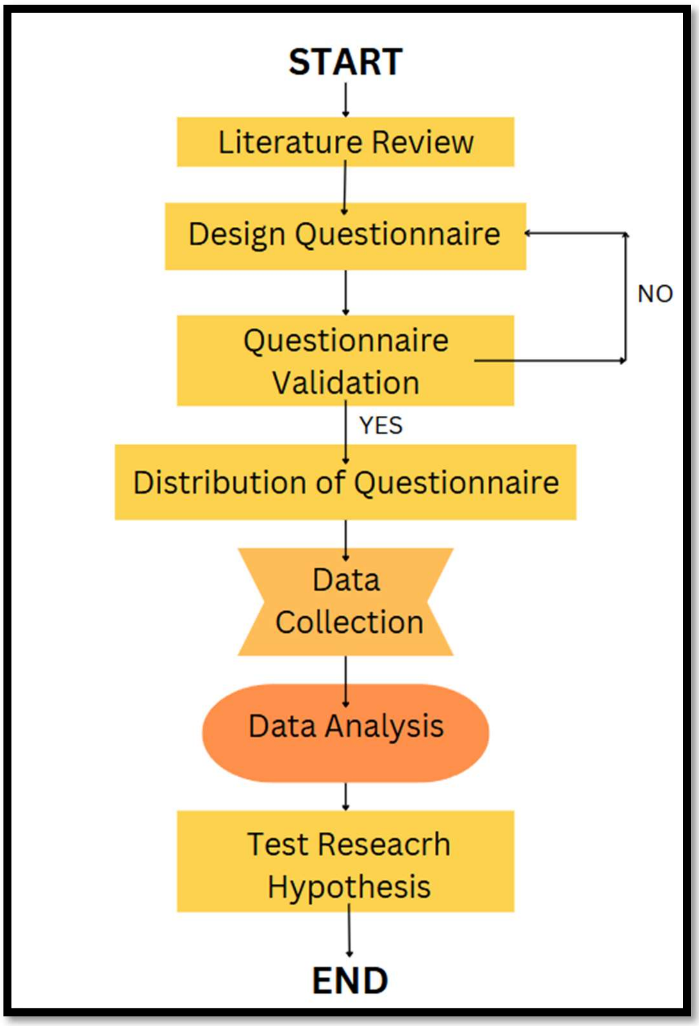


Figure 3.1: Research Process and Procedures

3.4 DATA TYPE AND SOURCE

For access to the information factor and the impact of the train construction delay, primary and secondary data were collected. The study used instruments for gathering primary and secondary data that are appropriate for a descriptive research design. While secondary data is gathered from earlier research sources pertaining to the study's goal, primary data is gathered from the project's personnel.

3.5 TARGET POPULATION

The phrase "target population" describes the particular set of people or things that a researcher wants to investigate or draw conclusions from in a study. This group, which is the subject of the study, is usually defined in accordance with particular traits, standards, or qualities that are pertinent to the goals of the study. The target population is the main interest group from whom information is gathered or conclusions are made. The primary project stakeholders, including contractors, clients, consultants, and those currently working on railway construction projects, are the research's target group.

3.6 SAMPLE SIZE DETERMINATION

According to Dattalo (2008), the sample size represents a subset of the entire population. A statistical technique called Slovin's Formula is used to calculate the right sample size for a study based on a margin of error and a particular degree of confidence. In order to guarantee that the sample size is representative of the intended population, the formula is frequently used in survey research (Adam, 2020). Slovin's formula can be used for simplicity, especially with small populations:

$$\eta = \frac{N}{1+N \cdot e^2} \tag{1}$$

where η is sample size, N is total of population (61) and e is margin of error (0.05 for 5%). This gives a sample size of 53 samples with 61 population when it is applied to equation (1).

3.7 DATA COLLECTION

The process of data collection for understanding delays in construction projects involves a two-fold approach, encompassing both primary and secondary sources. Secondary data, derived from literature reviews of past studies, serves as a foundational exploration into the sources and reasons behind project delays, drawing from the wealth of existing knowledge. This method allows researchers to glean insights from previous research, identifying common patterns and key factors contributing to delays. Complementing this historical perspective is the acquisition of primary data through questionnaire surveys aimed at construction managers. These surveys provide a contemporary understanding of on-the-ground perspectives, offering real-time insights into the challenges and nuances of project management. By synthesizing insights from both primary and secondary sources, a comprehensive understanding of delay sources and their underlying reasons can be attained, facilitating informed decision-making and proactive mitigation strategies within the construction industry.

3.7.1 Phase 1 – Identify the cause of railway construction delays using past studies and questionnaire

After conducting an extensive literature review, the critical factors contributing to delays in railway construction projects have been identified and organized into specific categories. These categories the owner, contractors, consultant, material and external factor. The preferred method for data collection in this current study is through the utilization of a questionnaire (Appendix 2). The questionnaire method is commonly employed by numerous publishers to gather data regarding the factors contributing to railway sectors. Utilizing questionnaire surveys to gather insights into the origins of delays within the construction sector stands as a credible and effective methodology, exemplified by Figure 3.2, which depicts a publisher employing this approach for data collection.

This is due to the fact that questionnaires have the capacity to be disseminated to a large number of respondents concurrently. Rendering them well-suited for acquiring data from a diverse array of origins, whether they be individuals, entities, or entire populations. Moreover, questionnaires guarantee uniformity in data collection, as all respondents respond to an identical set of questions presented in an identical format. This uniformity greatly simplifies the process of data analysis and permits comparisons across various sources. This scenario has demonstrated that utilizing questionnaire survey is among the appropriate methods for collecting data pertaining to construction delays, complementing the retrieval of information from prior research studies.

The questionnaire survey used in this study is divided into three sections: Section A: Background Information, Section B: Causes of Delays in Railway Construction Projects, and Section C: Effects of Delays. Collecting demographic data in the initial section of the questionnaire is crucial. According to the "Encyclopaedia of Survey Research Methods" (2008), this information helps define the characteristics of the target respondents participating in the survey. For example, respondents need to provide details such as their gender, age, nationality, role, and highest educational level.

Sections B and C are designed based on the Likert Scale to meet the objective of the study, which is to identify the causes of delays in railway construction projects and to understand the effects of these delays on the overall project. The responses are often structured in a range, such as "strongly disagree," "disagree," "slightly agree," "agree," and "strongly agree" (Jin, K. and Wang, 2013). Likert scales are known for their flexibility and adaptability to various contexts, with the validity of the scale being driven by the relevance of the topic to the participants (Finnerty et al., 2023). The scale of the weighting in this study is as follows:

Table 3.1: Likert Scale for Weighting Responses

Weighting	Scale
1	Strongly disagree
2	Disagree
3	Slightly agree
4	Agree
5	Strongly Agree

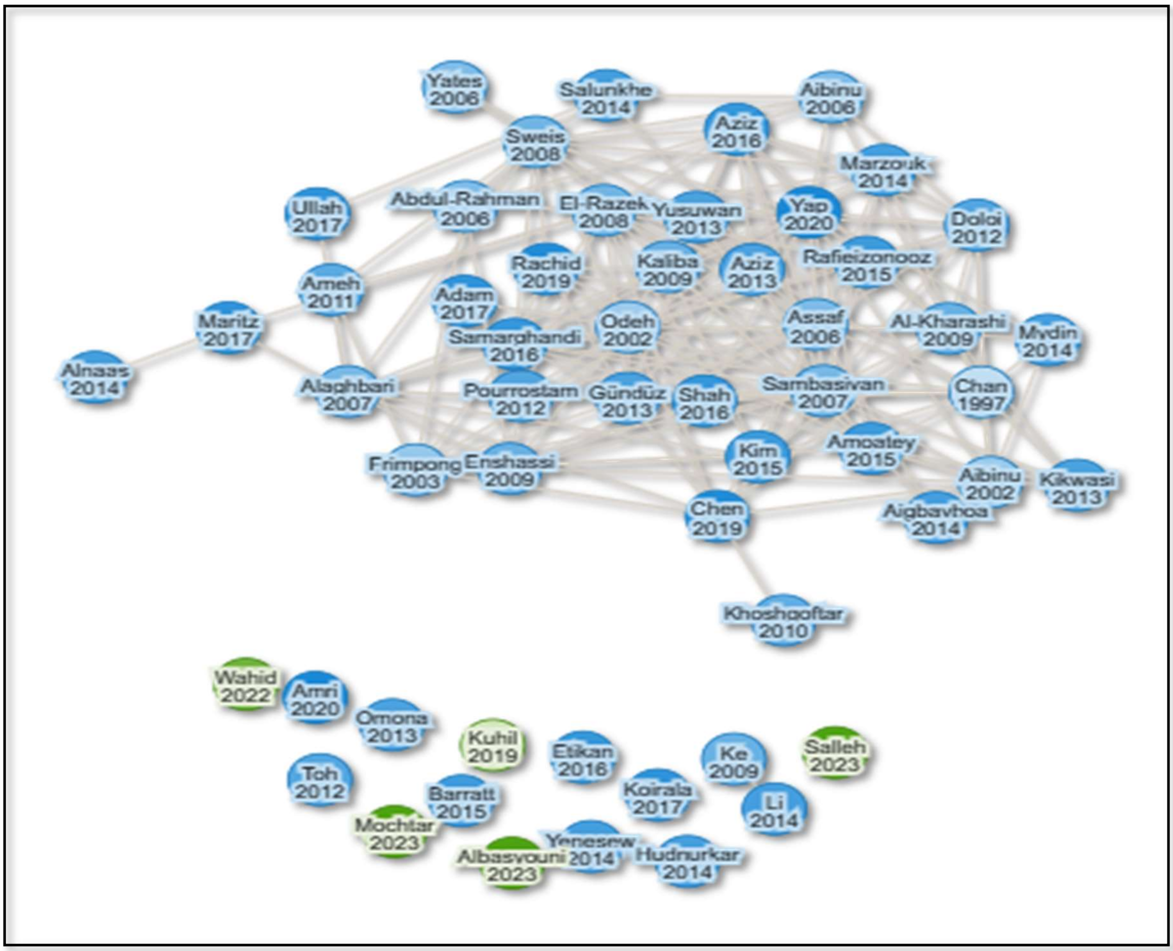


Figure 3.2: A network for authors who utilize questionnaire surveys for data collection

3.7.2 Phase 2 – Assess the priority of causes of delay using the Relative Importance Index (RII)

The Relative Importance Index (RII) is a method utilized in various fields such as construction, agriculture, mental health, and urban development to assess the relative importance of different factors or criteria as perceived by participants or stakeholders (Kapella et al., 2023). This index enables the ranking of items or factors based on their perceived significance, providing a quantitative measure of importance (Al Khatib et al., 2020). The RII method involves analyzing data, often collected through surveys using Likert scales, to prioritize factors based on their perceived importance (Lukuman et al., 2017). It assists in identifying key variables that significantly contribute to outcomes or decisions (Tukur et al., 2019).

Researchers have applied the RII method to diverse areas such as assessing delays in construction projects (Sambasivan & Soon, 2007), determining genetic resource conservation preferences (Kapella et al., 2023), identifying liveable housing attributes (Lukuman et al., 2017), and ranking delay factors in railway projects (Ramli et al., 2021). The RII method has been crucial in quantifying and comparing the relative importance of various factors within these contexts.

For this reason, the RII method was also used in the thesis to determine the location of the delay caused by the railway project. Relative Importance Index (RII) approach was used to determine the relative importance of the delay factors involved by using Equation 1 below (Sambasivan & Soon, 2007). The five-point Likert-scale was used in the questionnaire design ranged from 1 (not important) to 5 (extremely important).

$$RII = \frac{\Sigma W}{A \times N} \tag{2}$$

where W is weighting given to each factor by the respondent (1 to 5), A is the highest weight in the research and N is total number of respondents.

The Importance Rate (RII) value obtained from the above equation can be classified as important if the RII value is high. If you have a different item, RII is used to classify the items according to the RII classification shown in Table 3.1 below (Sarki et al., 2021).

Table 3.2: RII Categorized (Sarki et al., 2021)

Scale	Level of Preference	RII value
1	Not preferred at all	0 ≤ RII ≤ 0.2
2	Slightly preferred	0.2 ≤ RII ≤ 0.4
3	Moderately preferred	0.4 ≤ RII ≤ 0.6
4	Preferred	0.6 ≤ RII ≤ 0.8
5	Most preferred	0.8 ≤ RII ≤ 1.0

3.7.3 Phase 3 – Examine the relationship between delay factors and their effects

Before importing all the data into SPSS, the demographic variables were coded. The demographic variable related to the role was coded using a nominal scale. According to Stevens (1946), the nominal scale categorizes data without assigning inherent value to the numbers, which only serve as identifiers for different categories, as illustrated in Table 3.3.

SPSS, which stands for Statistical Package for the Social Sciences, is a software tool widely used for statistical analysis in various fields such as social sciences, business, and medicine. It provides a user-friendly interface for data entry, manipulation, and analysis, making it a valuable tool for researchers and practitioners (Saleh et al., 2021). SPSS allows for the application of a wide range of statistical techniques, from simple descriptive statistics to complex multivariate analysis, enabling users to derive meaningful insights from their data (Saleh et al., 2021).

Keeping this in mind, the most accurate way to analyze the cause-effect relationship in the railway construction process is to use the SPSS method. Several important steps are required to analyze delay factors and their effects in the field of railway construction. Initially, the data needs to be cleaned and imported into SPSS for proper processing and analysis. Next, descriptive statistics such as mean, median, standard deviation, and frequency distribution are used to summarize the delay factors and their effects, providing a detailed description of the various delay factors and their impacts to determine whether there is a strong correlation between them. A regression analysis is then performed to determine the predictive power of various delay factors on project delays, providing insight into which factors have the greatest impact. Additionally, factor analysis is used to reveal underlying structures in the delay factors, facilitating the correlation of relevant factors and a deeper understanding of the delays. If possible, hypotheses are developed to test certain assumptions about delays and their consequences. Finally, the results of the analysis are visualized using graphs, Tables, and charts to better explain key points. This integrated approach provides a better understanding of the causes and consequences of delays in railway construction projects.

Table 3.3: Coding Scheme for Demographic Variables

Item	Types	Code
Gender	Male	1
	Female	2
Education	Diploma	1
	Bachelor	2
	Master	3
	Phd	4
	Other	5
Experience	<1 years	1
	1-5 years	2
	6-10 years	3

	11-15 years	4
	>16 years	5
Designation	Project Manager	1
	Construction Manager	2
	Site Engineer	3
	Technical Officer	4
	Site teams	5
	M&E Engineer	6
	Other	7
Organization	Client (Owner)	1
	Consultant	2
	Contractor	3
	Other	4

3.8 DESCRIPTIVE STATISTICS

Descriptive statistics encompass a set of statistical techniques utilized to summarize and describe the main features of a dataset. These statistics offer a concise overview of the data, including measures of central tendency (such as mean, median, and mode) and measures of variability (such as range, variance, and standard deviation) (Alabi, 2023). Descriptive statistics are fundamental in various fields, enabling researchers to effectively understand and interpret data.

Five variables were included in the survey questionnaire to measure the reasons behind delays in railway construction projects: Owner, Contractor, Consultant, Materials, and External Related Causes. The strongest and weakest causes of delays in the railway industry can be found by analysing these variables. Reviewing the reasons for delays in railway construction projects and strengthening their contribution to project success are made easier with the help of this analysis. These results were presented by the study using Table 3.4.

Table 3.4: Standard of mean (Gomez-Pomar et al., 2018)

Mean score	Standard
<3.39	Minimal
3.40-3.79	Middle-range
>3.8	Elevated

Next, standard deviation is a statistical measure that quantifies the amount of variation or dispersion in a set of values. It indicates how spread out the values in a dataset are from the mean. A low standard deviation suggests that the data points tend to be close to the mean, while a high standard deviation indicates that the data points are spread out over a wider range of values (Kim, 2013). The study used the Table 3.5 to present these results.

Table 3.5: Interpretation of Standard Deviation Scores

Standard Deviation score	Standard
0-1	Very low
1-2	Low
2-3	Middle
3-4	High
Above 4	Very high

3.9 RELIABILITY AND VALIDITY OF INSTRUMENTS

3.9.1 Validity

A key idea in research, validity measures or reflects the intended concept or phenomena, ensuring the precision and reliability of study findings. Four main categories of validity are identified by Cook and Campbell's traditional method of doing social science research: concept validity, external validity, statistical conclusion validity, and internal validity (Wiener et al., 2011). Internal validity, which determines cause-and-effect linkages between variables, will be used in this study. On the other hand, statistical conclusion validity will be used to assess the precision of statistical analysis and conclusions. The operationalization of variables also improves validity. All the variables being measured are covered by the extensive questionnaires. For validation, a comparison was made between the theoretical framework—what other people have said—and the conceptual framework, which included the own variables.

3.9.2 Reliability

In research, measures or findings from a study are considered reliable if they are consistent, stable, or repeatable. It shows the degree to which a measurement device or instrument yields reliable and consistent data over an extended period of time or under various circumstances. In order for the data gathered to be reliable and able to be repeated or extrapolated to different samples or conditions, reliability is essential.

With the use of SPSS Cronbach's alpha, the data collected from these respondents was examined. (Cronbach, 1951) states that Cronbach's alpha is a reliability coefficient that provides an unbiased measure of the generalizability of the data. In practical application, a variety of criteria and coefficients are employed to evaluate dependability; among these, Cronbach's alpha (α) is a frequently utilised measure. The following guidelines apply to the interpretation of reliability coefficients, especially Cronbach's alpha.

Table 3.6: Cronbach's Alpha Interpretation

Level	Standard
$\alpha \geq 0.90$	Excellent reliability
$0.80 \leq \alpha < 0.90$	Good reliability
$0.70 \leq \alpha < 0.80$	AccepTable reliability
$0.60 \leq \alpha < 0.70$	Questionable reliability
$0.50 \leq \alpha < 0.60$	Poor reliability
$\alpha < 0.50$	UnaccepTable reliability

Table 3.7 presents the Cronbach's Alpha value of delay factors, which is a widely used measure of internal consistency or reliability for a set of scale or test items (Tavakol & Dennick, 2011). The Table shows a Cronbach's Alpha value of 0.852, which is considered a good level of reliability based on the commonly accepted threshold of 0.7 or higher (Nunnally, 1978). This value suggests that the survey instrument used in the study has a satisfactory level of internal consistency, meaning that the items in the instrument are measuring the same underlying construct or phenomenon.

Additionally, the Table also reports the Cronbach's Alpha value based on standardized items (0.883), which takes into account the variance of the items and adjusts for potential differences in their scales or units of measurement (Tavakol & Dennick, 2011). The Table indicates that the survey instrument consists of 52 items or questions, providing information about the length and complexity of the instrument used in the study

Table 3.7: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of items
0.852	0.883	52

3.10 CORRECTION TEST

Correlation analysis is a statistical technique used to assess the relationship between two or more variables. It measures the strength and direction of association between variables, providing insights into how changes in one variable are related to changes in another. Correlation analysis is crucial in various fields, including psychology, sociology, economics, and healthcare, as it helps researchers understand patterns, make predictions, and identify potential causal relationships.

When conducting correlation analysis, researchers often calculate correlation coefficients, such as Pearson's correlation coefficient, Spearman's rank correlation coefficient, or Kendall's tau coefficient, to quantify the degree of association between variables. A correlation coefficient close to 1 indicates a strong positive relationship, while a coefficient close to -1 suggests a strong negative relationship. A coefficient near 0 indicates a weak or no relationship between the variables (Cheung and Chan, 2005). Table 3.8 presents the range of r values and their corresponding interpretation levels.

Table 3.8: Interpretation of Pearson's Correlation Coefficient (r) Values (Marczyk, Dematteo and Festinger, 2005)

r Value Range	Interpretation
0.0 to ±0.1	No to very weak correlation
±0.1 to ±0.3	Weak correlation
±0.3 to ±0.5	Moderate correlation
±0.5 to ±0.7	Strong correlation
±0.7 to ±1.0	Very strong correlation

3.11 MULTI REGRESSION

Multiple regression, also known as multiple regression, is a statistical technique used to analyze the relationship between multiple independent variables and a single dependent variable. In multiple regression analysis, the goal is to understand how the independent variables collectively impact the dependent variable. This method allows researchers to assess the influence of each independent variable while controlling for the effects of other variables in the model.

Several important metrics are used to analyse the link between an independent variable and a dependent variable in order to give light on the type and intensity of this association. In order to indicate the strength and direction of the link between the variables being studied, coefficients (β) are utilised. A p-value less than 0.05 ($p < 0.05$) indicates a significant coefficient, indicating that it is unlikely that the observed association happened by chance alone (KÜÇÜK et al., 2021). Furthermore, the coefficient of determination, which is commonly represented as R-squared (R^2), provides important details about how much of the variance in the dependent variable can be accounted for by the independent variable or variables. R-squared values close to 1 indicate a strong explanatory power, meaning that the independent variable(s) accounts for a significant amount of the variability in the dependent variable.

On the other hand, R-squared values that are close to zero indicate a limited capacity for explanation, meaning that the independent variable or variables have little effect on the variability seen in the dependent variable. Together, these measurements help researchers gain a thorough knowledge of the correlations between variables and the predictive power of their models.

3.12 MODEL SPECIFICATION WITH VARIABLES

Among the references given, Arganis et al. (2012) addresses modelling the relationship between a dependent variable and two or more independent variables using Multiple Linear Regression (MLR). The following is a representation of the equation used in the MLR study:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_n X_n + \epsilon \qquad (3)$$

where, Y is dependent variable (the outcome trying to predict), β_0 is intercept (Y's predicted value when all X variables are zero), β_1, β_2, β_3,…, β_n is coefficients for each independent variable, which, while keeping all other X variables constant, show how much Y changes for every unit change in the corresponding X variable, X_1, X_2, X_3,…, X_n is independent variables (the predictors) and ϵ is error term, or the discrepancy between Y's observed and anticipated values. In general, the software SPSS was used to find the co-efficient, and more results were shown in the study's data analysis section based on Table 3.9.

Table 3.9: Symbols and Corresponding Variables in Regression Analysis

Symbol	Items
Y	Effect of delay on railway construction
$\boldsymbol{\beta_0}$	regression constant
$\boldsymbol{\beta_1}$	Slope for variable X_1
$\boldsymbol{\beta_2}$	Slope for variable X_2
$\boldsymbol{\beta_3}$	Slope for variable X_3
$\boldsymbol{\beta_4}$	Slope for variable X_4
$\boldsymbol{\beta_5}$	Slope for variable X_5
$\mathbf{X_1}$	Owner (Client)
$\mathbf{X_2}$	Contractor
$\mathbf{X_3}$	Consultant
$\mathbf{X_4}$	Materials
$\mathbf{X_5}$	External Factors
$\boldsymbol{\epsilon}$	error (or residual) value

CHAPTER 4
DATA ANALYSIS AND DISCUSSION

4.1. INTRODUCTION

In order to answer the study questions and objectives mentioned in previous sections, the emphasis in Chapter 4 moves to the analysis and interpretation of the collected data. This chapter explores the empirical conclusions drawn from the gathered information, providing light on the reasons behind and effects of delays in railway building projects. The data was collected through a questionnaire survey, which into included 39 common delay causes categorized into 5 group which is client (owner), contractors, consultant, material, and external factors. A total 53 respondents participated in this survey. This research objective were tested using descriptive analysis and hypotheses testing using correlation pearson and multi regression.

4.2. RESPONSE RATE

There were 53 questionnaires collected and analyzed for this study, comprising groups of owners, contractors, consultants, materials, and external factors. Table 4.1 shown the background information of respondents, including gender, education, experience, designation, and organization.

Table 4.1 Background Information of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Gender	Male	28	52.8	52.8	52.8
	Female	25	47.2	47.2	100.0
Education	Diploma	10	18.9	18.9	18.9
	Bachelor's	41	77.4	77.4	96.2
	Master	1	1.9	1.9	98.1
	Phd	0	0	0	98.1
	Other	1	1.9	1.9	100.0
Experience	< 1 year	3	5.7	5.7	5.7
	1-5 years	14	26.4	26.4	32.1

	6-10 years	21	39.6	39.6	71.7
	11-15 years	8	15.1	15.1	86.8
	16 years and above	7	13.2	13.2	100.0
Designation	Project Manager	5	9.4	9.4	9.4
	Construction Manager	3	5.7	5.7	15.1
	Site Engineer	3	5.7	5.7	20.8
	Technical Officer	4	7.5	7.5	28.3
	Site Teams	3	5.7	5.7	34.0
	M&E Engineer	4	7.5	7.5	41.5
	Others	31	58.5	58.5	100.0
Organization	Client (Owner)	9	17	17	17.0
	Consultant	11	20.8	20.8	37.7
	Contractor	30	56.6	56.6	94.3
	Others	3	5.7	5.7	100.0

Firstly, regarding gender, the analysis revealed that the sample encompassed 28 male respondents (52.8%) and 25 female respondents (47.2%), indicating a balanced representation of both genders. Secondly, concerning education levels, a significant portion of respondents (77.4%) held Bachelor's degrees, followed by individuals with Diplomas (18.9%), Master's degrees (1.9%), and other educational qualifications (1.9%). Thirdly, in terms of work experience, the respondents exhibited a diverse range of tenure. The largest cohort (39.4%) possessed 6-10 years of experience, followed by those with 1-5 years (26.4%), 11-15 years (15.1%), 16 years and above (13.2%), and less than 1 year of experience (5.7%). Fourthly, regarding job designations, respondents held various roles within the construction sector. The majority (58.5%) fell under the "Others" category, encompassing roles such as trackwork engineers, QAQC engineers, surveyors, and safety teams. Additionally, designations such as M&E Engineer and Technical Officer (7.5%), as well as Project Manager, Construction Manager, Site Engineer, and Site Teams (each representing 5.7% of the sample) were identified. Lastly, concerning organizational affiliations, respondents were associated with different entities, including Contractors (56.6%), Consultants (20.8%), Clients (Owners) (17%), and Others (5.7%).

4.3. DESCRIPTIVE STATISTICS FOR CAUSES OF DELAY IN RAILWAY CONSTRUCTION

The descriptive statistics provided insights into how respondents perceived the various delay factors and their effects on railway construction projects, helping to identify areas of concern and potential focus for mitigation strategies.

Table 4.2: Descriptive Statistics of Delay Factors and Effect

Descriptive	Mean	Std. Deviation	Rank	N
Owner (Client)	4.30	0.45	2	53
Contractor	4.22	0.29	4	53
Consultant	4.32	0.34	1	53
Material	4.21	0.31	5	53
External Factors	4.29	0.30	3	53
Effect	4.18	0.27	6	53

Based on survey responses, the descriptive statistics of delay factors and their impacts were present in Table 4.2. The respondent's average evaluations for each delay factor were shown by the mean scores. The variability or dispersion of the ratings around the mean was measured by the standard deviation (Std. Deviation). With a mean rating of 4.32 and a standard variation of 0.34, the Consultant category had the highest mean score among the delay causes.

Following closely behind were the Owner (Client) and External Factors categories, with mean ratings of 4.30 and 4.29, respectively. These elements high mean scores indicate that they were also thought to have a significant role in project delays. Next, contractor and material categories had a somewhat lesser impact on delays, with mean values of 4.22 and 4.21, respectively. The Effect category had the lowest mean rating (4.18), indicating that respondents thought the overall impact of delays on railway construction projects was marginally less than the impact of the individual delay factors.

4.3.1 Descriptive Statistics for Client (Owner)

The descriptive statistics provided offered insights into various aspects related to the client (owner) in railway construction project. Delayed payment to supplier or subcontractor ranked first among the factors. This factor had a mean of 4.80 and a standard deviation (SD) of 0.41. Next, the consultant site delivery is delayed. This component, which had a mean of 4.42 and an SD of 0.64, showed how long it took to give consultants or contractors the site information or paperwork they need.

Thirdly, the client inadequate project planning by the customer revealed flaws in project scoping, timing, or resource allocation, with a mean of 4.40 and an SD of 0.64. Owner financial problem and the mean of the change orders during construction is 4.38, although the SD values are 0.567 and 0.68, respectively.

Table 4.3: Analysis of Client (Owner) Demographics

No	Delays Factor	Mean	Std. Deviation	N
1	Delay payment to supplier/subcontractor	4.80	0.40	53
2	Payment delays from the client	4.32	0.55	53
3	Delays in decision-making	4.30	0.54	53
4	Inadequate project funding	4.18	0.52	53
5	Owner financial problems	4.38	0.57	53
6	Choosing an inefficient design team	4.30	0.71	53
7	Inadequate project planning by client	4.40	0.64	53
8	Delays in site delivery to consultant	4.42	0.64	53
9	Change orders during construction	4.38	0.67	53
10	Changes in project requirements	4.32	0.65	53

4.3.2 Descriptive Statistics for Contractor

The ten-item summary of contractor characteristics is present in Table 4.4. Ranked first among the factors was the lack of experience of the construction manager, with a mean of 4.60 and a standard deviation (SD) of 0.57. This factor raised concerns about the expertise and competency of the construction manager overseeing project execution, potentially leading to errors in decision-making, inadequate project oversight, and challenges in managing project resources and personnel effectively. Following closely behind was poor contractor coordination with subcontractors, which ranked second with a mean of 4.48 and an SD of 0.68. Ranked third was labor-related issues, with a mean of 4.46 and an SD of 0.65, indicating challenges or conflicts involving workforce management, labor relations, or safety concerns on the construction site. In fourth place was delays in payments to subcontractors, scoring a mean of 4.38 and an SD of 0.60. This factor highlighted delays in disbursing payments owed by the contractor to subcontractors, which could strain subcontractor relationships, impact subcontractor performance, and lead to project disputes or legal issues, thereby affecting project progress and outcomes.

Table 4.4: Summary of Contractor Characteristics

No	Delays Factor	Mean	Std. Deviation	N
1	Lack of experience of the construction manager	4.60	0.57	53
2	Incompetent subcontractors	4.28	0.61	53
3	Poor project management	4.40	0.57	53
4	Delays in mobilizing equipment and manpower	4.14	0.54	53
5	Contractor's financial difficulties	4.22	0.68	53
6	Delays in payments to subcontractors	4.38	0.60	53
7	Delay in material delivery	4.38	0.73	53
8	Labor-related issues	4.46	0.65	53
9	Poor contractor coordination with subcontractors	4.48	0.68	53
10	Incompetence of contractor	4.50	0.61	53

4.3.3 Descriptive Statistics for Consultant

The descriptive statistics provided offer insights into various aspects related to consultants in railway construction projects. Delayed review and approval of design documents, with a high mean of 4.54 and an SD of 0.54, underscores the importance of timely review and approval of design documents by consultants and stakeholders. Similarly, delayed in design approvals also record a high mean of 4.50 and an SD of 0.51. Lack of coordination between consultants recorded a mean of 4.44 and a standard deviation (SD) of 0.58, this factor indicates challenges in communication and collaboration among different consultants involved in the project.

Table 4.5: Consultant Profile Statistics

No	Delays Factor	Mean	Std. Deviation	N
1	Lack of coordination between consultants	4.44	0.58	53
2	Changes in design requirements	4.36	0.53	53
3	Delays in design approvals	4.50	0.51	53
4	Delays in reviewing and approving design documents	4.54	0.54	53
5	Inadequate consultant experience	4.46	0.58	53

4.3.4 Descriptive Statistics for Material

Table 4.6 shows that the poor quality of materials, with a mean of 4.48 and an SD of 0.58, indicates concerns regarding the quality and suitability of materials used in construction. Poor-quality materials may fail to meet project specifications or performance requirements, leading to safety hazards, structural deficiencies, and durability issues, necessitating replacement or remediation efforts. Late delivery of materials, with a mean of 4.40 and an SD of 0.57, highlights instances where materials arrive behind schedule, impacting project timelines and progress Next, the factor of changes in material specification and type is also one of the higher means recorded with 4.36 and a standard deviation (SD) of 0.56. Changes in material specification and type indicate that alterations in project requirements or design can impact the selection and use of materials.

Table 4.6: Overview of Material Descriptive Statistics

No	Delays Factor	Mean	Std. Deviation	N
1	Changes in material specification and type	4.36	0.56	53
2	Delays in material procurement	4.20	0.54	53
3	Inflation affecting material prices	4.24	0.59	53
4	Errors during construction	4.34	0.56	53
5	Late delivery	4.40	0.57	53
6	Poor quality of materials	4.48	0.58	53

4.3.5 Descriptive Statistics for External Factor

Based on Table 4.7, the factor of weather has the highest mean score of 4.84 and standard deviation (SD) of 0.422 indicating that it is perceived as having the greatest impact among the listed external factors. Moreover, the delay in mandatory monitoring, evaluation, and project inspection, while still significant with a mean of 4.32, has a higher standard deviation of 0.62 compared to weather factors. Economic factors affecting the construction industry and land acquisition problems have the same value of 4.28 and different SDs of 0.671 and 0.54

Table 4:7 Key Metrics for External Factor Attributes

No	Delays Factor	Mean	Std. Deviation	N
1	Weather factors	4.84	0.42	53
2	Delays in the mandatory monitoring, evaluation, and project inspection	4.32	0.62	53
3	Environmental issues	4.20	0.54	53
4	Delay in securing permits	4.22	0.51	53
5	Congested construction site	4.14	0.50	53
6	Different nationalities of the workforce	4.18	0.56	53
7	Economic factors affecting the construction industry	4.28	0.67	53
8	Land acquisition problems	4.28	0.54	53

4.4.6 Descriptive Statistics for Effect

The high value of the mean is Cost overrun, with a mean of 4.60 and an SD of 0.5, highlights that delays in railway construction frequently result in exceeding budgeted project costs. These overruns can strain financial resources, impacting project profitability and resource allocation. Besides, railway construction delays can lead to reduced profit margins, as indicated by a mean of 4.24 and an SD of 0.72. Not only that, but delays in railway construction projects can also raise safety concerns, as indicated by a mean of 4.24 and an SD of 0.72.

Table 4:8 Overview of Effect Descriptive Statistics

No	Delays Factor	Mean	Std. Deviation	N
1	Time overrun	4.18	0.44	53
2	Cost overrun	4.60	0.50	53
3	Dispute between parties	4.18	0.44	53
4	Reduced profit	4.24	0.72	53
5	Arbitration	4.02	0.59	53
6	Litigation and court case	3.96	0.73	53
7	Abandonment	3.94	0.65	53
8	Safety Concerns	4.24	0.72	53

4.4 Ranking Cause of Delays Based On RII

4.4.1 Relative Importance Index (RII) value for Client (Owner)

Table 4.9 presents the ranks of delay factors attributed to clients in railway construction projects using the Relative Importance Index (RII) method. The top-ranked factor is delaying payment to supplier or subcontractor (RII = 0.960), indicating the significant impact of late payments on project delays (Ramli et al., 2021). Other high-ranking factors include delays in site delivery to consultant (RII = 0.884). Next, inadequate project planning by client (RII = 0.880) and owner financial problems (RII = 0.876). These findings align with previous studies that have identified client-related issues as major contributors to construction delays (Sambasivan & Soon, 2007; Yap et al., 2021)

Table 4.9: Ranking of Project Delay Factors by Client

Delay Factors	RII value	Rank
Delay payment to supplier/subcontractor	0.960	1
Delays in site delivery to consultant	0.884	2
Inadequate project planning by client	0.880	3
Owner financial problems	0.876	4
Change orders during construction	0.876	5
Payment delays from the client	0.864	6
Changes in project requirements	0.864	7
Delays in decision-making	0.860	8
Choosing an inefficient design team	0.860	9
Inadequate project funding	0.836	10

4.4.2 Relative Importance Index (RII) value for Contractors

Table 10 provides an overview of delays experienced by contractors on railway construction projects. The highest-ranked factor is lack of experience of the construction manager (RII = 0.920), highlighting the importance of project management experience (Rivera et al., 2020). Other factors that scored highly were incompetence of contractor (RII = 0. 900), poor contractor coordination with subcontractors (RII = 0.896) and labor-related issues (RII = 0.892). These findings corroborate previous research highlighting the impact of contractor-related factors on project delays (Abbasi et al., 2020; Asmi & Djamaris, 2021).

Table 4.10: Ranking of Project Delay Factors by Contractors

Delay Factors	RII value	Rank
Lack of experience of the construction manager	0.920	1
Incompetence of contractor	0.900	2
Poor contractor coordination with subcontractors	0.896	3
Labor-related issues	0.892	4
Poor project management	0.880	5
Delays in payments to subcontractors	0.876	6
Delay in material delivery	0.876	7
Incompetent subcontractors	0.856	8
Contractor's financial difficulties	0.844	9
Delays in mobilizing equipment and manpower	0.828	10

4.4.3 Relative Importance Index (RII) value for Consultant

Table 4.11 shows that ranks delay factors attributed to consultants in railway construction projects. The top-ranked factor is delays in reviewing and approving design documents (RII = 0.908), followed by delays in design approvals (RII = 0.900) and inadequate consultant experience (RII = 0.892). These findings align with previous studies that have identified consultant-related issues, such as lack of coordination, design changes, and delays in approvals, as significant contributors to construction delays (Fashina et al., 2021; Said Al Hinai Student et al., 2020; Yap et al., 2021).

Table 4.11: Ranking of Project Delay Factors by Consultant

Delay Factors	RII value	Rank
Delays in reviewing and approving design documents	0.908	1
Delays in design approvals	0.900	2
Inadequate consultant experience	0.892	3
Lack of coordination between consultants	0.888	4
Changes in design requirements	0.872	5

4.4.4 Relative Importance Index (RII) value for Material

Table 4.12 presents the ranked delay factors related to materials in railway construction projects. The top-ranked factor is poor quality of materials (RII = 0.896), followed by late delivery (RII = 0.880) and changes in material specification and type (RII = 0.872). These findings are consistent with prior research that underscores the impact of material-related issues, such as procurement delays, quality problems, and specification changes, on construction project delays (Abbasi et al., 2020; Asmi & Djamaris, 2021; Fashina et al., 2021; Yap et al., 2021).

Table 4.12: Ranking of Project Delay Factors by Material

Delay Factors	RII value	Rank
Poor quality of materials	0.896	1
Late delivery	0.880	2
Changes in material specification and type	0.872	3
Errors during construction	0.868	4
Inflation affecting material prices	0.848	5
Delays in material procurement	0.840	6

4.4.5 Relative Importance Index (RII) value for External Factors

Based on Table 4.13, ranks delay factors related to external factors in railway construction projects. The top-ranked factor is weather factors (RII = 0.968), which aligns with previous studies that have identified adverse weather conditions as a significant contributor to construction delays (Fashina et al., 2021). Other highly ranked factors include delays in the mandatory monitoring, evaluation, and project inspection (RII = 0.864), economic factors affecting the construction industry (RII = 0.856), and land acquisition problems (RII = 0.856).

Table 4.13: Ranking of Project Delay Factors by External Factors

Delay Factors	RII value	Rank
Weather factors	0.968	1
Delays in the mandatory monitoring, evaluation, and project inspection	0.864	2
Economic factors affecting the construction industry	0.856	3
Land acquisition problems	0.856	4
Delay in securing permits	0.844	5
Environmental issues	0.840	6
Different nationalities of the workforce	0.836	7
Congested construction site	0.828	8

4.4.6 Major Delay Factors in Railway Construction

Table 4.14 presents the top ten delay factors in the railway sector, ranked according to their Relative Importance Index (RII) values. The RII is a statistical method used to determine the relative importance of different factors based on respondents' ratings (Ramli et al., 2021). The top-ranked delay factor is weather factors from the external factor group, with an RII value of 0.968. The second highest-ranked factor is delaying payment to supplier or subcontractor from the client group, with an RII value of 0.960.

Table 4.14: Top Ten Ranking Delay Factors in Railway Sector

Delay Factor	Group	RII Value	Rank
Weather factors	External Factor	0.968	1
Delay payment to supplier/subcontractor	Client	0.960	2
Lack of experience of the construction manager	Contractor	0.920	3
Delays in reviewing and approving design documents	Consultant	0.908	4
Incompetence of contractor	Contractor	0.900	5
Delays in design approvals	Consultant	0.900	6
Poor quality of materials	Material	0.896	7
Poor contractor coordination with subcontractors	Contractor	0.896	8
Labor-related issues	Contractor	0.892	9
Inadequate consultant experience	Consultant	0.892	10

4.5 Correlation Analysis

Correlations are perhaps the most basic and most useful measure of association between two or more variables (Marczyk, Dematteo & Festinger, 2005). The Table 4.15 presents the Pearson correlation coefficients, which measure the strength and direction of the linear relationship between the dependent variable (effect) and each of the independent variables (client (owner), contractor, consultant, material, and external factors).

The correlation coefficient of 0.380 indicates a moderate positive relationship between External Factors and Effect variables. The double asterisks (**) next to the correlation coefficient indicate that this correlation is statistically significant at the 0.01 level. This suggests strong evidence supporting the relationship between external factors (such as weather, delays, economic conditions, etc.) and the overall effect of the construction project. Another independent variable recorded weak positive relationship with dependent. This means that the observed correlation could have occurred by random chance, and there may not be a meaningful relationship between the client's involvement and the overall effect of the construction project. The Table also reports the significance levels (Sig. (1-tailed)) and the sample size (N = 53) for each correlation coefficient. The significance levels indicate whether the correlation is statistically significant or not, based on a predetermined level of significance (e.g., 0.05 or 0.01).

Table 4.15: Corrections Between Dependent and Independent Variable

		Client (Owner)	**Contractor**	**Consultant**	**Material**	**External Factors**	**Effect**
Effect	Pearson Correlation	0.126	0.286*	0.154	0.086	0.380**	1
	Sig. (2-tailed)	0.369	0.38	0.272	0.540	0.005	
	N	53	53	53	53	53	53

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

4.6 REGRESSION ANALYSIS

This section of the study delves into the findings and discussions stemming from the regression analysis. Initially, the study laid the groundwork by conducting a literature review and analyzing descriptive statistics and correlation analysis. These analyses aimed to pinpoint the factors contributing to effect of project delays in railway sector. To delve deeper into understanding the significant factors influencing project delays, the study employed an ordered logit regression model. The model summary in Table 4.16 shows that the R-squared value is 0.231, which means that 23.1% of the variation in the dependent variable (effect) is explained by the independent variables (Owner (Client), Contractor, Consultant, Material and External Factors).

Table 4.16: Model Summary[b]

R	**R Square**	**Adjusted R Square**	**Std Error of the Estimate**
0.480[a]	0.231	0.149	2.47677

a. Predictors: (Constant), Owner (Client), Contractor, Consultant, Material and External Factors

4.7 MULTIPLE REGRESSION ANALYSIS

Table 4.17 presents that the coefficients presented in the multiple regression analysis provide insights into the relationship between the independent variables (owner (client), contractor, consultant, material, and external factor) and the dependent variable (effect). The external factor recorded a positive standardised coefficient beta of 0.716, which indicates a strong positive relationship between the external factor variable and project delays. This coefficient suggests that an increase in the external factor variable is strongly associated with an increase in project delays. Importantly, the associated p-value of 0.007 is below the conventional significance level of 0.05, indicating that this relationship is statistically significant. Therefore, the influence of the external factor variable on project delays is likely substantial and warrants further attention. Another independent variable for p-value shows that the relationship is not statically significant at the conventional significance level of 0.05.

Table 4.17 Coefficients of Multiple Regression

	Unstandardized B	**Coefficients Std Error**	**Standardized Coefficients Beta**	**t**	**Sig.**
(Constant)	29.096	5.805		5.012	<0.001
Owner (Client)	0.032	0.079	0.054	0.401	0.690
Contractor	0.077	0.204	0.083	0.379	0.707
Consultant	-0.575	0.402	-0.369	-1.429	0.159
Material	-0.192	0.218	-0.176	-0.881	0.383
External Factor	0.788	0.279	0.716	2.821	0.007

4.8 MODEL STRUCTURE BETWEEN INDEPENDENT AND DEPENDENT VARIABLE

Figure 4.1 presents the relationship between cause and effect of delay in railway project. The model structure shows that the R-squared value is 0.231, which means that 23.1% of the variation in the dependent variable (effect) is explained by the independent variables (Owner (Client), Contractor, Consultant, Material and External Factors). Based on the analysis, external factors are the only hypotheses accepted in this study. This indicates that clients, contractors, consultants, and materials do not have a significant relationship with the impact of railway project delays according to the findings.

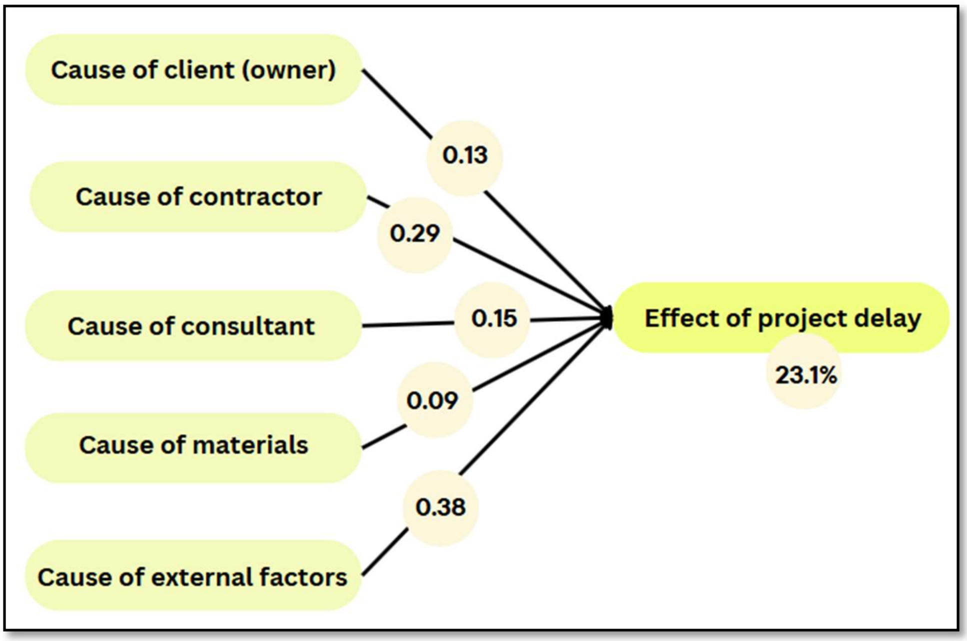


Figure 4.1: Model structure between cause and effect of delay

4.9HYPOTHESES TESTING

Based on the analysis conducted, Table 4.18 hypotheses appear to be supported by the data.

Table 18: Hypotheses and Results on Factors Contributing to Project Delays

Hypotheses	Results
Client-related factors significantly contribute to project delays.	Rejected
Contractor factors significantly contribute to project delays.	Rejected
Consultant factors significantly contribute to project delays.	Rejected
Material factors significantly contribute to project delays.	Rejected
External factors significantly contribute to project delays.	Accepted

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1. INTRODUCTION

This chapter presents the conclusions and recommendations derived from the analysis and findings of the study, which aimed to identify the causes of delays in railway construction projects, rank these delay factors, and examine the relationships between the factors and their effects on project outcomes. The chapter serves as a culmination of the research efforts, synthesizing the key insights and offering practical recommendations for stakeholders involved in railway construction projects.

5.2. CONCLUSION

In summary, the delay factors commonly identified in the literature review were grouped into five categories: client, contractor, consultant, material, and external factors. The internal consistency of the factors that influence project delays was assessed and confirmed through the utilization of Cronbach's alpha. The major causes of delay were analyzed using the RII method. The analysis revealed that weather conditions from the external factors group had the highest value of 0.968, followed by payment delays to supplier or subcontractor from the client group, which had a value of 0.960. The study also demonstrated a significant correlation between the causes and the effects of construction delays. Regression analysis results indicated that weather factor are external factors that significantly affect project delays. The model structure show that 23.1% of the variation in the dependent variable (effect) is explained by the independent variable (client, contractor, consultant, material and external factor). The hypotheses for external factor are accepted in this study.

5.3. FUTURE RECOMMENDATION

Based on the findings of this study, the following recommendations are proposed to mitigate delays in railway construction projects:

Recommendation	Explanation
Create thorough weather contingency plans	Project managers must create thorough strategies to handle any weather-related issues, since weather conditions have a substantial influence on project delays. To reduce delays brought on by bad weather, these plans should incorporate techniques for efficient site management, resource allocation, and alternate work schedules.
Implement effective contract management practices	To address delays related to payment issues, it is recommended that project owners and contractors implement effective contract management practices. Clear payment terms and conditions should be established, and regular audits should be conducted to ensure timely payments to suppliers and subcontractors. This will foster positive relationships and prevent disruptions in the supply chain
Incorporate advanced analytical techniques	Apply more sophisticated statistical techniques such as Structural Equation Modelling (SEM) or Artificial Neutral Networks (ANN) to explore complex relationship between variables.

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Appendix 1: Impact weather factor in Site

Appendix 2: Questionnaire Survey

QUESTIONNAIRES

Politeknik Ungku Omar, Ipoh.

Dear Sir/Madam,

I am Anum Juita, a final year student pursuing Bachelor of Civil Engineering Technology from the Department of Civil Engineering at Politeknik Ungku Omar (PUO). I am currently conducting a research study for my final year project titled "On Track or Off Course? Unveiling the Causes and Consequences of Delays in Railway Construction Projects."

Your cooperation and feedback are invaluable in helping me achieve the objectives of this research. The purpose of this questionnaire is to critically assess effective methodologies for predicting the likelihood of delays by examining historical data related to the causes of delays in railway construction projects. The main aim of this investigation is to present a meticulous approach capable of predicting the duration of forthcoming projects and assessing risk levels based on insights derived from past projects.

To accomplish this goal, I will begin by extracting sources and factors of delay risk from available literature. Subsequently, I will employ questionnaire surveys to evaluate the impact of various factors on delays in construction projects. Next, I will utilize the Relative Importance Index (RII) method to determine the location of the delays caused by railway projects. The final step involves analyzing the cause-effect relationship in the railway construction process using the SPSS method.

Your insights and feedback on the following questionnaire will greatly contribute to the success of my research. Thank you for your time and cooperation.

SECTION A: BACKGROUND INFORMATION

1. Gender ☐ Male ☐ Female
2. Educational background ☐ Diploma ☐ Bachelor's ☐ Master ☐ Phd Others:…………….
3. Experience ☐ <1 years ☐ 1-5 years ☐ 6-10 years ☐ 11-15 years ☐ >16 years
4. Designation ☐ Project Manager ☐ Construction Manager ☐ Site Engineer ☐ Technical Officer ☐ Site teams ☐ M&E Engineer Other:……………
5. Organization ☐ Client (owner) ☐ Consultant ☐ Contractor Other:………

SECTION B: CAUSE OF DELAYS IN CONSTRUCTION RAILWAY PROJECT

Instructions: Please assess the following matters on a scale of 1-5 by circling your chosen answer.

1= Strongly Disagree
2=Disagree
3=Neutral
4=Agree
5= Strongly Agree

Causes of Delay		SD (1)	D (2)	N (3)	A (4)	S.A (5)
Client (Owner)	Delay payment to supplier/subcontractor					
	Delays in site delivery to consultant					
	Inadequate project planning by client					
	Owner financial problems					
	Change orders during construction					
	Payment delays from the client					
	Changes in project requirements					
	Delays in decision-making					
	Choosing an inefficient design team					
	Inadequate project funding					
Contractor	Lack of experience of the construction manager					
	Incompetence of contractor					
	Poor contractor coordination with subcontractors					
	Labor-related issues					
	Poor project management					
	Delays in payments to subcontractors					
	Delay in material delivery					
	Incompetent subcontractors					
	Contractor's financial difficulties					
	Delays in mobilizing equipment and manpower					
Consultant	Delays in reviewing and approving design documents					
	Delays in design approvals					
	Inadequate consultant experience					
	Lack of coordination between consultants					
	Changes in design requirements					
Material	Poor quality of materials					
	Late delivery					
	Changes in material specification and type					
	Errors during construction					
	Inflation affecting material prices					
	Delays in material procurement					
External Factor	Weather factors					
	Delays in the mandatory monitoring, evaluation, and project inspection					

	Economic factors affecting the construction industry					
	Land acquisition problems					
	Delay in securing permits					
	Environmental issues					
	Different nationalities of the workforce					
	Congested construction site					

SECTION 3: EFFECTS OF DELAY

On a scale of 1 to 5, where 1 indicates strongly disagree and 5 indicates strongly agree, please rate your perception of project delays.

Effect of delay	SD (1)	D (2)	N (3)	A (4)	S.A (5)
Time overrun					
Cost overrun					
Dispute between parties					
Reduced profit					
Arbitration					
Litigation and court case					
Abandonment					
Safety Concerns					

THANK YOU

I extend my sincere gratitude to everyone who took the time to respond to my questionnaire. Your valuable input is greatly appreciated. Thank you for your participation and contribution to my research