4-5-2024

Effective Project Management Strategies for Identifying and Addressing Projects' Complexities and Improving Projects' Success Rates

Daryl L. Gilbert II
Walden University

Walden University

College of Management and Human Potential

This is to certify that the doctoral study by

Daryl Gilbert

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Ronald Black, Committee Chairperson, Doctor of Business Administration Faculty

Dr. Brenda Jack, Committee Member, Doctor of Business Administration Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2024

Abstract

Effective Project Management Strategies for Identifying and Addressing Projects' Complexities and Improving Projects' Success Rates

by

Daryl Gilbert

MS, University of Texas at El Paso, 2021

BS, New England College, 2017

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Business Administration

Walden University

March 2024

Abstract

Some project managers lack strategies to mitigate project failures in detailed execution. Project leaders are concerned that an inapt definition and planning are used to deliver successful projects. Grounded in contingency theory, the purpose of this qualitative single-case study was to explore effective strategies used by industrial chemical plant project managers to mitigate failure in detailed execution. Five project managers from the southern United States who successfully led the execution of capital projects participated in the study. Data were collected from semistructured interviews and a review of company procedures. Four themes emerged from the thematic analysis: proactive complexity and risk management, knowledge and expertise utilization, project planning and scope management, and stakeholder engagement and communication. A key recommendation for project leaders is implementing early risk identification and mitigation protocols by involving the team in decision-making processes and establishing clear and regular communication with all stakeholders. The implications for positive social change include the potential for improved project management practices and the promotion of a more inclusive and collaborative work environment, which can lead to increased customer satisfaction, job creation, and societal advancements.

Effective Project Management Strategies for Identifying and Addressing Projects' Complexities and Improving Projects' Success Rates

by

Daryl Gilbert

MS, University of Texas at El Paso, 2021

BS, New England College, 2017

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Business Administration

Walden University

March 2024

Dedication

This study is foremost dedicated to my spouse, Mrs. Yashica Nacole Gilbert, whose support and understanding have been the cornerstone of my resilience and determination throughout this journey. Equally, this study is dedicated to Mr. John P. Stafford, a friend and mentor of unparalleled wisdom and foresight. Commencing my professional trajectory as a project manager was made possible by your ability to recognize the potential in me as a leader. As a testament to the impact of focus and determination, I dedicate this study to my children. May each of you find the focus and determination to reach your goals.

Acknowledgments

I wish to acknowledge Dr. Ronald Black, my chair and advisor. It has been a pleasure to receive guidance from you throughout this journey. I must acknowledge my sister, Mrs. Stephanie Hornsby, for encouraging me and taking the time to listen to me discuss interesting findings each week. I also want to thank my friends and colleagues for their encouragement and inspiration.

Table of Contents

List of Tables

List of Figures

Section 1: Foundation of the Study

In the intricate landscape of industrial chemical plant projects, effective project management strategies are pivotal for identifying and addressing project complexities, thereby enhancing the success rates of these projects. In an industry characterized by high stakes and substantial risks, project managers must navigate myriad threats to ensure project objectives are met within the constraints of time, cost, and quality (AlNoaimi & Mazzuchi, 2021). In this study, I explored the strategies employed by project managers in the industrial chemical plant sector. In this single case study, I focused on exploring the strategies that these professionals use during the early phases of execution to identify project complexities and mitigate potential failures. This section includes the background of the problem, the problem statement, the purpose of the study, research and interview questions, the significance of the study, and a comprehensive review of academic literature. The objective was to identify the best practices in project management within the context of industrial chemical plant projects, thereby contributing to the body of knowledge and improving project outcomes in this critical industry.

Background of the Problem

Various elements, including investment costs, environmental effects, stakeholders, accessible technology, and community participation, can expose projects to numerous hazards (Anggraeni et al., 2019; Bahamid et al., 2019; Khahro et al., 2021). In contemporary project environments characterized by increasing levels of uncertainty and complexity, effective risk management by project managers is critical to mitigate

deviations from established goals and handle uncertainties (Farahani et al., 2021). Effective management of project complexity is imperative, and it is not without its difficulties (Kermanshachi et al., 2020). Ensuring a comprehensive assessment process is necessary for successful management. Chenger and Woiceshyn (2021) suggested that due to the emphasis on officially reviewing and choosing projects and managing the current portfolio, more is needed to know how new project possibilities are recognized at the front end before formal selection. The findings from this study may give project managers a unique knowledge of project complexity methods, which they might employ to prevent failures in detailed project execution.

Problem and Purpose

Front-end engineering design (FEED) is a crucial phase of problem and solution development of industrial projects that can lack a consistent agreed-upon definition assessment of the FEED maturity (Yussef et al., 2019) and complexity (Fabic et al., 2019). EY-US assessed 500 oil and gas capital projects with a total installed cost (TIC) executed 5 years before 2019 and discovered that 60% experienced delays in schedule, with 38% having cost overruns (Fane, 2020). The general business problem is that FEED can lack the appropriate definition and planning to deliver successful projects. The specific business problem is that some industrial chemical plant project managers lack strategies to mitigate project failures in detailed project execution. The purpose of this qualitative case study was to explore effective strategies used by industrial chemical plant project managers to mitigate project failures in detailed project execution.

Population and Sampling

I focused on industrial chemical plant project managers within an industrial chemical company that has led the execution of capital projects from FEED through project completion. The study's geographic location was the southern United States, where the industrial chemical company operates. The sampling method was purposive, with the sample size determined by the number of eligible project managers within the company. Participants must have experience leading capital project improvements from initiation through completion to be considered for inclusion in the study. Participant recruitment was facilitated through the company, who provided contact information for eligible project managers. Data sources included interviews with project managers and company project management documents.

Nature of the Study

Research methodologies can be categorized generally as qualitative, quantitative, and mixed methods. Unlike quantitative methods, which prioritize numerical data and statistical analysis, qualitative approaches lend themselves to exploring the subjective experiences, social phenomena, and human behaviors at hand (Braun & Clarke, 2019). Researchers can employ qualitative methods to understand complex social issues in-depth, build hypotheses, or investigate the lived experiences of individuals and communities (Roblek et al., 2019). Observation, interviews, and textual or visual data analysis enable a nuanced exploration of the live experiences of individuals and

communities, which would not be possible with a purely quantitative approach. Qualitative methodology was used in this study.

I considered two research designs: (a) phenomenology and (b) case study. A single case study design was used in this study rather than phenomenology because phenomenology focuses on examining the essence of an experience and the lived experiences of several participants (see Creswell & Creswell, 2018). Phenomenology, while effective for examining the essence of an experience across multiple participants, did not align with the objectives of this study. The focus was not on shared lived experiences but instead on the specific risk analysis strategies employed during front-end engineering design from the perspective of project managers.

A case study design using interview-based data collection was better suited for investigating risk analysis strategies used during FEED from the perspective of project managers. I chose the case study design to examine a phenomenon within the boundaries of an industrial chemical business. The intention is to analyze a phenomenon within the specific context of an industrial chemical business. The single-case study design offers a detailed evaluation of the effectiveness of various project management strategies in addressing the complexities and challenges faced by the organization under study. Consequently, other research designs would provide a different level of contextual understanding in this particular scenario.

Research Question

What effective strategies do industrial chemical plant project managers use to mitigate project failures in detailed execution?

Interview Questions

1. As a project manager of industrial chemical plant projects, could you describe your role and responsibilities?
2. How do you identify the potential complexities in the early stages of a project, and can you provide specific examples of how you have done so in the past?
3. What strategies do you use during the Front-End Engineering Design (FEED) phase to mitigate any identified complexities?
4. Can you provide an example of a project where early identification of complexities significantly impacted the outcome of the project?
5. In your approach to managing project complexities, can you explain your decision-making process?
6. How do you manage risks during the execution of a project, and can you provide an example of a project where risk management significantly influenced the project's success?
7. Have you ever encountered a situation where project scope creep occurred, and if so, how did you manage it?
8. How do you foster collaboration among different stakeholders during a

project, and can you share an example of a project where collaboration significantly influenced the project's success?

9. Given each project's unique context and complexities, how do you adapt your project management strategies accordingly?
10. Can you provide an example of a project that did not go as planned, and what lessons did you learn from that experience regarding identifying and managing project complexities?

Conceptual Framework

I used contingency theory for improving project success rates in industrial chemical plant projects to ground my study. The effectiveness of project management in industrial chemical plant projects is crucial for ensuring their successful completion. One way to enhance the success rate of these projects is by identifying and addressing complexities during the FEED phase. Contingency theory emerged in the 1960s as a response to the limitations of the suggested best way approach to management and leadership (Fiedler, 1964; Lawrence & Lorsch, 1967). Key figures who contributed to the development of contingency theory include Lawrence and Lorsch (1967), Fiedler (1964), Perrow (1967), and Burns and Stalker (1994).

The logical connections between the framework presented and the nature of my study include the contingency theory that there is no one-size-fits-all approach to organizational design and behavior but rather that structure and behavior are contingent on situational factors (see Donaldson, 2001 p. 1). Comparably, the success of a project is

contingent on the project's elements, including the project's complexity, available resources, and the project environment. Therefore, to mitigate project delays, cost overruns, and failure, project managers must be willing and able to identify the situational factors relevant to the project and develop strategies appropriate to the specific context. According to contingency theory in project management, various situational circumstances call for various project types and project management approaches (Boonstra & Reezigt, 2023 p. 2).

Operational Definitions

The following key terms are operationally represented in the study:

Capital Expenditure (CAPEX): CAPEX refers to capital expenditure, which is the money a company spends to acquire or upgrade physical assets such as property, buildings, or equipment (Brunekreeft & Rammerstorfer, 2021).

Front-end engineering design: FEED is a phase of project execution where a business idea is studied before the project's design process to assess a project's technical and economic viability (Bhown et al., 2021; Yussef et al., 2020).

Project contingency theory: Project contingency theory is an approach that emphasizes the importance of adapting project management practices to the specific context and conditions of a project. It posits that there is no one-size-fits-all solution for managing projects. The most effective strategies depend on the unique internal, external, and environmental factors affecting the project (Leeman et al., 2022).

Assumptions, Limitations, and Delimitations

Assumptions

Assumptions are views, limits are flaws in the study design, and delimitations in academic research are the bounds specified by the researcher (Ross & Zaidi, 2019). There were three assumptions in this study. My first assumption was that the participants in this study would comprehend and understand the interview questions. The second assumption was that the interview questions were answered truthfully, accurately, and objectively by the participants. My third assumption was that the organization's leadership would grant full access to the documentation and data required for this study.

Limitations

The limitations of academic research refer to elements that may impact the study's validity and potential flaws (Adu & Van Der Walt, 2022; Ding et al., 2020). There are three limitations in this study. The first limitation was the sample size of participants, which may limit the research breadth and the ability to acquire meaningful responses. Second, participants' varying degrees of project management experience could have limited the study. The third limitation was that the projects executed by industrial chemical plant managers are more technical than other industries; therefore, the findings of this study may not be fully applicable to other industries.

Delimitations

Delimitations refer to the study's bounds, scope, or parameters (Jäckel et al., 2021; Racionero-Plaza et al., 2021). There are three delimitations in this study. The first

delimitation of the study was that only project managers for the industrial chemical business were eligible to participate. The second delimitation was that the research population included only a specific number of participants from the large pool of project managers. The third delimitation was that the study was focused on specific strategies, limiting the scope to certain aspects of project management.

Significance of the Study

Contribution to Business Practice

The front-end development phase of a project is a crucial step of project management that entails identifying essential success elements that influence project results through conception, planning, and initiation (Williams et al., 2019). Effective front-end planning and design may prove project outcomes, including better cost and schedule performance. Capital investments for industrial chemical plants are executed in project phases where risk reduction efforts include stakeholder design to execution to desired levels of value, risk, and opportunity (Browning, 2018). Project leaders create value for stakeholders in the FEED phase through risk analysis strategies to deliver a project for optimal return on investment. The results of this study may contribute to businesses through better use of resources, improved efficiency, and higher profitability.

Implications for Social Change

Implications for social change include improving the communities the industrial chemical plant operates in, helping companies increase their profitability, and retaining top talent. Identifying essential success factors in the early phases of industrial chemical

plant projects that influence benefits realization enhances results that promote the value and growth of communities and institutions (Serugga et al., 2020; Williams et al., 2019). By exploiting a community's economics through new projects, project leaders for industrial chemical plant construction may affect beneficial social change. All local industry enterprises may benefit from the projects' additional services and support opportunities, which could enhance demand for workers and lead to the creation of several new hires. The results of this study may implicate positive social change by attracting people to the local businesses in the community.

A Review of the Professional and Academic Literature

The purpose of this qualitative single case study was to explore the existing scholarly work related to industrial chemical plant project managers' strategies to mitigate project failures. The goal is to identify gaps in the current knowledge, understand the various strategies project managers employ in different contexts, and explore how these strategies can be applied or adapted to the specific context of industrial chemical plant projects. The insights gleaned from this review informed the subsequent stages of this study and may contribute to the broader academic discourse on project management in the context of industrial chemical plants. In synthesizing the existing literature, I sought to understand the underlying causes of project failures and the factors contributing to project complexity.

To conduct the literature review, I retrieved articles from sources published in the Walden University database and Google Scholar as my primary research sources. The

databases used included Business Source Complete, Emerald Insight, SAGE Journals, Science Direct, EBSCOhost, and ProQuest. The academic literature review began with a search of specific keywords such as *project management, contingency theory, capital project, industrial project, risk management, risk analysis, front-end design, front-end engineering design,* and *complexity strategy*. I reviewed and analyzed a total of 121 sources in the literature review, which included both peer-reviewed and non-peer-reviewed articles. Among these, 121 articles were peer-reviewed, and 121 had publication dates within the last 5 years (i.e., between 2019 and 2023). Table 1 presents a summary of the citations used in this literature review.

Table 1

Literature Review Matrix

	Number	Percentage (%)
References	121	–
Peer-reviewed	107	88
Published within the last 5 years	121	100

Common themes and disagreements among researchers are found and linked through examining peer-reviewed literature, including qualitative and quantitative studies. Studying and synthesizing literature is essential to comprehensively understanding previous and current research on a topic (Snyder, 2019). This process enables the identification of crucial themes integral to the subject matter. The objective is

to comprehend project managers' varied approaches in various situations, identify knowledge gaps, and investigate how these strategies might be applied or modified to the specific case of industrial chemical plant projects. The literature review is organized with the following main topics: (a) contingency theory, (b) project contingency theory, (c) front-end engineering design, (c) project complexity, (d) risk management, and (e) project success.

Contingency Theory

The perspective of contingency theory is widely recognized and holds significant influence in organizational management. Contingency theory is a management theory that suggests there is no one best way to organize and manage an organization; rather, the most effective approach depends on the specific circumstances or contingencies the organization faces (Islam et al., 2020; Mahmud et al., 2021). Moreover, Islam et al. and Mahmud et al. emphasized the importance of considering an organization's specific context and contingencies when determining the most effective management and leadership approaches.

One business area where contingency theory has been applied is the study of supply chain sustainability trajectories. Silvestre et al. (2020) argued that implementing sustainability initiatives in supply chains is comparable to implementing innovation, as both require significant mindset changes. Silvestre et al. proposed a theoretical framework combining evolutionary and contingency theories to examine how supply chains learn and evolve in their sustainability trajectories. Adding to the supply chain and

contingency theory theme, Kros et al. (2019) highlighted the role of contingency theory in recognizing the relationship between the external business environment, firm performance, and internal structures. Additionally, Kros et al. suggested that quality management approaches may effectively reduce the risk of counterfeits entering the supply chain. The authors emphasized the importance of considering the context and contingencies within supply chains when implementing sustainability initiatives.

Organizational change is a complex process that requires careful consideration of various factors and theories. Contingency theory is often used to understand and guide organizational change. The contingency theory suggests that the effectiveness of an organization is contingent upon the fit between its structures and the external environment (Chong & Duan, 2022). Chong and Duan (2022) were, furthermore, signifying that organizations must adapt and change their structures in response to changing contingencies. In the context of organizational change, Islam et al. (2020) developed a paradigm for comprehending employee championing behavior in Bangladeshi commercial companies. The authors argued that contingency theory is highly relevant in this setting, suggesting there is no one optimal model for managing change that applies to all organizations in the same industry. Islam et al. underlined the importance of aligning organizational change strategies with the organization's specific contingencies and challenges. These authors provided insights into applying contingency theory in organizational change, highlighting the importance of considering contingencies

and aligning organizational structures with the external environment to ensure organizational effectiveness and success.

Quality management plays a crucial role in improving strategic alignment within organizations. Contingency theory provides a perspective for understanding this role and its impact on organizational performance. McAdam et al. (2019) explored the role of quality management theory and practice using a contingency theory perspective in strategic alignment. The authors focused on small and medium-sized enterprises and emphasized the importance of strategic alignment within the organizations. Based on their findings, they suggested that when aligned with organizational strategies, quality management practices can improve strategic alignment and enhance administrative performance (McAdam et al., 2019). Building on McAdam et al. (2019), Parast et al. (2022) compared quality management practices in manufacturing firms and services using a repeated cross-sectional analysis. The study applied contingency theory to examine the similarities and differences in quality management practices between the two sectors. Parast et al. revealed significant differences in quality management practices, particularly in human resource development, management, customer focus, and satisfaction. This suggests that quality management practices vary based on the context and industry sector. These authors provide valuable insights into the relationship between quality management and contingency theory. They highlighted the importance of alignment of quality management practices with organizational strategies and external contingencies to improve performance and competitive advantage. Organizations can

effectively manage quality and enhance their strategic alignment for long-term success by understanding and applying contingency theory.

Overall, contingency theory offers an indispensable blueprint for comprehending and scrutinizing organizational phenomena across myriad sectors. The theory underscores the criticality of context, contingencies, and the dynamism inherent to organizations (McAdam et al., 2019; Parast et al., 2022), thereby equipping scholars and practitioners with the ability to make astute, context-specific decisions that effectively navigate the complexities and challenges unique to their situations. This perspective fosters an environment of flexibility and adaptability, encouraging a more nuanced understanding of organizational strategy and management. Hence, the contingency theory serves not merely as an academic concept but as a practical tool that underscores the interconnectedness of organizational structures, the external environment, and strategic implementation, ultimately optimizing organizational effectiveness in various situational contexts.

Project Contingency Theory

In project management, contingency theory guides practice and improves organizational performance by considering the unique factors and uncertainties that may impact a project. Nachbagauer and Schirl-Boeck (2019) acknowledged that projects are subject to inherent uncertainty and risk, and project managers must be flexible and adaptable. The authors used an approach grounded on constructionism and system theory with selected methods from organization theory. Project managers can identify project

complexities by building resilience through risk management and contingency planning, developing a culture of learning and adaptation, encouraging collaboration and communication among project stakeholders, and flexible project management approaches. Contingency management in project management involves identifying and addressing potential risks and uncertainties through effective project planning, risk assessment, and allocating management services (Tiwari & Suresha, 2021; Urbański et al., 2019). By taking a contingency approach, project managers may respond better to unexpected events, mitigate risks, and ensure project success.

Project contingency theory probes into how uncertainties and unforeseen circumstances can affect the success and results of a project. It recognizes that projects operate in dynamic and uncertain environments and that adapting and responding to these uncertainties is crucial for project success (Jia et al., 2023). Furthering these dimensions of project contingency, Boonstra and Reezigt (2023) suggested that the effectiveness of project management practices and strategies depends on the fit between the project's characteristics and the management approach employed. Additionally, this highlights the importance of flexibility and adaptation in project management, as different projects may require other methods based on their unique circumstances and contingencies (Jia et al., 2023).

Shash et al. (2021) posited that the identification and management of risks and uncertainties in projects are complex tasks underscored by contingency theory. Their study was conducted using a case study analysis of a construction project in Malaysia.

Shash et al. compared the analytical hierarchy process and multicriteria decision making for cost contingency prediction and evaluated their effectiveness. The theoretical basis for the research was the need for accurate cost contingency prediction, which is crucial for project success and profitability. Their study considered other factors affecting cost contingency prediction, such as project complexity or uncertainty. Fernandes and O'Sullivan (2023) highlighted the importance of considering a range of factors and perspectives when determining the appropriate level of contingency for a project.

In comparison, Patil et al. (2023) determined that in contingency theory, the effectiveness of project management practices and strategies can be influenced by organizational context. Factors such as the sector of activity, organization size, geographic area, and project types can impact the applicability and effectiveness of project management improvement initiatives and embedding factors. Therefore, it is essential to consider these contextual factors when implementing project management practices and strategies.

The project contingency theory offers a theoretical point of view to comprehend and handle project uncertainties and contingencies (Boonstra & Reezigt, 2019). Additionally, project contingency theory considers internal, external, and environmental factors when managing a project (Sing et al., 2022). It accentuates the need for flexibility, adaptation, and proactive risk management to enhance project success. Incorporating the unique characteristics of a project and its organizational context is essential for project

managers to make sound decisions and execute successful strategies that mitigate risks and uncertainties.

Internal Factors

Internal factors are elements within an organization or project team that can influence the success of a project (Mohajeri et al., 2023). Ajibike et al. (2022) quantitatively analyzed survey data collected from oil and gas employees. The authors' primary conclusion was that internal factors play a significant role in project management and can affect the application of project contingency theory. Moreover, Ajibike et al. found that these factors include elements within an organization or project team that can influence the success of a project, such as the skills and competencies of project team members, the organizational culture, communication and collaboration among team members, and the availability of resources. A project team with strong technical skills and a culture that promotes open communication will likely complete a project on time and within budget (Oh & Choi, 2020; Swart et al., 2022).

External Factors

External factors are elements outside of an organization or project team that can impact the success of a project (Oh & Choi, 2020). External factors play a significant role in project contingency theory, as they can impact the success of a project and require project managers to adapt their strategies accordingly (Leeman et al., 2022). Maqbool et al. (2022) discussed the influence of internal and external stakeholders on the success of renewable energy projects. Using stakeholder management theory to ground their study,

the authors surveyed renewable energy professionals in Pakistan to examine the impact of stakeholder satisfaction and five critical success factors on the industry. Maqbool et al. noted the role of effective practices, including communication, team, organizational, and environmental factors, in improving project performance. A project's success and efficiency rely on internal and external factors that can provide valuable insights for project management and decision-making.

Kassem et al. (2020) discussed external risk factors contributing to project failure in developing countries' oil and gas construction projects. These factors include political instability, lack of skilled labor, and the hazardous nature of the industry. The authors postulated that external risk factors significantly impact project success and are influenced by project characteristics. Expanding upon external factors, Nevstad et al. (2021) investigated how project managers could improve partnering strategies to achieve better project success. The survey conducted by the author involved 124 engineering consultancies that had a stake in ongoing multipartner projects. The survey aimed to measure individual-level perceptions of collaborative behaviors. Nevstad et al. discussed the significance of early planning, continuing monitoring, and assessment to ensure the effectiveness of partnership methods. While Nevstad et al. did not account for external factors such as market conditions or regulatory environments, they found that the level of success in partnering is positively correlated with project performance, including cost, schedule, and quality outcomes. The authors concluded that a range of factors, including trust, communication, commitment, and compatibility, influence the success of partnering

in project management. Prioritizing trust and communication between partners is crucial for productive partnership and project performance, making it a key responsibility for project managers.

External factors to the organization or project, such as the political and economic environment, may bear significant implications for the eventual outcomes of a project, offering a refined viewpoint that insinuates that the interaction between these external elements and the performance of the task might exhibit variation based on the particular context (Kaufmann & Kock, 2022). Project management, therefore, necessitates an acute sensitivity to these external factors and a readiness to adapt strategies in response to evolving circumstances. As these factors intersect with project characteristics, they amplify the complexity of the management task, underscoring the importance of robust practices such as effective communication, trust building, and strategic planning (Lubis, 2021; Montenegro et al., 2021). Understanding this relationship between external factors and project performance can equip project managers with critical insights for decision making, facilitating more effective and context-responsive project management strategies.

Environmental Factors

Environmental factors, such as political, economic, and social, refer to external factors influencing project success (Hussain et al., 2021). These factors can impact the project in various ways, such as affecting the availability of resources, changing regulations, or altering stakeholder expectations. Qazi (2022) posited that project

complexity significantly impacts project performance, and the impact is multidimensional. Through statistical analysis of survey data gathered from 102 construction projects in Pakistan, Qazi identified the factors that lead to project complexity and their effects on project performance. They highlighted the number of external stakeholders, the variety of external stakeholders' perspectives, internal strategic pressure, and project environment instability as some elements of environmental complexity.

A notable observation by Qazi (2022) is the size of the CAPEX and the size of the project team. Expanding upon cost and team, Mohd Roshdi et al. (2022) found that managing money and maximizing all resources are the most crucial aspects of resource allocation, building upon the previous considerations of cost and team. Their study consisted of a literature review of cost issues, questionnaires, and semistructured interviews with engineering, procurement, and construction professionals. There needs to be more resource management and consistent allocation by construction management, which were the main reasons for the increase in costs. The authors recommended that management create a framework based on available resources to enhance project cost control performance. Project managers should consider environmental factors and their complexity when assessing and developing strategies to mitigate the negative impact on project performance (Li et al., 2019).

Front-End Engineering Design

The FEED phase of projects, particularly in the context of industrial chemical plants, plays a crucial role in planning and design. It involves various activities and considerations where stakeholders define the project's objectives, scope, and feasibility that are essential for the successful execution of the project. Several studies have focused on different aspects of the FEED phase of the project in the industrial chemical plant sector. Takahashi and Takahashi (2022) analyzed the dynamic of front-end development in the co-creation process with multiple stakeholders. Williams et al. (2019) explored the concept of front-end projects, determining it is a critical phase of project management. Siriram (2022) focused on integrating and transitioning the project front-end and project phases in South African electrical engineering industrial projects.

Gibson et al. (2023) posited that the maturity of FEED has proven to impact cost growth, change orders, and other key project performance metrics. The authors' objective was to measure the accuracy of FEED and its impact on various aspects of project performance, including cost, schedule, change performance, financial performance, and customer satisfaction. The authors identified 27 factors to objectively and scalable measure FEED accuracy. Projects with high FEED accuracy outperformed those with low accuracy by 20% in approved budgets. Those with low accuracy by 20% in terms of their approved budgets.

A critical aspect of the project FEED is risk assessment. Marković et al. (2021) developed a risk assessment model for wastewater treatment plants' planning and design

processes. This model is particularly relevant in the initial phases of the project when the investor starts the project and during the design phases. By incorporating risk assessment into the front end of engineering design projects, potential risks and uncertainties can be identified and mitigated, leading to more successful project outcomes.

Effective planning and scheduling are other critical factors in the project FEED. Seddeeq et al. (2019) studied time and cost overrun in the Saudi Arabian oil and gas construction industry. The results highlighted the importance of adequate planning and scheduling of the project by contractors to avoid delays and cost overruns. The study identified poor site management and supervision, problems with subcontractors, and inadequate planning and scheduling as significant causes of delays. To ensure project success, stakeholders must prioritize proper planning and scheduling during the FEED phase.

Another concept highlighted in the initial stages of engineering design projects is constructability. Al Hamadani et al. (2022) discussed applying constructability practices in the construction industry. Constructability involves integrating new construction methodologies into project phases, including planning, design, and engineering. By implementing constructability practices during the front-end phase, projects can achieve cost savings of 10-20% and improve overall project efficiency.

In addition to risk assessment, planning and scheduling, and constructability, the project FEED in the industrial chemical plant sector also involves safety and disaster management considerations. Rebeeh et al. (2019) conducted a literature review on

disaster management in industrial areas. The study highlighted the importance of incorporating disaster management practices into all project phases, including the front-end phase. By considering potential hazards and implementing appropriate safety measures during the front-end phase, the sustainability of operations and the safety of facilities and the surrounding population can be ensured.

Managing information flow and design processes is another critical aspect of the FEED phase, particularly in offsite construction projects. Sutrisna and Goulding (2019) researched offsite construction projects and identified the information requirements and associated risks in the design process. The study highlighted the importance of information flow from various project stages, including design, offsite manufacturing, handling and transporting, site works, and installation. By understanding and managing these information flows, design risks can be reduced, improving project outcomes.

The project FEED is a critical phase that requires careful consideration of various factors. These factors include risk assessment, effective planning and scheduling, constructability, and safety and disaster management. By addressing these aspects during the front-end phase, project stakeholders can enhance project outcomes, minimize delays, and cost overruns, and ensure the safety and sustainability of the project.

Project Management: Project Complexity

Boonstra and Reezigt (2019) postulated that complexity theory can be used to understand project complexity and predictability. They not only theorized the connection but went further to develop a well-defined model. This model can be a reliable and valid

instrument for project managers, enabling them to accurately diagnose project complexity and predictability. The utility of such a model lies in its ability to assist managers in making well-informed decisions and strategically taking appropriate actions to mitigate project failures, a common obstacle in complex projects.

Building on their insightful work, Boonstra and Reezigt (2023) introduced a comprehensive complexity framework specifically designed for project management. This innovative framework considers various integral elements, such as the project's content, the internal context within which the project operates, and the influencing external environment. Doing so affords crucial personnel the ability to devise a more robust and improved project management strategy, complete with associated protocols, thereby offering a tailored approach that addresses the unique demands of individual projects. This work resonates with other researchers who have made noteworthy strides in proposing different project complexity frameworks.

Kermanshachi et al. (2020) took a methodical approach in presenting the Project Complexity Assessment and Management Framework (PCAMF). This framework distinguishes itself by including 10 well-defined dimensions of project complexity, such as technical aspects, organizational structures, and stakeholder relations. They provide compelling arguments that if project managers effectively utilize the PCAMF, they will gain an intricate and comprehensive understanding of the various facets of complexity. This, in turn, equips them to craft specific strategies and solutions tailored to address these multifaceted complexities.

According to Bathallath et al. (2022), project complexity encompasses other dimensions, such as technical complexity, stakeholder complexity, and information complexity, which is not explicitly addressed in the PCAMF. There is also a lack of guidance on effectively managing project complexity. While the framework classified project complexity, it may not offer specific strategies or approaches for dealing with the identified complexities. Bathallath et al. hypothesized that projects are dynamic and evolve, and the complexity they face may change throughout the project lifecycle. This suggests that focusing on structural and dynamic complexity may not capture the changing nature of complexity in projects, which can limit its applicability in dynamic project environments.

Sing et al. (2022) introduced another contribution with their framework, focusing on four dimensions to classify project complexity. They articulated that their more concentrated framework has the potential to be applied in crafting tailored project management strategies designed to address the complexity identified through classification. The benefit of this approach is its ability to provide a targeted and specific response to the complexity at hand. However, some researchers argue that these dimensions may only partially capture the multifaceted nature of project complexity. Dawande et al. (2019) suggested that other dimensions of complexity, such as organizational and information complexity, may need to be explicitly addressed in the framework.

Another area for improvement is the need for practical guidance on managing and mitigating project complexity. While the framework classifies project complexity, it may not provide specific strategies or methods for addressing the identified complexities. Knickel et al. (2019) argued that the framework should be complemented with practical tools and techniques to help project managers navigate and address the identified complexities. Additionally, the framework may need to consider the temporal aspect of project complexity adequately. Projects are dynamic and evolve, and the complexity they face may change throughout the project lifecycle. Shi et al. (2020) suggested that the framework should incorporate a temporal dimension to account for the changing nature of complexity in projects. Addressing these weaknesses can enhance the framework's applicability and effectiveness in managing project complexity.

Vaz-Serra et al. (2021) furthered the discourse by presenting an early-stage project complexity assessment tool grounded in four key complexity dimensions: technical, organizational, stakeholder, and external factors. They emphasized the practicality of their tool, highlighting its efficacy in pinpointing potential risks and challenges early in a project's life cycle, informing decision-making processes, and allowing for proactive measures.

Along the same line of thought, A. Nachbagauer (2021) designed a nuanced framework for managing complexity in a project, comprising contextual understanding, shared understanding, and adaptive approaches. Their work adds layers to the ongoing discussions on complexity by introducing a system emphasizing collaboration and

adaptability. However, one area for improvement of the framework is that it may not fully capture the multifaceted nature of project complexity. Projects often involve various other dimensions of complexity, such as technical, organizational, and stakeholder complexity, which must be explicitly addressed in the framework (Adel & Cleveland, 2021). Furthermore, the nuanced framework may need a comprehensive assessment of the interdependencies and interactions among different dimensions of complexity. This limitation may hinder the comprehensive understanding and management of complexity in projects. Nachbagauer's nuanced framework for managing complexity in a project provides a valuable starting point for understanding project complexity, but it has specific weaknesses. Addressing these weaknesses can enhance the framework's applicability and effectiveness in managing project complexity.

Peñaloza et al. (2020) proposed a framework tool to monitor project complexity and resilience continuously. Their framework uses the Cynefin framework in categorizing projects as simple, complicated, and complex domains within repetitive and non-repetitive projects. The innovation of their approach lies in a proactive monitoring capacity, enabling project managers to identify potential issues at early stages and take corrective action promptly, which is vital in improving project outcomes. However, Di Luozzo et al. (2023) suggested that the Cynefin framework may not fully capture the nuances and interdependencies of real-work situations.

Another area for improvement of the Cynefin framework in this use case is its limited focus on crisis management. The framework is primarily designed to guide

decision-making during crises but may not provide comprehensive guidance for long-term resilience and sustainability planning (Sawyerr & Harrison, 2019). Additionally, the Cynefin framework may not fully consider the unique characteristics and challenges of specific industries or sectors. In the case of the construction sector, for example, the framework may not account for the temporary nature of projects and the complex working arrangements that can impact the implementation of crisis measures (Stiles et al., 2021). The framework's generalizability across different industries and sectors may be limited, and industry-specific considerations may need to be incorporated for more effective decision-making.

These contributions shed light on the intricate nature of project complexity, offering an array of methodologies and tools that have progressively shaped the field's understanding. The emphasis on a comprehensive understanding and distinct approaches, though varying in their specifics, aligns with a unified task of providing effective strategies for project managers through the unpredictable terrains of project management. Transitioning from these frameworks, it becomes paramount to delve deeper into the domains and dimensions that constitute project complexity, providing a finer granularity of the challenges and strategies at hand.

Domains of Project Complexity

In the context of project complexity, domains refer to areas of influence or knowledge that contribute to the overall intricacy and difficulty of managing a project. While structural and dynamic complexity are dimensions of project complexity, some

domains include technological, organizational, stakeholder, and environmental factors (Luo et al., 2020; Ma & Fu, 2020; Peñaloza et al., 2020; Wickert et al., 2021). Understanding the domains of project complexity is crucial for project managers and stakeholders to plan, execute, and control projects effectively. To ensure successful project outcomes, the team should analyze the factors within each domain and design effective strategies to minimize risks and promote clear communication. Awareness of technological complexity can help project teams allocate resources and expertise appropriately. At the same time, an understanding of stakeholder factors can aid in determining the effectiveness of project management processes and communication within the organization. By thoroughly evaluating and addressing the domains of project complexity, project managers may increase their ability to negotiate the challenges and uncertainties inherent to complex projects.

Technological. Technological complexity is a critical factor that significantly contributes to the overall complexity of a project. Luo et al. (2020) defined technical complexity as the challenges and intricacies associated with the technology utilized in a project, including the level of innovation, integration with existing systems, and the specialized knowledge or skills required for implementation. The project's scale further influences this complexity, the number of stakeholders involved, and the degree of interdependence between different technological components.

Additional research by Ma and Fu (2020) corroborates the impact of technological complexity on project outcomes, revealing a strong correlation between

high levels of technical complexity and adverse effects on cost, schedule, and quality in mega-construction projects. Sing et al. (2022) further elaborated on the interconnectedness of technological complexity with other dimensions, such as organizational and environmental complexity, emphasizing the need for tailored management strategies.

Consequently, technological complexity is not an isolated factor but is often intertwined with other dimensions like organizational and environmental complexities, requiring a multifaceted approach for effective management (Hafseld et al., 2021). Therefore, adept understanding and strategic management of technological complexity are not optional but imperative for project managers, as they not only influence the selection of appropriate project management strategies but also have a demonstrable impact on the project's success in an increasingly complex and technologically advanced environment.

Organizational. The organizational domain is a crucial facet that encompasses elements such as the structure, culture, and governance of the organization undertaking the project. Kaufmann and Kock (2022) conducted an extensive study involving 917 project status reports to explore the causal impact of project management efforts on project profitability. Their research revealed that organizational factors, particularly size and complexity, significantly influence project success. Micán et al. (2020) further elaborated that large and more complex organizational structures often face heightened

challenges in project management, requiring increased allocation of both human and financial resources.

Additional insight by Orlandi et al. (2020) emphasized the challenge of aligning project management with organizational strategy in complex structures. They argued that misalignment can lead to the wasteful allocation of essential resources. Blomfield and Vakili (2023) also highlighted the complexity of resource allocation, especially in organizations managing multiple projects, stating that effective resource allocation is vital for the efficient use of resources and successful project implementation.

Therefore, the organizational domain of project complexity is not a standalone element but is deeply interconnected with other facets like resource allocation and strategic alignment, necessitating a comprehensive approach for effective management (Fernandes & Araújo, 2022; Turner & Miterev, 2019). Consequently, a nuanced understanding and strategic management of organizational factors are not merely beneficial but essential, as they directly impact the allocation of resources, alignment with organizational strategy, and, ultimately, the success or failure of projects in complex organizational settings.

Stakeholder. The stakeholder domain is a pivotal area that includes the diverse stakeholders involved in a project and their varying interests, expectations, and power dynamics. Mwesigwa et al. (2019) asserted that stakeholder factors significantly contribute to project complexity. They emphasized the need for effective communication, negotiation, and stakeholder management skills to navigate the often-conflicting interests

and achieve project objectives. This domain encompasses the various stakeholders involved in a project, including their interests, expectations, and power dynamics. Irfan et al. (2019) posited stakeholder conflicts in the construction industry are positively correlated with project constraints like cost, time, and resources, and they can be triggered by various factors such as poor contractor management, delayed payments, and lack of communication. To mitigate these conflicts and their detrimental effects on project outcomes, effective communication, realistic time and cost estimates, and proper resource allocation are essential for the project management team.

Rankinen et al. (2022) highlighted that complex projects, such as positive energy district projects, are fraught with uncertainties due to emerging technologies and the involvement of multiple stakeholders with diverse positions and requirements. This complexity necessitates a heightened focus on stakeholder analysis and management. T. S. Nguyen et al. (2021) added another layer to this discussion by emphasizing the importance of stakeholder engagement in complex projects. They pointed out that stakeholder interrelationships can be a specific source of complexity, and inadequate mutual understanding among stakeholders can harm project success.

The stakeholder domain is not an isolated factor but is intricately linked with other dimensions of project complexity, requiring a multifaceted approach for effective collaboration with stakeholders (Malik et al., 2020). Consequently, mastering the complexities of stakeholder engagement, communication, and management is not merely

an optimal skill for project managers but an essential competency, as it directly impacts the project's success, particularly in complex and multi-stakeholder environments.

Environmental. Environmental factors contribute significantly to project complexity by introducing uncertainties and risks that must be managed and mitigated. These environmental factors encompass various physical and social aspects of the project location, including topography, climate, natural, political, economic, and regulatory factors (Maqbool & Akubo, 2022; Onubi et al., 2019). The complexity of the project environment, such as economic, social, and political factors, can directly impact the overall complexity of the project. External environmental factors affect the project externally and are beyond the direct control of the project management team and have been found to have a noteworthy impact on project success (Hussain et al., 2021). These factors include political, economic, and social factors at the macro level.

The influence of environmental factors on project complexity can be further understood by examining the relationship between project complexity and other dimensions. Environmental complexity is often considered one of the main factors of project complexity. It is part of a broader spectrum of project complexities, including organizational complexity, uncertainty, dynamic complexity, intra-organizational complexity, marketing complexity, temporary complexity, development complexity, and structural complexity (Andringa et al., 2022a; Zhao et al., 2021). These complexities interact with each other and contribute to the overall complexity of the project.

The impact of environmental factors on project complexity can also be seen in the context of risk management (Maqbool & Akubo, 2022). In complex and significant civil engineering projects, the risk exposure environment constantly changes due to external factors and objectives. Such projects' risk and uncertainty management must be continuous, holistic, and real-time throughout the life cycle. This highlights the need for managers to constantly assess and manage the environmental risks and uncertainties that can arise during the project.

Furthermore, external environmental factors influence the relationship between project complexity and the project (Hafseld et al., 2021). Project managers' personality traits, such as extraversion and openness, are positive predictors of success, and external factors, such as political, economic, and social factors, moderate the relationship between personality traits and project success. This suggests that external environmental factors can either enhance or hinder the impact of project managers' personality traits on project success. Understanding and managing environmental factors are necessary for project success, as they directly influence risk profiles and interact with other complexities, even moderating the effectiveness of project management competencies.

Dimensions of Project Complexity

Project management is replete with complexities that manifest in various dimensions, each with unique characteristics and implications for project outcomes. Project complexity can be measured and analyzed in multiple dimensions. A dimension represents a single aspect or characteristic of a domain that can be measured or analyzed.

This section aims to dissect the intricate layers of project complexity, focusing on key dimensions such as structural, dynamic, uncertainty, emergent, and socio-political complexities drawing upon seminal works in the field, including those by (Boonstra & Reezigt, 2023; Gautam & Kiridena, 2019; Rezende & Blackwell, 2019).

Structural Complexity: The Bedrock of Project Outcomes. Structural complexity serves as a cornerstone in the landscape of project management, profoundly influencing the trajectory of project outcomes. As delineated by Boonstra and Reezigt (2023), structural complexity is quantified by the size, variety, and interdependence of the components within a project, making it a subset of project complexity and dynamic complexity. The complexity escalates as the number of elements and their interdependencies increase, encompassing various factors such as system hierarchies, system integration, and team interactions. These factors necessitate specialized management strategies to effectively navigate the intricate web of relationships and dependencies, directly impacting the project's success or failure (Andreev et al., 2022).

There is a significant distinction between structural and dynamic complexity in project management, each having unique implications for project execution. According to Andreev et al. (2022), structural complexity pertains to the intricacy of project elements, encompassing their degree, number, heterogeneity, and interrelatedness. This complexity often manifests in a project's organizational and technological aspects, requiring a focus on system hierarchies and integration. On the other hand, dynamic complexity is characterized by the uncertainty surrounding project methods and goals, influenced by

the level of dependable and accessible knowledge about future outcomes. Understanding these forms of complexity is essential for project managers, as it informs the selection of appropriate management strategies and risk mitigation approaches, thereby impacting the project's overall success (Boonstra & Reezigt, 2023).

Managing structural complexity in projects is crucial for successful project delivery (Luo et al., 2020). Understanding and addressing structural complexity can help project managers select appropriate project management strategies (Boonstra & Reezigt, 2023). Boonstra and Reezigt proposed a complexity framework for project management strategies that aids in determining project management strategies based on the level of structural complexity and dynamic complexity. This framework categorizes projects into four generic types based on complexity and identifies corresponding project management strategies. In project management, skillful comprehension and handling of structural intricacies are imperative. These factors shape the choice of appropriate project management tactics and significantly impact the project's overall success. Therefore, it is crucial to cultivate the necessary abilities for effective management.

To effectively manage structural complexity, project managers must possess the necessary competencies (Khattak & Mustafa, 2019). Competencies such as leadership, management skills, communication skills, effectiveness, and result orientation are required to manage the complexities of a project. Khattak and Mustafa's research on the management competencies, complexities, and project performance of engineering infrastructure projects has revealed a significant correlation between management

competencies and complexities and project performance. Developing the appropriate management skills can assist project managers in dealing with complex structures and enhancing project outcomes.

Dynamic Complexity: Navigating Uncertainty and Ambiguity. Dynamic complexity is distinguished by its focus on the uncertainties and ambiguities surrounding project objectives and methodologies. This complexity often manifests in the project's organizational and technological aspects, requiring a focus on system hierarchies and integration (Andreev et al., 2022; Boonstra & Reezigt, 2023). The dynamic nature of projects introduces an element of unpredictability, thereby necessitating the adoption of risk mitigation strategies and agile management approaches to ensure project success.

Dynamic complexity in projects is a multi-faceted concept that encapsulates the unpredictable, nonlinear characteristics involving change, adaptation, and evolution. (Rezende & Blackwell, 2019) examined the complexity of Information System Development Projects (ISDP) from different perspectives. Task complexity considers the details and variables involved in the project's tasks. Organizational complexity looked at the frequency and pattern of changes in the project's organizational environment. These changes can affect user information needs, business processes, and organizational structures. Notably, traditional managerial processes, like risk management and change control, often need help to effectively handle the fluid nature of dynamic complexity because the scale and frequency of changes in various project elements can prove challenging to manage. Therefore, understanding and addressing dynamic complexity is

crucial for achieving project success, warranting more agile and adaptive management strategies (Butler et al., 2020; Hoerl et al., 2021; Onubi et al., 2019).

Emergence, or the spontaneous creation of new patterns or behaviors resulting from the interactions of different components within a system, is another aspect of dynamic complexity. Emergence can be observed in various biological systems and complex networks (Wang et al., 2019). The complex interactions during the coevolving dynamics of these systems lead to rich phase transition phenomena and novel physics. The multiscale structure of networks also plays a significant role in determining the behavior of emergent phenomena.

Chaos is another manifestation of dynamic complexity, characterized by sensitivity to initial conditions and unpredictable behavior. Chaotic systems exhibit complex and irregular dynamics, making long-term predictions challenging (Schmickl, 2022). The inability to predict emergent phenomena in a micro-to-macro way is often attributed to the pattern formation process, which is usually classified as weak emergence. Predictions of emergent phenomena can fail when made by microscopic models, highlighting the need for macroscopic mean-field models to capture these properties. In complex systems, understanding and adapting to elements like uncertainty, emergence, and chaos are not just academic exercises but practical necessities for organizations and researchers. This equips them to navigate better the inherent unpredictability and ever-changing nature of complex systems.

Uncertainty: The X-Factor in Project Complexity. Uncertainty in project complexity stems from many factors, such as fluctuating market conditions, stakeholder expectations, and changing requirements (Morgan & Nyonje, 2022; Vaz-Serra et al., 2021). Effectively managing uncertainty is not merely a recommendation but a prerequisite for project success. This involves resilient scheduling, leveraging advanced technologies like Building Information Modeling (BIM), and a comprehensive understanding of the different dimensions of project complexity.

Project uncertainty is closely related to project uncertainty about project inputs, such as requirements, and can affect project modeling, evaluation, and control (Fossum et al., 2022). Uncertainty can also arise from unknown variables in the project output, particularly in large-scale or research projects. A project's complexity can be affected by organizational complexity, technical complexity, and unpredictability (Joseph & Marnewick, 2021). The presence of uncertainty can make a project more complex. Therefore, it is crucial to have effective communication and perceive uncertainty to manage project complexity, according to (Vaz-Serra et al., 2021).

Managing uncertainty in projects is crucial for project success. Uncertainty can introduce risks that may influence the outcome of a project (Milat et al., 2021). Resilient scheduling is one approach to managing uncertainty in construction projects, aiming to improve the probability of reaching project goals despite uncertainty. Leveraging state-of-the-art technologies, such as building information modeling (BIM), can also help manage complex construction projects.

Project managers play a crucial role in managing project uncertainty. Insufficient project management standards can lead to project uncertainties, and the responsibility for managing project uncertainty lies with the project manager. Identifying and assessing project uncertainty factors is essential for project managers to effectively cope with uncertainty (Rankinen et al., 2022). Project managers should also consider the different dimensions of project complexity, such as technical and organizational complexity, in their management strategies (Joseph & Marnewick, 2021).

Understanding the relationship between uncertainty and complexity is essential in engineering management. Uncertainty can compound over time and hamper uncertainty resolution, increasing uncertainty during later project states (Kreye et al., 2022). Correctly identifying uncertainty types can reduce the adverse effects of uncertainty in later project stages. Misidentifying or masking types of uncertainty can lead to an increase in uncertainty in complicated engineering projects. In project management, especially in engineering situations, it is crucial to identify and manage uncertainties to reduce risks and tackle the challenges that may arise during a project. This is not just a suggestion but a requirement for success.

Emergent Complexity: The Unpredictable Nature of Project Interactions. Emergent complexity is characterized by the spontaneous and often unpredictable outcomes that arise from the interactions among various project components (Artime & De Domenico, 2022; Markolf et al., 2021). In infrastructure management and megaprojects, the ability to manage emergent complexity is not merely an optional skill

but a critical necessity. Mastery of various leadership competencies, such as adaptive and ambidextrous leadership skills, is imperative for navigating the complexities inherent in these projects.

Complex systems and emergent complexity are relevant in the field of infrastructure management. Infrastructure systems, which form networks and span across cities, exhibit complex interactions with other aspects of society and the environment, leading to unpredictable failures and cascading effects (Bondank & Chester, 2020). The complexity of infrastructure interdependencies and the emergence of failures underscore the need to understand and manage the interactions within these systems.

In megaprojects, (Damayanti et al., 2021) argued that emergent complexity is a crucial aspect that needs to be managed by project managers. The authors proposed that the leadership competency required to handle emergent complexity includes adaptive, flexible, and ambidextrous leadership skills. These skills enable project managers to accommodate changes and uncertainties during megaprojects. Additionally, the authors suggested that the theories of adaptive leadership, complexity leadership (entrepreneurial or innovation), emotional and social intelligence leadership, ambidextrous leadership, and agile leadership are all identified as relevant to managing emergent complexity in megaprojects. Therefore, in the context of megaprojects and infrastructure management, the mastery of various leadership competencies aimed at addressing emergent complexity is not an optional skill set but a critical necessity for project managers, as it equips them

to anticipate better, adapt to, and manage the unpredictable and nonlinear behaviors that inherently arise in complex systems.

Social-Political Complexity: The Human Element in Project Management. Socio-political complexity introduces another layer of intricacy, encapsulating stakeholder interests, power dynamics, and organizational politics (Fossum et al., 2022). Effective project management in this dimension involves a nuanced understanding of stakeholder analysis, power dynamics, and organizational politics. The project manager must skillfully navigate these complexities to ensure equitable stakeholder engagement and, consequently, the successful completion of the project.

Stakeholder analysis is an essential tool for understanding social-political complexity in projects. The process entails identifying and assessing the pertinent stakeholders and considering their influence and interest in the project (Onasanya et al., 2020). The power-interest matrix is commonly used to map stakeholders and determine their level of impact and engagement in the project. Stakeholders can be categorized as players, context setters, crowds, and subjects based on their power and interests.

Power dynamics play a significant role in social-political complexity. Dominant stakeholders with legitimate power and privilege can shape projects' trajectory to serve their interests (Eidt et al., 2020). This can lead to the marginalization of less powerful stakeholders, reinforcing existing power hierarchies. When making decisions regarding a project, it is vital to acknowledge power imbalances and ensure that all relevant stakeholder groups can participate equitably in the decision-making process.

Organizational politics also contribute to social-political complexity in projects. Stakeholders within the project context can have static and dynamic roles, interactions, flows, and interdependencies (Onasanya et al., 2020). Understanding the political landscape within an organization is essential for effective project management. Project managers must navigate organizational politics and build relationships with key stakeholders to ensure project success (Boutilier & Bahr, 2020). The success of projects is influenced by external environmental factors, including political, economic, and social factors (Hussain et al., 2021). These factors can moderate the relationship between project managers' personality traits and project success. Project managers must develop specific skills, including political and social skills, to navigate project complex social and political landscape (Sawadogo et al., 2022). In project management, it is essential to recognize and effectively handle the intricacies of social and political dynamics. This involves analyzing stakeholders, understanding power dynamics, and having a keen sense of organizational politics. By doing so, equitable stakeholder engagement can be ensured, leading to successful project completion in an ever-changing and complex environment.

Risk Management

Early risk identification is not merely a procedural step but a critical juncture that can determine the trajectory of a project. By identifying risks at the outset, project managers can formulate strategies to mitigate potential threats, thereby increasing the likelihood of project success. Zaman et al. (2019) underscored the importance of early risk identification by examining two key strategies: project flexibility and visibility.

Flexibility allows project teams to adapt to changes and uncertainties, thereby enabling the identification of emerging risks. Conversely, visibility ensures transparency and accessibility of project information, facilitating effective communication and collaboration among team members. These strategies are particularly crucial in high-stakes, complex environments like industrial chemical plants, where multiple variables interact unpredictably. Jalali Sohi et al. (2019) and Son (2022) further supported this by emphasizing the strategic integration of flexibility and visibility as indispensable for successful risk management in such settings.

The relationship between project complexity and risk is often intricate, especially in industrial contexts. Complex projects inherently possess numerous variables that can interact unpredictably, elevating the project's risk profile. For example, technological complexity could introduce equipment failure risks, while organizational complexity could lead to team coordination and communication risks. Maqsoom et al. (2020) explored this further by investigating the moderating role of complexity risk on project performance. The research by Maqsoom et al. indicated that the level of complexity in a project affects how outcome control and behavior control impact project performance. Specifically, complexity risk strengthens the positive relationship between outcome control and project performance but weakens the negative relationship between behavior control and project performance. This emphasizes the importance of accounting for complexity risk to improve project outcomes.

Andringa et al. (2022) and Tshering (2023) extend the discourse by emphasizing risk management's dynamic and continuous nature in complex projects. Tshering focused on major civil engineering projects where the risk environment is in constant flux due to external factors and evolving objectives. Andringa et al. examined the complexities in construction projects notably, technical, organizational, and external aspects, as significant sources of risks. Both studies advocate for continuous risk and uncertainty management throughout the project lifecycle. These findings suggest that understanding and managing complexity risk is not optional but a critical requirement for achieving successful project outcomes.

The identification and management of risks in the early stages of any project must be considered (Sarvari et al., 2019). It is necessary to identify and allocate risks in the early stages of the project to minimize their consequences on the outcome. Effective control measures must be implemented, and a constant risk assessment must be done to ensure the successful completion of complex projects. A thorough understanding of the complexities involved is also necessary for the smooth execution of the project. Therefore, it is imperative to prioritize risk management and take the steps needed to mitigate any potential risks.

Complexities and risks are often inevitable in large industrial projects, particularly those within the oil and gas sector. These challenges necessitate implementing effective management strategies to mitigate risks and improve project outcomes (Barghi & Sikari, 2020). One such strategy that has gained prominence is the integration of lean

construction principles into the Front-End Loading (FEL) methodology. Lean construction aims to streamline processes by eliminating waste and unnecessary activities, improving overall project outcomes (Pandithawatta et al., 2019). Implementing lean construction within the FEL framework is a proactive approach to complexity management in large industrial projects, making them safer, easier to manage, and quicker to complete. Therefore, adopting lean construction within the FEL framework is a critical step in enhancing the effectiveness and efficiency of large industrial projects.

The successful implementation of lean construction is more than merely a theoretical concept. It requires the practical application of specialized tools and techniques. Various tools such as Value Stream Mapping (VSM), Process Activity Mapping (PAM), and techniques like Failure Mode Effect Analysis (FMEA) and Pareto Analysis (PA) have been identified as instrumental in implementing lean construction effectively (Badreddine et al., 2022). These tools and techniques identify bottlenecks, prioritize areas for improvement, and facilitate the seamless integration of lean principles into construction projects. Hence, the strategic use of these tools is vital for the successful implementation and sustainability of Lean Construction practices.

While lean construction's theoretical and practical aspects are important, empirical evidence further strengthens the case for its implementation. There is a broad scholarly consensus that lean construction, often in conjunction with Integrated Project Delivery (IPD), significantly improves project outcomes and reduces risks (Alizadehsalehi et al., 2019; Aslam et al., 2020; Evans et al., 2023; Evans & Farrell, 2022; P. Nguyen &

Akhavian, 2019). Nguyen and Akhavian (2019) demonstrated that integrating lean construction and project delivery leads to enhanced quality, reduced waste, lower costs, and improved schedule performance. Given the empirical support, it is prudent for project managers to consider the integration of lean construction and integrated project delivery as a standard practice in large industrial projects.

Adopting and implementing lean construction and integrated project delivery is challenging despite the proven benefits and empirical support. Barriers to adoption include a lack of awareness, resistance to change, and lack of top management support (Aslam et al., 2020; Evans et al., 2023). These challenges necessitate targeted strategies for successful implementation. For instance, Aslam et al. (2020) recommended selecting and implementing lean construction tools and techniques by focusing on meeting immediate needs and adding practical elements. Evans and Farrell (2022) proposed a framework for implementing lean construction, integrated project delivery, and global integrated delivery on megaprojects, including key performance indicators and strategies for global initiatives. Therefore, addressing these challenges through strategic planning and execution is essential for reaping the full benefits of lean construction and integrated project delivery.

Project Success

Stakeholder engagement is a critical factor in the success of a project. Effective stakeholder engagement involves identifying key stakeholders, maintaining open communication, and ensuring stakeholder satisfaction. Ebekozien et al. (2023)

highlighted the significance of efficient stakeholder engagement in construction projects, as it enhances team collaboration and integrated project delivery. Similarly, Shaukat et al. (2022) emphasized stakeholder engagement and suggested firms should scrutinize project decisions from a sustainability perspective to enhance success. Stakeholder satisfaction is a crucial success factor in projects, as it has a greater impact on strategic value than information on project or corporate performance (Barbalho et al., 2019). Investing in the emotional intelligence of project managers may be used as a strategic lever to increase project success rates.

Project success depends heavily on emotional intelligence, especially when managing teams and stakeholders effectively. Project managers with high emotional intelligence levels are better equipped to handle the complexities and interpersonal challenges that often arise in complex projects, leading to higher success rates (Doan et al., 2020; Jamshed & Majeed, 2019; Montenegro et al., 2021). Emotional intelligence is important for individual team members but also for the collective emotional intelligence of the working team, which ultimately impacts performance (Jamshed & Majeed, 2019). Emotional intelligence has been found to affect trust, collaboration, and project success positively (Zheng et al., 2021). It is also considered crucial in effectively managing complex projects and delivering construction projects (Montenegro et al., 2021; Zhang & Hao, 2022). Emotional intelligence is a crucial factor in project management, impacting multiple aspects of the process rather than being solely an individual trait.

According to Mindeguia et al. (2021), emotional intelligence can enhance team effectiveness by mediating the relationship between management's transformational behaviors and employees' responses. Moreover, it mediates the relationship between project commitment and performance (Zhu et al., 2021). Emotional intelligence has also been identified as a preventive strategy for mitigating the detrimental effects of conflict in large-scale projects (Khosravi et al., 2020). Additionally, emotional intelligence has been linked to positive team emotional climate, passion, and positive affective events for team members (J. Yin et al., 2022).

Metrics and Key Performance Indicators (KPIs) are indispensable tools for evaluating and enhancing project success, particularly in the specialized context of industrial chemical plants. These quantitative measures offer an objective lens through which project performance can be assessed, areas of improvement identified, and data-driven decisions made to optimize outcomes (Kissi et al., 2019). Given the inherent complexities and unique characteristics of projects within industrial chemical plants, the judicious selection of metrics and KPIs becomes a critical success factor.

Project Monitoring and Evaluation (M&E) constitutes another pivotal aspect of project success evaluation, acting as a linchpin for effective project management. M&E practices facilitate tracking project progress, identifying deviations from planned objectives, and implementing corrective measures to ensure project success (Kissi et al., 2019). Moreover, M&E provides granular insights into project components such as cost, schedule, quality, and stakeholder satisfaction, enabling proactive risk mitigation

(Gadekar et al., 2022). Integrating M&E practices, underpinned by appropriate metrics and KPIs, is essential for preempting potential pitfalls and ensuring project success.

In industrial chemical plants, real-time metrics and KPIs have revolutionized project management. Real-time monitoring empowers project managers with current data, enabling timely decision-making to address emerging challenges (Akpan et al., 2020). Technologies such as 3D visualization and virtual reality further augment the utility of real-time metrics by offering immersive and interactive experiences that enhance stakeholder understanding and evaluation of project outcomes. Deploying real-time metrics and KPIs is particularly salient in complex projects, where timely interventions can differentiate success and failure.

The selection of metrics and KPIs should be multifaceted, encompassing various dimensions of project performance, including technical, functional, financial, and sustainability aspects (Kourtzanidis et al., 2021; Su & Cao, 2022). Each of these dimensions requires a tailored set of metrics and KPIs that can effectively measure the corresponding aspects of project performance. A comprehensive approach to metric selection is imperative for capturing the full spectrum of project performance and aligning it with broader organizational and sustainability goals.

Establishing a comprehensive framework or index system is advisable to maximize the utility of metrics and KPIs. This framework should be tailored to the specific characteristics and objectives of the project, as well as the needs and expectations of stakeholders (Kourtzanidis et al., 2021). It should encompass a well-defined set of

metrics and KPIs aligned with project goals and subject to regular monitoring and evaluation throughout the project lifecycle. A robust framework ensures that the metrics and KPIs serve not merely as isolated data points but as integral components of a cohesive strategy for project success evaluation.

Project success is a multi-dimensional endeavor that relies on effective stakeholder engagement, the role of emotional intelligence, and the strategic use of Metrics and KPIs. Stakeholder engagement is crucial for fostering collaboration and ensuring project sustainability. Emotional intelligence is not just an individual trait but a systemic factor that impacts team dynamics and overall project outcomes. It also mediates organizational aspects like conflict resolution. Metrics and KPIs offer an objective framework for evaluating project performance, and their effectiveness is amplified by real-time monitoring and a comprehensive evaluation framework. These elements collectively form a robust strategy, enabling project managers to tackle complexities and achieve optimal results.

Transition

In Section 1, I discussed how industrial chemical plant project managers mitigate project failure for project success. Throughout the literature review, complex strategies to mitigate project failure is verified. Section 1 is the foundation and includes several subsections. These subsections cover the background of the problem, the problem statement, the nature of the study, the research question, and the interview questions. Additionally, Section 1 contains the conceptual framework, operational definitions, the

significance of the study, and a review of professional and academic literature. In Section 2, the purpose statement, the role of the researcher, participants, research method and design, population and sampling, data collection instruments and techniques, organizational techniques, data analysis, and reliability and validity are presented. The findings of the study and recommendation are included in Section 3.

Section 2: The Project

Section 2 contains the purpose of the case study, the project outline, the protocol as well as the role of the researcher. I provide a description of the participants and the selection process, as well as the population and sampling method used. I offer a comprehensive explanation and justification for the research method, design, and techniques used to gather and organize the data. Additionally, I address ethical considerations and develop a plan to ensure the research's credibility, confirmability, dependability, and data saturation. Following the guidelines in Section 2 is crucial for ensuring the reliability and validity of the study and the resulting findings.

Purpose Statement

The purpose of this qualitative case study was to explore effective strategies used by industrial chemical plant project managers to mitigate project failures in detailed project execution.

Role of the Researcher

In this qualitative case study, I acted as the primary instrument for data collection, a role that is well-established in qualitative research (see Morse et al., 2002; R. K. Yin, 2018). The responsibilities of the researcher extend beyond mere data collection to include the design of the research framework, the formulation of research questions, and the assurance of the study's ethical integrity (Draper & Swift, 2011; Roberts, 2015). Data was primarily collected through semistructured interviews, which were designed to include 10 open-ended questions (see Flynn et al., 2018). This approach is consistent with

recommendations for achieving reliability and consistency in qualitative research. The interviews strictly adhered to a protocol outlined in Appendix A to ensure methodological rigor.

My specialization in business administration with a focus on project management brought a unique lens to this study. It is important to acknowledge that my academic and professional background may influence the research process with biases, whether overt or covert. Participants were selected from a pool of project managers with a history of successfully executing projects for over 4 years throughout each phase of execution for the organization. This selection process was conducted within the researcher's professional network. Ethical standards were maintained by adhering to guidelines set forth by R. K. Yin (2018) and the ethical principles outlined in the Belmont Report (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). Compliance with all institutional review board (IRB) protocols will also be ensured. Research ethics planning worksheets served as an additional guide to identify and mitigate potential biases. During the data collection phase, an interview protocol was employed to minimize personal biases and ensure the reliability and validity of the data (see Flynn et al., 2018; Roberts, 2015).

Given the potential biases that may arise from my role, several strategies were employed to mitigate their influence (see Noble & Smith, 2015). These strategies included member checking, transcript validation and review, and striving for data saturation. Additionally, I refrained from presenting any conclusions during the

interviews to allow participants to bracket their own experiences and preconceptions throughout the research process. This was designed to ensure that the data collected reflects the participants' perspectives rather than the researcher's interpretations.

I was the primary instrument for data collection in this qualitative study (see Morse et al., 2002). My responsibilities extended beyond data gathering to include the design of the research framework, formulation of research questions, and assurance of ethical integrity (see Draper & Swift, 2011; Roberts, 2015). Data was collected through semistructured interviews, following a protocol to ensure methodological rigor as recommended by Flynn et al. (2018). To address potential biases, participant selection was based on specific criteria (see Morse et al., 2002). Ethical standards were maintained through adherence to guidelines and protocols. Strategies such as member checking and epoché were employed to mitigate biases and ensure the validity and reliability of the data (see Noble & Smith, 2015).

Participants

In order to be eligible for my study, participants needed to be project managers who execute projects within an industrial chemical company. The project managers must be actively employed in the organization and lead the execution of capital projects through all phases of execution (i.e., study, FEED, detail execution, closeout). I conducted the study in the southern United States, where the industrial chemical company has operating facilities. Conducting semistructured interviews in an embedded case study involves selecting participants relevant to the case (Ampofo et al., 2019). The

sampling method was purposive, with the sample size determined by the number of eligible project managers within the company.

Participant recruitment was facilitated through an internal organization group for project managers. The group organizers have a mailing list and host regular meetings to present new information to subscribers. According to Gode et al. (2019), one way to conduct employee interviews is by engaging them through internal social media. Each potential participant was sent a letter outlining the research's purpose, participant selection criteria, data collection procedures, and questions (see R. K. Yin, 2018). Study participants were sent an electronic form to give informed consent before data-gathering interviews. Data sources included interviews with project managers and company project management documents. I followed the strategies R. K. Yin (2018) recommended that accommodate the schedules and availability of prospective interview participants. During in-depth interviews, I listened without interfering with participants' experiences or cases.

Research Method and Design

Research Method

Qualitative research methodologies are beneficial for exploring complex social phenomena and human behavior as they allow for a nuanced understanding of subjective experiences, social contexts, and intricate human interactions (Braun & Clarke, 2019; Denzin & Lincoln, 2018). Qualitative approaches are often employed to build theories, develop hypotheses, or delve into the lived experiences of individuals and communities (Roblek et al., 2019; Smith & Osborn, 2004). These methodologies are especially

relevant for studies that aim to understand social issues in-depth, offering a rich, contextualized understanding that often needs more quantitative approaches (Flick, 2018).

Quantitative methodologies, on the other hand, focus on numerical data and statistical analysis. These approaches are often employed in studies that seek to test hypotheses, measure variables, and generalize findings to larger populations (Creswell & Creswell, 2018). While quantitative methods offer the advantage of scalability and generalizability, however, they may fall short of capturing the full complexity of social phenomena (Bryman, 2016). Mixed methods research combines qualitative and quantitative approaches to provide a more comprehensive understanding of the research problem (Johnson & Onwuegbuzie, 2004). This methodology is beneficial when either method needs to fully address the research questions or objectives (Tashakkori et al., 2021).

In this study, I employed a qualitative methodology, explicitly utilizing a single-case study design. This decision is grounded in the work of R. K. Yin, 2018, who argued that case studies are particularly effective for investigating contemporary phenomena within real-world contexts. I considered two research designs: phenomenology and case study. Phenomenology focuses on understanding the essence of an experience from the perspective of those who have lived it (Creswell & Creswell, 2018; Moustakas, 1994). While phenomenology offers deep insights into human experiences, it may not be the most suitable for investigating specific strategies or practices within an organizational

context. On the other hand, a case study design was more aligned with my objective of examining risk analysis strategies employed during FEED from the perspective of project managers. Case studies allow for an in-depth exploration of a phenomenon within its real-world context, mainly when the boundaries between the phenomenon and context are unclear (Stake, 1995; R. K. Yin, 2018).

My choice to focus on an industrial chemical business as the single case in this study was strategic. It allowed me to explore project management strategies within a specific yet complex organizational setting. This focus enabled me to provide deep and contextually relevant insights, thereby contributing to the field of project management in industrial environments (see Turner, 2014). The qualitative methodology, specifically a single-case study design, was most appropriate for this study. It facilitated an in-depth understanding of risk analysis strategies in FEED within the specific context of an industrial chemical business. This approach aligned with my aim to explore the effectiveness of various project management strategies in addressing the complexities and challenges that project organizations face.

Research Design

Utilizing open-ended semistructured interviews in embedded case studies offers a robust methodological approach for the in-depth exploration of complex research topics (Darlow et al., 2022; Fusch & Ness, 2015). The open-ended nature of the questions allows participants to offer detailed, nuanced responses, thereby enabling researchers to delve into the intricacies of the subject matter (Smith, 2015). Semistructured questions

serve as a guiding framework, ensuring that the conversation remains aligned with the research objectives while still allowing for emergent themes (Burleigh, 2020; Dworkin, 2012).

In an embedded case study, the focus is often on a specific unit or aspect within a broader context, making semi-structured interviews particularly advantageous (Yazan, 2015). This approach facilitates the collection of rich, contextual data that illuminates the relationships, facts, and dynamics integral to the research framework (Ampofo et al., 2019; Baxter & Jack, 2015). The flexibility in conducting these in—person or remote interviews also accommodates various logistical constraints and participant preferences (Janghorban et al., 2014; MacKinnon et al., 2022).

Data saturation is a pivotal concept in qualitative research, referring to the point at which no new information or themes are observed in the data (Fusch & Ness, 2015). Data saturation ensures the comprehensiveness and validity of the study's findings (Guest et al., 2006). Researchers should be vigilant about reaching this point by conducting multiple rounds of interviews or incorporating additional participants until saturation is achieved (Saunders et al., 2018).

The design of the interview questions should elicit comprehensive and insightful responses. Researchers must avoid leading or biased questions that could skew the data (King, 2004). Follow-up questions can probe deeper into specific topics or clarify ambiguous responses (DiCicco-Bloom & Crabtree, 2006). Once collected, the data can be subjected to qualitative analysis techniques such as thematic analysis (Braun & Clarke,

2006; Salameh & Bass, 2022). This involves identifying patterns and themes within the data, which can provide valuable insights into the complexities of the case under investigation (Nowell et al., 2017).

When conducting an analysis, it is essential to maintain a rigorous approach. To achieve this, multiple sources of information, such as documents and observational data, in addition to interview data, must be utilized. Employing this methodological triangulation approach is crucial as it enhances the study's credibility, as Denzin and Lincoln (2018) and Carter et al. (2014) noted. Therefore, it is vital to ensure that all sources of information are thoroughly examined to provide an accurate and comprehensive analysis.

Population and Sampling

The study investigated the project management strategies employed in industrial chemical plants, explicitly focusing on project managers overseeing the execution of capital projects from initiation or FEED through project completion. The geographic scope of this study is confined to the southern United States, where the industrial chemical company under investigation operates (Creswell & Creswell, 2018; Palinkas et al., 2015). The sampling method employed in this study is purposive sampling, a non-probability sampling technique where participants are selected based on specific characteristics that serve the research objectives (Etikan, 2016; Patton, 2015). In this case, the sample size was determined by the number of project managers within the company who meet the eligibility criteria. Purposive sampling is beneficial for

specialized populations where specific expertise or experience is required (Robinson, 2014).

To be considered for inclusion in the study, participants had demonstrable experience in leading capital projects from initiation to completion. This criterion ensures that the participants have the requisite knowledge and expertise to provide insights that are both deep and contextually relevant (Coyne, 1997; Morse, 2015). The recruitment of participants was facilitated through the industrial chemical company, which provided access to project managers who met the study's criteria. This approach ensures a more streamlined and efficient recruitment process (Lavrakas, 2008).

Data saturation was closely monitored to ensure the validity and reliability of the study's findings. Data saturation in qualitative research is reached when no new information or themes emerge from the data (Fusch & Ness, 2015; Saunders et al., 2018). The study recruited participants until the data saturation was reached, ensuring the comprehensiveness of the data collected (Guest et al., 2006). The primary data sources for this study included semi-structured interviews with the selected project managers and a review of relevant company project management documents. Using multiple data sources enhances the study's credibility through methodological triangulation (Carter et al., 2014; Denzin, 2017). The interviews were held in person and one remotely due to logistical considerations. The setting chosen ensured confidentiality and comfort for the participants, thereby encouraging open and honest responses (Opdenakker, 2006).

Ethical Research

Informed consent serves as the cornerstone of ethical research involving human participants. It is incumbent upon the researcher to secure informed consent from all participants before their involvement in the study (Emanuel et al., 2000; Manti & Licari, 2018; World Medical Association, 2013). In this study, participants received a comprehensive consent form detailing the study's objectives, procedures, potential risks, and benefits. This form also included a clause allowing participants to withdraw from the study without penalty.

Participants were informed that they reserve the right to withdraw from the study at any stage without facing any repercussions. Should they have opted to withdraw, all their data would be immediately expunged from the study records (Fisher, 2023; Patton, 2015). While the primary incentive for participation is contributing to a body of knowledge that could benefit society, participants were also offered a summary report of the study findings as a token of appreciation for their time and insights (Grady, 2005; Resnik, 2020). To safeguard the ethical protection of participants, this study adhered to the principles of confidentiality and anonymity (Saunders et al., 2019; R. K. Yin, 2018). Each participant was assigned a unique identifier without personal or easily traceable information. This measure was implemented to prevent the traceability of participants by external parties (Saunders et al., 2019).

All collected electronic and hard copy data was securely stored. Electronic data was password-protected, and hard copy data was placed into a combination safe, as

Stewart and Shamdasani (2015) recommended. This data will be retained for 5 years post-study, after which it will be securely destroyed. To further ensure confidentiality, neither the identities of the participants nor the organization involved in the study will be disclosed. Approval number 12-12-23-1175957 was issued after Walden University's IRB reviewed and approved the research objectives and design. For this study, the organization will be referred to as *Company X* (Saunders et al., 2019).

Data Collection Instruments

In qualitative research, the researcher often serves as the primary instrument for data collection, acting as a conduit through which data is gathered, interpreted, and analyzed (see Creswell & Creswell, 2018; R. K. Yin, 2018). In this single-case qualitative study, I assumed the role of the primary data collection instrument, responsible for conducting semi-structured interviews and ensuring the reliability and validity of the collected data.

The primary method of data collection in this study was semi-structured interviews. This technique allows for collecting rich, context-specific data by enabling participants to express their views, experiences, and perceptions in a flexible yet focused manner (Feuerstein et al., 2010; Kallio et al., 2016). The interviews were conducted following a pre-established interview protocol, which is available in Appendix A. The protocol began with an opening question exploring the participant’s role and responsibilities. It was followed by a series of questions related to the central research question designed to explore the topic in depth (DiCicco-Bloom & Crabtree, 2006).

The semi-structured interview protocol facilitates a comprehensive exploration of the research topic. This approach ensures the discussion remains focused while enabling participants to share their unique perspectives (Galletta, 2013).

Several strategies were employed to enhance the reliability and validity of the data collection process. One such strategy was member checking, which involved sharing the transcribed interviews with the participants for verification (Birt et al., 2016; B. Smith & McGannon, 2018). This process allows the participants to confirm the accuracy of the data, thereby enhancing its credibility and trustworthiness. Additionally, a well-defined interview protocol contributes to the study's reliability by ensuring consistency across interviews (R. K. Yin, 2018). The interview protocol can be found in Appendix A.

Data Collection Technique

This study's primary data collection method is semi-structured interviews supplemented by audio recordings and a review of organizational documents. Semi-structured interviews are characterized by a blend of predetermined questions and the flexibility to explore topics in greater depth through follow-up questions (DeJonckheere & Vaughn, 2019; Jamshed, 2014). This approach allows for a nuanced understanding of the subject matter, allowing participants to elaborate on their experiences and perspectives (Rubin & Rubin, 2005). The interviews were conducted using a detailed interview protocol, which is available in Appendix A. This protocol outlines the step-by-step process during the interview, including the questions to be asked and the provision for audio recording (DiCicco-Bloom & Crabtree, 2006).

Some advantages of the chosen data collection technique are that it allows for in-depth exploration of the topic (Jamshed, 2014), provides flexibility to adapt to the flow of the conversation (DeJonckheere & Vaughn, 2019), and enables triangulation when supplemented with organizational documents, enhancing the study's validity (Flick, 2018). Disadvantages are the data collection and analysis can be time-consuming (Guest et al., 2013), and there is potential for interviewer bias (Kvale & Brinkmann, 2015).

To ensure the reliability and validity of the collected data, member checking was employed as a post-interview validation technique. After each interview, the audio was transcribed and cross-referenced with the notes taken during the interview. These transcriptions were then sent to the respective participants for review. Participants had the opportunity to confirm, augment, add to, or correct the transcriptions, thereby verifying the accuracy, completeness, and consistency of the gathered (Birt et al., 2016; Marshall et al., 2022).

Data Organization Technique

Effective data organization is crucial for the integrity and reliability of any research study. This study employed a multi-faceted approach to ensure meticulous data organization and management. This approach included using research logs, reflective journals, and coding software. Research logs were maintained to keep track of each participant's interview and the date it was conducted (Saldaña, 2021). This served as a chronological record of the data collection process. Reflexivity is an essential aspect of qualitative research, enabling the researcher to critically examine their biases,

assumptions, and interests in the study (Finlay, 2002; Gabriel, 2015). A reflective journal was maintained to document these self-examinations throughout the research process. After transcribing each interview, the data was coded using the specialized qualitative data analysis software NVivo. This software allows for categorizing data into themes and sub-themes, facilitating a more structured analysis (R.Gibbs, 2007; Sutton & Austin, 2015).

Research logs ensure that each step of the data collection process is documented, enhancing the study's transparency and traceability (Miles et al., 2020). The reflective journal allows for ongoing self-assessment, strengthening the study's credibility (Gabriel, 2015). Coding software streamlines the data analysis process, making it easier to identify patterns and themes (Sutton & Austin, 2015). All research-related documents, including transcriptions, research logs, and reflective journals, will be securely stored in cloud storage with multiple layers of encryption. Consistent with ethical guidelines, these documents will be permanently deleted after a retention period of 5 years (Corti et al., 2000).

Data Analysis

I employed methodological triangulation as the primary data analysis process in line with the case study research design. This approach involves using multiple data sources and methods, such as interviews and document analysis, to comprehensively understand the research topic (Abdalla et al., 2018; P. Fusch et al., 2018). Methodological

triangulation enhances the validity and reliability of the study by cross-verifying information and providing multiple perspectives on the subject matter (see Flick, 2022).

A sequence process for data analysis:

- Gather raw data from semi-structured interviews and organizational documents.
- Transcribe the audio recordings of the interviews.
- Employ open coding to identify preliminary themes and patterns (Corbin & Strauss, 2015).
- Conduct multiple iterations to refine themes and identify any missing information (Saldaña, 2021).
- Cross-verify the themes identified from interviews with the information gathered from organizational documents (Abdalla et al., 2018).
- Correlate the key themes with the existing literature and the study’s conceptual framework.

I used NVivo, a qualitative data analysis software, for coding. NVivo allows for efficient categorization and tagging of data, facilitating the identification of themes and patterns (Kuckartz, 2014; Paulus et al., 2014). The software's capabilities extend to handling large datasets, making it suitable for complex analyses. Once the key themes were identified, I correlated these with the existing literature and the study's conceptual framework. This step is crucial for situating the research findings within the broader academic discourse and validating the study's contributions to project management

(Tracy, 2020). After performing coding using NVivo, I exported the data into Microsoft Excel for further analysis.

Reliability and Validity

Reliability

Dependability in qualitative research refers to the stability and consistency of the research findings over time (Denzin & Lincoln, 2018; Lincoln & Guba, 1985). This study employed member checking of data interpretation and transcript review to address dependability. After transcribing the interviews, participants were allowed to review and validate the transcriptions and preliminary interpretations to ensure their viewpoints were accurately represented (Birt et al., 2016). This iterative process enhances the dependability of the research by ensuring that the data and interpretations are consistent and stable over time (Morse, 2015).

Credibility

Credibility is a cornerstone of trustworthiness in qualitative research, emphasizing the congruence between the participants' experiences and the researcher's representation of them (Shenton, 2004). Several strategies were employed to ensure credibility in this study. First, member checking was utilized, where participants could review the transcribed data and the researcher's interpretation to confirm the accuracy (Harper & Cole, 2015). This iterative process allows for the validation of the data and enhances the study's credibility. Second, methodological triangulation was applied, incorporating interview and organizational document data sources to cross-verify the findings (Carter et

al., 2014; Denzin, 2017). This multi-faceted approach strengthened the credibility by providing a more comprehensive view of the phenomena under study.

Transferability

Transferability refers to the applicability of research findings to other contexts or settings (Polit & Beck, 2010). To enhance the transferability of this study, a thorough and detailed description of the research context, methodology, and participant demographics is provided. This "thick description" allows future researchers and readers to make informed judgments about the extent to which the findings are transferable to other settings (see Amankwaa, 2016). Additionally, the use of purposive sampling is explicitly justified to aid in the assessment of transferability (Palinkas et al., 2015).

Confirmability

Confirmability in qualitative research refers to the degree to which others could corroborate the findings (Lincoln & Guba, 1985). To ensure confirmability, an audit trail documenting each stage of the research process was maintained (Belotto, 2018). This includes the rationale for methodological choices, data collection procedures, and decisions made during the data analysis (Busetto et al., 2020). The audit trail allowed for external verification of the research process, thereby enhancing its confirmability (Moser & Korstjens, 2018).

Data Saturation

Data saturation is a pivotal concept in qualitative research, indicating that no new information or themes are observed in the data (Fusch & Ness, 2015). To ensure data

saturation, this study continued data collection until no new themes or insights emerged. If new themes had arisen, additional interviews would have been conducted until saturation was reached (Guest et al., 2006). The attainment of data saturation enhances the depth and breadth of the study, contributing to its overall rigor and quality (Saunders et al., 2018).

Transition and Summary

In the preceding Section 2, the focus was on delineating the research framework for the case study under investigation. This included a reiteration of the study's objectives and a comprehensive description of my role as the principal investigator. The section also elaborated on the participant selection criteria, the population under study, and the sampling methodology employed. Furthermore, I provided a rigorous justification for the research method and design selected, outlined the sample size, and detailed the procedures for data organization and collection. Ethical considerations were integrated into the data collection framework, and I elaborated on the methodologies planned for data analysis. Additionally, strategies to ensure the credibility, confirmability, dependability, and saturation of the data were discussed.

Moving forward to Section 3, the emphasis will shift to the presentation and interpretation of the research findings. This section will offer multiple applications relevant to professional practices and will explore the broader implications these findings have for societal change. Moreover, Section 3 will feature actionable recommendations

derived from the study's outcomes, suggestions for future research endeavors, reflections on the research process, and a conclusive statement to encapsulate the overall study.

Section 3: Application to Professional Practice and Implications for Change

The purpose of this qualitative single case study was to explore what effective strategies industrial chemical plant project managers use to mitigate project failures. I focused on the various project management strategies in addressing the complexities and challenges in the early stages of project execution. I conducted four in-person interviews and one video conference interview with five project managers from the partner organization located in the southern region of the United States to collect data. The data collection included transcribed recorded audio from interviews, company documents, and guidelines, and was analyzed, and coded for emerging themes using NVivo 14 and Microsoft Excel. The thematic analysis revealed patterns and insights into the strategies used by project managers to prevent failures and support organizational viability.

The findings of this study suggest that proactive risk management, team involvement in decision making, careful scope management, and clear communication with stakeholders can enhance project success. These strategies promote a culture of preparedness, learning, and collaboration. The study's findings on project managers overseeing chemical plant projects could foster positive social change by influencing the economy of a community.

Presentation of Findings

The research question was the following: What strategies do industrial chemical plant project managers use to mitigate project failures in detailed execution? The analysis, grounded in the overarching research question, identified four salient themes

from the interview responses. These themes were (a) proactive complexity and risk management, (b) knowledge and expertise utilization, (c) project planning and scope management, and (d) stakeholder engagement and communication. Each theme emerged as a significant factor in addressing the research question, providing a comprehensive understanding of the subject matter under investigation. This thematic identification marks a pivotal step in the progression of the research, laying the foundation for further exploration and discussion within the academic paper.

Table 2 classifies themes from the study within the context of project contingency theory and domains and dimensions of project complexity. The table elements of project complexity are organized into themes, factors, domains, and dimensions, providing a structured overview that can assist in understanding and addressing the intricacies involved in managing complex projects. During the interviews and document review, a word cloud was generated to display the most frequently used words. Figure 1 displays this word cloud.

Table 2

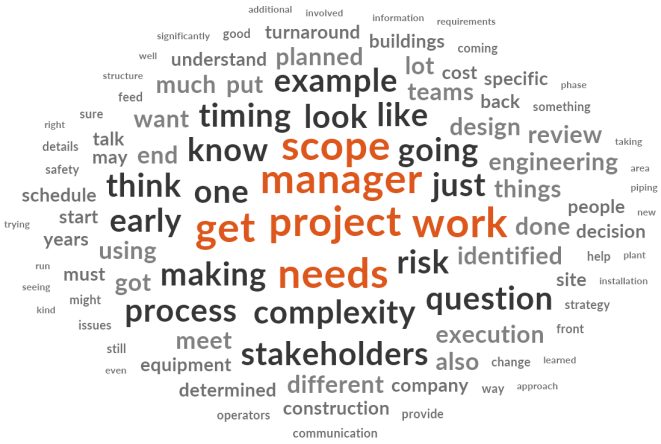
Themes Classifications

Themes	Factors of project contingency theory	Domains of project complexity	Dimensions of project complexity
Proactive complexity and risk management	External, environmental	Technological, organizational	Dynamic, uncertainty

Knowledge and expertise utilization	Internal, external	Technological, organizational	Structural, emergent
Project planning and scope management	Internal	Technological, organizational	Structural, emergent
Stakeholder engagement and communication	External	Stakeholder	Social-political

Figure 1

Word Cloud of Common Terms



Theme 1: Proactive Complexity and Risk Management

The first theme that emerged was proactive complexity and risk management. Each project manager identified the early stages of a project as crucial for spotting potential complexities and emphasized the importance of in-depth research and understanding of the project's scope. P1, P2, and P4 discussed the importance of collaboration and involving various stakeholders or experts to help identify potential

complexities early on. P5 also recognized the importance of early identification but focused more on defining the project's objectives and developing the scope to mitigate complexities. P5 shared an example of a schedule-driven project,

> We were tasked to implement a new feedstock to run trials in a limited timeframe. We organized field walks with a cross-functional team to identify the most suitable location for a skid, considering various factors such as the flammable nature of the material, maintenance footprints, existing firefighting infrastructure, and existing electrical hazard classifications. Ultimately, the chosen location did not require additional fire project scope, demonstrating the significant impact of early identification of complexities on the project's outcome.

P5's early involvement in the studies identified and their proactive approach to identifying potential complexities were crucial in successfully executing the project. P3 provided a detailed example of how early identification of material and structural complexities can significantly influence the project's outcome. P3 shared a past project experience,

> In the initial stages of the cooling tower project, the initial construction was performed with wood, which prompted a thorough inspection of the material's condition. Due to durability concerns, this early evaluation helped us decide against using wood for the replacement. We requested bids for both timber and fiberglass reinforced plastic (FRP). The comparison led to the selection of FRP, which was more robust and long-lasting. Another complexity identified early on

> was whether to replace the structure from the first splice above the water up to the deck. We determined that the contractor might face potential issues due to the weight of the new structure on the weaker wooden pieces at the bottom. We first decided to replace all the tower's exterior columns to mitigate this. This strengthened the tower, allowing the contractor to proceed with the interior replacement. The early identification of these complexities significantly influenced the project's outcome, underlining the importance of thorough initial assessment in project management.

Two other factors of the theme are risk management during execution and adapting project management strategies. Participants P1, P3, and P4 emphasized the importance of a proactive approach to risk management. P1 achieves this through maintaining strong relationships and effective communication with the team, while P3 leverages “previous experiences” and the company's risk management process to anticipate and mitigate risks. P2 monitors costs weekly and compares the percentage of the budget spent to the percentage of the project completed, while P5 develops a risk register and uses a change log to “keep track of any changes affecting the project's contingency fund.” P5 shared an example of adaptability to management risk during the execution phase of a past project,

> The project required significant pre-turnaround work to be completed within a tight schedule. When it became apparent that the pre-turnaround work was falling behind schedule due to supply chain issues and late material deliveries, we

> negotiated with the turnaround director for an additional two months of pre-turnaround construction time. To ensure this extension would not interfere with the turnaround group's preparation work, we provided a plot plan showing the remaining work fronts overlaid with the turnaround group's plot plan. The project was completed within the scheduled duration and budget, demonstrating effective risk management.

P1, P3, and P4 described adjusting their strategies based on technical aspects and the project's size. P3 described a "fit-for-purpose strategy that scales management processes" based on the project's needs. P4 adjusts strategies based on the project's complexity, explaining that "with more complex projects, a larger team requires more extensive communication." P1 leaves the technical decisions to the experts, focusing on how these decisions impact cost and schedule. P1 asserted, "I do not get emotionally attached to the technical aspects of how the project is executed, leaving those decisions to the technical experts."

I noted that Theme 1, centered on the importance of proactive complexity and risk management, aligned with the findings of Andringa et al. (2022), which delineated the intricate relationship between risk and complexity within construction projects, advocating for an integrated approach to managing these elements. All project managers interviewed in the industrial chemical plant domain agree that early risk detection, strategic mitigation efforts, and customized strategies tailored to specific project nuances are essential for success. This aligns with the findings of Maqsoom et al. (2020), who

suggested that structured control mechanisms are strongly correlated with improved project performance. Additionally, the emphasis by Tshering (2023) on the dynamic essence of risk management further corroborates the necessity of a forward-looking approach to complexity and risk management, underscoring its indispensable role in achieving project success.

The insights derived from Theme 1, focusing on proactive management of project complexities and risks, resonate strongly with the adaptive and responsive strategies advocated by contingency theory. Sawyerr and Harrison (2019) underscored the necessity of adaptability and forward-looking risk management, a perspective that is echoed by the participants who highlighted the critical role of engaging effectively with stakeholders, aligning with the theory's principles of situational adaptability. Moreover, the emphasis on the need for flexibility in managing projects and customizing approaches to meet evolving circumstances and stakeholder expectations, as discussed by Jalali Sohi et al. (2019), underscores the applicability of contingency theory's core tenets to real-world project management scenarios. This synthesis demonstrates the theory's relevance and practical utility in navigating the complexities and uncertainties inherent in project environments, validating the experiences and strategies of the participants.

Theme 2: Knowledge and Expertise Utilization

The second theme that emerged from the interviews was knowledge and expertise utilization for the project's accomplishment. This theme pertains to acquiring project-specific knowledge, learning from experienced colleagues, leveraging subject matter

experts (SMEs), and using expertise for complex problem solving. The skills and knowledge required can be acquired from various sources and from the lessons learned from unexpected project outcomes.

The project managers stressed the significance of comprehending the project's range, goals, and potential complications in managing them. P1's approach involves understanding “stakeholders' objectives and risk appetite,” providing a framework to manage complexities. Similarly, P5 starts by “defining the project's objectives and identifying potential complexities.” P2, on the other hand, prioritizes early alignment with stakeholders and “breaking down the project into manageable chunks.” They rely on subject matter experts, akin to P3 and P4, who “build competent teams” and gather input from the project team and stakeholders. P4 also “documents the decision-making process for future reference”. All participants affirmed the importance of clearly defining the project's scope and objectives, engaging with stakeholders, and seeking expert advice when managing project complexities.

Without using expertise in project management, it's difficult to achieve successful outcomes. All the participants unanimously agreed on the significance of project management expertise and its crucial role in achieving project objectives. P1, P3, and P4 indicated the significance of “technical specialists” in identifying potential complexities early on a project and making informed decisions. P3 explained, “pulling the right people together at the beginning of the project… look at the scope and technology to determine special needs.” Collaboration with internal and external experts regarding project scoping

and planning is also emphasized in P3 and P4. P4 shared a project experience about including stakeholders not typically considered.

> We sought to add a structure to a compressor deck. The project faced unexpected interruption due to budget cuts and design reevaluation. The initial design had to be scrapped because, after a discussion that included stakeholders from the turnaround group, we learned disassembly during future turnarounds or outages would be difficult. The project would require a complete redesign with a more complex structure, but it offers a better solution than the initial design. The primary lesson learned from this experience is ensuring that all the right stakeholders are in place in the initial phases to provide their input and perspective. Even those not typically considered.

Conversely, P2 and P5 underscored the significance of conducting comprehensive preliminary evaluations and modifying project management approaches to suit the distinct conditions of each undertaking. Additionally, they emphasized the importance of engaging team members during suitable project phases. However, gaining knowledge is a complex process as sometimes the knowledge is too complex to acquire. Sometimes, there is a wide gap between the problems and perceived solutions. To deal with such complexity, the knowledge should be comprehensive. In this regard, P4 described their approach as “beginning with gathering input from the project team, various stakeholders, and discipline experts to determine the best course of action.” P2 stated, "At the end of

the day, you get a holistic look at the project when you put all those smaller pieces back together… Many disciplines are involved in that project."

The insights from Theme 2, juxtaposed with the scholarly landscape, underscore a unanimous recognition of the pivotal role of knowledge and expertise in navigating the intricacies of project management. The emphasis by study participants on the importance of thorough due diligence, robust preparedness, meticulous organization, and early, proactive engagement within project teams mirrors the scholarly assertions posited by Silvestre et al. (2020), regarding the instrumental role of knowledge and expertise in overcoming project challenges and optimizing outcomes. This concurrence is further supported by Fernandes and O'Sullivan (2023), who highlighted the indispensable contribution of knowledge and expertise to effective project management and complexity reduction. Moreover, the literature, as evidenced by Tiwari and Suresha (2021), suggested that the innovative application of knowledge can significantly mitigate project risks and enhance flexibility, thereby improving project performance. Expertise and early engagement are critical for successful project management.

The exploration of Theme 2, which focuses on the utilization of knowledge and expertise, distinctly echoes the principles outlined in the conceptual framework of contingency theory. Participants prioritize adaptability, proactive responses, early risk identification, quality control, safety measures, and stakeholder communication. These align with contingency theory's situational-responsive ethos, as noted by Boonstra and Reezigt (2023). This alignment is further affirmed by research from Jalali Sohi et al.

(2019), which underscored the value of flexibility in project management and its positive impact on project outcomes, mirroring the participants' advocacy for adaptable and situation-specific strategy formulation. Hence, the congruence between the project managers' insights and the foundational tenet of contingency theory underscores a robust validation of knowledge and expertise as critical levers in enhancing project management effectiveness. Therefore, the interviewees' responses strongly support the principles of contingency theory and the theme of knowledge and expertise utilization in project management.

Theme 3: Project Planning and Scope Management

The third theme from the interviews was project planning and scope management. All project managers accentuated the importance of fostering stakeholder collaboration for successful project management. Though their methods varied, they all agreed on the necessity of regular, clear communication. P2 summarized scope development as "building or defining the scope to bridge that gap between the problem and the solution." P1 focused on the project manager's role as a communicator, "emphasizing the project's importance to various stakeholders". Additionally, P1 explained how all his projects start with a "team field walk of process and instrumentation diagrams." P2, P3, and P5 highlighted the effectiveness of regular meetings and the early involvement of all stakeholders. P4 and P5 discussed the necessity of coordinating with various team members and keeping track of action items to ensure successful project execution.

Participants P1, P2, and P5 each stressed the importance of thoroughness in the early stages of a project to prevent scope creep; agreeing early communication of project objectives to all stakeholders is crucial. Furthermore, P2 and P5 underscored the importance of detailed documentation in managing scope creep. P4 shared experience from a past project,

> I had a project to replace PLCs [programmable logic controllers] throughout the plant. Due to unforeseen circumstances, such as postponements and unexpected outages, the project was extended beyond its original timeline. One notable occurrence was when the hardware meant for the project was used for another project due to delays caused by the COVID-19 pandemic. This led to more work as parts had to be removed and reinstalled, and factory acceptance tests had to be run again. To manage this scope creep, we maintained constant communication with the vendor to ensure we were aware of potential delays and could address them promptly. We closely monitored charged and documented arising costs from the extended scope.

P3, on the other hand, focused more on the role of experience and risk management in anticipating and mitigating potential risks. They emphasized that each project is unique, and thus, it is important to focus on the specific details of each project. P3 shared experience from a past project,

> This project initially seemed simple; it involved installing some platforms. However, the project's complexity escalated due to challenging spaces where the

> platforms needed to be installed, leading to the tripling of the engineering estimates. The difficulties could have been encountered earlier and managed if an in-depth examination had been conducted in the FEED phase. We decided not to proceed with certain parts of the project scope due to the concerns and mounting costs.

The participants' insights suggest that a comprehensive approach to managing scope creep should include careful planning and scoping at the outset, clear communication with stakeholders, detailed documentation, and past experiences and risk management processes.

Theme 3, project planning and scope management, was consistent with the findings of Andringa et al. (2022) and Ma and Fu (2020), which underlined the criticality of early planning and meticulous scope management as pillars for project success. This thematic alignment extends to the broader discourse within the literature, highlighting the pivotal role of project planning and management in mitigating prevalent challenges such as scope creep, stakeholder conflicts, and unforeseen project contingencies. Furthermore. Kissi et al. (2019) underscored the significance of rigorous project monitoring and evaluation practices as key determinants of success in construction projects. Collectively, these scholarly insights bolster the argument for the indispensable nature of proactive planning, dynamic leadership, engaged stakeholder participation, and flexible management approaches in steering projects toward their successful completion.

Theme 3 corroborates and underscores a profound correlation with the conceptual framework grounded in contingency theory, particularly within the factors of project planning and scope management. The emphasis on adaptability and the capacity to respond effectively to evolving project dynamics, as highlighted by the participants, is in direct alignment with the core tenets of contingency theory, as illustrated by Wickert et al. (2021). This alignment is further evidenced through the prioritization of effective communication and active stakeholder engagement, reinforcing the theory's advocacy for situational awareness and adaptability, a viewpoint supported by the research findings of Ebekozien et al. (2023) and Mwesigwa et al. (2019).

The significance attributed to early planning phases and a comprehensive understanding of the project scope as strategies to mitigate risks effectively dovetails with the principles of contingency theory. This perspective is supported by Boonstra and Reezigt (2023) and Zhao et al. (2021), who highlighted the critical nature of early and informed planning in ensuring project success, reinforcing the theoretical assertion that adaptability and thorough preparation are indispensable in managing project complexities. These findings collectively not only validate the relevance of contingency theory in the context of project management but also enrich the discourse on the strategic implementation of project planning and scope management techniques to enhance project outcomes.

Theme 4: Stakeholder Engagement and Communication

The fourth theme that unfolded from the interviews is a culmination of stakeholder engagement and communication presented within the previous themes. All the project managers emphasized the importance of fostering collaboration among stakeholders for successful project management. Though their methods varied, all participants agreed on the necessity of regular, clear communication. P1 focused on the project manager's role as a communicator, emphasizing the project's importance to various stakeholders, comparing the role as a "salesman, sharing ideas with stakeholders." P2, P3, and P5 highlighted the effectiveness of regular meetings and the early involvement of all stakeholders. P2 found using PowerPoint presentations useful in meetings for alignment, stating, "PowerPoint slides are great for collaboration", given that participants may interpret spoken information differently. P4 and P5 discussed the necessity of coordinating with various team members and keeping track of action items to ensure successful project execution. P5 highlighted a project that used a model review in FEED and progress reviews throughout detail execution,

> The project involved 30, 60, and 90 percent model reviews with representatives from all disciplines, operations, and construction present. Our engineering partner catered lunch to get 100% participation. These reviews were used to identify all scope items, in detail, where all the interferences for the demo of existing and installation of new exchangers. Through these early model reviews and field walks, we identified a significant scope of structural changes needed to create the

> lift window to support the heavier exchanger. The engineering partner kept a log of the items discovered during the reviews and ensured they would be addressed in their packages for demo and installation. The process was successful because it prevented much discovery in the field. We did not have any scope changes to the project.

Theme 4 correlates to the literature on stakeholder engagement and communication, particularly concerning the dynamics of stakeholder engagement and its pivotal role in facilitating successful project outcomes. The research conducted by Ebekozien et al. (2023) underscored the value of efficient stakeholder engagement in not only enhancing team collaboration but also in promoting the integration of project delivery mechanisms. This finding resonates with the broader consensus in the literature, as illustrated by Zaman et al. (2019), who asserted the critical importance of stakeholder engagement and effective communication as foundational elements of project success.

Moreover, the dimension of leadership, specifically transformational leadership, emerges as a significant factor in this discourse, with Shaukat et al. (2022) identifying its contribution to project success through the lenses of enhanced communication and collaboration. This form of leadership, characterized by its ability to inspire and motivate, is a crucial role in navigating the complexities of project management by fostering an environment conducive to success from multiple perspectives.

The findings from the interviews reveal a significant alignment with the conceptual underpinnings of contingency theory, as McAdam et al. (2019) highlighted,

which posits situational adaptability and responsiveness as key factors in effective project management. The emphasis placed by interviewees on adaptability, consistent communication, and proactive stakeholder engagement not only echoes the principles of contingency theory but also underscores the necessity of tailoring communication strategies to meet the unique demands of each project and the preferences of its stakeholders. This correlation suggests that the principles of contingency theory are not merely theoretical constructs but are actively reflected in the practices and perspectives of project management professionals, underscoring the theory's relevance in guiding project management strategies toward addressing complexities effectively.

Furthermore, the integration of learning for sustainability initiatives, as discussed by Silvestre et al. (2020), and the focus on stakeholder satisfaction mechanisms identified by Maqbool et al. (2022) resonate with the themes of adaptability and stakeholder involvement emphasized by the interviewees. These scholarly insights, together with the observations on the importance of creativity and innovation in organizational success from Chong and Duan (2022) and the conceptual framework for employee championing behavior in organizational change by Islam et al. (2020), reinforce the practical applications of contingency theory in project management. These findings collectively highlight the importance of adaptability, effective communication, and stakeholder engagement as fundamental to managing project complexities, providing a robust foundation for future research directions and practical applications in project management.

Application to Professional Practice

The study findings may provide business leaders and project managers with strategies to address projects' complexities and improve projects' success rates. This qualitative analysis revealed four themes central to the research question: a) proactive complexity and risk management, b) knowledge and expertise utilization, c) project planning and scope management, and d) stakeholder engagement and communication. Business leaders and project managers may apply these strategies to create effective processes and practices to improve project execution.

Leaders can implement early risk identification and mitigation protocols for proactive complexity and risk management. This may be established by creating a culture of preparedness that encourages looking ahead and anticipating potential issues through open collaboration with supporting groups' internal and external core executing teams. Regarding knowledge and expertise utilization, leaders can involve the team in decision-making processes from the onset. Fostering an environment that values learning from past project challenges and encourages early and thorough analysis during planning phases. Sawyer and Harrison's (2019) findings underscore the importance of strong managerial commitment, which can be translated into involving the team in decision-making processes. In project planning and scope management, careful management, and documentation of changes to the project's scope, cost, or schedule can prevent misunderstandings and set clear expectations. The influences of the power-interest matrix and the critical success factors are pertinent to effective planning and scope management

(Maqbool et al., 2022). In stakeholder engagement and communication, leaders can establish clear and regular communication with all stakeholders to foster collaboration, emphasizing the importance of the project's goals and objectives. The moderating role of stakeholder engagement and team building emphasizes the importance of stakeholder engagement in project success (Shaukat et al., 2022).

Implications for Social Change

The results of this study have implications for positive social change by providing the inclusion of project strategies among project managers and internal business units (Montenegro et al., 2021). The identified strategies, such as preparedness, adaptability, learning from failures, and effective communication, that can contribute to improved project management practices. This, in turn, can lead to more successful projects, positively impacting organizations and the individuals they serve. Moreover, the emphasis on collaboration and peer reviews fosters a culture of knowledge sharing and mutual learning (Siriram, 2022). This not only enhances individual competencies but also strengthens the collective intelligence of the organization.

Furthermore, improved project outcomes can have far-reaching effects, including increased customer satisfaction, job creation, and even societal advancements if the projects are geared towards social good. Essentially, the study's findings can catalyze beneficial change at individual, organizational, and societal levels. Additionally, the inclusion of project strategies among project managers and internal business units promotes a more inclusive and collaborative work environment, which is a key driver for

positive social change. The research and interview findings have significant implications for social change, chiefly through improved project management practices, enhanced collaboration, and the potential for far-reaching positive impacts from successful project outcomes.

Recommendation for Action

The study findings support strategies used by project managers to proactively identify complexities, utilize subject matter experts, and engage with stakeholders throughout early planning. The study identified seven strategies for improving project success rates. These strategies include: a) being prepared and organized, b) adapting strategies based on complexity, c) learning from failures, d) engaging early and managing risks, e) fostering effective communication and collaboration, f) mitigating scope creep, and g) communicating with vendors to aid in integration. Business leaders and project managers are recommended to apply these strategies to create effective processes and practices to improve project execution.

A second recommendation is that organizations consider implementing a peer review system among project managers. This will foster a culture of knowledge sharing, enhance decision-making processes, and mitigate potential risks. This is particularly relevant for business leaders, project management office (PMO) leaders, and project managers. For example, before scheduling a meeting with business stakeholders for phase 1 review, a peer review with another peer project manager. The review would be an informal review of documents and a discussion of steps taken, objectives, apparent

complexity, and uncertainties. The informal discussion aims to facilitate conversation on strategy, share past examples, and identify communication and collaboration opportunities. The first initial benefit is to enhance decision-making by discussing strategies, uncertainties, and complexities, potentially providing a fresh perspective and ideas. The second benefit is knowledge sharing from the peer review, providing a platform for sharing past experiences and learning for each other, leading to the adoption of best practices across the organization. The long-term benefits are improved communication and collaboration to foster better relationships among project managers and increased quality.

The results of this study support the recommendations that project managers and project management office leaders may find beneficial for their organizations. These findings will be published in the literature so that employers, project managers, and business leaders can benefit from them. Additionally, the findings may be available as a resource at professional conferences or company training where project management strategies are discussed. Finally, the study will be published in the ProQuest dissertation database.

Recommendations for Further Research

Future research may reveal different results and findings if a different method or design is used. Future researchers may use a larger sample size of participants. This could provide a broader perspective and allow for more generalizable findings. Further studies could try to include project managers with a diverse range of experiences, to gain insights

into how project management strategies differ based on experience levels. Given that the projects executed by industrial chemical plant managers are more technical than other industries, future research could explore the applicability of the findings in other less technical industries. Research could be broadened to include other roles within the industry that contribute to the project implementation process. For example, representatives from supporting roles in the operations and reliability groups are involved from the outset in developing project objectives by providing initial input. These representatives are integral stakeholders throughout the project's scope development and execution phases. Exploring their roles in more detail could lead to significant improvements in project success rates.

Reflections

This doctoral study in the field of business administration has significantly enhanced my understanding of research methods, program and portfolio project management, and the application of contingency theory to business issues. By completing this DBA doctoral study, I gained a deeper understanding of my personal preconceptions and reactions to participants. Additionally, I obtained new knowledge during the research process. Before I began the DBA journey, I understood there was a gap in my current knowledge of project management, but I was unsure how I could fill the void to be a better project manager. After enrolling in the DBA program at Walden University and engaging with the course work, in the second course, I began to see paths to closing my knowledge gaps. I also began to understand the business environment and strategic

decision-making, justification for change, and the need for transparency throughout the organization.

Fifteen years ago, a long-term goal was discussed with the intention of fulfilling a personal aspiration and to acquire knowledge that would enable me to better support others. On a personal level, I am hopeful that my story, with all its challenges and triumphs, will serve as an inspiration to my children, family, friends, and colleagues. As a professional, I take pride in my academic accomplishments and unwavering determination to achieve my objectives.

Conclusion

In conclusion, the findings of this study highlight important strategies that project managers can use to prevent project failures in detailed project execution, particularly in the industrial chemical plant context. The findings emphasize the significance of proactive complexity and risk management, utilization of knowledge and expertise, comprehensive project planning and scope management, and effective stakeholder engagement and communication. These strategies not only have a significant impact on enhancing project success rates and individual and organizational competencies but also help drive positive social change. The research reinforces the principles of contingency theory, emphasizing the importance of being proactive, adaptable, and responsive to the unique demands and intricacies of each project. Ultimately, the study gives project managers a roadmap to navigate project complexities and improve project execution

effectively, contributing to the broader goal of organizational success and positive societal impact.

References

Abdalla, M. M., Oliveira, L. G. L., Azevedo, C. E. F., & Gonzalez, R. K. (2018). Quality in qualitative organizational research: Types of triangulation as a methodological alternative. *Administração: Ensino e Pesquisa*, *19*(1), 66–98. https://doi.org/10.13058/raep.2018.v19n1.578

Adel, A. J., & Cleveland, S. (2021). Exploring project management complexity dimensions, factors, and strategies. *International Journal of Project Management and Productivity Assessment (IJPMPA)*, *9*(1), 1–14. https://doi.org/10.4018/IJPMPA.2021010101

Adu, T. L., & Van Der Walt, T. B. (2022). Knowledge of students of the exceptions and limitations clause in copyright administration in academic libraries in Ghana. *Journal of Librarianship and Information Science*, *54*(4), 737–750. https://doi.org/10.1177/09610006211048003

Ajibike, W. A., Adeleke, A. Q., Muuka, G. N., Bamgbade, J. A., Darun, M. R., & Moshood, T. D. (2022). Impact of oil and gas internal risk factors on project success: Moderating role of government support. *Construction Economics and Building*, *22*(1), Article 1. https://doi.org/10.5130/AJCEB.v22i1.7842

Akpan, I. J., Shanker, M., & Razavi, R. (2020). Improving the success of simulation projects using 3D visualization and virtual reality. *Journal of the Operational Research Society*, *71*(12), 1900–1926. https://doi.org/10.1080/01605682.2019.1641649

Al Hamadani, S., Al Alawi, M., & Al Nuaimi, A. (2022). Constructability practices in construction industry in Muscat: Case study. *Asian Journal of Civil Engineering*, *23*(7), 1141–1153. https://doi.org/10.1007/s42107-022-00475-3

Alizadehsalehi, S., Hadavi, A., & Huang, J. C. (2019). BIM/MR-Lean construction project delivery management system. *2019 IEEE Technology & Engineering Management Conference (TEMSCON)*, 1–6. https://doi.org/10.1109/TEMSCON.2019.8813574

AlNoaimi, F. A., & Mazzuchi, T. A. (2021). Risk management application in an oil and gas company for projects. *International Journal of Business Ethics and Governance*, 1–30. https://doi.org/10.51325/ijbeg.v4i3.77

Amankwaa, L. (2016). Creating protocols for trustworthiness in qualitative research. *Journal of Cultural Diversity*, *23*(3), 121–127.

Ampofo, S. Y., Onyango, G. A., & Ogola, M. (2019). Influence of school heads' direct supervision on teacher role performance in public senior high schools, central region, Ghana. *IAFOR Journal of Education*, *7*(2), 9–26. https://doi.org/10.22492/ije.7.2.01

Andreev, A. I., Zinkina, J., & Petrovskaya, I. G. (2022). Globalization impact on project management. *Journal of Globalization Studies*, *13*(1). https://doi.org/10.30884/jogs/2022.01.05

Andringa, L., Ökmen, Ö., Leijten, M., Bosch-Rekveldt, M., & Bakker, H. (2022a). Incorporating project complexities in risk assessment: Case of an airport

expansion construction project. *Journal of Management in Engineering*, *38*(6), 05022015. https://doi.org/10.1061/(ASCE)ME.1943-5479.0001099

Andringa, L., Ökmen, Ö., Leijten, M., Bosch-Rekveldt, M., & Bakker, H. (2022b). Incorporating project complexities in risk assessment: Case of an airport expansion construction project. *Journal of Management in Engineering*, *38*(6), 05022015. https://doi.org/10.1061/(ASCE)ME.1943-5479.0001099

Anggraeni, M., Gupta, J., & Verrest, H. J. L. M. (2019). Cost and value of stakeholders participation: A systematic literature review. *Environmental Science & Policy*, *101*, 364–373. https://doi.org/10.1016/j.envsci.2019.07.012

Artime, O., & De Domenico, M. (2022). From the origin of life to pandemics: Emergent phenomena in complex systems. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *380*(2227), 20200410. https://doi.org/10.1098/rsta.2020.0410

Aslam, M., Gao, Z., & Smith, G. (2020). Exploring factors for implementing lean construction for rapid initial successes in construction. *Journal of Cleaner Production*, *277*, 123295. https://doi.org/10.1016/j.jclepro.2020.123295

Badreddine, A., Azakir, O., Itani, A., & Al-Hussein, M. (2022). A fuzzy-AHP and house of quality integrated approach for lean construction concepts assessment in off-site construction. *Modular and Offsite Construction (MOC) Summit Proceedings*, 130–137. https://doi.org/10.29173/mocs274

Bahamid, R. A., Doh, S. I., & Al-Sharaf, M. A. (2019). Risk factors affecting the construction projects in the developing countries. *IOP Conference Series: Earth and Environmental Science*, *244*, 012040. https://doi.org/10.1088/1755-1315/244/1/012040

Barbalho, S. C. M., De Toledo, J. C., & Silva, I. A. D. (2019). The effect of stakeholders' satisfaction and project management performance on transitions in a project management office. *IEEE Access*, *7*, 169385–169398. https://doi.org/10.1109/ACCESS.2019.2955446

Barghi, B., & Sikari, S. S. (2020). Qualitative and quantitative project risk assessment using a hybrid PMBOK model developed under uncertainty conditions. *Heliyon*, *6*(1). https://doi.org/10.1016/j.heliyon.2019.e03097

Bathallath, S., Smedberg, Å., & Kjellin, H. (2022). Managing project interdependencies in IT/IS project portfolios: A review of managerial issues. *International Journal of Information Systems and Project Management*, *4*(1), Article 1. https://doi.org/10.12821/ijispm040104

Baxter, P., & Jack, S. (2015). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. *The Qualitative Report*. https://doi.org/10.46743/2160-3715/2008.1573

Belotto, M. (2018). Data analysis methods for qualitative research: Managing the challenges of coding, interrater reliability, and thematic analysis. *The Qualitative Report*, *23*(11), 2622–2633. https://doi.org/10.46743/2160-3715/2018.3492

Bhown, A., Dillon, D., Berger, A. H., Du, Y., Haney, K., Carroll, B., Gilmartin, J., Simonson, T., & Reddy, S. (2021). *Front end engineering design study for carbon capture at a natural gas combined cycle power plant in California* (SSRN Scholarly Paper 3812087). https://doi.org/10.2139/ssrn.3812087

Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation? *Qualitative Health Research*, *26*(13), 1802–1811. https://doi.org/10.1177/1049732316654870

Blomfield, M., & Vakili, K. (2023). Incentivizing effort allocation through resource allocation: Evidence from scientists' response to changes in funding policy. *Organization Science*, *34*(1), 100–128. https://doi.org/10.1287/orsc.2021.1565

Bondank, E. N., & Chester, M. V. (2020). Infrastructure interdependency failures from extreme weather events as a complex process. *Frontiers in Water*, *2*. https://www.frontiersin.org/articles/10.3389/frwa.2020.00021

Boonstra, A., & Reezigt, C. (2019). Complexity-predictability project diagnosis model. *Procedia Computer Science*, *164*, 337–342. ScienceDirect. https://doi.org/10.1016/j.procs.2019.12.191

Boonstra, A., & Reezigt, C. (2023). A complexity framework for project management strategies. *Project Management Journal*, *54*(3), 1–15. https://doi.org/10.1177/87569728221142229

Boutilier, R. G., & Bahr, K. (2020). A natural language processing approach to social license management. *Sustainability*, *12*(20), Article 20. https://doi.org/10.3390/su12208441

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, *11*(4), 589–597. https://doi.org/10.1080/2159676X.2019.1628806

Browning, T. R. (2018). Planning, tracking, and reducing a complex project's value at risk. *Project Management Journal*, *50*(1), 71–85. https://doi.org/10.1177/8756972818810967

Brunekreeft, G., & Rammerstorfer, M. (2021). OPEX-risk as a source of CAPEX-bias in monopoly regulation. *Competition and Regulation in Network Industries*, *22*(1), 20–34. https://doi.org/10.1177/1783591720983184

Bryman, A. (2016). *Social research methods* (Fifth Edition). Oxford University Press.

Burleigh, C. (2020). Education leaders' perceptions of faculty ethical decision-making: Awareness, learning, and change. *Journal of Educational Research and Practice*, *10*(1). https://doi.org/10.5590/JERAP.2020.10.1.23

Burns, T., & Stalker, G. M. (1994). *The management of innovation* (Rev. ed). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198288787.001.0001

Busetto, L., Wick, W., & Gumbinger, C. (2020). How to use and assess qualitative research methods. *Neurological Research and Practice*, *2*(1), 14. https://doi.org/10.1186/s42466-020-00059-z

Butler, C. W., Vijayasarathy, L. R., & Roberts, N. (2020). Managing software development projects for success: Aligning plan- and agility-based approaches to project complexity and project dynamism. *Project Management Journal*, *51*(3), 262–277. https://doi.org/10.1177/8756972819848251

Carter, N., Bryant-Lukosius, D., DiCenso, A., Blythe, J., & Neville, A. J. (2014). The use of triangulation in qualitative research. *Oncology Nursing Forum*, *41*(5), 545–547. https://doi.org/10.1188/14.ONF.545-547

Chenger, D., & Woiceshyn, J. (2021). Executives' decision processes at the front end of major projects: The role of context and experience in value creation. *Project Management Journal*, *52*(2), 176–191. https://doi.org/10.1177/8756972820977225

Chong, J., & Duan, S. X. (2022). Riding on the waves of the COVID-19 pandemic in re-thinking organizational design: A contingency-based approach. *Journal of Strategy and Management*, *15*(4), 628–646. https://doi.org/10.1108/JSMA-07-2021-0142

Corbin, J. M., & Strauss, A. L. (2015). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (Fourth edition). SAGE.

Corti, L., Day, A., & Backhouse, G. (2000). Confidentiality and informed consent: Issues for consideration in the preservation of and provision of access to qualitative data archives. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *1*(3), Article 3. https://doi.org/10.17169/fqs-1.3.1024

Coyne, I. T. (1997). Sampling in qualitative research. Purposeful and theoretical sampling; merging or clear boundaries? *Journal of Advanced Nursing*, *26*(3), 623–630. https://doi.org/10.1046/j.1365-2648.1997.t01-25-00999.x

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (Fifth edition). SAGE.

Damayanti, R. W., Hartono, B., & Wijaya, A. R. (2021). Leadership competency for megaproject‘s complexity management: A conceptual study. *International Journal of Innovation, Management and Technology*, *12*(4), 68–74. https://doi.org/10.18178/ijimt.2021.12.4.911

Darlow, G., Rotimi, J. O. B., & Shahzad, W. M. (2022). Automation in New Zealand’s offsite construction (OSC): A status update. *Built Environment Project and Asset Management*, *12*(1), 38–52. https://doi.org/10.1108/BEPAM-11-2020-0174

Dawande, M., Janakiraman, G., Qi, A., & Wu, Q. (2019). Optimal incentive contracts in project management. *Production and Operations Management*, *28*(6), 1431–1445. https://doi.org/10.1111/poms.12997

DeJonckheere, M., & Vaughn, L. M. (2019). Semistructured interviewing in primary care research: A balance of relationship and rigour. *Family Medicine and Community Health*, *7*(2), e000057. https://doi.org/10.1136/fmch-2018-000057

Denzin, N. K. (2017). *The research act* (1st ed.). Routledge. https://doi.org/10.4324/9781315134543

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2018). *The SAGE handbook of qualitative research* (Fifth edition). SAGE.

Di Luozzo, S., Del Beato, F., & Schiraldi, M. M. (2023). Measuring coherence of performance measurement indicators in complex and changing environments. *International Journal of Productivity and Performance Management*, *72*(3), 625–658. https://doi.org/10.1108/IJPPM-03-2021-0176

DiCicco-Bloom, B., & Crabtree, B. F. (2006). The qualitative research interview. *Medical Education*, *40*(4), 314–321. https://doi.org/10.1111/j.1365-2929.2006.02418.x

Ding, J., Liu, C., & Kandonga, G. A. (2020). Exploring the limitations of the h-index and h-type indexes in measuring the research performance of authors. *Scientometrics*, *122*(3), 1303–1322. https://doi.org/10.1007/s11192-020-03364-1

Doan, T. T. T., Nguyen, L. C. T., & Nguyen, T. D. N. (2020). Emotional intelligence and project success: The roles of transformational leadership and organizational commitment. *The Journal of Asian Finance, Economics and Business*, *7*(3), 223–233. https://doi.org/10.13106/jafeb.2020.vol7.no3.223

Donaldson, L. (2001). *The contingency theory of organizations*. SAGE Publications, Inc. https://doi.org/10.4135/9781452229249

Draper, A., & Swift, J. A. (2011). Qualitative research in nutrition and dietetics: Data collection issues. *Journal of Human Nutrition and Dietetics*, *24*(1), 3–12. https://doi.org/10.1111/j.1365-277X.2010.01117.x

Dworkin, S. L. (2012). Sample size policy for qualitative studies using in-depth interviews. *Archives of Sexual Behavior*, *41*(6), 1319–1320. https://doi.org/10.1007/s10508-012-0016-6

Ebekozien, A., Aigbavboa, C. O., & Ramotshela, M. (2023). A qualitative approach to investigate stakeholders' engagement in construction projects. *Benchmarking: An International Journal*. https://doi.org/10.1108/BIJ-11-2021-0663

Eidt, C. M., Pant, L. P., & Hickey, G. M. (2020). Platform, participation, and power: How dominant and minority stakeholders shape agricultural innovation. *Sustainability*, *12*(2), Article 2. https://doi.org/10.3390/su12020461

Emanuel, E. J., Wendler, D., & Grady, C. (2000). What makes clinical research ethical? *JAMA*, *283*(20), 2701. https://doi.org/10.1001/jama.283.20.2701

Etikan, I. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1. https://doi.org/10.11648/j.ajtas.20160501.11

Evans, M., & Farrell, P. (2022). A strategic framework managing challenges of integrating lean construction and integrated project delivery on construction

megaprojects, towards global integrated delivery transformative initiatives in multinational organisations. *Journal of Engineering, Design and Technology*, *21*(2), 376–416. https://doi.org/10.1108/JEDT-08-2021-0402

Evans, M., Farrell, P., Elbeltagi, E., & Dion, H. (2023). Barriers to integrating lean construction and integrated project delivery (IPD) on construction megaprojects towards the global integrated delivery (GID) in multinational organisations: Lean IPD&GID transformative initiatives. *Journal of Engineering, Design and Technology*, *21*(3), 778–818. https://doi.org/10.1108/JEDT-02-2021-0070

Fabic, M., Pavletic, D., Valic, G. Š., & Markovic, M. (2019). Moderating impact of complexity on process management of turnaround project. *Management & Production Engineering Review (MPER)*, *10*(4), 25–36. https://doi.org/10.24425/mper.2019.131442

Fane, M. (2020, September 3). *How to unlock value in oil and gas capital projects in any environment*. EY-US. https://www.ey.com/en_us/oil-gas-digital-skills-survey/how-to-unlock-value-in-oil-and-gas-capital-projects-in-any-environment

Farahani, A. F., Khalili-Damghani, K., Didehkhani, H., Sarfaraz, A. H., & Hajirezaie, M. (2021). A framework for project risk assessment in dynamic networks: A case study of oil and gas megaproject construction. *IEEE Access*, *9*, 88767–88781. https://doi.org/10.1109/ACCESS.2021.3084349

Fernandes, G., & Araújo, M. (2022). Improving and embedding project management practice: Generic or context dependent? *International Journal of Information*

Systems and Project Management, *7*(1), Article 1. https://doi.org/10.12821/ijispm070103

Fernandes, G., & O'Sullivan, D. (2023). Project management practices in major university-industry R&D collaboration programs – a case study. *The Journal of Technology Transfer*, *48*(1), 361–391. https://doi.org/10.1007/s10961-021-09915-9

Feuerstein, R., Feuerstein, R., & Falik, L. H. (2010). Beyond smarter: Mediated learning and the brain's capacity for change. In *Teachers College Press*. Teachers College Press.

Fiedler, Fred. E. (1964). A contingency model of leadership effectiveness. *Advances in Experimental Social Psychology*, 149–190. https://doi.org/10.1016/S0065-2601(08)60051-9

Finlay, L. (2002). "Outing" the researcher: The provenance, process and practice of reflexivity. *Qualitative Health Research*, *12*(4), 531–545. https://doi.org/10.1177/104973202129120052

Fisher, C. B. (2023). *Decoding the ethics code: A practical guide for psychologists* (Fifth edition). SAGE.

Flick, U. (2018). Triangulation in data collection. In U. Flick, *The SAGE Handbook of Qualitative Data Collection* (pp. 527–544). SAGE Publications Ltd. https://doi.org/10.4135/9781526416070.n34

Flick, U. (2022). *The SAGE handbook of qualitative research design*. SAGE Publications Ltd. https://doi.org/10.4135/9781529770278

Flynn, R., Albrecht, L., & Scott, S. D. (2018). Two Approaches to Focus Group Data Collection for Qualitative Health Research: Maximizing Resources and Data Quality. *International Journal of Qualitative Methods*, *17*(1), 1609406917750781. https://doi.org/10.1177/1609406917750781

Fossum, K. R., Honoré-Livermore, E., Veitch, E., Haskins, C., & Palmer, E. K. (2022). Toward an integrated project complexity narrative – A case study of academic organizations. *Systems Engineering*, *25*(5), 443–456. https://doi.org/10.1002/sys.21623

Fusch, P., Fusch, G. E., & Ness, L. R. (2018). Denzin's paradigm shift: Revisiting triangulation in qualitative research. *Journal of Social Change*, *10*(1). https://doi.org/10.5590/JOSC.2018.10.1.02

Fusch, P. I., & Ness, L. R. (2015). Are we there yet? Data saturation in qualitative research. *The Qualitative Report*, *20*(9), 1408–1416. https://doi.org/10.46743/2160-3715/2015.2281

Gabriel, Y. (2015). Reflexivity and beyond – a plea for imagination in qualitative research methodology. *Qualitative Research in Organizations and Management: An International Journal*, *10*(4), 332–336. https://doi.org/10.1108/QROM-07-2015-1305

Gadekar, R., Sarkar, B., & Gadekar, A. (2022). Key performance indicator based dynamic decision-making framework for sustainable Industry 4.0 implementation risks evaluation: Reference to the Indian manufacturing industries. *Annals of Operations Research*, *318*(1), 189–249. https://doi.org/10.1007/s10479-022-04828-8

Galletta, A. (2013). *Mastering the semi-structured interview and beyond*. New York University Press. https://doi.org/10.18574/nyu/9780814732939.001.0001

Gautam, A., & Kiridena, S. (2019). Assessing the complexity of large-scale engineering projects. *2019 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, 149–153. https://doi.org/10.1109/IEEM44572.2019.8978512

Gibson, G. E., El Asmar, M., Yussef, A., & Ramsey, D. (2023). A novel approach for measuring the accuracy of front end engineering design. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ECAM-05-2022-0418

Gode, H. E., Johansen, W., & Thomsen, C. (2019). Employee engagement in generating ideas on internal social media: A matter of meaningfulness, safety and availability. *Corporate Communications: An International Journal*, *25*(2), 263–280. https://doi.org/10.1108/CCIJ-03-2019-0024

Grady, C. (2005). Payment of clinical research subjects. *Journal of Clinical Investigation*, *115*(7), 1681–1687. https://doi.org/10.1172/JCI25694

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough?: An experiment with data saturation and variability. *Field Methods*, *18*(1), 59–82. https://doi.org/10.1177/1525822X05279903

Guest, G., Namey, E. E., & Mitchell, M. L. (2013). *Collecting qualitative data: A field manual for applied research*. SAGE Publications. https://doi.org/10.4135/9781506374680

Hafseld, K. H. J., Hussein, B., & Rauzy, A. B. (2021). An attempt to understand complexity in a government digital transformation project. *International Journal of Information Systems and Project Management*, *9*(3), Article 3. https://doi.org/10.12821/ijispm090304

Harper, M., & Cole, P. (2015). Member checking: Can benefits be gained similar to group therapy? *The Qualitative Report*. https://doi.org/10.46743/2160-3715/2012.2139

Hoerl, R., Jensen, W., & de Mast, J. (2021). Understanding and addressing complexity in problem solving. *Quality Engineering*, *33*(4), 612–626. https://doi.org/10.1080/08982112.2021.1952230

Hussain, A., Jamil, M., Farooq, M. U., Asim, M., Rafique, M. Z., & Pruncu, C. I. (2021). Project managers' personality and project success: Moderating role of external environmental factors. *Sustainability*, *13*(16), Article 16. https://doi.org/10.3390/su13169477

Irfan, M., Thaheem, M. J., Gabriel, H. F., Malik, M. S. A., & Nasir, A. R. (2019). Effect of stakeholder's conflicts on project constraints: A tale of the construction

industry. *International Journal of Conflict Management*, *30*(4), 538–565. https://doi.org/10.1108/IJCMA-04-2019-0074

Islam, M. N., Furuoka, F., & Idris, A. (2020). Employee championing behavior in the context of organizational change: A proposed framework for the business organizations in Bangladesh. *Journal of Asia Business Studies*, *14*(5), 735–757. https://doi.org/10.1108/JABS-01-2019-0019

Jäckel, D., Mortega, K. G., Sturm, U., Brockmeyer, U., Khorramshahi, O., & Voigt-Heucke, S. L. (2021). Opportunities and limitations: A comparative analysis of citizen science and expert recordings for bioacoustic research. *PLOS ONE*, *16*(6), e0253763. https://doi.org/10.1371/journal.pone.0253763

Jalali Sohi, A., Bosch-Rekveldt, M., & Hertogh, M. (2019). Does flexibility in project management in early project phases contribute positively to end-project performance? *International Journal of Managing Projects in Business*, *13*(4). https://doi.org/10.1108/IJMPB-07-2019-0173

Jamshed, S. (2014). Qualitative research method-interviewing and observation. *Journal of Basic and Clinical Pharmacy*, *5*(4), 87–88. https://doi.org/10.4103/0976-0105.141942

Jamshed, S., & Majeed, N. (2019). Relationship between team culture and team performance through lens of knowledge sharing and team emotional intelligence. *Journal of Knowledge Management*, *23*(1), 90–109. https://doi.org/10.1108/JKM-04-2018-0265

Janghorban, R., Roudsari, R. L., & Taghipour, A. (2014). Skype interviewing: The new generation of online synchronous interview in qualitative research. *International Journal of Qualitative Studies on Health and Well-Being*, *9*(1), 24152. https://doi.org/10.3402/qhw.v9.24152

Jia, M., Stevenson, M., & Hendry, L. (2023). A systematic literature review on sustainability-oriented supplier development. *Production Planning & Control*, *34*(8), 727–747. https://doi.org/10.1080/09537287.2021.1958388

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, *33*(7), 14–26. https://doi.org/10.3102/0013189X033007014

Joseph, N., & Marnewick, C. (2021). Measuring information systems project complexity: A structural equation modelling approach. *Complexity*, 1–15. https://doi.org/10.1155/2021/5907971

Kallio, H., Pietilä, A.-M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*, *72*(12), 2954–2965. https://doi.org/10.1111/jan.13031

Kassem, M. A., Khoiry, M. A., & Hamzah, N. (2020). Assessment of the effect of external risk factors on the success of an oil and gas construction project. *Engineering, Construction and Architectural Management*, *27*(9), 2767–2793. https://doi.org/10.1108/ECAM-10-2019-0573

Kaufmann, C., & Kock, A. (2022). Does project management matter? The relationship between project management effort, complexity, and profitability. *International Journal of Project Management*, *40*(6), 624–633. ScienceDirect. https://doi.org/10.1016/j.ijproman.2022.05.007

Kermanshachi, S., Dao, B., Rouhanizadeh, B., Shane, J., & Anderson, S. (2020). Development of the project complexity assessment and management framework for heavy industrial projects. *International Journal of Construction Education and Research*, *16*(1), 24–42. https://doi.org/10.1080/15578771.2018.1499568

Khahro, S. H., Ali, T. H., Hassan, S., Zainun, N. Y., Javed, Y., & Memon, S. A. (2021). Risk severity matrix for sustainable public-private partnership projects in developing countries. *Sustainability*, *13*(6), 3292. https://doi.org/10.3390/su13063292

Khattak, M. S., & Mustafa, U. (2019). Management competencies, complexities and performance in engineering infrastructure projects of Pakistan. *Engineering, Construction and Architectural Management*, *26*(7), 1321–1347. https://doi.org/10.1108/ECAM-05-2017-0079

Khosravi, P., Rezvani, A., & Ashkanasy, N. M. (2020). Emotional intelligence: A preventive strategy to manage destructive influence of conflict in large scale projects. *International Journal of Project Management*, *38*(1), 36–46. https://doi.org/10.1016/j.ijproman.2019.11.001

King, N. (2004). Using interviews in qualitative research. In C. Cassell & G. Symon, *Essential Guide to Qualitative Methods in Organizational Research* (pp. 11–22). SAGE Publications. https://doi.org/10.4135/9781446280119.n2

Kissi, E., Agyekum, K., Baiden, B. K., Tannor, R. A., Asamoah, G. E., & Andam, E. T. (2019). Impact of project monitoring and evaluation practices on construction project success criteria in Ghana. *Built Environment Project and Asset Management*, *9*(3), 364–382. https://doi.org/10.1108/BEPAM-11-2018-0135

Knickel, M., Knickel, K., Galli, F., Maye, D., & Wiskerke, J. S. C. (2019). Towards a reflexive framework for fostering co—Learning and improvement of transdisciplinary collaboration. *Sustainability*, *11*(23), Article 23. https://doi.org/10.3390/su11236602

Kourtzanidis, K., Angelakoglou, K., Apostolopoulos, V., Giourka, P., & Nikolopoulos, N. (2021). Assessing impact, performance and sustainability potential of smart city projects: Towards a case agnostic evaluation framework. *Sustainability*, *13*(13), 7395. https://doi.org/10.3390/su13137395

Kreye, M. E., Cash, P. J., Parraguez, P., & Maier, A. (2022). Dynamism in complex engineering: Explaining uncertainty growth through uncertainty masking. *IEEE Transactions on Engineering Management*, *69*(4), 1552–1564. https://doi.org/10.1109/TEM.2019.2937570

Kros, J. F., Falasca, M., Dellana, S., & Rowe, W. J. (2019). Mitigating counterfeit risk in the supply chain: An empirical study. *The TQM Journal*, *32*(5), 983–1002. https://doi.org/10.1108/TQM-02-2019-0054

Kuckartz, U. (2014). *Qualitative text analysis: A guide to methods, practice & using software*. SAGE Publications. https://doi.org/10.4135/9781446288719

Kvale, S., & Brinkmann, S. (2015). *InterViews: Learning the craft of qualitative research interviewing* (Third edition). Sage Publications.

Lavrakas, P. (2008). *Encyclopedia of survey research methods*. Sage Publications. https://doi.org/10.4135/9781412963947

Lawrence, P. R., & Lorsch, J. W. (1967). Differentiation and integration in complex organizations. *Administrative Science Quarterly*, *12*(1), 1–47. https://doi.org/10.2307/2391211

Leeman, J., Wangen, M., Kegler, M., Lee, M., O'Leary, M. C., Ko, L. K., Fernández, M. E., & Birken, S. A. (2022). Applying theory to explain the influence of factors external to an organization on the implementation of an evidence-based intervention. *Frontiers in Health Services*, *2*, 889786. https://doi.org/10.3389/frhs.2022.889786

Li, Y., Ding, R., & Sun, T. (2019). The Drivers and Performance of Environmental Practices in the Chinese Construction Industry. *Sustainability*, *11*(3), Article 3. https://doi.org/10.3390/su11030614

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage Publications.

Lubis, Z. (2021). The importance of communication management improving the performance of construction project managers in developing countries. *Journal of Southwest Jiaotong University*, *56*(3), Article 3. https://doi.org/10.35741/issn.0258-2724.56.3.40

Luo, L., Zhang, L., & He, Q. (2020). Linking project complexity to project success: A hybrid SEM–FCM method. *Engineering, Construction and Architectural Management*, *27*(9), 2591–2614. Emerald Insight. https://doi.org/10.1108/ECAM-05-2019-0241

Ma, L., & Fu, H. (2020). Exploring the influence of project complexity on the mega construction project success: A qualitative comparative analysis (QCA) method. *Engineering, Construction and Architectural Management*, *27*(9), 2429–2449. Emerald Insight. https://doi.org/10.1108/ECAM-12-2019-0679

MacKinnon, L., Kerman, N., Socías, M. E., Brar, R., & Bardwell, G. (2022). Primary care embedded within permanent supportive housing for people who use substances: A qualitative study examining healthcare access in Vancouver, Canada. *Health & Social Care in the Community*, *30*(6), e5062–e5073. https://doi.org/10.1111/hsc.13921

Mahmud, M., Soetanto, D., & Jack, S. (2021). A contingency theory perspective of environmental management: Empirical evidence from entrepreneurial firms. *Journal of General Management*, *47*(1), 3–17. https://doi.org/10.1177/0306307021991489

Malik, M. F., Khan, R. A., Khan, M. M., & Humayon, A. A. (2020). Role of sustainability and project complexity in achieving project success. *City University Research Journal (CURJ)*, *10*(1), 1–15. Business Source Complete.

Manti, S., & Licari, A. (2018). How to obtain informed consent for research. *Breathe*, *14*(2), 145–152. https://doi.org/10.1183/20734735.001918

Maqbool, R., & Akubo, S. A. (2022). Solar energy for sustainability in Africa: The challenges of socio-economic factors and technical complexities. *International Journal of Energy Research*, *46*(12), 16336–16354. https://doi.org/10.1002/er.8425

Maqbool, R., Rashid, Y., & Ashfaq, S. (2022). Renewable energy project success: Internal versus external stakeholders' satisfaction and influences of power-interest matrix. *Sustainable Development*, *30*(6), 1542–1561. https://doi.org/10.1002/sd.2327

Maqsoom, A., Hamad, M., Ashraf, H., Thaheem, M. J., & Umer, M. (2020). Managerial control mechanisms and their influence on project performance: An investigation of the moderating role of complexity risk. *Engineering, Construction and Architectural Management*, *27*(9), 2451–2475. https://doi.org/10.1108/ECAM-05-2019-0244

Markolf, S. A., Chester, M. V., & Allenby, B. (2021). Opportunities and Challenges for Artificial Intelligence Applications in Infrastructure Management During the

Anthropocene. *Frontiers in Water*, *2*. https://www.frontiersin.org/articles/10.3389/frwa.2020.551598

Marković, J. T., Mučenski, V., Savić, D., Velkovski, T., Peško, I., & Tomaš, L. (2021). Risk assessment model for planning and design processes of wastewater treatment plants. *Periodica Polytechnica Civil Engineering*, *65*(1), Article 1. https://doi.org/10.3311/PPci.16740

Marshall, C., Rossman, G. B., & Blanco, G. L. (2022). *Designing qualitative research* (Seventh edition). SAGE Publishing.

McAdam, R., Miller, K., & McSorley, C. (2019). Towards a contingency theory perspective of quality management in enabling strategic alignment. *International Journal of Production Economics*, *207*, 195–209. https://doi.org/10.1016/j.ijpe.2016.07.003

Micán, C., Fernandes, G., & Araújo, M. (2020). Project portfolio risk management: A structured literature review with future directions for research. *International Journal of Information Systems and Project Management*, *8*(3), Article 3. https://doi.org/10.12821/ijispm080304

Milat, M., Knezić, S., & Sedlar, J. (2021). Resilient scheduling as a response to uncertainty in construction projects. *Applied Sciences*, *11*(14), Article 14. https://doi.org/10.3390/app11146493

Miles, M. B., Huberman, A. M., & Saldaña, J. (2020). *Qualitative data analysis: A methods sourcebook* (Fourth edition). SAGE.

Mindeguia, R., Aritzeta, A., Garmendia, A., Martinez-Moreno, E., Elorza, U., & Soroa, G. (2021). Team emotional intelligence: Emotional processes as a link between managers and workers. *Frontiers in Psychology*, *12*, 619999. https://doi.org/10.3389/fpsyg.2021.619999

Mohajeri, M., Ardeshir, A., & Malekitabar, H. (2023). Diagnostic intervention program based on construction workers' internal factors for persistent reduction of unsafe behavior. *Engineering, Construction and Architectural Management*, *30*(2), 478–495. https://doi.org/10.1108/ECAM-05-2021-0435

Mohd Roshdi, F. R., Ismail, K., Lop, N. S., & Ab Wahab, L. (2022). Cost overruns in engineering procurement construction (EPC) fabrication oil and gas megaprojects in Malaysia: The importance of resource allocation (5M). *International Journal of Academic Research in Business and Social Sciences*, *12*(9), 1491–1499.

Montenegro, A., Dobrota, M., Todorovic, M., Slavinski, T., & Obradovic, V. (2021). Impact of construction project managers' emotional intelligence on project success. *Sustainability*, *13*(19), Article 19. https://doi.org/10.3390/su131910804

Morgan, A., & Nyonje, P. R. (2022). Leveraging project uncertainity: A practical approach to the contribution of design thinking in complex projects. *IJRDO - Journal of Business Management*, *8*(7), Article 7. https://doi.org/10.53555/bm.v8i7.5200

Morse, J. M. (2015). Critical analysis of strategies for determining rigor in qualitative inquiry. *Qualitative Health Research*, *25*(9), 1212–1222. https://doi.org/10.1177/1049732315588501

Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods*, *1*(2), 13–22. https://doi.org/10.1177/160940690200100202

Moser, A., & Korstjens, I. (2018). Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis. *European Journal of General Practice*, *24*(1), 9–18. https://doi.org/10.1080/13814788.2017.1375091

Moustakas, C. (1994). *Phenomenological research methods*. SAGE Publications. https://doi.org/10.4135/9781412995658

Mwesigwa, R., Bagire, V., Ntayi, J. M., & Munene, J. C. (2019a). Antecedents of stakeholder management in public private partnership projects in Uganda. *World Journal of Entrepreneurship, Management and Sustainable Development*, *15*(2), 169–181. https://doi.org/10.1108/WJEMSD-03-2018-0034

Mwesigwa, R., Bagire, V., Ntayi, J. M., & Munene, J. C. (2019b). Antecedents of stakeholder management in public private partnership projects in Uganda. *World Journal of Entrepreneurship, Management and Sustainable Development*, *15*(2), 169–181. https://doi.org/10.1108/WJEMSD-03-2018-0034

Nachbagauer, A. (2021). Managing complexity in projects: Extending the Cynefin framework. *Project Leadership and Society*, *2*. ScienceDirect. https://doi.org/10.1016/j.plas.2021.100017

Nachbagauer, A. G. M., & Schirl-Boeck, I. (2019). Managing the unexpected in megaprojects: Riding the waves of resilience. *International Journal of Managing Projects in Business*, *12*(3), 694–715. https://doi.org/10.1108/IJMPB-08-2018-0169

National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. (1979). The Belmont report: Ethical principles and guidelines for the protection of human subjects of research. *U.S. Department of Health and Human Services*. https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/read-the-belmont-report/index.html

Nevstad, K., Madsen, T. K., Eskerod, P., Aarseth, W. K., Karlsen, A. S. T., & Andersen, B. (2021). Linking partnering success factors to project performance—Findings from two nation-wide surveys. *Project Leadership and Society*, *2*, 100009. https://doi.org/10.1016/j.plas.2021.100009

Nguyen, P., & Akhavian, R. (2019). Synergistic effect of integrated project delivery, lean construction, and building information modeling on project performance measures: A quantitative and qualitative analysis. *Advances in Civil Engineering*, *2019*, e1267048. https://doi.org/10.1155/2019/1267048

Nguyen, T. S., Mohamed, S., & Mostafa, S. (2021). Project stakeholder's engagement and performance: A comparison between complex and non-complex projects using SEM. *Built Environment Project and Asset Management*, *11*(5), 804–818. https://doi.org/10.1108/BEPAM-11-2020-0181

Noble, H., & Smith, J. (2015). Issues of validity and reliability in qualitative research. *Evidence-Based Nursing*, *18*(2), 34–35. https://doi.org/10.1136/eb-2015-102054

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods*, *16*(1), 1609406917733847. https://doi.org/10.1177/1609406917733847

Oh, M., & Choi, S. (2020). The competence of project team members and success factors with open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, *6*(3), 51. https://doi.org/10.3390/joitmc6030051

Onasanya, A., Keshinro, M., Oladepo, O., Van Engelen, J., & Diehl, J. C. (2020). A stakeholder analysis of schistosomiasis diagnostic landscape in south-west Nigeria: Insights for diagnostics co-creation. *Frontiers in Public Health*, *8*. https://www.frontiersin.org/articles/10.3389/fpubh.2020.564381

Onubi, H. O., Yusof, N. A., & Hassan, A. S. (2019). Green site practices and environmental performance: How project complexity moderates the relationship. *Construction Economics and Building*, *19*(1), Article 1. https://doi.org/10.5130/AJCEB.v19i1.6574

Opdenakker, R. (2006). Advantages and disadvantages of four interview techniques in qualitative research. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *Vol 7*, No 4 (2006): Qualitative Research in Ibero America. https://doi.org/10.17169/FQS-7.4.175

Orlandi, T. R., Santos Dantas, F., & Souza Neto, J. (2020). The use of portfolio management for strategic alignment—A survey with Brazilian companies. *JISTEM - Journal of Information Systems and Technology Management*, *17*, Article e202017004. https://doi.org/10.4301/s1807-1775202017004

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health*, *42*(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Pandithawatta, T. P. W. S. I., Zainudeen, N., & Perera, C. S. R. (2019). An integrated approach of Lean-Green construction: Sri Lankan perspective. *Built Environment Project and Asset Management*, *10*(2), 200–214. https://doi.org/10.1108/BEPAM-12-2018-0153

Parast, M. M., Safari, A., & Gölgeci, I. (2022). A comparative assessment of quality management practices in manufacturing firms and service firms: A repeated cross-sectional analysis. *IEEE Transactions on Engineering Management*, 1–16. https://doi.org/10.1109/TEM.2022.3221851

Patil, H., Niranjan, S., Narayanamurthy, G., & Narayanan, A. (2023). Investigating contingent adoption of additive manufacturing in supply chains. *International Journal of Operations & Production Management*, *43*(3), 489–519. https://doi.org/10.1108/IJOPM-05-2022-0286

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (Fourth edition). SAGE Publications, Inc.

Paulus, T., Lester, J., & Dempster, P. (2014). *Digital tools for qualitative research*. SAGE Publications. https://doi.org/10.4135/9781473957671

Peñaloza, G. A., Saurin, T. A., & Formoso, C. T. (2020). Monitoring complexity and resilience in construction projects: The contribution of safety performance measurement systems. *Applied Ergonomics*, *82*, 102978. ScienceDirect. https://doi.org/10.1016/j.apergo.2019.102978

Perrow, C. (1967). A framework for the comparative analysis of organizations. *American Sociological Review*, *32*(2), 194–208. https://doi.org/10.2307/2091811

Polit, D. F., & Beck, C. T. (2010). Generalization in quantitative and qualitative research: Myths and strategies. *International Journal of Nursing Studies*, *47*(11), 1451–1458. https://doi.org/10.1016/j.ijnurstu.2010.06.004

Qazi, A. (2022). Data-driven impact assessment of multidimensional project complexity on project performance. *International Journal of Productivity and Performance Management*, *71*(1), 58–78. Emerald Insight. https://doi.org/10.1108/IJPPM-06-2020-0281

Racionero-Plaza, S., Vidu, A., Diez-Palomar, J., & Gutierrez Fernandez, N. (2021). Overcoming limitations for research during the COVID-19 pandemic via the communicative methodology: The case of homelessness during the spanish home confinement. *International Journal of Qualitative Methods*, *20*, 160940692110501. https://doi.org/10.1177/16094069211050164

Rankinen, J.-A., Lakkala, S., Haapasalo, H., & Hirvonen-Kantola, S. (2022). Stakeholder management in PED projects: Challenges and management model. *International Journal of Sustainable Energy Planning and Management*, *34*, 91–106. https://doi.org/10.54337/ijsepm.6979

Rebeeh, Y. A. M. A., Pokharel, S., Abdella, G. M. M., & Hammuda, A. S. (2019). Disaster management in industrial areas: Perspectives, challenges and future research. *Journal of Industrial Engineering and Management*, *12*(1), Article 1. https://doi.org/10.3926/jiem.2663

Resnik, D. B. (2020, December 23). *What is ethics in research & why is it important?* National Institute of Environmental Health Sciences. https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

Rezende, L. B., & Blackwell, P. (2019). Revisiting project complexity: A new dimension and framework. *Journal of Modern Project Management*, *6*(3), 126–141. Business Source Complete. https://doi.org/10.19255/JMPM01808

R.Gibbs, G. (2007). *Analyzing qualitative data*. SAGE Publications. https://doi.org/10.4135/9781849208574

Roberts, L. D. (2015). Ethical issues in conducting qualitative research in online communities. *Qualitative Research in Psychology*, *12*(3), 314–325. https://doi.org/10.1080/14780887.2015.1008909

Robinson, O. C. (2014). Sampling in Interview-Based Qualitative Research: A Theoretical and Practical Guide. *Qualitative Research in Psychology*, *11*(1), 25–41. https://doi.org/10.1080/14780887.2013.801543

Roblek, V., Mesko, M., Dimovski, V., & Peterlin, J. (2019). Smart technologies as social innovation and complex social issues of the Z generation. *Kybernetes*, *48*(1), 91–107. https://doi.org/10.1108/K-09-2017-0356

Ross, P. T., & Zaidi, N. L. B. (2019). Limited by our limitations. *Perspectives on Medical Education*, *8*(4), 261–264. https://doi.org/10.1007/S40037-019-00530-X

Rubin, H., & Rubin, I. (2005). *Qualitative interviewing (2nd ed.): The art of hearing data*. SAGE Publications, Inc. https://doi.org/10.4135/9781452226651

Salameh, A., & Bass, J. M. (2022). An architecture governance approach for Agile development by tailoring the Spotify model. *AI & SOCIETY*, *37*(2), 761–780. https://doi.org/10.1007/s00146-021-01240-x

Saldaña, J. (2021). *The coding manual for qualitative researchers* (4th ed.). SAGE Publishing Inc.

Sarvari, H., Valipour, A., Yahya, N., Noor, N. M., Beer, M., & Banaitiene, N. (2019). Approaches to risk identification in public–private partnership projects:

Malaysian private partners' overview. *Administrative Sciences*, *9*(1), Article 1. https://doi.org/10.3390/admsci9010017

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H., & Jinks, C. (2018). Saturation in qualitative research: Exploring its conceptualization and operationalization. *Quality & Quantity*, *52*(4), 1893–1907. https://doi.org/10.1007/s11135-017-0574-8

Saunders, M. N. K., Lewis, P., & Thornhill, A. (2019). *Research methods for business students* (8th ed.). Pearson Education Unlimited.

Sawadogo, D., Sané, S., & Kaboré, S. E. (2022). Sustainability management and the success of international development projects: The role of political and social skills. *Journal of Business and Socio-Economic Development*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/JBSED-02-2022-0020

Sawyerr, E., & Harrison, C. (2019). Developing resilient supply chains: Lessons from high-reliability organisations. *Supply Chain Management: An International Journal*, *25*(1), 77–100. https://doi.org/10.1108/SCM-09-2018-0329

Schmickl, T. (2022). Strong emergence arising from weak emergence. *Complexity*, *2022*, 1–17. https://doi.org/10.1155/2022/9956885

Seddeeq, A. B., Assaf, S., Abdallah, A., & Hassanain, M. A. (2019). Time and cost overrun in the Saudi Arabian oil and gas construction industry. *Buildings*, *9*(2), Article 2. https://doi.org/10.3390/buildings9020041

Serugga, J., Kagioglou, M., & Tzortzopoulos, P. (2020). Front end projects benefits realisation from a requirements management perspective—A systematic literature review. *Buildings*, *10*(5), 1–35. https://doi.org/10.3390/buildings10050083

Shash, A. A., Al-Salti, M., & Hadidi, L. (2021). Predicting cost contingency using analytical hierarchy process and multi attribute utility theory. *Journal of Engineering, Project, and Production Management*, *11*(3), 228–242. https://doi.org/10.2478/jeppm-2021-0022

Shaukat, M. B., Latif, K. F., Sajjad, A., & Eweje, G. (2022). Revisiting the relationship between sustainable project management and project success: The moderating role of stakeholder engagement and team building. *Sustainable Development*, *30*(1), 58–75. https://doi.org/10.1002/sd.2228

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*(2), 63–75. https://doi.org/10.3233/EFI-2004-22201

Shi, Q., Hertogh, M., Bosch-Rekveldt, M., Zhu, J., & Sheng, Z. (2020). Exploring decision-making complexity in major infrastructure projects: A case study from China. *Project Management Journal*, *51*(6), 617–632. https://doi.org/10.1177/8756972820919205

Silvestre, B. S., Silva, M. E., Cormack, A., & Thome, A. M. T. (2020). Supply chain sustainability trajectories: Learning through sustainability initiatives.

International Journal of Operations & Production Management, *40*(9), 1301–1337. https://doi.org/10.1108/IJOPM-01-2020-0043

Sing, M. C. P., Edwards, D. J., Leung, A. W. T., Liu, H., & Roberts, C. J. (2022). A theoretical framework for classifying project complexity at the preconstruction stage using cluster analysis techniques. *Engineering, Construction and Architectural Management*, *29*(9), 3754–3774. Emerald Insight. https://doi.org/10.1108/ECAM-09-2020-0726

Siriram, R. (2022). Integrating and transitioning the project front-end and project initiation phases in South African electrical engineering industrial projects. *International Journal of Managing Projects in Business*, *16*(8), 1–26. https://doi.org/10.1108/IJMPB-04-2022-0094

Smith, B., & McGannon, K. R. (2018). Developing rigor in qualitative research: Problems and opportunities within sport and exercise psychology. *International Review of Sport and Exercise Psychology*, *11*(1), 101–121. https://doi.org/10.1080/1750984X.2017.1317357

Smith, J. A. (Ed.). (2015). *Qualitative psychology: A practical guide to research methods* (3rd ed.). SAGE.

Smith, J. A., & Osborn, M. (2004). Interpretative Phenomenological Analysis. In G. M. Breakwell (Ed.), *Doing Social Psychology Research* (1st ed., pp. 229–254). Wiley. https://doi.org/10.1002/9780470776278.ch10

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Son, J. (2022). Complexity and dynamics in construction project organizations. *Sustainability*, *14*(20), 1–20. Complementary Index. https://doi.org/10.3390/su142013599

Stake, R. E. (1995). *The art of case study research*. Sage Publications.

Stewart, D. W., & Shamdasani, P. N. (2015). *Focus groups: Theory and practice* (3rd ed.). SAGE.

Stiles, S., Golightly, D., & Ryan, B. (2021). Impact of COVID-19 on health and safety in the construction sector. *Human Factors and Ergonomics in Manufacturing & Service Industries*, *31*(4), 425–437. https://doi.org/10.1002/hfm.20882

Su, L., & Cao, Y. (2022). Performance monitoring and evaluation of water environment treatment PPP projects with multi-source heterogeneous information. *Frontiers in Environmental Science*, *10*, 1024701. https://doi.org/10.3389/fenvs.2022.1024701

Sutrisna, M., & Goulding, J. (2019). Managing information flow and design processes to reduce design risks in offsite construction projects. *Engineering, Construction and Architectural Management*, *26*(2), 267–284. https://doi.org/10.1108/ECAM-11-2017-0250

Sutton, J., & Austin, Z. (2015). Qualitative research: Data collection, analysis, and management. *The Canadian Journal of Hospital Pharmacy*, *68*(3), 226–231.

Swart, K., Bond-Barnard, T., & Chugh, R. (2022). Challenges and critical success factors of digital communication, collaboration and knowledge sharing in project management virtual teams: A review. *International Journal of Information Systems and Project Management*, *10*(4), Article 4. https://doi.org/10.12821/ijispm100404

Takahashi, S., & Takahashi, V. P. (2022). Analysis of front end dynamic in the value co-creation with multiple stakeholders. *International Journal of Managing Projects in Business*, *15*(5), 742–768. https://doi.org/10.1108/IJMPB-11-2021-0301

Tashakkori, A., Johnson, B., & Teddlie, C. (2021). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences* (Second Edition). SAGE Publications, Inc.

Tiwari, P., & Suresha, B. (2021). Moderating role of project innovativeness on project flexibility, project risk, project performance, and business success in financial services. *Global Journal of Flexible Systems Management*, *22*(3), 179–196. https://doi.org/10.1007/s40171-021-00270-0

Tracy, S. J. (2020). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact* (Second edition). Wiley-Blackwell.

Tshering, D. (2023). Risk management as a dynamic and continuous process in the life cycle of a typical major civil engineering project. *Bhutan Journal of Research and Development*, *2*. https://doi.org/10.17102/bjrd.rub.se2.043

Turner, J. R. (2014). *The Handbook of project-based management: Leading strategic change in organizations* (Fourth Edition). McGraw-Hill Education.

Turner, R., & Miterev, M. (2019). The organizational design of the project-based organization. *Project Management Journal*, *50*(4), 487–498. https://doi.org/10.1177/8756972819859746

Urbański, M., Haque, A. U., & Oino, I. (2019). The moderating role of risk management in project planning and project success: Evidence from construction businesses of Pakistan and the UK. *Engineering Management in Production and Services*, *11*(1), 23–35. https://doi.org/10.2478/emj-2019-0002

Vaz-Serra, P., Edwards, P., & Aranda-Mena, G. (2021). An early-stage project complexity assessment tool for the AEC industry. *Construction Innovation*, *22*(2), 242–262. https://doi.org/10.1108/CI-10-2020-0162

Wang, W., Liu, Q.-H., Liang, J., Hu, Y., & Zhou, T. (2019). Coevolution spreading in complex networks. *Physics Reports*, *820*, 1–51. https://doi.org/10.1016/j.physrep.2019.07.001

Wickert, C., Post, C., Doh, J. P., Prescott, J. E., & Prencipe, A. (2021). Management research that makes a difference: Broadening the meaning of impact. *Journal of Management Studies*, *58*(2), 297–320. https://doi.org/10.1111/joms.12666

Williams, T., Vo, H., Samset, K., & Edkins, A. (2019). The front-end of projects: A systematic literature review and structuring. *Production Planning & Control*, *30*(14), 1137–1169. https://doi.org/10.1080/09537287.2019.1594429

World Medical Association. (2013). World medical association declaration of helsinki: Ethical principles for medical research involving human subjects. *JAMA*, *310*(20), 2191–2194. https://doi.org/10.1001/jama.2013.281053

Yazan, B. (2015). Three approaches to case study methods in education: Yin, Merriam, and Stake. *The Qualitative Report*, *20*(2), 134–152. https://doi.org/10.46743/2160-3715/2015.2102

Yin, J., Qu, M., Liao, G., Jia, M., & Li, M. (2022). Exploring the relationships between team leader's conflict management styles and team passion: From the emotional perspective. *Frontiers in Psychology*, *13*, 921300. https://doi.org/10.3389/fpsyg.2022.921300

Yin, R. K. (2018). *Case study research and applications: Design and methods* (Sixth edition). SAGE.

Yussef, A., Gibson, G. E., Asmar, M. E., & Ramsey, D. (2019). Quantifying FEED maturity and its impact on project performance in large industrial projects. *Journal of Management in Engineering*, *35*(5), 04019021. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000702

Yussef, A., Gibson, G. E., El Asmar, M., & Ramsey, D. (2020). Industry survey for determining the state of practice of front end engineering design for industrial construction. *Practice Periodical on Structural Design and Construction*, *25*(4), 04020025. https://doi.org/10.1061/(ASCE)SC.1943-5576.0000504

Zaman, U., Nawaz, S., Tariq, S., & Humayoun, A. A. (2019). Linking transformational leadership and "multi-dimensions" of project success: Moderating effects of project flexibility and project visibility using PLS-SEM. *International Journal of Managing Projects in Business*, *13*(1), 103–127. https://doi.org/10.1108/IJMPB-10-2018-0210

Zhang, Q., & Hao, S. (2022). Construction project manager's emotional intelligence and team effectiveness: The mediating role of team cohesion and the moderating effect of time. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.845791

Zhao, L., Mbachu, J., Liu, Z., Zhao, X., & Wang, B. (2021). Investigating the causal relationships between project complexities and project cost: An empirical study from New Zealand. *Advances in Civil Engineering*, *2021*, e6624647. https://doi.org/10.1155/2021/6624647

Zheng, J., Gou, X., Li, H., Xia, N., & Wu, G. (2021). Linking work–family conflict and burnout from the emotional resource perspective for construction professionals. *International Journal of Managing Projects in Business*, *14*(5), 1093–1115. https://doi.org/10.1108/IJMPB-06-2020-0181

Zhu, F., Wang, X., Wang, L., & Yu, M. (2021). Project manager's emotional intelligence and project performance: The mediating role of project commitment. *International Journal of Project Management*, *39*(7), 788–798. https://doi.org/10.1016/j.ijproman.2021.08.002

Appendix A: Interview Questions

1. As a project manager of industrial chemical plant projects, could you describe your role and responsibilities?
2. How do you identify the potential complexities in the early stages of a project, and can you provide specific examples of how you have done so in the past?
3. What strategies do you use during the Front-End Engineering Design (FEED) phase to mitigate any identified complexities?
4. Can you provide an example of a project where early identification of complexities significantly impacted the outcome of the project?
5. In your approach to managing project complexities, can you explain your decision-making process?
6. How do you manage risks during the execution of a project, and can you provide an example of a project where risk management significantly influenced the project's success?
7. Have you ever encountered a situation where project scope creep occurred, and if so, how did you manage it?
8. How do you foster collaboration among different stakeholders during a project, and can you share an example of a project where collaboration significantly influenced the project's success?
9. Given each project's unique context and complexities, how do you adapt your project management strategies accordingly?

10. Can you provide an example of a project that did not go as planned, and what lessons did you learn from that experience regarding identifying and managing project complexities?