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Graduation Project Report II

" Risk Assessment and Management in Road Projects During Construction Phase "

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Disclaimer

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ABSTRACT

Road construction plays a crucial role in the development, growth, and prosperity of any country, especially developing countries such as Palestine. During road construction projects, many risks are anticipated, including time overruns (delays), cost overruns, accidents, safety issues, and poor quality. Therefore, it is essential to proactively identify and manage these risks to ensure smooth project execution.

This study focused on identifying the key risks affecting road construction projects, assessing their impact on costs, schedules, and quality, and exploring effective risk management strategies. The primary target groups were consultants, owners, and contractors.

The project's objectives included:

- Identifying the main risks associated with road construction projects.
- Evaluating how these risks influence project timelines, costs, and overall quality.
- Proposing practical strategies to manage and mitigate these risks.

A mixed-methods approach was employed, combining qualitative methods—such as interviews with relevant stakeholders—and quantitative methods, including a structured questionnaire distributed among consultants, owners, and contractors. Statistical analyses were performed to calculate the Relative Importance Index (RII).

Although prior studies have addressed risk management in construction, this study uniquely focused on the construction phase of road projects in Palestine. By concentrating on this phase, the study aimed to provide practical guidelines and mitigation measures to reduce common issues like cost overruns and delays.

Building upon this foundation, the current study developed and distributed a structured questionnaire to engineers, consultants, and contractors in the West Bank. Semi-structured interviews were also conducted to gain qualitative insights. The collected data were analyzed using SPSS software, including calculation of a Risk Index and reliability testing through Cronbach's Alpha. The results identified the most critical risks affecting road construction projects and offered evidence-based recommendations to improve risk management practices and enhance project outcomes in the Palestinian context. The main three factors were delays in payments, financing issues, and non-compliance with safety regulations, identified as the most

critical based on RII scores. The 40 risk factors were grouped into four main categories: financial, administrative, operational, and environmental.

Findings revealed that financial and administrative risks had the greatest impact on project performance. The study concludes with practical recommendations aimed at improving risk management and enhancing the success of road construction projects in Palestine.

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AHP – Analytic Hierarchy Process

RII – Relative Importance Index

ISO – International Organization for Standardization

BIM – Building Information Modeling

NGOs – Non-Governmental Organizations

UN – United Nations

ANOVA – Analysis of Variance

IRR – Internal Rate of Return

NPV – Net Present Value

SWOT: Strengths, Weaknesses, Opportunities, Threats

CHAPTER ONE: INTRODUCTION

1.1 Definitions

Risk assessment and management in road construction projects during the construction phase is critical for ensuring the project's success, maintaining safety, and minimizing negative environmental and societal impacts. Effective management of risks can significantly contribute to reducing delays, staying within budget, and improving overall project performance. In road construction, various types of risks must be identified and assessed to ensure proper handling during the construction phase, including environmental, financial, temporal, and operational risks (Zou et al., 2015).

According to Zou et al. (2015), **risk management** is the process of identifying, evaluating, and prioritizing risks followed by coordinated efforts to reduce or control the probability of undesirable events. In the context of road construction, risk management becomes even more complex due to the variety of challenges, such as unpredictable weather conditions, resource shortages, and environmental impacts. These risks must be systematically addressed through a structured risk management process to ensure the project's success.

Key risks in road construction projects during the construction phase include:

- **Environmental Risks**: Such as pollution from chemicals used in construction, destruction of natural habitats, and impacts on biodiversity (Chen et al., 2019).
- **Financial Risks**: Cost overruns, budget mismanagement, and inadequate funding (Lam et al., 2014).
- **Temporal Risks**: Delays due to unforeseen events like weather conditions, equipment failure, or supply chain issues (Goh & Unnikrishnan, 2017).

- **Operational Risks**: Accidents on-site, shortages of trained labor, and issues with quality control (Chien et al., 2018).

To manage and prioritize these risks, road construction projects often employ advanced tools and techniques for risk assessment:

- **Analytic Hierarchy Process (AHP)**: A decision-making tool used to prioritize risks by evaluating multiple factors such as likelihood, impact, and project relevance (Saaty, 1980).
- **Relative Importance Index (RII)**: A method to assess the severity of risks by ranking them based on their perceived importance and impact on the project (Ofori et al., 2019).

These tools help in structuring complex risk data, enabling project managers to allocate resources and make informed decisions. Additionally, **risk response plans** are developed that include strategies such as mitigation, transfer, or acceptance, ensuring a structured approach to each identified risk.

Managing these risks requires proactive planning and continuous monitoring throughout the construction phase. The process begins with the identification of potential risks through methods such as historical data analysis, expert consultations, and detailed checklists (Zou et al., 2015). Once identified, the risks are evaluated based on their **likelihood** of occurrence and **impact** on the project, using quantitative methods and qualitative judgment.

Risk mitigation strategies are then developed to reduce or eliminate the negative impact of identified risks. For instance:

- **Design Modifications**: Adjusting construction designs to reduce environmental impacts or to meet financial constraints.
- **Alternative Construction Techniques**: Using modern technology or methods to reduce time delays, such as prefabrication or modular construction.

- **Resource Allocation**: Ensuring adequate resources are available to avoid operational shortages and prevent delays.

By systematically managing these risks, the project can progress with minimal disruptions, ensuring that safety, financial stability, and environmental compliance are maintained.

The primary objective of this graduation project is to implement an integrated **risk assessment and management system** in road construction projects during the construction phase. The objectives are as follows:

- **Objective 1**: Identify environmental, financial, temporal, and operational risks within road construction projects and apply effective strategies to mitigate these risks.
- **Objective 2**: Enhance **environmental risk management**, focusing on reducing pollution, managing waste disposal efficiently, and incorporating sustainable materials and techniques.
- **Objective 3**: Improve **financial risk management** by employing strategies to reduce cost overruns, optimize resource allocation, and explore new financing models for road construction projects.
- **Objective 4**: Achieve **effective time management** by using predictive modeling and contingency planning to minimize delays caused by weather conditions, labor shortages, or logistical challenges.
- **Objective 5**: Improve **operational safety** by implementing best practices for workforce training, safety protocols, and hazard identification on construction sites.

Effective **risk management** in road construction projects during the construction phase is essential to ensuring the project's success, maintaining environmental sustainability, and meeting financial and time constraints. By using tools like AHP and RII, and developing comprehensive risk response plans, potential risks can be addressed proactively, leading to reduced project disruptions, cost savings, and enhanced safety for workers and the surrounding community.

By focusing on environmental, financial, temporal, and operational risks, this project aims to create a systematic framework for risk assessment and management that will guide future road construction projects toward more successful and sustainable outcomes.

1.2 General Background

1.2.1 Addressing the Global Issue of Risk Management in Road Projects

Risk management in road construction projects involves the identification, assessment, and management of risks that may impact the construction process. These risks can include environmental, financial, and technical factors that can affect project timelines, quality, and costs. Effective risk management is essential to minimize or avoid damage caused by these risks.

Several global challenges impact risk management in road projects, including:

- **Increasing Complexity of Projects:** As road construction projects become more complex and larger in scale, managing the associated risks effectively becomes more challenging (Smith & Yang, 2020).
- **Climate Change and Environmental Factors:** Environmental challenges, such as flooding, extreme weather events, or changes in climate, can lead to unexpected disruptions, delays, and increased costs in road projects (Zhang et al., 2021).
- **Financial Risks:** Economic factors like fluctuating material and labor costs can significantly impact the budget of road construction projects, leading to financial challenges (Khan et al., 2019).

- **Limited Infrastructure for Risk Management:** In many regions, especially in developing countries like Palestine, there is a lack of comprehensive risk management infrastructure and expertise, making it difficult to address potential risks before they escalate (Al-Masri & Fayyad, 2018).
- **Public Health and Safety Concerns:** Poorly managed road construction projects can lead to safety hazards for workers and the public, contributing to accidents and health-related issues during the construction phase (Khan et al., 2019).
- **Political and Regulatory Issues:** Changes in regulations or political instability can disrupt project timelines, leading to unforeseen delays and financial risks (Al-Masri & Fayyad, 2018).

To address these challenges, road construction projects require a comprehensive approach, including proactive planning, early risk identification, and continuous monitoring throughout the project lifecycle. Collaborating across sectors, from government to private companies, is crucial to manage and mitigate these risks effectively (Khan et al., 2019). Effective risk management helps ensure that road projects are completed safely, within budget, and on time.

1.2.2. Projected Growth in Risk Factors in Road Construction Projects

As countries experience rapid development, the complexity and scale of road construction projects are also increasing. However, many of these countries lack adequate systems to manage the evolving risks associated with these large-scale infrastructure projects. Urban areas, where most of the development is concentrated, are particularly impacted by these challenges.

"The growth in road construction projects is expected to accelerate with increased economic development and population growth. Low- and middle-income countries are likely to experience the most significant increase in construction activities, with regions like Sub-

Saharan Africa and South Asia witnessing a rapid expansion in road infrastructure by 2050. The Middle East and North Africa region is expected to see a significant rise in road construction, doubling the number of new projects by 2050" (Smith & Yang, 2020).

"High-income countries tend to have better systems for managing road construction risks, such as proper safety regulations and well-established risk management protocols. However, lower-income countries face challenges such as insufficient infrastructure, limited technical expertise, and the lack of effective risk management strategies. In these regions, it is crucial to implement robust risk management systems to mitigate the rising risks associated with road construction projects" (Zhang et al., 2021).

1.2.3. Minimizing Negative Impacts and Ensuring Safe Management of Risks in Road Construction Projects

The goal of risk management in road construction projects is to minimize the negative impacts of risks on the environment, public safety, and project success, while ensuring the safe and efficient management of risks throughout the construction phase.

Risk reduction can be achieved through proactive planning, early risk identification, and the implementation of preventive measures. Identifying risks related to environmental, financial, and technical factors early can help mitigate the potential impact on the project timeline, cost, and quality. Effective risk management also includes continuous monitoring of risks during the construction phase, ensuring that appropriate mitigation strategies are applied, and adapting plans to emerging challenges. This ensures that risks are managed in compliance with safety and environmental standards (Khan et al., 2019).

1.2.4. Challenges in Road Construction Projects in Palestine

Road construction projects in Palestine face numerous challenges due to a complex combination of political, economic, and environmental factors, making the execution of such projects extremely difficult. The ongoing Israeli occupation significantly impacts nearly every aspect of infrastructure development, particularly in the West Bank and Gaza Strip. Restrictions on land access, movement of construction materials, and labor severely limit the scope of road construction activities, leading to project delays, cost overruns, and difficulties in meeting quality standards (Al-Qatarneh & Hammad, 2020).

One of the most critical challenges is the lack of a stable political environment, which complicates planning and implementation. In many cases, road construction in certain areas requires coordination with Israeli authorities, leading to delays and added complexity. The fragmentation of Palestinian territories into separate areas under different control (e.g., military zones, settlements) further complicates road network planning. As a result, access to critical regions is often restricted, reducing the ability to design and build comprehensive, connected road systems (United Nations, 2021; Al-Qatarneh & Hammad, 2020).

Financial limitations are also a significant barrier. Palestinian authorities face constraints in funding road construction projects, relying heavily on international aid or loans to fund such projects. However, the financial instability often results in underfunded projects, with many roads built using lower-quality materials and suffering from inadequate maintenance. This further exacerbates the problem of long-term infrastructure sustainability (Al-Masri & Fayyad, 2018).

Environmental factors, including the region's arid climate, present additional difficulties. Harsh weather conditions, such as extreme heat and torrential rains, accelerate the wear and tear on roads. Mountainous terrains and rocky soil further complicate construction and raise project costs. In some areas, soil erosion and inadequate drainage systems cause considerable challenges during both construction and maintenance phases (Thöni & Matar, 2019; United Nations, 2021).

A major contributing factor to the slow pace of construction is the shortage of skilled labor. Palestine faces a significant gap in trained engineers, project managers, and skilled workers. The limited availability of professionals and the restrictions on movement hinder workers' access to construction sites, resulting in delays and suboptimal project outcomes (Al-Masri & Fayyad, 2018; United Nations, 2021).

Overall, these compounded challenges necessitate comprehensive planning, coordination, and international support to overcome the obstacles in road construction projects. Efforts should focus on improving financial resources, fostering local expertise, and ensuring that political and environmental issues are adequately addressed to enhance the efficiency of infrastructure development in Palestine (Al-Qatarneh & Hammad, 2020).

1.2.5. Risk Management in Road Construction Projects in Palestine

Risk management is crucial for road construction projects in Palestine due to political, financial, environmental, and logistical challenges. The unique context necessitates a tailored approach to identifying and mitigating risks to ensure timely completion, budget adherence, and infrastructure sustainability.

One major risk is political instability, which leads to land access issues, permit delays, and restrictions on material and labor movement. These factors cause project disruptions and legal complications. Mitigation strategies include strong coordination with local authorities and international organizations (Al-Qatarneh & Hammad, 2020).

Financial risks arise from reliance on external funding, which is often uncertain due to political conditions. Delays in funding can impact project scope. Effective financial risk management involves realistic budgeting, diversified funding sources, and contingency planning (Al-Masri & Fayyad, 2018).

Environmental risks stem from Palestine's climate and topography. Extreme temperatures and heavy rainfall accelerate road deterioration, while mountainous terrain increases soil erosion and drainage challenges. Addressing these risks requires high-quality materials, advanced drainage systems, and ongoing environmental monitoring (Thöni & Matar, 2019).

Labor shortages and movement restrictions affect workforce availability and project quality. Training programs and improved workforce management help mitigate these risks (Al-Qatarneh & Hammad, 2020).

Additional risks include safety concerns in conflict zones, technical limitations due to outdated construction methods, and logistical delays caused by movement restrictions or damaged infrastructure.

A comprehensive risk management plan should identify and assess risks while implementing mitigation strategies. Regular risk assessments, collaboration with international organizations, and proactive planning are key to overcoming challenges (United Nations, 2021). A robust approach ensures more efficient and sustainable road infrastructure development in Palestine.

1.2.6. Risk Management in Road Construction for Higher Education Institutions

Universities and colleges have a unique opportunity to contribute to the development of innovative solutions for risk management in road construction projects, either through research or guidance in safety and resources. Risk management in road construction projects within higher education institutions requires comprehensive strategies to mitigate potential risks and improve project effectiveness. Due to the complex nature of construction projects in Palestine, especially in areas surrounding educational institutions, it is crucial to identify key risks and develop systems to manage them effectively:

- **Risk Planning and Assessment**

Any road construction project in higher education institutions should begin with a comprehensive risk assessment, identifying potential risks such as political risks related to the Israeli occupation, environmental risks stemming from climatic conditions, and geographical terrain challenges. This assessment should include strategies to mitigate the negative impacts of these risks (Al-Qatarneh & Hammad, 2020).

- **Financial Risk Management**

Financial constraints are a significant challenge in road construction projects within higher education institutions in Palestine. Some of these projects are funded through international grants or loans, which can create budgetary pressures and affect the quality of execution. Therefore, effective financial planning and cost control are essential (Al-Masri & Fayyad, 2018).

- **Sustainable Technologies and Innovation**

Some higher education institutions in Palestine rely on innovation for road construction projects, such as using environmentally friendly technologies and innovative road design and implementation methods to reduce environmental impact. Additionally, research conducted within these institutions contributes to developing effective solutions to improve infrastructure sustainability (Thöni & Matar, 2019).

- **Public-Private Partnerships**

Cooperation between educational institutions and private companies or government agencies is often crucial for providing funding and coordinating project activities. This helps mitigate political and economic risks associated with construction (United Nations, 2021).

- **Training and Capacity Building**

Higher education institutions in Palestine face challenges in training skilled professionals in engineering and project management fields. Therefore, a key component of risk management strategies should include investments in education and training to develop local skills and increase project execution efficiency (Al-Qatarneh & Hammad, 2020).

- **Education and Community Engagement**

Universities play an important role in developing risk assessment strategies and tools that can help improve processes. Additionally, many universities work on building partnerships with governments and the private sector to analyze infrastructure-related risks and develop innovative solutions. Universities also contribute significantly to improving risk management policies and systems through their research and community engagement (Al-Khatib et al., 2018).

1.2.7. Vision of Risk Management for An-Najah National University in Road Construction Projects

An-Najah National University plays a pivotal role in enhancing risk management in road construction projects in Palestine, given the impact of political, environmental, and financial factors on project execution. Through academic research and collaboration with relevant entities, the university can develop effective risk management strategies to ensure the sustainability of infrastructure projects (An-Najah National University, 2021).

- **Research and Innovation in Risk Management**

The university is strengthening research on risk assessment in road projects, developing methodologies to address challenges arising from political instability, environmental factors, and financial constraints. These efforts contribute to improving project efficiency and reducing risks (Al-Qatarneh & Hammad, 2020).

- **Collaboration and Capacity Building**

An-Najah can collaborate with the public and private sectors to develop integrated risk management strategies and offer training programs for engineers and contractors. These programs enhance their ability to manage risks effectively in road construction projects (Al-Qatarneh & Hammad, 2020).

- **Focus on Sustainability**

Through its research, the university promotes sustainable construction practices, such as the use of eco-friendly materials and green infrastructure technologies. These approaches help reduce the environmental impact of road projects and ensure long-term sustainability (Thöni & Matar, 2019).

- **Awareness and Community Engagement**

An-Najah plays a vital role in raising awareness about the importance of risk management in road projects. By supporting policies and engaging local communities in finding innovative solutions to project challenges, the university ensures that road construction projects align with both national and local needs (Al-Khatib et al., 2018).

1.2.8. Importance and Use of Risk Index in Road Construction Projects

In the context of road construction projects, managing risks effectively requires not only identifying potential threats but also evaluating their significance. One of the most widely used tools in this process is the Risk Index, which provides a quantitative assessment of risks.

The Risk Index is calculated by multiplying the probability of occurrence of a risk by its impact (severity). Mathematically, it is expressed as:

Risk Index = Probability × Impact

Both probability and impact are typically measured on a predefined numerical scale (e.g., 1 to 5 or 1 to 10), allowing for consistent comparisons across various types of risks.

The primary objective of using a Risk Index is to prioritize risks and allocate resources efficiently. Risks with a high index value represent a serious threat to the project and should be addressed with appropriate mitigation strategies. On the other hand, risks with low values may require only minimal attention.

In road construction projects, where delays, cost overruns, safety concerns, and technical uncertainties are common, the use of a Risk Index becomes crucial in decision-making. It allows engineers and project managers to focus on the most critical risks that could hinder the project's success.

This study incorporates the concept of the Risk Index to evaluate the relative importance of different risks identified through the questionnaire. The results will be analyzed in later chapters to guide risk management strategies specific to road construction projects in Palestine.

1.3 Objectives

1. **Implementing Effective Risk Management Strategies:**

- Develop and apply risk management strategies addressing environmental, financial, and logistical risks to minimize costs, enhance performance, and ensure sustainability and safety (Khaled et al., 2020).

2. **Quantifying and Categorizing Risks:**

- Identify, measure, and categorize risks such as environmental, financial, safety, and logistical risks.
- Analyze key risk factors contributing to delays, cost overruns, and quality issues (Smith & Yang, 2020).

3. **Enhancing Stakeholder Knowledge and Engagement:**

- Assess stakeholder awareness of risk management practices and implement training programs to improve knowledge.
- Use questionnaires to evaluate training effectiveness and stakeholder attitudes (Al-Khatib et al., 2018).

4. **Gathering Data on Financial, Operational, and Logistical Aspects:**

- Conduct interviews with project managers, contractors, and government agencies to collect data on financial costs, operational constraints, and logistical challenges.
- Examine project timelines, resource allocation, and existing risk mitigation measures (Khaled et al., 2020).

5. **Analyzing Data for Feasibility and Risk Mitigation:**

- Use statistical tools such as ANOVA and Excel to assess major risks and evaluate mitigation strategies.
- Develop a risk management model to analyze feasibility from financial and environmental perspectives (Zhang et al., 2021).

6. **Projecting Financial and Operational Viability:**

- Apply financial analysis methods like Net Present Value (NPV) and Internal Rate of Return (IRR) to assess financial feasibility.
- Evaluate costs, savings, and return on investment from improved risk management (Khan et al., 2019).

7. **Proposing Recommendations for Risk Management and Policy Improvement:**

- Provide recommendations to enhance risk management in Palestinian road construction projects.
- Suggest policy revisions to support more effective risk mitigation (Khaled et al., 2020).

8. Contributing Insights for Future Projects:

- Identify best practices and innovative risk management solutions.
- Share findings to serve as a model for future construction projects (Al-Qatarneh & Hammad, 2020).

1.4 Study Area

This study focused on road construction projects located in several governorates of the northern West Bank, namely Tulkarm, Nablus, Qalqilya, and Tubas. These areas were selected based on the accessibility to municipal departments and the availability of contacts or direct communication with professionals working in these locations, which facilitated the distribution of the questionnaire and data collection. Although the selection of governorates was not based on strict methodological criteria, this geographical distribution provided a relative diversity in responses and helped form a broader perspective on the risks associated with the execution phase of road construction projects within the local context.

The following maps show the municipalities included in the study across the four targeted governorates. These maps help visualize the geographical distribution and support the explanation of the study area.

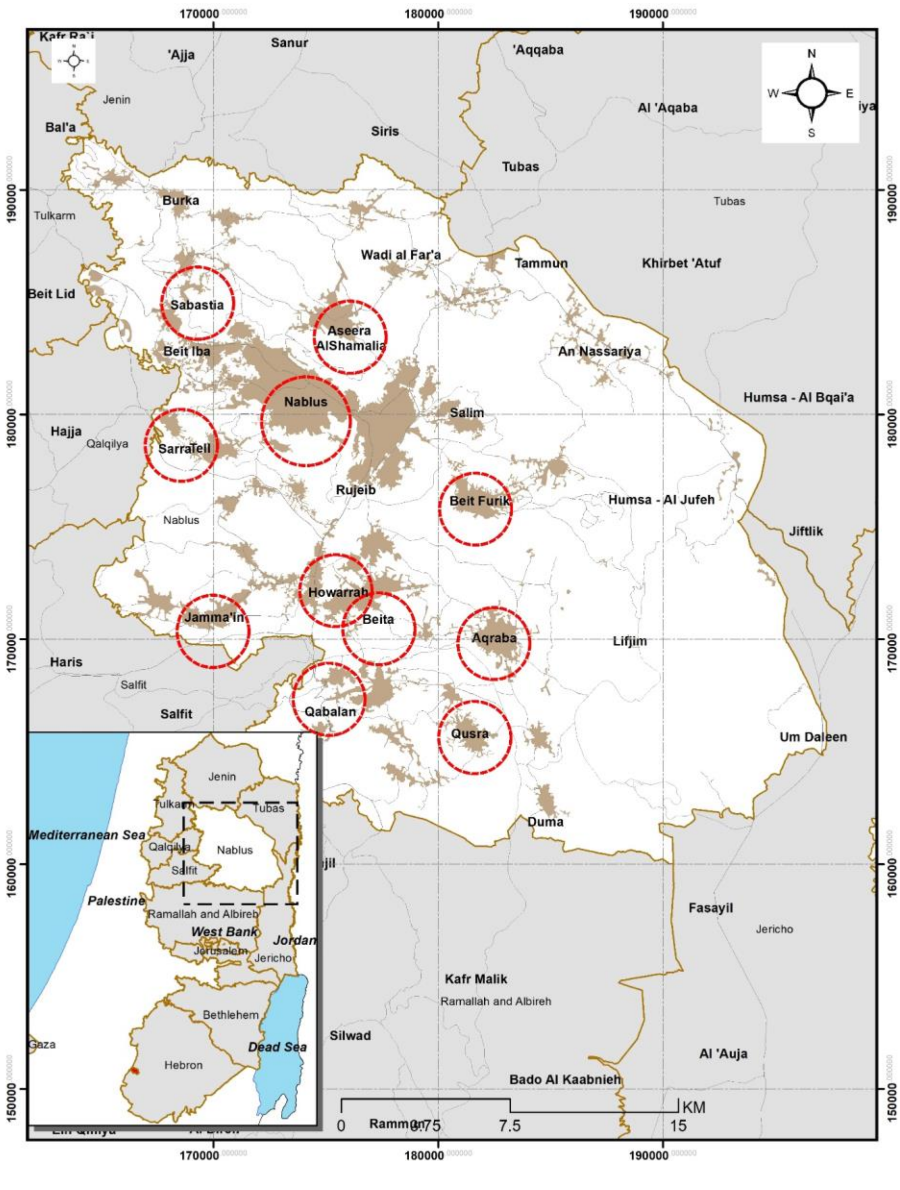

Figure 1.1: Participating Municipalities in Nablus Governorate

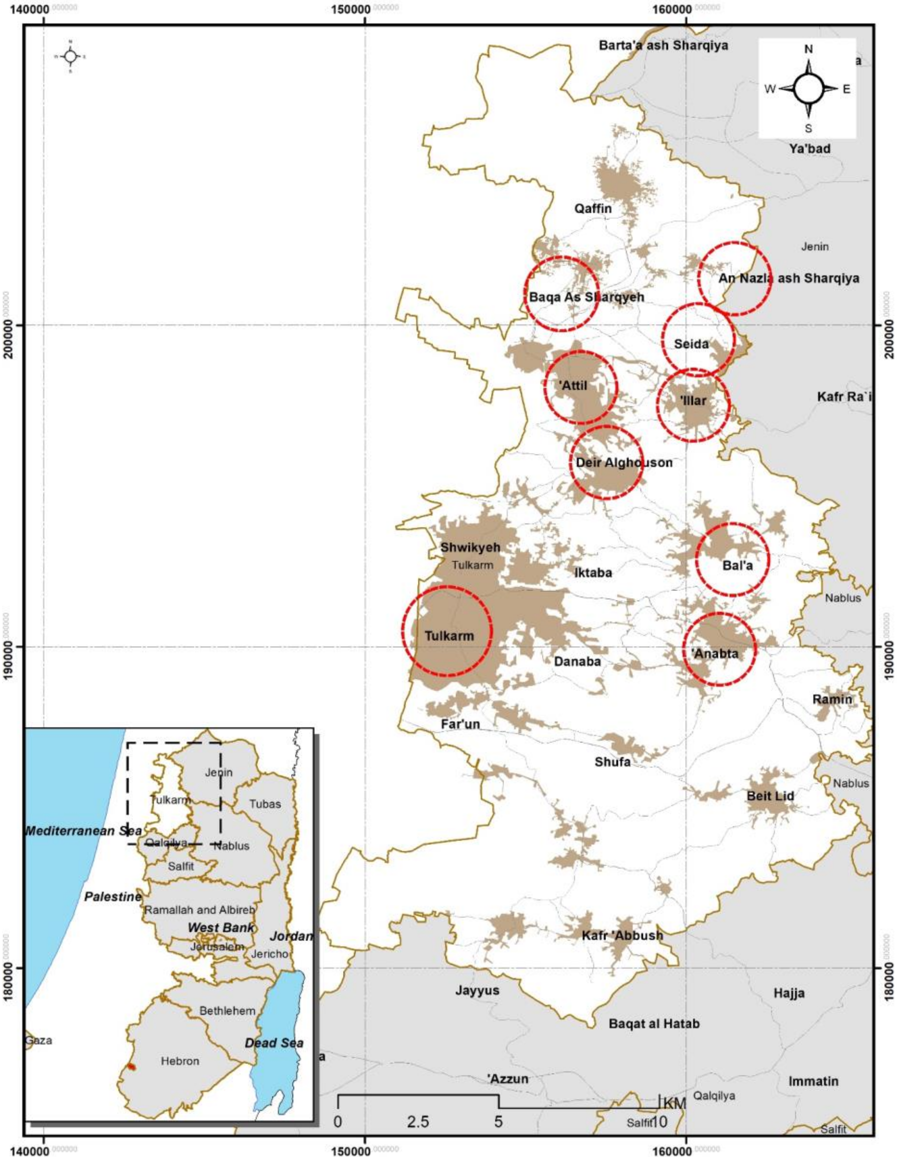

Figure 1.2: Participating Municipalities in Tulkarem Governorate

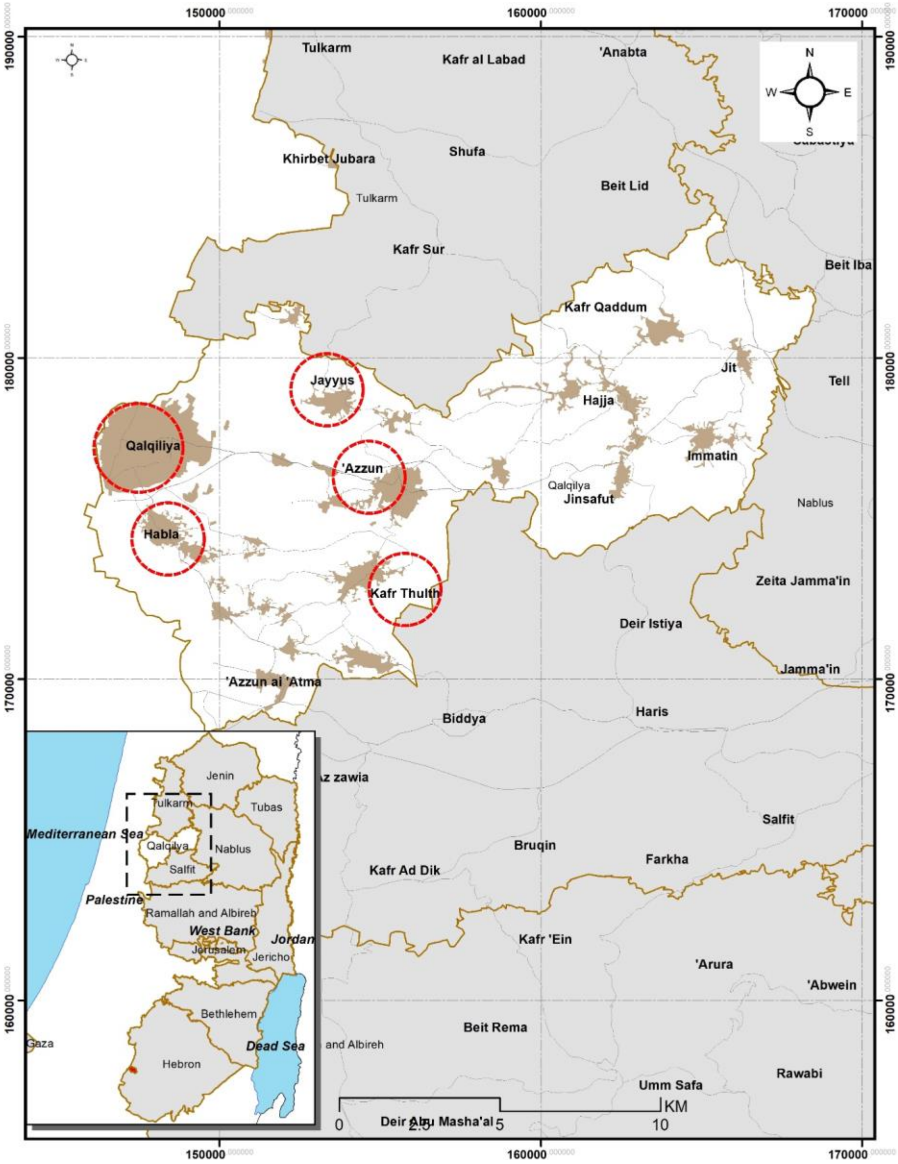

Figure 1.3: Participating Municipalities in Qalqilya Governorate

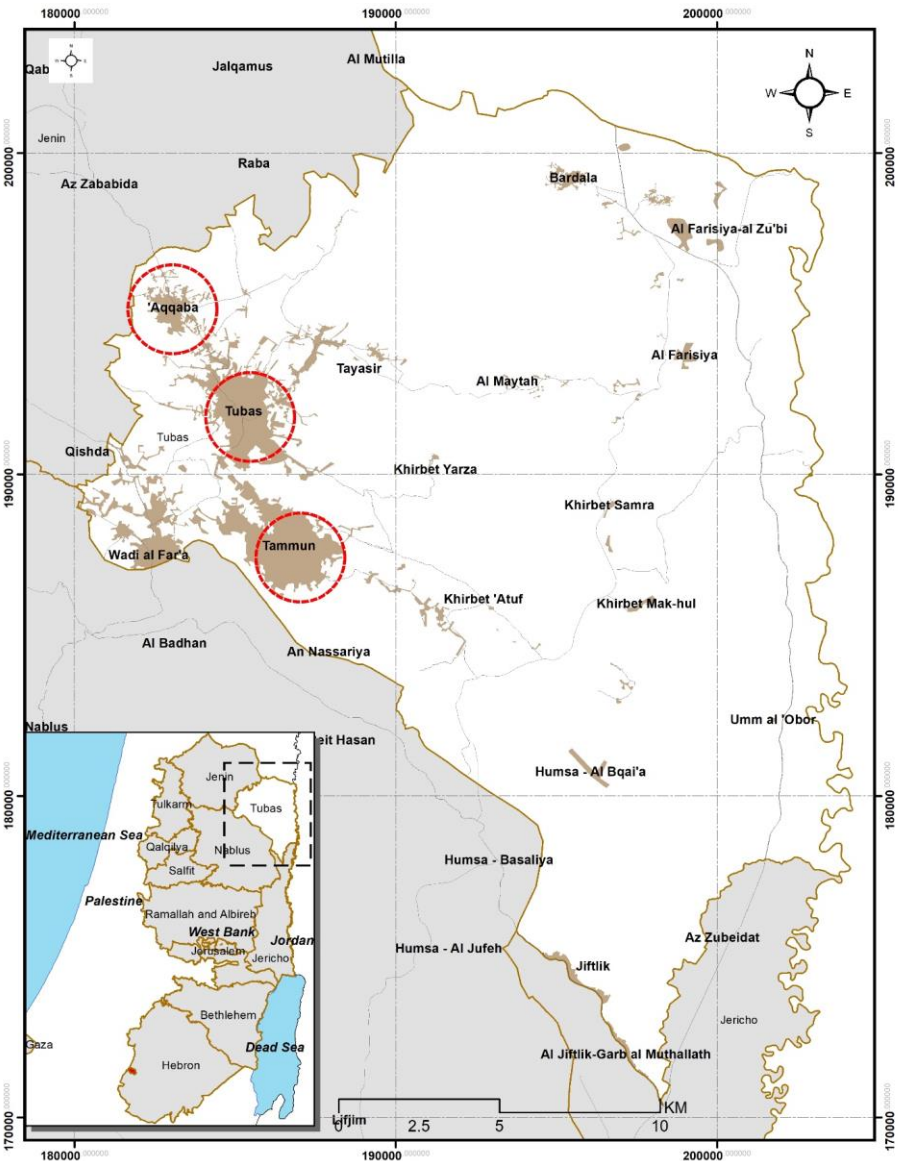

Figure 1.4: Participating Municipalities in Tubas Governorate

1.5 Project Constraints

The research team encountered a number of minor challenges during the implementation of this project; however, they were limited in impact and did not pose a significant obstacle to the successful completion of the work. One of the main difficulties was related to mobility and access to certain municipalities at specific times, especially in the Tulkarm area, which experienced unstable security conditions that affected movement and communication. Additional challenges emerged during the literature review phase, particularly due to limited access to updated scientific sources, as many academic databases are paid or difficult to access from within Palestine.

Despite these challenges, several municipalities and institutions showed clear cooperation and contributed by completing the questionnaires and providing the available data, which supported the successful completion of the project within the scheduled timeframe.

1.6 Structure of the Report

The report is composed from six chapters. Chapter One is the introduction, which presents the background of the study, defines key concepts, outlines the research objectives, describes the study area, and highlights the main constraints encountered during the project.

Chapter Two provides a comprehensive literature review, discussing previous studies related to risk management in road construction and identifying the research gap this study aims to fill.

Chapter Three outlines the research methodology, including the research design, risk classification, data collection tools, and the analytical techniques applied for both quantitative and qualitative data.

Chapter Four focuses on the data collection process, detailing the questionnaire development, sample distribution across governorates, and the pilot testing phase.

Chapter Five presents the analysis of the collected data, including reliability testing, frequency analysis, Relative Importance Index (RII) calculations, and a categorized discussion of risk factors.

Finally, Chapter Six summarizes the study’s key findings, discusses their practical implications, proposes targeted risk management strategies, and provides recommendations for future improvements.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Road construction projects are inherently exposed to a variety of risks due to their complexity, extended durations, and involvement of multiple stakeholders. Effective risk management is essential to ensure that such projects are completed on time, within budget, and at the desired quality. Over the years, numerous studies have addressed risk factors in construction projects, focusing on identifying, assessing, and mitigating different types of risks.

While many international studies have explored various risk assessment methods—including qualitative and quantitative approaches—there is a noticeable lack of research in this area within the Palestinian context, especially in road construction. This chapter presents a review of relevant literature that discusses risk factors in road projects, their classification, and methods of assessment. These studies provide foundational insights that support the development of the current study's methodology.

2.2 Review of Previous Studies

Several studies have addressed the topic of risk assessment and management in construction projects, particularly in road construction. In this section, a selection of relevant studies is presented, highlighting various approaches, geographical scopes, and findings related to construction risks. These studies were reviewed to provide a broader understanding of how risk factors are identified and managed in different contexts. However, this review does not focus on the specific methods or tools (such as the Risk Index) used in each study.

2.2.1 Mahamid I (2013): 'Common risks affecting time overrun in road construction projects in Palestine: Contractors' perspective'

This study aims to identify the risks that cause delays in road construction projects in the West Bank, Palestine, through a survey distributed to contractors in the region. Forty-five contributing factors to delays were identified through a literature review and categorized into six main groups: construction-related items, external factors, financial factors, consultant-related factors, and administrative factors. The questionnaire consisted of two parts: the first part gathered general information about the contractors' companies and the respondents' experience in the construction industry, while the second part included a list of the identified delay factors. For each factor, two questions were asked: "What is the frequency of its occurrence?" and "What is its impact on the project?"

The data were analyzed using descriptive analysis, risk mapping, and statistical techniques such as frequency analysis, ANOVA, and correlation analysis. The risks were classified using a risk map into three zones: the red zone (high impact and frequent risks), the yellow zone (moderate impact risks), and the green zone (low impact and frequency risks).

The results showed that seven factors were in the red zone (high impact and frequent), 30 factors in the yellow zone (moderate impact), and eight factors in the green zone (low impact and frequency). The critical factors causing delays in road projects in the West Bank include the financial status of contractors, delays in payments by the owner, the political situation and fragmentation of the West Bank, poor communication among project parties, high competition in tenders, and low equipment efficiency.

These factors lead to poor performance, increased costs, resource shortages, and coordination problems, negatively affecting project progress. The study found that the critical factors are divided into external factors such as the political situation and fragmentation of the West Bank, and internal factors such as payment delays, poor communication, and low equipment efficiency.

2.2.2 Elsaied, A., & Alghamdi, M. (2024). Risk Management Impact for Roadworks in the Kingdom of Saudi Arabia.

This study addresses the impact of risk management on road projects in the Kingdom of Saudi Arabia, focusing on environmental, logistical, and regulatory challenges. It analyzes risks related to cultural, regulatory, and economic factors, and the impact of legislative changes in safety laws and environmental regulations. The study also examines the role of sustainability in planning and risk management, aligning with global trends toward sustainable projects.

The study followed an organized methodology consisting of several stages for accurate data collection and analysis. Risk management in road projects was explored using various data collection methods, including surveys for project management and civil engineering experts. Personal interviews with professionals with extensive experience in major projects ensured accurate information on how risks are identified and managed. Collaboration with governmental entities helped collect data related to local regulations and their impact on risks.

Operational data from real road projects were gathered, focusing on costs, schedules, accidents, and injuries, allowing for an analysis of the real-world impact of risks. Logistical challenges, such as delays in material supply due to market fluctuations, were examined. Advanced techniques, including quantitative methods and risk matrices, were used to determine the likelihood and impact of risks. Sensitivity analysis assessed the impact of each type of risk on project outcomes.

Building Information Modeling (BIM) techniques addressed risks related to logistics and design, while computer simulation programs displayed multiple scenarios regarding the impact of risks on schedules and costs. Specialized risk analysis software, such as Primavera and Microsoft Project, tracked risks and assessed their potential impacts. Three-dimensional visualization techniques analyzed the logistical and environmental impacts of risks throughout the project lifecycle.

The study highlighted the importance of continuous risk assessment throughout the project phases. Several major risks affecting road projects were identified, including climate risks such as high temperatures, sandstorms, and heavy rainfall, which significantly affect construction, particularly during excavation and groundwork. Risks related to supplies, including delays in material and equipment deliveries due to market fluctuations or logistical problems, were emphasized. Schedules and quality were affected by labor-related risks, such as a shortage of skilled labor, and cultural factors negatively impacted certain communities. Legal and regulatory risks, such as changes in local legislation, complicated project execution. The study showed that poorly managed risks led to delays, increased costs, and reduced quality, often due to rushed processes or sudden changes in work plans. It also demonstrated that unexpected expenses increased, and poor risk management resulted in higher accidents and injuries at construction sites.

2.2.3 Leo-Olagbaye, F. and Odeyinka, H.A. (2020), "An assessment of risk impact on road projects in Osun State, Nigeria".

This study focused on the impact of risks on time and cost performance in road projects, using a comprehensive quantitative approach. Data were collected through a survey involving 146 participants from various stakeholders (such as civil engineers, project managers, and financiers) across 40 projects in Osun State, Nigeria.

The study used a full enumeration approach to ensure all participants were included. Additionally, archival data on contract costs and actual versus expected time periods were utilized. The survey tool was designed using a five-point Likert scale ranging from 0 (no impact) to 5 (high impact) to measure the frequency and potential impacts of the risks. The results of the Cronbach's Alpha (0.927 for risk frequency and 0.873 for risk impact) indicated high reliability of the research tool.

The data were analyzed using mean classification to identify the most significant risks, and multiple regression models were developed to assess the impact of risks on performance. A two-dimensional risk analysis approach (Williams, 1996) was also applied, considering both the likelihood and the potential impact of risks. This approach helped reduce the number of factors studied from 32 to 8 main risks that significantly impacted performance, including: changes in scope, errors in designs or defects, unexpected ground conditions, cash flow issues for contractors, poor relationships with local communities, delays in payments from clients, and non-compliance with contract requirements.

The findings showed that design and scope-related risks were the most frequent, while political and economic risks (such as government changes and liquidity issues) had the highest impact on performance. The study concluded that high-frequency risks did not necessarily correlate with high impact, highlighting the need to analyze risks based on both their frequency and impact. The study recommended that project managers focus on the most impactful risks by improving planning, enhancing communication with stakeholders, and allocating resources for effective risk management. The study also emphasized the importance of integrating these risks into project management plans to improve performance and reduce negative effects on road projects.

2.2.4 B.A.K.S. Perera, Indika Dhanasinghe & Raufdeen Rameezdeen (2009), "Risk management in road construction: The case of Sri Lanka".

This study focused on risk management in road construction projects in Sri Lanka, a country facing significant challenges in this area. The aim of the study was to analyze the risks affecting road projects in Sri Lanka and assess how these risks are managed, as well as propose ways to improve risk management practices.

The methodology included both qualitative and quantitative approaches and was divided into four main stages. In the first stage, primary data were collected through interviews with experts and contractors, as well as surveys distributed to stakeholders such as contractors and government consultants. The main risks identified included financial risks (material and labor cost fluctuations, high costs, delayed payments), environmental risks (climatic factors such as floods and storms, weak soil conditions), technical risks (design flaws or equipment failure), regulatory risks (delays in permits or changes in regulations), and social/political risks (political instability, local community objections).

In the second stage, the risks were categorized according to their type to facilitate management in subsequent stages. The risks were grouped into five main categories: financial, environmental, technical, regulatory, and social/political risks. This classification helped organize the risks to prioritize and manage them effectively.

In the third stage, the identified risks were assessed based on their likelihood and potential impact on the project. A risk matrix was used as the main tool to evaluate these risks, classifying them according to their likelihood (from low to high) and impact on the project (from low to high). This analysis helped identify the risks that required immediate attention and those that could be addressed later. In the final stage, the most appropriate strategies for managing the identified risks were determined based on their significance and impact. These strategies included mitigation (reducing the likelihood or impact of risks), transfer (shifting the risks to third parties such as insurance companies or subcontractors), and acceptance (accepting the risks with a contingency plan to minimize their impact). These strategies were compared with international best practices to ensure that the methodology used in Sri Lanka was improved.

The study showed that the major risks affecting road projects in Sri Lanka were financial, environmental, technical, and regulatory. The most commonly used risk management strategies were mitigation, transfer, and acceptance. However, several challenges hindered project execution, such as poor infrastructure in rural areas, political volatility, increasing climatic events like floods and storms, and a lack of coordination among stakeholders, leading to delays and disruptions in projects.

تعليق عليه [AI1]: يفضل اضافة بلد الدراسة

2.2.5 Okate, Anmol and Kakade, Vijay, "Risk Management in Road Construction Projects: High Volume Roads".

This study focused on the risks encountered during the construction of high-traffic volume roads and how to effectively manage them. Conducted in India, the study addressed projects such as expressways, national highways, and major district roads. It defined risks as uncertain events that can be measured by their likelihood, severity, and impact on a project's time and cost. Emphasizing early risk identification, the study aimed to reduce their impact and enhance project efficiency.

The methodology consisted of reviewing existing literature, followed by a pilot study to verify the relevance of these factors in the context of road projects and to identify the most relevant and significant factors. Based on the results of the pilot study, the number of risk factors was reduced from 40 to 31 essential factors.

A questionnaire was developed and distributed to professionals in road construction projects, including engineers, contractors, consultants, and project owners. It comprised three parts: background information, risk assessment using a Likert scale, and responsibility allocation for managing each risk. Data was collected through direct site visits and electronically via Google Forms.

The Relative Importance Index (RII) was then used to prioritize the risks based on their likelihood and impact. The findings revealed the most significant risks affecting the projects, including payment delays (RII = 93.33%), which were the main cause of project delays, owner bankruptcy and unclear project scope (RII = 91.11%), and weak leadership by the project manager (RII = 88.89%). Ineffective planning, poor site management, inadequate supervision, and insufficient data collection before design (RII = 86.67%) were also critical factors that caused delays.

Moderately important factors included disputes in contract documents, inadequate safety measures, unexpected underground utilities, and a lack of effective monitoring by the project manager (RII = 84.44%). Additionally, delays in handing over the site to the contractor and adverse weather conditions (RII = 82.22%) were identified as medium-level risks. The study identified less important risks, including criminal activities (RII = 53.33%) and cultural differences (RII = 48.89%), which had relatively low impacts. Bribery and delays in material supply (RII = 68.89% and 66.67%) also had moderate impacts but were not as critical as other factors. Equipment breakdowns (RII = 53.33%) and outdated design technologies (RII = 73.33%) were similarly less impactful.

2.3 Research Gap and Contribution of the Study

Numerous international studies have addressed the topic of risk assessment and management in road construction projects, with a particular focus on developing quantitative indicators such as the Risk Index (RI). These studies have employed various models and incorporated multiple criteria(most notably environmental, operational, temporal, and financial dimensions) to better understand the nature of risks and how to manage them throughout different project phases.

Despite this broad global interest, the research landscape in Palestine still lacks specialized quantitative studies that utilize precise mathematical models to assess construction risks, especially in the road sector. Most existing local studies have relied on descriptive analyses or general qualitative classifications without employing quantitative measures such as the RI.

This is where the significance of the current study lies. It is considered the first of its kind in Palestine to calculate a Risk Index (RI) for risks associated with road construction projects, based on four main criteria: Environmental, Operational, Temporal, and Financial. The model was developed using field data collected through questionnaires distributed to experts and engineers working in the road construction sector in Palestine. This enhances the credibility and accuracy of the findings, providing a practical perspective that reflects the local context.

Therefore, this study not only addresses a clear gap in the local literature but also offers a scientifically grounded and applicable RII model that can be used for future risk assessment and management in road infrastructure projects in Palestine.

CHAPTER THREE: METHODOLOGY

This study employed a structured and multi-stage methodology to identify, assess, and prioritize the key risks affecting road construction projects during the execution phase in the West Bank. The methodology combined both quantitative and qualitative research approaches, supported by a comprehensive review of previous literature. The methodological framework followed four main stages.

3.1 Research Design

The study adopted a descriptive analytical approach that integrates quantitative methods (questionnaires) and qualitative methods (expert interviews), with the aim of providing both measurable results and deeper contextual insights into risk factors in road construction.

3.2 Methodological Framework

The figure below illustrates the overall research methodology adopted in this study, including the data collection methods, questionnaire preparation, analysis techniques, and the formulation of conclusions and recommendations.

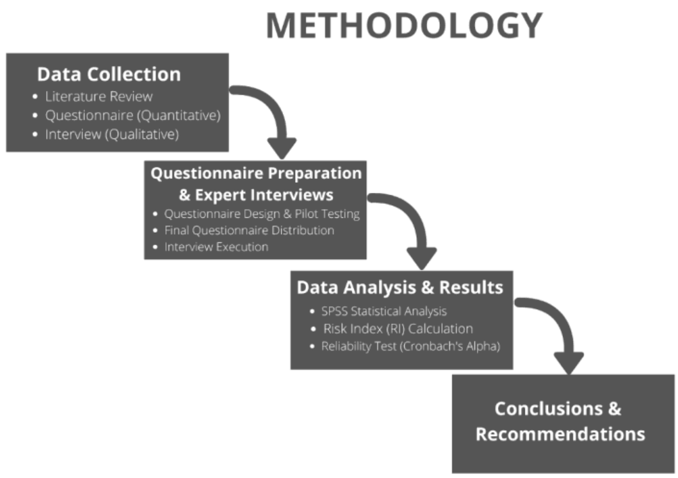

Figure 3.1: Research Methodology Steps

The research methodology adopted in this study followed a structured and multi-source approach to ensure comprehensive data collection and analysis. Initially, data was gathered from three primary sources: a thorough literature review, quantitative data through questionnaires, and qualitative data via expert interviews. The literature review involved analyzing previous studies to identify common risk categories and critical factors affecting road construction projects. This review served as the foundation for designing the questionnaire and guided the overall research direction.

Building upon the insights from the literature, a structured questionnaire was carefully prepared to reflect key risk categories—namely, temporal, financial, operational, and environmental risks. To ensure its clarity and effectiveness, a pilot test was conducted, and necessary refinements were made before distributing the final version to engineers and technical staff in municipalities across the West Bank. The questionnaire responses were collected from a total of 30 completed surveys distributed across various municipalities.

Simultaneously, semi-structured interviews were conducted with selected professionals and field experts to complement the quantitative findings with deeper insights and practical perspectives.

Once the data collection phase was completed, the responses were analyzed using the Statistical Package for the Social Sciences (SPSS). A Risk Index (RI) was calculated for each factor based on its frequency and perceived impact, allowing the identification of the most critical risks. Descriptive statistical tools, including frequency tables and mean values, were used to interpret the quantitative data, while Cronbach's Alpha was applied to test the reliability and internal consistency of the questionnaire.

Finally, the results of the analysis were synthesized to draw meaningful conclusions regarding the most significant risks impacting road construction projects. Based on these findings, practical recommendations were formulated to improve risk management practices, with particular attention to the local context and implementation realities in the West Bank.

3.3 Risk Classification

The risk factors in this study were classified into four main categories, based on findings from the literature review and supported by insights gathered through expert interviews. These categories include temporal risks, which refer to delays caused by factors such as permitting issues or adverse weather conditions; financial risks, which encompass challenges like budget overruns and delayed payments; operational risks, which involve problems such as equipment failure or labor shortages; and environmental risks, which include negative impacts such as pollution or violations of environmental regulations. This classification formed the structural basis for the design of the questionnaire and provided a framework for interpreting the collected data in a coherent and organized manner.

3.4 Data Analysis Tools

The analysis of quantitative data was conducted using the Statistical Package for the Social Sciences (SPSS). Descriptive statistical methods, including frequency tables and mean calculations, were used to summarize and interpret the responses. A Relative Importance Risk Index (RII) was computed for each factor to determine its criticality based on frequency and perceived impact. In addition, the reliability of the questionnaire was assessed using Cronbach's Alpha coefficient. For qualitative data obtained through expert interviews, a thematic analysis was performed to extract key insights and ensure that the findings align with or complement the quantitative results, thereby enhancing the overall validity and depth of the research outcomes.

CHAPTER FOUR: DATA COLLECTION

4.1 Definitions

This chapter focuses on the data collection methodology followed to identify and analyze the most significant risks affecting road construction projects during the execution phase. Data was collected using a structured questionnaire designed based on a comprehensive review of previous studies, as explained in the first part of the project.

4.2 Questionnaire Design

The questionnaire was prepared after reviewing several previous studies related to risk assessment and management in road projects. Based on these references, the main risk classification criteria were identified as follows: Temporal risks, financial risks, Operational risks and Environmental risks.

Questions within each category were selected based on the frequency of factors in the literature and their relevance to the local context of road projects. A five-point Likert scale was used to evaluate the impact level of each factor, where (1) indicates “very low impact” and (5) indicates “very high impact.”

The table below presents the main risk categories identified for this study, along with example risk factors for each category. These categories were derived from the literature and adapted to fit the local context of road construction projects.

Table 4.1: Main Risk Categories with Example Risk factors

Examples of Risk Factors	Risk Category
Delay in permits, weather delays	Temporal Risks
Budget overruns, payment delay	Financial Risks
Equipment failure, labor shortages	Operational Risks
Pollution, environmental violations	Environmental Risks

The full version of the questionnaire used in this study is presented below for reference. It includes all the items designed to measure the key risk factors affecting road construction projects during the execution phase.

Road Risk Management and Assessment Questionnaire

(إدارة وتقييم المخاطر في مشاريع الطرق)

<u>Part 1: General Information</u>

1. **Name of Respondent: ______________________________**
2. **Job Title/Role: __________________________________**
3. **Organization/Department: ________________________**
4. **Date: ______________________________**
5. **Years of experience: ________________________**

<u>Part II: Questionnaire Instructions</u>

Please rate the following statements based on your agreement or experience by filling the appropriate number.

Section 1: Operational Risks

No.	Questions	Degree of Approval				
		1 = Strongly Disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly Agree
1.	ضعف مهارات العمالة الفنية Poor technical skills of the workforce					
2.	تأخير دفع المستحقات المالية للمقاولين والعمال Delay in payment of financial dues to contractors and workers					
3.	مشاكل في جدولة العمل وتنسيق الأنشطة المختلفة Issues in work scheduling and coordination of various activities					
4.	ضعف كفاءة المقاولين في تنفيذ الأعمال Low efficiency of contractors in executing the work					

5.	تعطل المعدات بسبب سوء الصيانة أو الأعطال المفاجئة Equipment breakdown due to poor maintenance or unexpected failures					
6.	ضعف الاتصال والتنسيق بين الأطراف المختلفة في المشروع Weak communication and coordination among different project parties					
7.	أخطاء تنفيذية بسبب عدم دقة المخططات أو ضعف الإشراف Execution errors due to inaccurate drawings or weak supervision					
8.	ضعف التخطيط للعمليات اليومية مما يؤدي إلى تأخير في الإنجاز Poor planning of daily operations leading to delays in completion					
9.	عدم توفر المعدات المناسبة أو استخدامها غير الفعال Unavailability of suitable equipment or inefficient usage					
10.	عدم الالتزام بمتطلبات السلامة مما يسبب تأخيرًا وحوادث في الموقع Non-compliance with safety requirements causing delays and site accidents.					

Section 2: Financial Risks

No.	**Questions**	**Degree of Approval**				
		1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**
1.	تقلبات الاسعار(تغير أسعار المواد الخام مثل الأسفلت والحديد والاسمنت وتقلبات أسعار الوقود والطاقة اللازمة للمعدات الثقيلة) Price fluctuations.					
2.	(تكاليف العمالة والإنتاجية (نقص في العمال الماهرة وزيادة تكاليف الأجور وانخفاض الانتاجية بسبب ضعف التدريب واستخدام تقنيات قديمة) Labor costs and productivity.					

3.	التمويل والاستثمار(صعوبة في التمويل للمشروع وارتفاع تكلفة القروض وارتفاع أسعار الفوائد ومشاكل السيولة المالية لدى المقاولين والموردين) Financing and investment.					
4.	مخاطر السوق والمنافسة(دخول شركات منافسة جديدة بأسعار منخفضة تؤدي إلى منافسة غير متوازنة) Market and competition risk.					
5.	_التأخيرات والتكاليف الاضافية(التأخيرات الناتجة عن سوء التخطيط او سوء تقدير التكاليف او التاخيرات بسبب كوارث طبيعية او سوء الاحوال الجوية) Delays and additional costs.					
6.	مخاطر الاستحواذ على الاراضي والتعويض(هناك تكاليف غير متوقعة بسبب نزاعات الاراضي او القضايا القانونية) Land acquisition and compensation risks.					
7.	مخاطر سعر الصرف(بالنسبة للمشاريع التي تعتمد على الموارد المستوردة او المقاولين الاجانب فان تقلبات العملة يمكن ان تاثر على التكاليف وتزيد الاسعار) Exchange rate risks**.**					
8.	ارتفاع تكاليف الصيانة واعادة التأهيل(قد تدهور المشاريع بسبب سوء التصميم الاولي السيء او الظروف الجوية القاسية) High maintenance and rehabilitation costs.					
9.	التغيرات في السياسات الحكومية والضرائب(رسوم استخدام الطريق رسوم ضرائب المشاريع وزيادة تكاليف التشغيلية للمشروع) Changes in government policies and taxes.					
10.	تكاليف الهدم واعادة التدوير(نفقات غير متوقعة تتعلق بازالة البنية التحتية القديمة وضمان التخلص منها بشكل سليم) Demolition and recycling costs.					

Section 3: Temporal Risks

No.	Questions	Degree of Approval				
		1 = Strongly Disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly Agree
1.	تاخيرات الدفع تؤثر على تدفق النقد للمقاولين وجداول المشاريع Delays in payments affecting cash flow.					
2.	تأخيرات لوجستية بسبب مشاكل الإمدادات Logistical delays due to material issues.					
3.	تغييرات تنظيمية تؤثر على الجداول Regulatory changes affecting timelines.					
4.	تغييرات في نطاق المشروع تؤدي إلى تجاوزات Changes in project scope leading to overruns.					
5.	تأخير في القرارات من قبل أصحاب المصلحة Delays in decision-making by stakeholders.					
6.	الحصول على تأخيرات تنظيمية في التصاريح Regulatory delays in obtaining permits.					
7.	تجاوزات تخطيط ضعيف يؤدي إلى زمنية Poor planning resulting in overruns.					
8.	إضرابات العمال أو مشاكل عمالية Labor strikes or labor issues.					
9.	أخطاء في التصميم أو تغييرات تصميمية متأخرة Design errors or late design changes.					
10.	نقص العمالة الماهرة أو هروب العمالة labor attrition Shortage of skilled labor or labor attrition.					

Section 4: Environmental Risks

No.	Questions	Degree of Approval				
		1 = Strongly Disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly Agree
1.	الحرارة العالية، العواصف الرملية، والأمطار الغزيرة التي تؤثر على البناء					

	High temperatures, sandstorms, and heavy rainfall affecting construction.					
2.	ظروف أرضية غير متوقعة تؤثر على التكاليف وتنفيذ المشروع Unexpected ground conditions impacting costs and project execution.					
3.	الفيضانات، العواصف، وضعف التربة التي تعطل أنشطة البناء Floods, storms, and weak soil conditions disrupting construction activities.					
4.	عدم دراسة العوامل البيئية قبل التصميم، مما يؤدي إلى عدم كفاءة التنفيذ Failure to assess environmental factors before project design, leading to inefficiencies.					
5.	تأخيرات بسبب الأحوال الجوية القاسية، مما يؤثر على جداول المشروع والتكاليف Delays due to extreme weather conditions, affecting project timelines and costs.					
6.	تغيرات في ظروف التربة تؤدي إلى عدم استقرار أساسات الطرق Changes in soil conditions leading to instability in road foundations.					
7.	المخاوف البيئية التي تؤدي إلى مقاومة من المجتمعات المحلية Environmental concerns leading to resistance from local communities.					
8.	التغيرات في القوانين البيئية التي تؤثر على تنفيذ المشروع Regulatory changes in environmental laws affecting project implementation.					
9.	اضطرابات في توريد المواد بسبب العوامل البيئية مثل العواصف أو الفيضانات Material supply disruptions due to environmental factors like storms or floods.					
10.	سوء التخطيط البيئي الذي يؤدي إلى أضرار بيئية طويلة المدى Poor environmental planning leading to long-term ecological damage.					

Section 5: Suggestions for Improving Risk Management

1.ما هي الاستراتيجيات التي تقترحها لتقليل تأثير المخاطر على المشاريع؟

What strategies do you suggest to minimize the impact of risks on projects?

____

____

2. هل لديك أي توصيات إضافية لتحسين إدارة المخاطر في مشاريع الطرق؟

Do you have any additional recommendations to improve risk management in road projects?

____

____

Thank You for Your Participation

4.3 Data Sources and Study Sample

The study relied on primary data collected through questionnaires distributed to municipalities involved in road construction projects across the West Bank. A total of 30 completed questionnaires were collected from four different governorates: Tulkarm, Nablus, Qalqilya, and Tubas. These municipalities were selected because they are responsible for implementing or supervising road construction works and are therefore best positioned to assess the associated risks. The following table presents the number of questionnaires collected from each governorate. This distribution helps ensure that the data reflects a variety of geographic and administrative contexts.

Table 4.2: Number of Distributed Questionnaires by Governorate

Governorate	Number of Questionnaires
Tulkarm	10
Nablus	12
Qalqilya	5
Tubas	3
Total	**30**

The following pie chart illustrates the percentage distribution of the questionnaires across the four governorates. As shown, Nablus contributed the highest proportion, followed by Tulkarm, while Tubas had the smallest share.

Figure 4. 1: Percentage Distribution of Collected Questionnaires by Governorate

4.4 Data Collection Process

The questionnaires were distributed to engineers and staff within the technical departments of the selected municipalities. To ensure active participation and enhance the response rate, members of the research team personally visited the municipalities in Tulkarm, Nablus, Qalqilya, and Tubas. During these visits, printed copies of the questionnaire were handed directly to the relevant engineers, and in some cases, short discussions were held to clarify the purpose of the study and explain the questions when needed.

The questionnaire was also shared electronically to accommodate participants who preferred digital access. This combined approach facilitated broader engagement and allowed the researchers to collect more accurate and contextually grounded responses. The data collection process extended over a suitable period to allow sufficient time for responses and to reflect the practical realities of road construction projects in different regions.

4.5 Pilot Study

Before distributing the final questionnaire, a pilot study was conducted with a small group of engineers (n=5) from selected municipalities to evaluate the clarity, structure, and relevance of the questions. The purpose was to ensure the reliability and validity of the instrument. Based on the feedback received, minor modifications were made to improve the wording of certain questions and the overall flow of the questionnaire. This step helped enhance the quality of the data collection tool and ensured its suitability for the target respondents.

CHAPTER FIVE: DATA ANALYSIS & RESULTS

This chapter focuses on the analysis of the collected data using SPSS software and the corresponding results The following subsections illustrate the most important analysis and results.

5.1 Reliability of the Instrument (Cronbach's Alpha Test)

The reliability of the questionnaire, which consisted of 40 variables, was assessed using Cronbach's Alpha to ensure the quality and internal consistency of the collected data. The questionnaire aimed to evaluate the perceptions of professionals regarding risk factors in road construction projects during the construction phase. The data were collected from a sample of 30 participants.

Table 5.1summarizes the number and percentage of valid and excluded responses obtained from the 30 distributed questionnaires. This step ensures that only reliable responses are used in the following reliability analysis.

Table 5.1: Case Processing Summary for Reliability

Cases	N	Percentage (%)
Valid	30	100
Excluded	0	0
Total	**30**	**100**

As shown in Table 5.1, 100% of the responses (30 cases) were valid and included in the reliability analysis. No responses were excluded.

Table 5.2 presents the result of the reliability test using Cronbach's Alpha. The value obtained reflects the internal consistency of the 40 questionnaire variables used to assess risk factors in road construction projects.

Table 5.2: Reliability Statistics

No. of Items	Cronbach's Alpha
40	0.863

A Cronbach's Alpha value of 0.863 indicates a very good level of internal consistency for the instrument, suggesting that the questionnaire variables are well correlated and reliably measure the intended constructs. Therefore, the collected data are considered dependable and suitable for further analysis in this research.

5.2 Frequency Analysis of Risk Factors

This section presents the frequency analysis of the 40 risk factors identified in the questionnaire. The responses were measured using a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The analysis provides insights into how participants perceive the significance of each risk factor in road construction projects during the construction phase.

To illustrate the findings more clearly, the following tables present the frequency and percentage distribution of three selected risk factors. These examples help highlight how the participants perceived certain common risks.

The first example focuses on the risk factor "Poor Technical Skills of the Workforce". The table below shows how respondents evaluated the impact of this factor on road construction projects during the construction phase.

Table 5.3: Frequency Distribution for Poor Technical Skills of the Workforce

Poor technical skills of the workforce					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	3.3	3.3	3.3
	Disagree	7	23.3	23.3	26.7
	Neutral	6	20.0	20.0	46.7
	Agree	15	**50.0**	**50.0**	96.7
	Strongly Agree	1	**3.3**	**3.3**	100.0
	Total	30	100.0	100.0	

A total of 53.3% of respondents agreed or strongly agreed that poor technical skills of the workforce pose a significant risk, while 26.6% disagreed and 20% were neutral. This suggests that a majority of participants recognize this as a relevant concern in road construction.

The second example addresses the risk of “Delay in Payment of Financial Dues”, which is commonly cited as a financial obstacle in construction projects.

Table 5.4: Frequency Distribution for Delay in Road Projects of Financial Dues

Delay in payment of financial dues					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	3.3	3.3	3.3
	Disagree	3	10.0	10.0	13.3
	Neutral	6	20.0	20.0	33.3
	Agree	12	**40.0**	**40.0**	73.3
	Strongly Agree	8	**26.7**	**26.7**	100.0
	Total	30	100.0	100.0	

40% agreed and 26.7% strongly agreed, totaling 66.7% who believe that delayed payments are a major risk causing project delays and stoppages. Meanwhile, 13.3% disagreed and 20% were neutral.

The third example illustrates the risk factor “Issues in Work Scheduling”, which falls under temporal risks and concerns delays in managing project timelines.

Table 5.5: Frequency Distribution for Issues in Work Scheduling

Issues in work scheduling					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	5	16.7	16.7	16.7
	Neutral	6	20.0	20.0	36.7
	Agree	17	**56.7**	**56.7**	93.3
	Strongly Agree	2	**6.7**	**6.7**	100.0
	Total	30	100.0	100.0	

56.7% agreed and 6.7% strongly agreed, making 63.4% who view scheduling problems as a major risk to project success. However, 16.7% disagreed and 20% were neutral.

In addition to the previously discussed risks, the analysis of the remaining factors is summarized below, based on the same set of survey responses.

Low efficiency of contractors is considered a significant risk by more than half of the respondents, with 53.3% agreeing or strongly agreeing that it negatively affects project outcomes. However, about 30% disagree or strongly disagree, indicating some variation in perceptions regarding this factor. A smaller percentage remains neutral, suggesting that while many see it as important, not everyone is fully convinced of its impact.

Equipment breakdown is viewed as a risk by nearly half of the participants, with approximately 47% agreeing or strongly agreeing that it poses a challenge during project execution. Meanwhile, around a quarter of respondents are neutral on this issue, and about 27.5% disagree, reflecting mixed opinions about how critical equipment failure is in project risk management.

Weak communication stands out as a more prominent risk factor, with two-thirds of respondents (66.7%) agreeing or strongly agreeing that poor communication leads to significant project risks. Only about 23% disagreed, while 10% were neutral. This indicates a strong consensus on the importance of effective communication in managing risks during construction projects.

Execution errors are identified as a considerable risk by 60% of participants who agreed or strongly agreed that mistakes during execution adversely affect projects. A substantial portion (26.7%) remained neutral, and a smaller group (13.3%) disagreed, showing that execution quality is generally seen as a critical concern but with some room for differing opinions.

Poor planning is one of the most agreed-upon risk factors, with nearly three-quarters (73.4%) of respondents affirming its negative impact on project success. Only 16.6% disagreed, and 10% were neutral. This highlights the crucial role that proper planning plays in mitigating risks in road construction projects.

The unavailability of suitable equipment was considered a risk by half of the respondents (50%), while 20% were neutral, and 30% disagreed or strongly disagreed. This suggests that while equipment availability is an important factor for many, there remains a significant portion that does not see it as a primary risk.

Non-compliance with safety regulations is recognized as a major risk by a large majority, with 73.3% agreeing or strongly agreeing that failure to follow safety standards increases project risks. Only 13.3% disagreed, and a similar percentage were neutral. This reflects widespread awareness of the critical importance of safety adherence in construction projects.

Price fluctuations are perceived as a notable risk by 60% of respondents, while 23.3% remained neutral and 16.7% disagreed. The financial instability caused by changing prices is thus recognized as a significant concern, though not universally accepted as a risk by all participants.

Labor costs represent a moderate risk factor according to the responses, with 46.6% agreeing or strongly agreeing that they influence project risk levels. About 26.7% were neutral, and 26.6% disagreed or strongly disagreed, indicating some division in opinion regarding the extent to which labor costs impact project risk management.

Financing and investment risks are perceived as a major concern by the majority of respondents, with 80% agreeing or strongly agreeing that inadequate financing and poor investment strategies can significantly affect project success. Only a small portion expressed disagreement, indicating strong consensus that financial stability is crucial for managing risks in construction projects.

Market and competition risks are recognized by most participants as an important factor, with nearly 67% agreeing or strongly agreeing that competition and market fluctuations can impact project outcomes. However, about a third of respondents remain neutral or disagree, suggesting some uncertainty about the severity of this risk compared to others.

Delays and additional costs are viewed as a highly critical risk, with 76.6% of respondents agreeing or strongly agreeing that such delays and unplanned expenses adversely affect project performance. This indicates widespread concern about time management and cost overruns as key challenges in project execution.

Land acquisition and compensation risks show more mixed opinions, with about 36.7% agreeing that these issues pose significant risks, but a notable 36.7% either disagree or are neutral. This reflects variability in how much impact land-related challenges are perceived to have on construction projects in the sample.

Exchange rate risks are considered relevant by half of the respondents who agreed, plus another 6.7% who strongly agreed, making it a notable financial risk. However, 30% remained neutral and about 13% disagreed, indicating that currency fluctuations are recognized but may not be universally seen as critical across all projects.

High maintenance and rehabilitation costs are identified by most respondents as an important risk, with 63.4% agreeing or strongly agreeing on their potential negative impact. A significant minority, however, disagrees or remains neutral, which could reflect differences in project scope or management strategies.

Changes in government policies and taxes are viewed as moderate risks, with 46.6% agreeing and a small fraction strongly agreeing. Around 53.4% either disagreed or were neutral, showing some divergence in opinions on how government regulatory changes affect project risks.

Demolition and recycling costs generate a more divided response, with only 36.6% agreeing that these costs represent a risk, while a majority of respondents either disagreed or remained neutral. This suggests that these costs may not be considered a primary concern in most cases.

Delays in payments are perceived as a significant risk by a large majority, with 80% agreeing or strongly agreeing that late payments impact project continuity and risk management. Only a small percentage disagreed, highlighting the importance of timely cash flow in project success.

Logistical delays are also recognized as a considerable risk, with 60% of respondents agreeing or strongly agreeing that disruptions in logistics can cause project delays and cost increases. Around a third of participants were neutral or disagreed, indicating varying experiences with logistical challenges across projects

Regulatory changes are considered a moderate risk, with 43.4% of respondents agreeing or strongly agreeing that frequent changes in regulations can disrupt road construction projects. However, about a third of the participants disagreed or strongly disagreed, reflecting diverse perceptions of regulatory impact.

Scope changes pose a significant risk, as 73.3% of respondents agree or strongly agree that alterations in project scope led to delays and cost overruns. Only a small fraction disagreed, indicating widespread consensus on the negative effect of scope changes.

Delays in decision-making are a major concern, with 83.3% of participants agreeing or strongly agreeing that slow decisions by stakeholders significantly hinder project progress. This highlights the critical need for timely approvals in road projects.

Delays in permits issuance are seen as a notable risk, with 60% agreeing or strongly agreeing that bureaucratic delays can stall project timelines. Meanwhile, some respondents remained neutral or disagreed, suggesting variability depending on the project context.

Poor planning is identified as a key risk factor, with 73.4% agreeing or strongly agreeing that inadequate project planning leads to inefficiencies and increased risks during road construction.

Labor strikes are perceived as less frequent or impactful, with only 43.4% agreeing or strongly agreeing about their effect on projects. The substantial neutral and disagree responses imply this risk is context-dependent.

Design errors are widely acknowledged as a critical risk, with 70% agreeing or strongly agreeing that design mistakes cause rework and delays, emphasizing the importance of thorough design review.

Labor shortages concern about half of the respondents (50%), indicating that workforce availability can be a challenge but may vary by location and project size.

Extreme weather conditions such as high temperatures and storms are considered a moderate risk, with roughly 33.4% agreeing or strongly agreeing, while most participants were neutral or disagreed, suggesting weather impact is project-specific.

Ground conditions are viewed as a factor affecting some projects, with 36.7% agreeing or strongly agreeing, while others did not perceive it as a significant risk.

Floods are generally seen as a less common risk, with only 26.6% agreeing or strongly agreeing, indicating limited relevance in many cases.

Environmental assessment failures are recognized as a concern by about half the respondents (50%), pointing to the importance of proper environmental studies in project success.

Weather delays are perceived as a significant factor by half of the respondents (50%), highlighting the impact of weather conditions on project timelines.

Soil condition changes are identified as a key risk by 53.4% of respondents, emphasizing the importance of thorough geotechnical investigations in construction projects.

Community resistance is noted as a challenge by 56.7% of participants, indicating the need for effective stakeholder engagement and communication.

Environmental laws are seen as influential by only one-third of respondents (33.3%), suggesting varied awareness or enforcement levels related to environmental regulations.

Material supply issues are considered impactful by 33.3% of respondents, pointing to the necessity of reliable procurement and logistics planning.

Bad environmental planning is viewed as a concern by about one-third (33.3%) of the participants, underscoring the role of sustainable and strategic environmental design in project success.

5.3 Relative Importance Index (RII) Analysis

This section presents the analysis and ranking of the 40 risk factors identified in the study based on their Relative Importance Index (RII) values. The RII reflects the perceived significance of each risk factor as evaluated by the survey respondents, offering insight into which risks pose the greatest threats to road construction projects and should be prioritized in risk management plans.

To calculate the RII for each variable, the following formula was used (Enshassi et al., 2009):

$$RII = \frac{\sum \mathrm{W}}{\mathrm{A\ X\ N}} \qquad\qquad Equation\ (1)$$

Where:

- W = weight assigned to each response (from 1 = Strongly Disagree to 5 = Strongly Agree),
- A = highest possible weight (5),
- N = total number of respondents.

This analysis provides a numerical value representing the relative weight of each factor, helping project stakeholders to better understand and address the most pressing risks.

The overall RII scores for all 40 risk factors ranged from 2.73 (54.6%) to 4.10 (82.0%), highlighting the varying levels of concern among stakeholders. These values offer a comprehensive overview of how each risk was perceived in terms of its potential impact on road construction projects. This ranking forms the foundation for effective prioritization of mitigation efforts.

The following table presents the Relative Importance Index (RII) values for all 40 risk factors identified in the study, reflecting the perceived significance of each factor as evaluated by the survey respondents. It provides a clear overview of which risks are considered most critical in road construction projects:

Table 5.6: Relative Importance Index for All Variables (Original Order)

	Original		
	Relative importance index for All Variables	RII (Mean)	RII (%)
1	Poor technical skills of the workforce	3.27	65.4%
2	Delay in payment of financial dues	3.77	75.4%
3	Issues in work scheduling	3.53	70.6%
4	Low efficiency of contractors	3.3	66.0%
5	Equipment breakdown	3.24	64.8%
6	Weak communication	3.47	69.4%
7	Execution errors	3.57	71.4%
8	Poor planning	3.6	72.0%
9	Unavailability of suitable equipment	3.23	64.6%
10	Non-compliance with safety	3.9	78.0%
11	Price fluctuations	3.67	73.4%
12	Labor costs	3.2	64.0%
13	Financing and investment	3.93	78.6%
14	Market and competition risk	3.8	76.0%
15	Delays and additional costs	3.6	72.0%
16	Land acquisition and compensation risks	2.9	58.0%
17	Exchange rate risks	3.47	69.4%
18	High maintenance and rehabilitation costs	3.5	70.0%
19	Changes in government policies and taxes	3.23	64.6%
20	Demolition and recycling costs	3.1	62.0%
21	Delays in payments	4.1	82.0%
22	Logistical delays	3.53	70.6%
23	Regulatory changes	3.1	62.0%
24	Scope changes	3.67	73.4%
25	Delays in decision-making	3.9	78.0%
26	Delays in permits	3.37	67.4%
27	Poor planning	3.7	74.0%
28	Labor strikes	3.07	61.4%
29	Design errors	3.6	72.0%
30	Labor shortage	3.13	62.6%
31	High temperatures, storms	2.87	57.4%
32	Ground conditions	2.87	57.4%
33	Floods	2.73	54.6%

34	Environmental assessment failures	3.07	61.4%
35	Weather delays	3.3	66.0%
36	Soil condition changes	3.3	66.0%
37	Community resistance	3.4	68.0%
38	Environmental laws	3	60.0%
39	Material supply	3	60.0%
40	Bad environmental planning	2.9	58.0%

5.3.1 Overall Risk Factors Rankings

The following table presents all 40 risk factors ranked in descending order according to their Relative Importance Index (RII) values. The highest-ranked risk was Delays in Payments, with an RII of 4.1 (82%), indicating that financial delays are perceived as the most significant and impactful threat to road construction projects. This ranking highlights the critical importance of timely payments in ensuring project success and minimizing risk exposure.

This table ranks all 40 risk factors in descending order based on their RII values, highlighting the most significant risks that pose the greatest threats to project success.

Table 5.7: All Risk Factors Sorted by RII in Descending Order

Risk Factor	RII (Mean)	RII (%)
Delays in payments	4.1	82.0%
Financing and investment	3.93	78.6%
Non-compliance with safety	3.9	78.0%
Delays in decision-making	3.9	78.0%
Market and competition risk	3.8	76.0%
Delay in payment of financial dues	3.77	75.4%
Poor planning	3.7	74.0%
Price fluctuations	3.67	73.4%
Scope changes	3.67	73.4%
Poor planning	3.6	72.0%
Delays and additional costs	3.6	72.0%
Design errors	3.6	72.0%
Execution errors	3.57	71.4%
Issues in work scheduling	3.53	70.6%
Logistical delays	3.53	70.6%
High maintenance and rehabilitation costs	3.5	70.0%
Weak communication	3.47	69.4%
Exchange rate risks	3.47	69.4%
Community resistance	3.4	68.0%

Delays in permits	3.37	67.4%
Low efficiency of contractors	3.3	66.0%
Weather delays	3.3	66.0%
Soil condition changes	3.3	66.0%
Poor technical skills of the workforce	3.27	65.4%
Equipment breakdown	3.24	64.8%
Unavailability of suitable equipment	3.23	64.6%
Changes in government policies and taxes	3.23	64.6%
Labor costs	3.2	64.0%
Labor shortage	3.13	62.6%
Demolition and recycling costs	3.1	62.0%
Regulatory changes	3.1	62.0%
Labor strikes	3.07	61.4%
Environmental assessment failures	3.07	61.4%
Environmental laws	3	60.0%
Material supply	3	60.0%
Land acquisition and compensation risks	2.9	58.0%
Bad environmental planning	2.9	58.0%
High temperatures, storms	2.87	57.4%
Ground conditions	2.87	57.4%
Floods	2.73	54.6%

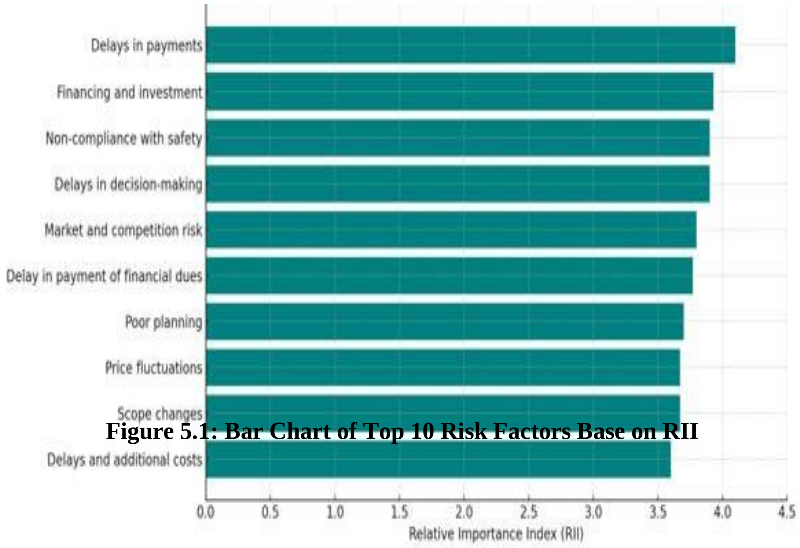

Figure 5.1: Bar Chart of Top 10 Risk Factors Base on RII

5.3.2 Risk Factors Rankings by Category

To provide more detailed insight, the 40 risk factors were also grouped and ranked within their respective categories (e.g., Financial, Environmental, Operational, etc.). This helps in identifying the most critical risks within each domain and allows for more targeted risk management strategies.

This table categorizes and ranks the 40 risk factors within their respective risk domains, offering detailed insights into the critical risks in each category to support targeted risk management strategies.

Table 5.8: Risk Factor Rankings Categorized by Risk Type

Operational Risk Factors	**RII (Mean)**	**RII (%)**
Non-compliance with safety	3.90	78%
Delay in payment of financial dues	3.77	75%
Poor planning	3.60	72%
Execution errors	3.57	71%
Issues in work scheduling	3.53	71%
Weak communication	3.47	69%
Low efficiency of contractors	3.30	66%
Poor technical skills of the workforce	3.27	65%
Equipment breakdown	3.24	65%
Unavailability of suitable equipment	3.23	65%
Financial Risk Factors		
Financing and investment	3.93	79%
Market and competition risk	3.80	76%
Price fluctuations	3.67	73%
Delays and additional costs	3.60	72%
High maintenance and rehabilitation costs	3.50	70%
Exchange rate risks	3.47	69%
Changes in government policies and taxes	3.23	65%
Labor costs	3.20	64%
Demolition and recycling costs	3.10	62%
Land acquisition and compensation risks	2.90	58%
Temporal Risk Factors		
Delays in payments	4.10	82%
Delays in decision-making	3.90	78%
Poor planning	3.70	74%
Scope changes	3.67	73%
Design errors	3.60	72%

Logistical delays	3.53	71%
Delays in permits	3.37	67%
Labor shortage	3.13	63%
Regulatory changes	3.10	62%
Labor strikes	3.07	61%
Environmental Risk Factors		
Community resistance	3.40	68%
Weather delays	3.30	66%
Soil condition changes	3.30	66%
Environmental assessment failures	3.07	61%
Environmental laws	3.00	60%
Material supply	3.00	60%
Bad environmental planning	2.90	58%
High temperatures, storms	2.87	57%
Ground conditions	2.87	57%
Floods	2.73	55%

5.4 Analysis of Risk Factors by Category

This section presents the frequency analysis of responses for each category of risk factors, highlighting how respondents evaluated the importance and severity of risks under four main categories: Operational, Financial, Temporal, and Environmental. The analysis provides insights into which categories are perceived as more critical, thereby helping prioritize areas for risk mitigation.

5.4.1 Operational Risks

The responses indicate that operational risks are of considerable concern. A total of 66.6% of participants agreed or strongly agreed with the importance of these risks, while only 3.3% expressed strong disagreement. This reflects a consensus on the significance of operational challenges such as poor planning, equipment breakdowns, and weak communication.

This strong agreement likely stems from the frequent and practical issues encountered in the field. Engineers and contractors often face disruptions caused by inadequate technical skills or inefficient execution, which can result in substantial project delays and cost overruns.

The following table presents a frequency analysis of participants' responses regarding operational risks in road construction projects. It illustrates the extent of agreement or disagreement on the significance of risks such as poor planning, equipment failures, and weak communication, which directly impact project workflow.

Table 5.9: Frequency Distribution of Responses for Operational Risks

Operational Risks					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	**Strongly Disagree**	1	3.3	3.3	3.3
	Neutral	9	30.0	30.0	33.3
	Agree	19	63.3	63.3	96.7
	Strongly Agree	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

5.4.2 Financial Risks

The survey results suggest that financial risks are highly recognized among respondents. Approximately 53.4% agreed or strongly agreed on the importance of these risks, while only 6.7% expressed disagreement. The relatively high agreement indicates that financial aspects (such as delays in payments, fluctuating prices, and investment uncertainties) are perceived as major threats to the progress and stability of road construction projects.

These concerns are likely influenced by common financial challenges in infrastructure projects, especially in regions where funding delays or unpredictable cost variations are frequent. Such risks can directly stall construction activities, impact cash flow, and create disputes among stakeholders, all of which can significantly undermine project performance.

The next table provides a frequency analysis of respondents' perceptions of financial risks faced in road projects. It reflects their awareness of risks related to payment delays, price fluctuations, and investment uncertainties, which can significantly affect project continuity and success.

Table 5.10: Frequency Distribution of Responses for Financial Risks

Financial Risks					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	**Disagree**	2	6.7	6.7	6.7
	Neutral	12	40.0	40.0	46.7
	Agree	14	46.7	46.7	93.3
	Strongly Agree	2	6.7	6.7	100.0
	Total	30	100	100	

5.4.3 Temporal Risks

Temporal risks also emerged as a significant concern. A combined 70% of participants agreed or strongly agreed that timing-related risks are impactful, while 13.3% expressed some level of disagreement. This suggests a general consensus on the relevance of issues like permit delays, decision-making lags, and schedule disruptions.

In practice, delays in approvals or slow administrative processes often lead to the extension of project timelines. These temporal risks not only increase costs but can also create coordination conflicts and disrupt supply chain activities. As time is a critical factor in construction success, these results emphasize the need for proactive scheduling and regulatory alignment.

This table shows the frequency distribution of participants' views on temporal risks associated with road construction. It highlights their opinions on potential delays in approvals, slow decision-making processes, and schedule disruptions, all of which are critical for timely project completion.

Table 5.11: Frequency Distribution of Responses for Temporal Risks

Temporal Risks					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	**Strongly Disagree**	1	3.3	3.3	3.3
	Disagree	3	10.0	10.0	13.3
	Neutral	5	16.7	16.7	30.0
	Agree	15	50.0	50.0	80.0
	Strongly Agree	6	20.0	20.0	100.0
	Total	30	100.0	100.0	

5.4.4 Environmental Risks

Environmental risks were relatively less emphasized compared to other categories. About 33.3% of participants agreed on their importance, while 23.3% disagreed and 43.3% remained neutral. This indicates a more varied perception of environmental concerns, such as weather conditions, soil changes, or environmental regulations, within road construction projects.

The mixed responses may reflect the context-dependent nature of environmental risks. For example, some projects may not face harsh weather or stringent environmental laws, making these risks seem less significant. However, in locations where natural conditions or environmental assessments are more demanding, these factors can introduce severe disruptions or additional costs. Therefore, while not universally viewed as critical, environmental risks should not be overlooked.

The following table displays a frequency analysis of respondents' attitudes towards environmental risks in road construction projects. It highlights the recognition of risks related to weather conditions, soil changes, and environmental regulations, which may affect project progress depending on local circumstances.

Table 5.12: Frequency Distribution of Responses for Environmental Risks

Environmental Risks					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	**Strongly Disagree**	1	3.3	3.3	3.3
	Disagree	6	20.0	20.0	23.3
	Neutral	13	43.3	43.3	66.7
	Agree	10	33.3	33.3	100.0
	Total	30	100.0	100.0	

5.4.5 Comparative Analysis of Risk Categories

This section provides a comparative summary of respondents' perceptions across the four main risk categories: Operational, Financial, Temporal, and Environmental. The table below shows the frequency and percentage distribution of agreement levels for each risk category, enabling identification of the most critical risk types as perceived by participants.

Table 5.13: Summary of Frequency Percentages for All Risk Categories

Category		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Operational Risks	Frequency	1	0	9	19	1
	Percentage	3.3	0	30.0	63.3	3.3
Financial Risks	Frequency	0	2	12	14	2
	Percentage	0	6.7	40.0	46.7	6.7
Temporal Risks	Frequency	1	3	5	15	6
	Percentage	3.3	10.0	16.7	50.0	20.0
Environmental Risks	Frequency	1	6	13	10	0
	Percentage	3.3	20.0	43.3	33.3	0

The results indicate that Temporal Risks are perceived as the most critical, with 70% of participants agreeing or strongly agreeing to their importance. Operational Risks follow closely with a combined agreement rate of 66.6%. Financial Risks have a moderate agreement level at 53.4%, while Environmental Risks receive the lowest perceived urgency, evidenced by the highest neutral responses (43.3%) and only 33.3% agreement.

These findings suggest prioritizing risk management efforts toward operational and temporal challenges in road construction projects.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of Findings

This study conducted a comprehensive analysis of risk factors affecting municipal road construction projects in Palestine. Through structured surveys administered to engineers across more than 30 municipalities, the study evaluated the perceived impact of various risks on project performance.

The analysis revealed that financial and administrative risks are the most influential, surpassing technical and environmental concerns. Among these, Delays in Payments emerged as the most critical risk, with a Relative Importance Index (RII) of 0.82. This was followed closely by Financing and Investment Issues (RII = 0.786), Non-compliance with Safety Regulations (RII = 0.78), and Delays in Decision-Making (RII = 0.78). These findings highlight urgent areas requiring targeted intervention to enhance the efficiency and outcomes of municipal infrastructure projects.

Table 6.1 presents the top 10 most critical risk factors ranked by their Relative Importance Index (RII), as identified by survey respondents.

Table 6.1: Top 10 Risk Factors Based on RII Values

No.	Risk Factor	RII Score
1.	Delays in Payments	0.820
2.	Financing Issues	0.786
3.	Non-compliance with Safety	0.780
4.	Delays in Decision-Making	0.780
5.	Market Competition	0.760
6.	Poor Planning	0.740
7.	Scope Changes	0.734
8.	Design Errors	0.720
9.	Logistical Delays	0.706
10.	Permit Delays	0.674

Figure 6.1 provides a visual representation of these risk factors, illustrating their relative severity based on the RII values.

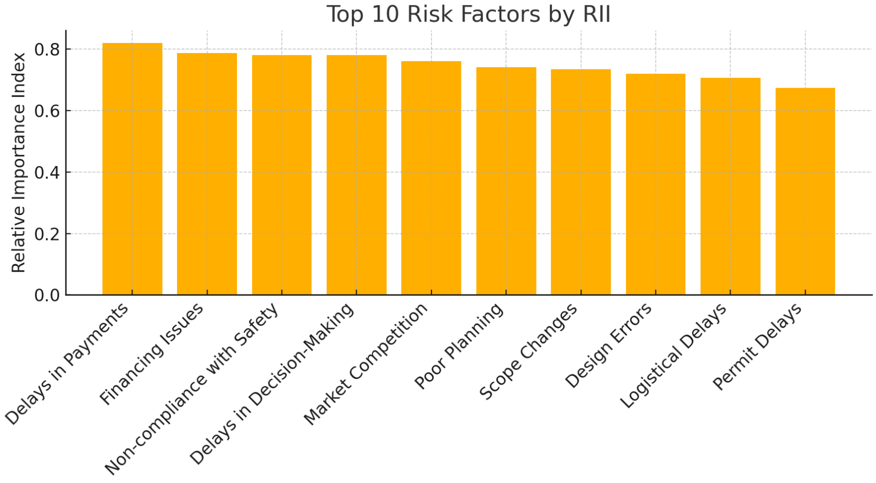

Figure 6.1: Bar Chart of Top 10 Risk Factors

In addition, risks stemming from poor planning, logistical delays, and market fluctuations were also prominent, indicating significant challenges in coordination and project preparation. Although environmental risks were present, they were rated as less impactful, suggesting their influence is contingent upon local conditions and existing regulatory frameworks.

6.2 Practical Implications

The results offer valuable insights for municipal leaders, project managers, and policymakers. Understanding which risks have the most detrimental impact enables better resource allocation, strategic planning, and proactive decision-making.

For instance, addressing payment delays through streamlined financial protocols and enhanced accountability mechanisms can significantly minimize project disruptions. Similarly, improving compliance with safety standards can reduce accidents, ensure project continuity, and foster public trust. These implications emphasize the need for targeted, risk-based interventions to support sustainable infrastructure development.

6.3 Proposed Risk Management Strategies

Based on the findings, the following strategies are recommended to mitigate key risks in municipal road construction projects:

- Develop a centralized digital risk management platform accessible to all relevant departments.
- Integrate Building Information Modeling (BIM) with Geographic Information Systems (GIS) to enable real-time risk detection and monitoring.
- Implement automated alert systems for issues such as budget overruns, scheduling delays, and permit lags.
- Conduct mandatory risk assessment workshops at the inception of each project cycle.
- Appoint dedicated risk officers or establish municipal risk committees to oversee coordination and response.
- Enforce monthly project reviews specifically focused on tracking risk status and mitigation effectiveness.

6.4 Recommendations for Future Improvements

To further strengthen the risk management framework within municipal engineering practices, the following recommendations are proposed:

- Institutionalize risk management training and education across all municipal engineering departments.
- Promote the adoption of e-government solutions to accelerate financial approvals and streamline permitting processes.
- Develop structured stakeholder engagement frameworks to foster community input and ensure transparency.
- Create a national municipal risk database for knowledge sharing, documentation of lessons learned, and best practices.
- Establish a national RII benchmarking index to support predictive risk planning in future infrastructure projects.

6.5 Conclusions

This study underscores the fact that the success of municipal road construction projects depends not only on sound technical design but also (more fundamentally) on effective risk identification, analysis, and control. Financial discipline, administrative efficiency, and enhanced interdepartmental collaboration are key drivers of improved project outcomes.

The implementation of the proposed strategies and recommendations can significantly reduce delays, improve safety standards, and ensure optimal utilization of public funds. Ultimately, adopting a structured and proactive approach to risk management will foster more resilient, efficient, and sustainable infrastructure development across Palestine.

APPENDIX

The following appendix contains copies of the 30 questionnaires filled by municipal engineers as part of the data collection for this research.

Questionnaire 1

استطلاع المخاطر التشغيلية والمالية والبيئية بلدية طولكرم.pdf

Questionnaire 2

استطلاع المخاطر التشغيلية والمالية والبيئية بلدية طولكرم 2.pdf

Questionnaire 3

استطلاع المخاطر التشغيلية والمالية والبيئية عتيل.pdf

Questionnaire 4

استطلاع المخاطر التشغيلية والمالية والبيئية دير الغصون.pdf

Questionnaire 5

استطلاع المخاطر التشغيلية والمالية والبيئية بلعا.pdf

Questionnaire 6

استطلاع المخاطر التشغيلية والمالية والبيئية علار.pdf

Questionnaire 7

استطلاع المخاطر التشغيلية والمالية والبيئية باقة الغربية.pdf

Questionnaire 8

استطلاع المخاطر التشغيلية والمالية والبيئية باقة الشرقية.pdf

Questionnaire 9

استطلاع المخاطر التشغيلية والمالية والبيئية صيدا.pdf

Questionnaire 10

استطلاع المخاطر التشغيلية والمالية والبيئية عنبتا.pdf

Questionnaire 11

استطلاع المخاطر التشغيلية والمالية والبيئية حبلة.pdf

Questionnaire 12

استطلاع المخاطر التشغيلية والمالية والبيئية قلقيلية.pdf

Questionnaire 13

استطلاع المخاطر التشغيلية والمالية والبيئية طوباس.pdf

Questionnaire 14

استطلاع المخاطر التشغيلية والمالية والبيئية قلقيلية 2.pdf

Questionnaire 15

استطلاع المخاطر التشغيلية والمالية والبيئية صرة.pdf

Questionnaire 16

استطلاع المخاطر التشغيلية والمالية والبيئية عصيرة الشمالية.fdp

Questionnaire 17

استطلاع المخاطر التشغيلية والمالية والبيئية عقابا.fdp

Questionnaire 18

استطلاع المخاطر التشغيلية والمالية والبيئية سبسطية.fdp

Questionnaire 19

استطلاع المخاطر التشغيلية والمالية والبيئية طمون.fdp

Questionnaire 20

استطلاع المخاطر التشغيلية والمالية والبيئية نابلس 2.fdp

Questionnaire 21

قبلان.fdp

Questionnaire 22

قبلان 2.fdp

Questionnaire 23

قبلان 3.fdp

Questionnaire 24

بيتا.fdp

Questionnaire 25

جماعين.fdp

Questionnaire 26

fdp.حوارة

Questionnaire 27

fdp.قصرة

Questionnaire 28

fdp.بيت فوريك

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Tools and Data Sources Used in Analysis:

- IBM SPSS Statistics: Version 28.0 was used to conduct statist6ical analysis, including frequency distribution and reliability testing.
- Expert Interviews: Preliminary interviews were conducted with engineers and project managers to guide the development of the questionnaire.
- Structured Questionnaire: A custom-designed questionnaire was distributed to collect data regarding risk factors in road construction projects.