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FACTORS RESPONSIBLE FOR COST OVERRUNS IN PROJECTS WITHIN THE MANUFACTURING INDUSTRY

by

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DECLARATION

I, Muhammad Fazl-Ur-Rahman Rawoot, declare that the contents of this dissertation/thesis represent my own unaided work, and that the dissertation/thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

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ABSTRACT

The purpose of the study was to identify and analyse the main factors that influence project-cost overruns within the manufacturing industry. The implementation of projects within the stipulated budget is vital for both the investor and the contractor, yet manufacturing projects, even those perfectly planned and organised, run the risk of cost overruns. Despite many tools supporting construction and project management, cost overruns continue to occur in manufacturing projects.

The objectives of the study were to identify, through a critical review and analysis of the literature and previous studies, the most dominant factors responsible for cost overruns and suggest an alternative strategy to mitigate their influence on cost overruns. To gather data for the study, a quantitative research method using a survey was employed. Data was collected from a sample of project managers, financial managers, procurement managers, original equipment manufacturers, and project executives or sponsors. A total of 76 questionnaires were received. Of these, 400 surveys were sent out; 69 responses were duly fully completed, while 7 were incomplete, resulting in a response rate of 17%. These seven incomplete questionnaires were excluded from the data analysis.

The results revealed that, during the execution phase, cost overruns are frequently encountered throughout the implementation phase of a project. The key findings regarding the contributors to cost overruns in the manufacturing industry were found to be construction-related factors, estimation, design- and contract-related factors. Other factors, like planning- and scheduling-related factors, experience of the PM, labour, communication, materials and machinery, financial and, to a lesser degree, external-related factors, were also identified and align with the existing corpus of knowledge concerning cost overruns across diverse sectors, including manufacturing and the public sector.

This research also presents recommendations like enhanced design and contract management, improved estimation accuracy, strengthening risk-management practices, enhancing stakeholder engagement and communication, and leveraging new technologies in mitigating cost overruns within the manufacturing industry. The study contributes to the body of knowledge about the causes of cost overruns in South Africa.

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ABBREVIATIONS

Terms/ Acronyms/ Abbreviations	Definition/Explanation
BD	Business Domains
CTC	Cost to Complete
EVM	Earned Value Management
GCC	Gulf Corporation Council
GDP	Gross Domestic Product
MW	Megawatt
OEM	Original Equipment Manufacturer
PM	Project Manager
PMBOK	Project Management Book of Knowledge
PMI	Project Management Institute
SOR	Statement of Requirements
SPSS	Statistical Package for the Social Sciences
UAE	United Arab Emirates

CHAPTER ONE – INTRODUCTION

1.1 Introduction

In industry today, there is a strong reliance on project-management controls and techniques when implementing modifications or infrastructure upgrades to further streamline or improve plant or processes. Problem-solving has evolved over the last century (Aljohani, 2017), especially within the manufacturing industry, to improve the quality of products being manufactured and reduce the number of defects in a production line. Industries have become accustomed to the use of project-management tools to help implement these changes and improvements to meet ever-demanding technology changes, as well as the ability to reduce overheads (Bekr, 2015). In many cases these changes are required to enhance the existing processes or improve the productivity or safety of an existing process.

The value to clients is a very complex and often subjective issue, but it is recognised that time, cost and quality of a project are key components of perceived value to clients (Rahman et al., 2013). There are many other project-performance parameters that are equally valued by clients, such as scope, utility, integration, risks, zero-carbon status, and health and safety. For the purpose of this study, the focus would be on time, cost and quality, also known as the iron triangle. The “lack of quality” in projects is manifested in poor or non-sustainable workmanship, unsafe structures, delays, cost overruns and disputes in construction contracts (Aljohani, 2017). The value and quality of projects is of concern to both public- and private-sector clients. It is this perceived value to the client, that organisations aim to make improvements to existing processes and infrastructure to improve the quality of the product.

As these projects are implemented, organisations tend to endure constant challenges to the budget proposals presented to the senior leadership to get approval to initiate these projects. Manufacturing industries have a poor reputation in terms of finishing projects on budget. Nine out of ten projects normally experience cost overruns (Aljohani, 2017). A cost overrun is a general occurrence in the global construction industry (Rahman et al., 2013).

Successful project execution is defined as “a project delivered on time, within budget, and to specification at completion” (Bannerman, 2008, p. 1). Management by projects is now increasingly the norm in industries in general and is perceived to be more efficient than traditional operations management (Hamilton, 1997). A project typically goes through five stages in its life cycle. Each of those elements has a cost factor that impacts the final cost of production. Meanwhile there is a high project-execution failure rate (Project Management Works, 2021). Across many disciplines, successful execution is measured against the triple parameters of time, cost, and quality. PMBOK (2017) defines successful project execution as

a measure by product and project quality, timeliness, budget compliance, and degree of customer satisfaction.

The manufacturing industry periodically undergoes changes to plant to enhance safety in terms of operations, engineering, maintenance, and management systems. Education in problem-solving was revolutionised with the perspective of Einstein, who stated that problems cannot be solved with the same thinking that was used when they were created (Bono, 2009). A change is needed in how problems are solved and a different perspective is required from a different angle (Bono, 2009).

South Africa (SA) has numerous problems in the technical environment, such as the electricity supply shortage and under-developed infrastructure (Mzimba, 2017). The Innovation Index suggests that SA must think of problem-solving with innovation in mind (Mzimba, 2017). The fact that SA is slow to convert solutions to execution is partly attributed to the lack of guidelines to aid the project manager in solving technical problems with innovative solutions that remain within budget (Mzimba, 2017).

Construction projects could be measured or evaluated against many important performance criteria. However, cost remains the most agreed indicator of a project success (Tichacek, 2006). Enterprises and businesses operating in a technical space in SA could benefit from a guideline that solves problems without enduring cost overruns. Not having a problem-solving process for addressing technical problems in an enterprise or an organisational context will not promote the development of organisational innovation (Jeroen & Lokkerbol, 2012). The importance of this study is to provide the South African and international industry with clear focus guidelines to implement a strategy to prevent cost overruns when undertaking manufacturing projects.

1.2 Problem statement

During a project, there is always an adjustment that must be made to the initially forecasted budget. Project managers tend to have to go back to the management committee to justify the need for more funds to conclude the project. Cost is a major consideration throughout the project-management lifecycle and can be regarded as one of the most important parameters of a project and the driving force of project success (Akinsiku et al., 2014). Nine out of ten times, projects are overspent by anything from 10% to 300%, but the factors responsible for these cost overruns are not clearly understood by project managers (Bekr, 2015). Amoah et al., (2020) found that the financial plan for projects in South Africa increased by more than 400% throughout the years.

The dilemma faced by project managers is how to effectively manage a project's scope and associated costs set for their project, to ensure they complete within time and cost and achieve the expected quality. There are countless reports of projects where the factors responsible for cost overruns are realised at the end of the project. This, however, is too late. Had the project manager been familiar with the key indicators, they would have been better prepared to mitigate these factors. Many previous studies have identified cost and time overruns as a general problem in industry worldwide (Abdelgawad & Fayek, 2010; Ahmad et al., 2013; Al-Khaldi, 1990; Altshuler & Luberoff, 2003; Bekr, 2015).

Cost overruns in construction projects impact the economy in that they lead to an increase in the capital-output ratio for the entire economy. According to Rathi and Khandve (2016), India is infamous for delays and cost overruns. Cost overruns have become a hallmark of infrastructure projects in India, as very few projects are delivered in time and on cost. It was also noted that the pattern of cost overruns in public and private sector projects is comparable. In a survey of 308 public and 51 private projects in Malaysia, Endut (2009) found that, respectively, 46.8% and 37.2% of public and private sector projects were reported to have been finished within budget. An additional finding from their analysis indicates that, in contrast to 76.0% of public-sector projects, 84.3% of private-sector projects were finished within the 10% cost deviation. This suggests that initiatives led by the public and private sectors are both prone to cost overruns (Akinsiku et al., 2014).

When a project is finished on schedule, within budget, and with the required level of technical performance or quality, it is deemed successful (Williams, 2003). Chimwaso (2000) asserts that it is uncommon to find projects finished within the allocated budget. Time and cost overruns are significant issues that arise throughout the development of projects and are common in business, particularly in developing nations. Contractors as clients end up with substantial expenditures as a result. As time overrun is also a heavy contributor to cost overruns, contractors are burdened with reduced profit margins and battered reputation. This research will explore the areas within the project where cost overruns are encountered. Based on the challenge that very few projects are delivered on cost, the problem may be stated as follows:

Determine what factors are primarily responsible for cost overruns and analyse their contribution to developing a strategy to mitigate their influence.

1.3 Research questions

The main research question can be stated as follows:

How can the factors responsible for project-cost overruns be mitigated through the development of an appropriate strategy?

Sub-questions:

1. Which factors are most frequently responsible for cost overruns?
2. What mitigating strategies are currently used to mitigate cost overruns?
3. How effective would the development of an alternative strategy be to mitigate these factors?

1.4 Research objectives

The purpose of this study is to identify, through a critical review and analysis of the literature and previous studies, the most dominant factors responsible for cost overruns and their contribution and to develop a strategy to mitigate their influence on cost overruns. By identifying these factors, the project manager is able to put measures in place to ensure that he is aware on these plaguing factors and accommodates them within the definition phase of the project prior to securing a budget for the project.

The objectives to be achieved by the research are as follows:

1. Determine which factors are responsible for cost overruns.
2. Identify the strategies currently used to mitigate these factors.
3. Develop an alternative strategy to mitigate these factors.

1.5 Research methodology

To achieve the objectives of this study, the research approach will be quantitative. The research will make use of a purposive random systematic stratified sampling technique whereby a representative number of participants in the survey will be estimated from a determined population. The study will use a quantitative method, such as a survey, to gather the data to meet the objectives of this study.

The research methodology shall make use of the following approach:

1. A detailed literature review of projects and reports detailing where cost overruns were experienced. This data will be analytically analysed to determine the most prominent factors responsible for cost overruns.
2. Data will be gathered by utilisation of an online survey that will be distributed among the determined population to a representative sample. The use of an online questionnaire will permit the user to do the survey at a convenient time, thereby increasing the prospects of a more comprehensive response.
3. Analysis of the data collected using an appropriate statistical analysis software package such as SPSS version 26.
4. Develop a strategy to effectively mitigate the impact of cost overruns and the potential impact of residual factors leading to cost overruns.

1.6 Study limitations and delimitations

The research limitations are as follows:

- The study will be predominantly confined to the United Arab Emirates (UAE) and South Africa (SA), due to time and location constraints.
- The population determined for this research will be limited to project-management practitioners in the UAE, SA and LinkedIn connections. The PMI and other institutions limit access to the register of their members, due to confidentiality and non-disclosure agreements.
- There are many project-performance parameters that are equally valued by clients, such as scope, utility, integration, risks, zero-carbon status, and health and safety. However, for the purpose of this study, the focus would be on time, cost and quality performance parameters, also known as the iron triangle.

The research delimitations are as follows:

- Although there are other performance parameters that could result in cost overruns, this study is limited to cost parameters in projects.
- The time allowed to complete this study is limited to 12 months.
- For this study, the geographical area of focus would be the UAE and SA.

1.7 Study assumptions

This study is based on the following assumptions:

1. Respondents will complete the survey honestly, accurately and to the best of their ability.

2. All respondents have project-management cost-control budget experience.
3. There would be adequate participation from all levels of individuals within the organisation to provide an accurate account of experiences.
4. The organisations will not place any restrictions on the information provided.
5. Projects experience cost overruns.

1.8 Ethical considerations

The ethical clearance application process of the Cape Peninsula University of Technology (CPUT) and applicable codes of conduct to be followed in terms of data collection and respondent protection shall strictly be adhered to during the study. The study shall also be approved by the relevant ethics committee of the university. The researcher shall share the research proposal and survey questionnaire with his company and obtain ethical clearance. The company will review the material in line with the company's confidentiality, non-disclosure, and business sensitivity in accordance with company policies and processes. The Data and Privacy Protection Act of the United Arab Emirates, where the researcher was employed at the time the research proposal was created, will be followed by the researcher.

All participants were required to acknowledge participation in this study as being voluntary. Participants who are not willing to participate are not engaged by the researcher and coerced to respond or to change his or her mind in responding voluntarily. All information provided by the participants will be kept confidential. The study will not violate any rights of any participant involved. No participant in the study will receive any benefit or be put at any risk because of the study.

1.9 Structure of the study - Dissertation Outline

The outline for this dissertation is as follows: -

Chapter 1 – Proposal

- Chapter 1 introduces the research problem, the research aim and objectives, the key research question, and the research design, as well as the scope, delineation, and limitations of the research.

Chapter 2 – Literature review

- Chapter 2 consists of the conceptual framework and literature review, which investigates the theoretical background of the problem that is being investigated. Applicable references will be tabulated with reference to each primary factor. The

main sub-factors will be identified for each primary factor, and a summary of the outcome of the literature review will be provided. A comparison of similar studies will also be indicated, thereby reaffirming the factor.

Chapter 3 – Research Methodology

- Chapter 3 presents the research design and an in-depth discussion of the operational methods used to gather and analyse data from the relevant sources. In this chapter, the procedure for determining the sample and type of questions, as well as the sample details required to achieve a good confidence level in the data gathered is discussed.

Chapter 4 – Data Analysis and results

- Chapter 4 assesses and discusses these results of the research questions collected from the survey. The data was analysed and documented to summarise the findings. The analysis shall also lead to the conclusions and recommendations discussed in the last chapter.

Chapter 5 – Conclusion and recommendations

- In this chapter, the objectives of this research will be reviewed in conjunction with the results and a determination will be made if the outcome met the study objectives. The findings of the data analysis and interpretation are summarised to formulate concluding remarks and further recommendations.

1.10 Chapter summary

This chapter introduces the study and summarises the background and problem that resulted in the need for this study. It sets out the motivation for the study being undertaken. This chapter further details the problem statement, research questions, research objectives and methodology to be utilised to conduct this research. Ethical considerations and the study structure have been briefly mentioned and are in alignment with the university policy.

Chapter 2 will focus on the literature review of previous studies on similar topics that were investigated based on factors responsible for cost overruns.

CHAPTER TWO – LITERATURE REVIEW

2.1 Introduction

Because the project team and management have different ideas about what constitutes good execution, the success of a project-execution process has always been a contentious issue (Wilemon & Thamhain, 1983). The efficacy of the project team is frequently a determining factor in the success or failure of a project. There is a consensus among researchers though that projects are characterised by the need to “satisfy” the triple constraints, also referred to as the iron triangle. The identification of these constraints in the early stages of the development of project management as a discipline have been in use in industry, as identified by Atkinson (1999). Atkinson (1999) later added scope as part of the measure of successful execution, resulting in the use of the square root (budget, quality, scope, and time) as standards against which successful execution is measured.

Successful project execution is defined as a project delivered “on time, within budget, and to specification” at completion (Bannerman, 2008). Management by projects is now increasingly the norm in industries in general and this norm is perceived to be more efficient than traditional operations management (Hamilton, 1997). A project typically goes through five stages in its life cycle, and each one of these stages has a cost factor that impacts the final cost of production. Meanwhile there is a high project-execution failure rate (Project Management Works, 2021) across many disciplines, as successful execution is to be measured against the triple constraints. According to PMBOK (2017), punctuality, budget compliance, customer satisfaction, and the quality of the project and its output are the key indicators of a successful project's execution.

The famous words of Boris Pasternak: “Literature is the art of discovering something extraordinary about ordinary people, and saying with ordinary words something extraordinary” (Bharadwaj, 2019, p. 1211–1213).

He explains that what is written in history is important, as it teaches about what others are expressing (Bharadwaj, 2019).

2.2 Theoretical guidelines

For the purpose of this study, PMBOK will be focused on for requirements. The PMBOK (Project Management Body of Knowledge) is, by definition, a set of the guidelines and standard terminology provided by the PMI (Project Management Institute). The development of project management as a discipline has introduced a new understanding of how to manage project

teams effectively to enable them to meet the triple constraints. The PMBOK (2017) identified the five phases of the project life cycle, namely:

1. **Initiating**: this stage involves the conceptualisation and bringing together of the stakeholders who are relevant to the process (PMI, 2017). The result of the phase is the drawing up of a project charter, which provides the details about the project to be implemented (PMI, 2017).
2. **Planning**: this stage translates the project charter into a detailed document identifying and quantifying the requirements needed for the purpose (PMI, 2017). Planning will provide details on the statement of requirements (SOR), which includes, among others, all resources necessary (human, outsourced services, and materials) necessary for the effective execution of the project (PMI, 2017). Budgeting is a critical component of this stage, since it will allow the sponsors to understand their commitment in financial terms, the cost of embarking on the project.
3. **Executing**: this stage is the translating of the intention/vision plan into a tangible deliverable product, the realisation of what was envisaged (PMI, 2017). The fulfilment of these plans within the specified iron triangle is what is used to measure the success or failure of the execution of a project (PMI, 2017).
4. **Monitoring and Controlling**: the processes necessary to measure, review, and control the project's progress and performance (PMI, 2017).
5. **Closing**: those processes performed to finalise all activities across all process groups to formally close the project or phase (PMI, 2017).

With the manufacturing and construction industry projects, cost remains one of the most important factors that must be considered throughout the project lifecycle. Despite the significance of this factor, projects have been failing to accomplish their objectives within the predefined budget of the project (Project Management Works, 2021). A cost overrun can simply be defined as the change in contracted amount divided by the original awarded amount. This is calculated at the end of the project and the success of the project is heavily dependent on this outcome. A construction project is deemed successful when it is finished on schedule, within budget, and with the required technical performance or quality (Williams, 2003).

Construction in South Africa is considered a significant contributor to the South African economy. The government uses construction projects to stimulate development and in turn it helps with financial-recession recuperation and poverty alleviation. In 2020, the South African construction sector contributed with an added value of approximately 83 billion rands (roughly

5.4 billion US dollars) to the country's gross domestic product (GDP), as reported by Galal (2021). A country's financial development is determined by the level of business development, which includes roads, hospitals, schools, and other infrastructure. As a result, it is critical that construction projects are finished on schedule, within budget, and to the desired quality. However, the construction business faces a number of challenges, including bad quality, cost overruns, schedule overruns, construction waste, and others. This issue has evolved into a practice in the South African building business. Amoah et al., (2020) found that the financial plan for projects in South Africa increased by more than 400% throughout the years.

From the beginning to the end of a project, there are cost overruns, which are mostly caused by variables that negatively affect cost performance. South Africa is one of numerous countries that face this problem of cost overruns. Cost overruns occur when the total cost of a project exceeds the anticipated amount. Compelling cost planning links the outline of buildings to their cost so that, while taking full account of value, modifications, hazards, usefulness, and appearance, the cost of a project is planned to be within the budget. Cost overruns are becoming a major concern in the construction industry as a result of widespread and ongoing poor cost management. Poor cost management is one of the most serious challenges concerning project costs in South Africa and other developing countries.

With reference to a study performed by Mahamid and Amund (2012), it was reported that all the tasks of 169 street-development projects experienced the ill effects of cost deviation. A review of these findings identified the following variables: design changes, experience of PM, frail direction and control, climate conditions, reliance on imported materials, low-talented labour, improper assessment of undertakings or time/length, project extortion, and irregularities in contract documentation. Of these variables, the five top variables were design changes, experience of PM, reliance on imported materials, low-talented labour, improper assessment of undertakings or time/length. This study, however, failed to identify the level of contribution of each of these variables to the overall cost of the project, as well the percentage overrun. As a result, the need to clearly understand the contribution levels of each variable is required to put measures in place as mitigation.

Subramani et al., (2014) identified the causes of cost overruns in their study, namely, absence of basic leadership in the arranging phase of a task, poor contract administration, poor plan, increments in the costs of materials and machines, and poor estimation. In another study by Okpala and Aniekwu (1988) in Nigeria, it was found that clients agreed that shortages of materials, finance, and payment of completed works and poor contract management were the most important causes of cost overruns. Mansfield et al., (1994) conducted research on the

performance of transport infrastructure projects in Nigeria and reported that the most common causes of cost overruns were material price variations, erroneous forecasts, project delays, and extra work. Elinwa and Buba's (1994) third research on Nigerian construction projects discovered that material costs, fraudulent activities, and material price changes had the greatest influence on project costs. Morris and Hough (1987) and Flyvbjerg et al., (2003) discovered that variations in material costs and additional work contributed the most to cost overruns in significant examinations of construction project performance in European countries.

There is still a strong correlation between schedule delays and cost overruns on building projects. In recent years, time delays have become the rule rather than the exception. According to Al-Khalil and Al-Ghafly (1999), who reported on public utility projects in Saudi Arabia, contractors judged sluggish decision-making, claim settlement delays, and progress payment delays to be the most significant delay reasons. Clients considered, as did the consultants, that 'poor early planning', scope modifications, and financial difficulties by the contractors were the primary causes of delay. Odeh and Battaineh (2002) discovered that poor worker productivity, owner intervention, and insufficient contractor experience were the root reasons of project delays in Jordan. Consultants on these projects identified inadequate contractor experience, late payment for finished work, and bad subcontracting as the primary reasons of delay. The inclusion of late payment for completed work from consultants is due to payment being handled after the agreed-upon deadline for work completed by contractors. Contractors suspend construction progress, resulting in schedule delays.

Poor cost management is one of the most serious challenges concerning project costs in South Africa and other developing countries. According to Mulenga (2014), the first and most important step in avoiding construction cost overruns is to identify and understand the elements that cause the overruns. Revamps during development due to design modifications, blunders, and supervision are the most common causes of project cost overruns. According to Park and Papadopoulou (2012), cost overruns can have a detrimental impact on the design team's reputation and client confidence.

South Africa has a few mega-projects in the energy and transport sectors that are either underway or have just been finished, including the Kusile Power Station (Eskom), the Medupi Power Station (Eskom), the New Multi-Product Pipeline (Transnet), and the Durban port renovation and extension project (Transnet). Medupi Power Station is a dry-cooled, coal-fired power plant being developed in Lephalale in Limpopo province. According to Phaahla (2015),

this is Eskom's fourth dry-cooled baseload station built in the last 20 years, following Kendal, Majuba, and Matimba.

According to Phaahla (2015), both the Medupi and Kusile power plants are experiencing construction delays. Medupi was originally scheduled to be finished in four years but is now in its seventh year of development. Phaahla (2015) predicted that it will be finished in 2019. The Kusile Power Station project, located near the current Kendal Power Station in Mpumalanga's Nkangala region, would consist of six units, each with an installed capacity of 800 MW, for a total capacity of 4800 MW. According to Eskom (2014), if finished, Kusile would be the world's fourth-largest coal-fired power plant. Kusile began in 2008 and was anticipated to be finished by the end of 2014; however, the project is still incomplete. The original cost was estimated at R69.1 billion. By July 2016, the cost of completion (CTC) had been estimated at R160 billion (Yelland, 2019).

According to Khumalo (2021), the Durban port renovation and extension project is also expected to cost more than anticipated. According to Khatleli (2020), Durban is the busiest port in the southern hemisphere, as well as South Africa's largest and busiest port. It now handles 64% of the country's seaborne container traffic. Transnet is carrying out this project to expand the container port handling capacity in Durban. However, the contractor has reportedly halted the R4.2 billion contract, which was intended to develop deeper berths at the Durban container terminal (Barradas, 2019).

As cited by Khumalo (2021), President Cyril Ramaphosa stated in his letter to the nation that “These ambitious plans will require greater private-sector participation and investment. Transnet, including the Durban Port, is an important national asset belonging to the people of South Africa. According to President Cyril Ramaphosa, the development of the Port of Durban precinct will require R100 billion in fresh investment over the next decade in a project targeted at boosting efficiency at one of the country's primary generators of economic growth, as reported by Khumalo (2021). Initially, the cost of this project was envisaged to be 4.2 billion rand in 2019. Recently in 2021, following the president’s announcement, this project has grown significantly to 100 billion rand. What were the factors influencing these significant cost overruns in these mega-projects in South Africa? Were the reasons for this cost overrun clearly understood? Was there influence from the government or corruption that led to such a significant cost overrun, as cited by Khumalo (2021) in the Durban port upgrade?

There appears to be a link between project size and cost overruns, with larger construction projects resulting in a higher percentage cost overrun. Shrestha et al., (2013) observed, in a study of 363 public construction projects, that larger project sizes resulted in more significant

cost overruns. According to Altshuler and Luberoff (2003), these projects, sometimes known as mega-projects, are distinguished by their cost, physical nature, and social effect, which attracts increasing public attention. The findings seem to suggest that there is a direct relationship between the size of a project and the expected cost overrun. However, by applying basic project-management principles, the budget should be carefully analysed and as the success of the project is based on the iron triangle: time, cost, and quality, where cost is one of the core compositions.

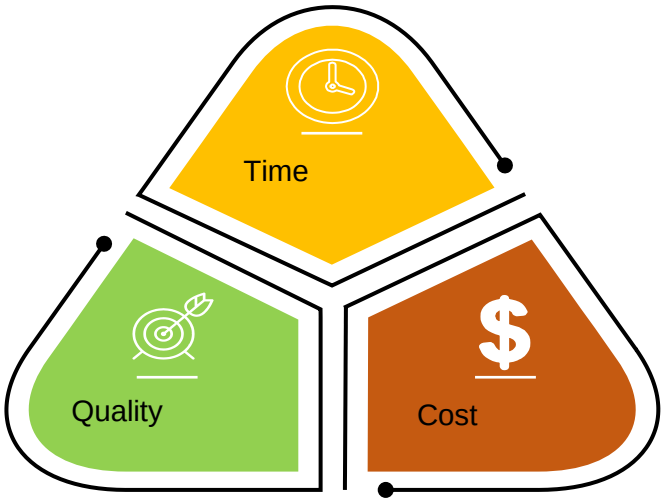

Figure 1-The Iron Triangle - adapted from PMBOK (2017)

Price rises are sometimes seen as a cause of cost overruns. This has been highlighted as one of the leading causes of expense overruns by both government organisations and researchers worldwide. According to Morris (1990), price rises account for around 20%-25% of all cost overruns in India. The remainder may be attributed to a variety of issues, the most significant of which include poor design and implementation, insufficient project finance, bureaucratic indecision, and a lack of collaboration between businesses and stakeholders. According to Subramani et al., (2014), one of the most prominent variables contributing to cost overruns is material price rises.

This viewpoint is not always shared by project managers, as demonstrated by Lind and Brunes (2015), who discovered that the majority of respondents in the observed sample size of 101 project managers were either unsure (32%) or opposed (48%) to the idea that price increases were a common cause of cost overruns. In addition to these criteria, the time required to complete the project will influence whether cost overruns occur (Morris, 1990).

The vast complexities of building projects allow for multiple cost-increasing reasons to arise, raising the risks and uncertainties involved. The tendency towards larger, more complicated

projects leads to more cost and schedule variances, resulting in failed endeavours (Abdelgawad & Fayek., 2010).
In a research study on road-construction projects in Bahrain, Hasan et al., (2014) found that bad planning and unskilled workforce are the leading reasons of contractor delays. Delays in decision-making are a key cause of concern for owners.

Two papers were evaluated that looked into the reasons for project delays in Kuwait. These investigations covered both government and residential construction projects. Al-Tabtabi (2002) distributed a questionnaire with 53 reasons of delay to 48 practitioners representing contractors, consultants, and government agencies. The main reasons for delays were delayed decision-making by government agencies, limited power for supervisory personnel, slow payment procedures, inefficient planning, and concerns about contractor favouritism. In another research, Koushki et al., (2005) investigated the reasons of delays in private residential projects in Kuwait. The approach employed was an interview with 450 private residence owners. The three most common reasons for schedule delays were modification orders, budgetary restrictions, and the owners' lack of expertise in the building industry.

Al Nuaimi & Mohsin (2013) and Ruquashi and Bashir (2013) conducted research on Oman's general construction and oil and gas industries. According to their findings, 40% of projects completed between 2007 and 2010 took longer than expected. They discovered that the causes of delay were shifting with time. Ruquashi and Bashir (2013) performed a survey to determine the reasons of delays in oil and gas projects. Based on replies from 59 project managers, it was determined that there is a high level of agreement on the reasons of delays. The most common causes of delay were poor site management and supervision by contractors, issues with subcontractors, insufficient planning and scheduling, poor management of contractor schedules, material delivery delays, a lack of effective communication among project stakeholders, and poor interaction with vendors during the engineering and procurement stages. The study discovered no indication of a link between organisational size or ownership and delay reasons. Furthermore, it was determined that the findings are likely to apply to other GCC nations.

In Qatar Jurf and Beheiry (2010) investigated the factors for delays in residential construction projects. They polled construction specialists working with Grade 'A' contractors in Qatar and discovered 42 probable reasons of delay. From these 42 probable causes, it was discovered that the most common causes of time overruns as viewed by contractors include material supply delays, design modifications, manpower shortages, inadequate estimates, and poor cash-flow forecasting.

Saudi Arabia is the first GCC country where published articles on building, general construction, manufacturing, oil and gas, and pipeline projects have reported delays. The first report, published in 1995, investigated big building projects through a review of 56 major reasons of delay. It uses an important index to assess the findings and then tests the correlation factor between two groups' importance rankings (Assaf et al., 1995). General construction was the most extensively researched area, with four publications published. Assaf et al., (2006) concentrated their research on significant building projects in the eastern province of Saudi Arabia. A survey questionnaire with 73 identified reasons was administered. According to the stated findings, 70% of the analysed projects were delayed, with an average overrun of 10% to 30% of the initial length, and modification orders were the most common cause identified by various stakeholders.

Albogamy et al., (2012) distributed a survey questionnaire containing 63 reasons of delay and used a significance measure to rate them. The significance index was calculated using a severity index and likelihood. The investigation was done in five Saudi cities. The most serious reason of delay was shown to be the land acquisition aspect. This underscores the severe land-ownership and acquisition difficulties that exist in the city. Other reasons that lead to delays include contractors' lack of experience, disorganised subsurface utilities (line services), and redesign. It is found that the owner was responsible for a greater number of project delays than contractors, consultants, and other stakeholders. Mahamid (2013) conducted a questionnaire with 22 public-owner participants to investigate the owners' viewpoints on the reasons of delays for public building projects in Saudi Arabia, and 35 causes of delay were discovered. According to the study's findings, the leading causes of public project delays include the allocation of bids to the lowest price, inadequate communication and coordination, bad site management, payment processing delays, and low workforce productivity.

Halloum and Bajracharya (2012) centred their investigation on Abu Dhabi, the UAE's richest emirate. They discovered that 90% of the projects analysed encountered delays in the Emirate of Abu Dhabi. Salama et al., (2008) looked at the reasons for schedule delays in the oil and gas construction industry. 37 construction experts took part in a poll utilising 35 reasons for schedule overruns documented in the literature. The sample consisted of individuals from owner and consultant organisations, with no contractors participating. Delays in procurement, item delivery, poor contractor selection based on bid value rather than contractor competence, insufficient communication methods, and a scarcity of skilled labour were among the reasons found.

Faridi and El-Sayegh (2006) looked at the reasons for delays in the UAE construction sector as a whole in another research. The study, which determined the significance of 44 identified reasons of delay, was based on a survey questionnaire completed by 105 industry practitioners. There was no owner representation among the participants, who had experience in consulting and contracting. Using the Spearman's correlation factor, the ranking technique and relative relevance index methodology were used, and the rank agreement between each pair of ranks was further statistically evaluated. According to the findings of the study done in 2006 by Faridi and El-Sayegh, individuals with more experience appear to rank differently from those with less experience. The research findings concluded that the main reasons of delays in the UAE construction sector include sluggish decision-making by owners, poor early planning, and approval of designs.

Motaleb and Kishk (2010) looked at the reasons for delays in the UAE building sector in a different research study. Thirty-five construction businesses participated in a survey covering forty-two sources of delay. The outcomes were contrasted with past research projects carried out by Faridi and El-Sayegh (2006). The findings and deviations presented corroborated Motaleb and Kishk's (2010) theory on the temporal variability of delay causes. The findings indicated that irrational project duration, designated subcontractors, and cultural effects are the primary reasons for delays.

According to Mansfield et al., (1994), financing and payment arrangements, subpar contract management, shortages of materials, unreliable estimators, and price volatility are the main causes of cost overruns in Nigeria. Mansfield et al., (1994) have also suggested that project management in developing nations be enhanced throughout the project's planning phase. Numerous publications have also proposed that the planning stage of a project, when more time is spent defining and understanding the project via a detailed grasp of the client's expectations, is where project management might be enhanced in developing nations. These expectations are refined into the project's scope, goals, and the necessary course of action to meet the goals for which the project was started after they are understood.

El-Kholy (2015) conducted research in Egypt and found that early cost estimate accuracy is highly valued by project teams as well as owners in engineering and construction projects. Two models for forecasting the percentage of cost overruns in building projects were employed in this study. In order to create the first model, 44 variables that have an influence on the cost performance of building projects were collected from the literature and employed in a regression analysis. General managers, technical office managers, and construction managers were among the responders. In addition to their various areas of expertise, all the

participants worked on building projects; 42% of them were engaged in civil works (roads, bridges, and airports), and 82% of them were working on public water and sewage projects.

El-Kholy (2015) reports that the top 11 factors that contribute to cost overruns are independent variables. These include the owner's financial situation, contractors' cash flow, the type of procurement (open or selective), the rise in material costs brought on by inflation, the level of competition during the tendering process (aggressive or not), changes in the currency used to make payments, the size of the project (small or large), the length of time it takes for design and approval, the client's assumption of risk regarding quantity variations, detailed or not-detailed drawings, and inaccurate material estimating. El-Kholy (2015) reported data that showed a strong linear association between the proportion of cost overruns and the 11 factors that have a major impact on project cost overruns.

2.3 The industry key factors highlighted from the literature review are:

1. Design- and contract-related factors (Alghonamy, 2015)
2. Estimation-related factors (Yelland, 2019)
3. Project- and scheduling-related factors (Alnuaimi & Mohsin, 2013)
4. Project-management-related factors (Galal, 2021)
5. Labour-related factors (Alnuaimi & Mohsin, 2013)
6. Financial-related factors (El-Kholy, 2015)
7. Material- and machinery-related factors (Naveenkumar & Prabhu, 2016)
8. Construction-related factors (Abusafiya & Suliman, 2017)
9. Communication-related factors (Alhomidan, 2013)
10. External-related factors (El-Kholy, 2015)

A summary of the primary factors is indicated in Figure 2.

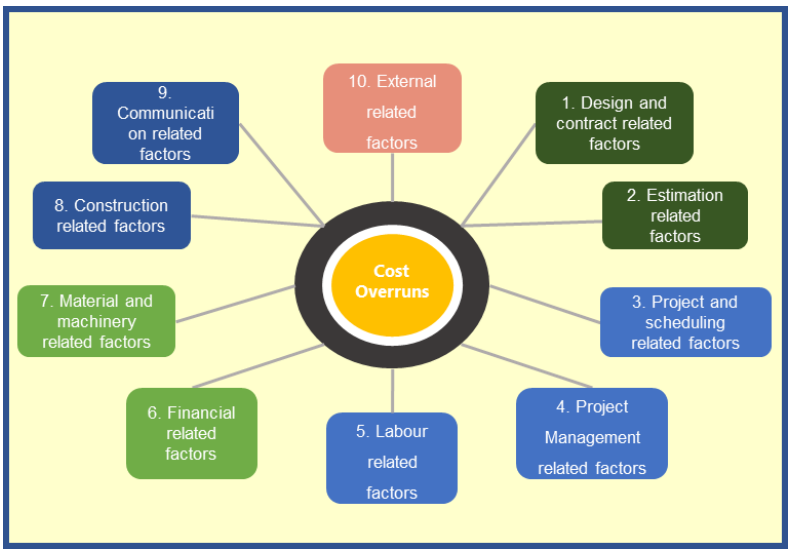

Figure 2 - Groups of primary factors causing cost overruns

2.3.1 Design- and contract-related factors

In research conducted in Malaysia by Roslan et al., (2015) states that the design phase of a project is the time when precise plans and drawings are created. Since the design phase plays a significant impact in the cost performance of projects, great care is taken to prevent cost overruns throughout the construction phase. According to Azhar et al., (2008), the reasons for design plan-related cost overruns in Pakistan are preventable since they could have been anticipated and avoided. It was identified that there are various causes of cost overruns related to the design stage. Factors that lead to design modifications, design errors, insufficient specifications, or extra work are examples of design- and contract-related issues that cause cost overruns and are shown in Table 1.

Table 1 – Design- and contract-related factors

Factor	Author/s	Number of authors
Design changes	Albogamy et al., (2012); Alghonamy (2015); Azman et al., (2013); Bekr (2015); Dubois & Gadde (2002); Jackson (2002); Olawale & Sun (2010); Ali & Kamaruzzaman (2010); Jurf & Beheiry (2010); Mahamid & Amund (2012)	14
Scope changes	Assaf & Al-Hejji (2006); Assaf et al., (1995); Chang (2002); Kaliba et al., (2009); Khabisi (2013); Khumalo (2021); Koushki et al., (2005); Mansfield et al., (1994); Manthar, Mangi, Sohu, Jamali, & Ullah (2017); Morris & Hough (1987); Nega (2008); Roslan et al., (2015); Yelland (2019)	13
Lowest bidding procurement method	Halloum & Bajracharya (2012); Mahamid (2013); Manthar, Mangi, Sohu, Jamali, & Ullah (2017); Salama et al., (2008); Azhar et al., (2008)	5
Inadequate pre-construction study	Park & Papadopoulou (2012)	1
Poor project design and implementation	Morris (1990)	1
Irregularities in contract documentation	Mahamid & Amund (2012)	1
Technical challenges	Kaliba et al., (2009)	1
Short bid preparation time	Iyer & Jha (2005)	1
Method of procurement (open tender or selective tender)	El-Kholy (2015)	1
Competition at tender stage (aggressive or not)	El-Kholy (2015)	1
Lack of coordination at design phase	Danso & Antwi (2012)	1
Number of bidders	Azman et al., (2013)	1
Location and types of projects	Azman et al., (2013)	1
Contract period	Azman et al., (2013)	1
Accurate selection of form of contract	Arcila (2012)	1
Adequate specifications	Arcila (2012)	1
Early involvement of contractor	Arcila (2012)	1

2.3.2 Estimation-related factors

The PMI defines estimating as a crucial component of project planning that entails a quantitative assessment of the resources, cost, and duration of a project (PMI, 2022). But estimate, in the words of Larson and Grey (2011), is the act of projecting and estimating the amount of money, time, and other resources required to complete the project's goal. According to Akintoye (2000), estimating is the scientific process of projecting how much it will cost to carry out certain tasks in order to complete the building project's goals within the allotted time frame.

Estimating the duration and cost of building projects is necessary to plan project funding. Effective project and resource information is essential for the estimating process, as is background knowledge on material, equipment, and labour costs. For the purpose of providing accurate time and expense estimates for certain tasks, accuracy estimation is crucial. Factors that cause cost overruns due to incorrect project-length estimates, improper estimating techniques, inadequate project-cost estimates, and erroneous material estimates are referred to as estimated associated factors and are shown in Table 2.

Table 2 - Estimation-related factors

Factor	Author/s	Number of authors
Inaccurate estimation	Azman et al., (2013); Ali & Kamaruzzaman (2010); Omoregie & Radford (2006); Belachew et al., (2017); Yelland (2019); Subramani et al., (2014); Mansfield et al., (1994); El-Kholy (2015)	8
Project size	Azman et al., (2013); Shrestha et al., (2013); Altshuler & Luberoff (2003); Abdelgawad & Fayek (2010)	4
Unrealistic project duration	Memon et al.,, (2010); Mahamid & Amund (2012); Motaleb & Kishk (2010)	3

2.3.3 Planning- and schedule-related factors

Every step of a project's lifetime, from pre-construction to construction, requires planning, including the procedures involved in construction. According to Russell and Taylor (2008), there are seven steps involved in project planning: defining project objectives, identifying activities, establishing precedence relationships, estimating project duration, comparing project schedule objectives, and figuring out what resources are needed to meet objectives.

Baldwin and Bordoli (2014) state that meeting the expectations of project stakeholders, producing realistic schedules and costs, and completing a project to established standards of

quality, design criteria, project resources, health, and safety are among the common goals of project planning. Table 3 lists several instances of planning- and schedule-related factors that lead to cost overruns: poor planning, schedule adjustments, or timetable delays.

Table 3 – Project- and scheduling-related factors

Factor	Author/s	Number of authors
Ineffective planning	Alnuaimi & Mohsin (2013); Al-Tabtabi (2002); Azhar et al., (2008); Faniran et al., (1998); Faridi & El-Sayegh (2006); Hasan et al., (2014); Manthar, Mangi, Sohu, Jamali, & Ullah (2017); Ramabodu & Verster (2010); Roslan et al., (2015); Ruquashi & Bashir (2013); Salunkhe & Patil (2014); Subramani et al., (2014)	12
Schedule delays	Alnuaimi & Mohsin (2013); Belachew et al., (2017); Mansfield et al., (1994); Kaliba et al., (2009)	4
Lack of monitoring and control	Faniran et al., (1998); Naveenkumar & Prabhu (2016)	2
Develop implementation plans	Faniran et al., (1998)	1

2.3.4 Project-management-related factors

According to Frimpong et al., (2003), project-management tools and practices are crucial to the efficient administration of a project. It is well known that the success of projects in the construction sector is largely dependent on project management. Construction projects require a large number of personnel, supplies, and equipment to complete their enormous job. Because of this, the project manager (PM) is in charge of various components and must carefully manage and regulate them to guarantee the efficient use of resources to complete the project. Improving the cost performance of building projects requires effective cost management.

Cost management is considered a vital part of project management that targets achieving efficient cost performance through the project-planning and execution phase within the limited budget of the project, as stated by Divakar and Britto (2018). Project-management-related factors include slow decision-making, inadequate supervision and site management, subpar contract management, and subpar vendor interactions. Table 4 lists these factors.

Table 4 – Project-management-related factors

Factor	Author/s	Number of authors
Poor contract management	Al-Khalil & Al-Ghafly (1999); Dubois & Gadde (2002); Eshofonie (2008); Faridi & El-Sayegh (2006); Frimpong & Oluwoye (2003); Galal (2021); Koushkiet al., (2005); Le-Hoai et al., (2008); Mansfield et al., (1994); Manthar, Mangi, Sohu, Jamali, & Ullah (2017); Morris (1990); Qureshi et al., (2009); Roslan et al., (2015); Subramani et al., (2014)	14
Poor project management	Abusafiya & Suliman (2017); Al Nuaimi & Mohsin (2013); Arcila (2012); Iyer & Jha (2005); Long et al., (2004); Mahamid & Amund (2012); Memon et al., (2010); Ruquashi & Bashir (2013)	8
Limited authority for supervision staff	Al-Tabtabi (2002)	1
Client's involvement and feedback	Arcila (2012)	1
Poor site management	Mahamid (2013)	1
Lack of coordination between enterprises	Morris (1990)	1
Owner interference	Odeh & Battaineh (2002)	1
Availability of management finance and plans	Al-Khaldi (1990)	1
Owner interference	Odeh & Battaineh (2002)	1

2.3.5 Labour-related factors

Building projects, according to Arcila (2012), are interdisciplinary and involve a wide range of stakeholders, including the project owner, different professions, contractors, suppliers, labour, and subcontractors. The study's conclusions included the following: sufficient pre-construction plans; contractor and architect competence; client feedback and involvement; positive relationships between project participants; funding availability; early contractor involvement; precise contract form selection; and sufficient specifications.

The construction sector is considered to be a dynamic industry which constantly faces uncertainties and this uncertainty, combined with the numerous stakeholders involved in these types of projects, makes cost management difficult, thus leading to cost overruns. The labour-related factors causing cost overruns can be defined as poor performance by contractors, a shortage of workers, employee skills and labour costs, as cited in Table 5.

Table 5 - Labour-related factors

Factor	Author/s	Number of authors
Poor labour performance	Abdul Rahman, Memon, Karim, & Tarmizi (2013); Abusafiya & Suliman (2017); Albogamy et al., (2012); Al Nuaimi & Mohsin (2013); Arcila (2012); Chua & Loh (1997); Dubois & Gadde (2002); Hasan et al., (2014); Kaliba et al., (2009); Mahamid & Amund (2012); Mahamid (2013); Motaleb & Kishk (2010); Odeh & Battaineh (2002); Roslan et al., (2015); Ruquashi & Bashir (2013); Tejale, Khandekar & Patil (2015); Sanvido, Grobler, Parfitt, Guvenis & Coyle (1992); Yelland (2019)	20
Poor site management and supervision by contractors	Al Nuaimi & Mohsin (2013)	2
Wages of labour and services	Amoa-Abban & Allotey (2014)	1
Labour shortage	Abusafiya & Suliman (2017); Baloyi & Bekker (2011); Jurf & Beheiry (2010); Peter & Willson (2006); Salama et al., (2008)	5
Poor relationship between top management and labourers	Durdyev et al., (2012)	1

2.3.6 Financial-related factors

According to Amoa-Abban & Allotey (2014) in Ghana, there are situations where clients do not have enough money to finish their projects and frequently do not pay contractors on time, as per the contract agreement. According to Ali and Kamaruzzaman (2010) in Malaysia, one of the causes still contributing to project cost overruns is inadequate funding for project finance. The financial-related factors causing cost overruns can be defined as slow payment process, cost management, inadequate funding, cashflow issues, contractor finances, owner financial constraints and late payment, as cited in Table 6.

Table 6 - Financial-related factors

Factor	Author/s	Number of authors
Inadequate funds	Ali & Kamaruzzaman (2010); Arcila (2012); El-Kholy (2015); Jurf & Beheiry (2010); Morris (1990); Nasir et al., (2011)	6
Payment delays	Al-Khalil & Al-Ghafly (1999); Al-Tabtabi (2002); Amoa-Abban & Allotey (2014); Frimpong & Oluwoye (2003); Mahamid (2013); Manthar, Mangi, Sohu, Jamali, & Ullah (2017); Odeh & Battaineh (2002); Okpala & Aniekwu (1988); Tejale, Khandekar & Patil (2015)	9
Financial constraints	Ameh et al., (2010); Amoah & Morena (2020); Barradas (2019); Divakar & Britto (2018); Manthar, Mangi, Sohu, Jamali, & Ullah (2017); Yelland (2019)	6
Environmental protection and mitigation costs	Kaliba et al., (2009)	1
Owners' financial constraints	Koushki et al., (2005)	1

2.3.7 Materials- and machinery-related factors

According to Subramani et al., (2014), materials make up more than half of the total cost of building projects in England, labour costs less than a third, and overhead and profit make up the remaining portion. Cost increases brought on by rising labour, material, and equipment prices may differ depending on where in the nation you live.

As agreed upon with the customer, contracts between suppliers and subcontractors may contain varied clauses related to inflation protection. According to Amoa-Abban & Allotey (2014), who centred their study on Accra, as inflation rises, financing rates rise as well, and project expenses rise. Lind and Brunes (2015) reported that price increases in Sweden were the common cause of cost overruns, while Jurf and Beheiry (2010) reported that delivery of materials in Qatar was the primary reason for cost overruns. Material- and machinery-related factors can be defined as delivery delays, poor material specification, high cost of machinery, reliance on imported material and shortage of materials. Cost overruns related to material and machinery can be defined as late delivery of material, elevated cost of machinery, reliance on imported material and material unavailability, as cited in Table 7.

Table 7 – Material- and machinery-related factors

Factor	Author/s	Number of authors
Cost of material	Azhar et al., (2008); Bekr (2015); Elinwa & Buba (1994); Flyvbjerg et al., (2003); Lind & Brunes (2015); Mansfield et al., (1994); Morris & Hough (1987); Naveenkumar & Prabhu (2016); Subramani et al., (2014)	9
Delivery delay	Al Nuaimi & Mohsin (2013); Halloum & Bajracharya (2012); Jurf & Beheiry (2010); Ruquashi & Bashir (2013); Salama et al., (2008)	5
Supply of raw materials and equipment by contractors	Enshassi et al., (2009)	1
Project-material monopoly by some suppliers	Enshassi et al., (2009)	1
Material specifications	Dubois & Gadde (2002)	1
Reliance on imported materials	Mahamid & Amund (2012)	1
Shortage of materials	Okpala & Aniekwu (1988)	1

2.3.8 Construction-related factors

Building projects experience an ongoing cycle of change. since of the physical distance between the project and the professional team, this procedure might prove to be challenging since teams—such as project managers, architects, contractors, quantity surveyors, and engineers—frequently exchange information. Change orders made during the construction phase of projects have had a major impact on cost performance (Shrestha et al., 2019).

Tejale, Khandekar & Patil (2015) reported that poor construction adopted by the constructor was the primary cause of cost overruns, whereas Belachew et al., (2017) reported that the lack of experience of the technical consultants was the main reason for construction-related cost overruns. Phaahla (2017) reported that the cause of construction-related overruns in South Africa can be attributed to delays in construction. Similarly, in Gaza, Enshassi et al., (2009) reported delays in construction to be the reason for cost overruns. Construction-related factors can be defined as delays in construction, mistakes during construction, lack of experience of technical consultants and complexity of works, as listed in Table 8.

Table 8 - Construction-related factors

Factor	Author/s	Number of authors
Construction errors	Abdul Rahman et al., (2013); Abusafiya & Suliman (2017)	2
Lack of experience of technical consultants	Belachew et al., (2017)	1
Delay in construction	Enshassi et al., (2009); Phaahla (2015)	2
Complexity of works	Olawale & Sun (2010)	1
High transportation cost	Patil & Bhangale (2016)	1
Poor construction adopted by constructor	Tejale, Khandekar & Patil (2015)	1

2.3.9 Communication-related factors

One of the most important abilities amongst teams participating in a project's construction management is communication. A construction project has several sources that necessitate effective communication amongst all stakeholders to prevent disagreements that might negatively impact the project. In Sweden, one of the key elements influencing the building phase is communication (Dubois & Gadde, 2002).

Roslan et al., (2015) reported that, in Malaysia, a lack of communication between parties was the main cause of cost overruns, whereas Tejale, Khandekar & Patil (2015) stated that, in India, a lack of communication and coordination was the primary cause of communication-related cost overruns. In Pakistan, Manthar, Mangi, Sohu, Jamali, & Ullah (2017) reported that owner/client interference was the reason cost overruns were experienced. However, an ineffective communication system was cited by Halloum et al., (2012) as the reason for communication-related cost overruns, as cited in Table 9.

Table 9 - Communication-related factors

Factor	Author/s	Number of authors
Poor communication	Alhomidan (2013); Al Nuaimi & Mohsin (2013); Dubois & Gadde (2002); Halloum & Bajracharya (2012); Roslan et al., (2015); Ruquashi & Bashir (2013); Salama et al., (2008); Tejale, Khandekar & Patil (2015)	8
Owner/client interference	Manthar et al., (2017)	1

2.3.10 External-related factors

Numerous experts have noted that a variety of external variables frequently impact construction projects and can lead to cost overruns. Factors that are outside of the project manager's control are categorised as external. According to El-Nawawy and Abdel-Alim (2017), external issues such as corruption and bribery led to cost overruns. However, El-Kholy (2015) stated that fluctuation in the currency that payments are made in was the main contributor to cost overruns in Egypt. In Pakistan, Manthar et al., (2017) reported that the laws and regulations framework was the factor responsible for cost overruns. In India, Naveenkumar et al., (2016) reported that unpredictable weather was the factor responsible for cost overruns.

External-related factors can be defined as factors beyond the control of the project, project manager or client. Typical examples of these factors are bad weather, government policy or influence, bribery and corruption, culture impacts on economic stability, and political instability, as cited in Table 10.

Table 10 - External-related factors

Factor	Author/s	Number of authors
Political instability	Ahmad et al., (2013)	1
Land acquisition	Albogamy et al., (2012); Nasir et al., (2011); Salunkhe & Patil (2014)	3
Government-related delays	Al-Tabtabi (2002); Azhar et al., (2008); Kaliba, Muya, & Mumba (2009); Manthar et al., (2017); Salunkhe & Patil (2014)	5
Fraudulent practices	Elinwa & Buba (1994); El-Nawawy & Abdel-Alim (2017); Mahamid & Amund (2012); Omoregie & Radford (2006)	4
Currency fluctuations	El-Kholy (2015)	1
Bad weather	Iyer & Jha (2005); Kaliba et al., (2009); Naveenkumar & Prabhu (2016)	3
Owners' lack of experience	Koushki et al., (2005)	1
Culture impacts	Motaleb & Kishk (2010)	1
Apprehension towards contractor's favouritism	Al-Tabtabi (2002)	1
Economic stability	Ameh et al., (2010)	1

Based on the literature review and analysis, the most significant factors in order of importance responsible for cost overruns are tabulated in Table 11 and graphically presented in Figure 3.

Table 11 – Distribution of primary factors

No.	Primary Factors	No. of sources
1	Design- and contract-related factors	41
2	Project-management-related factors	29
3	Labour-related factors	29
4	Financial-related factors	23
5	Material- and machinery-related factors	19
6	External-related factors	21
7	Project- and scheduling-related factors	19
8	Estimation-related factors	14
9	Communication-related factors	9
10	Construction-related factors	8

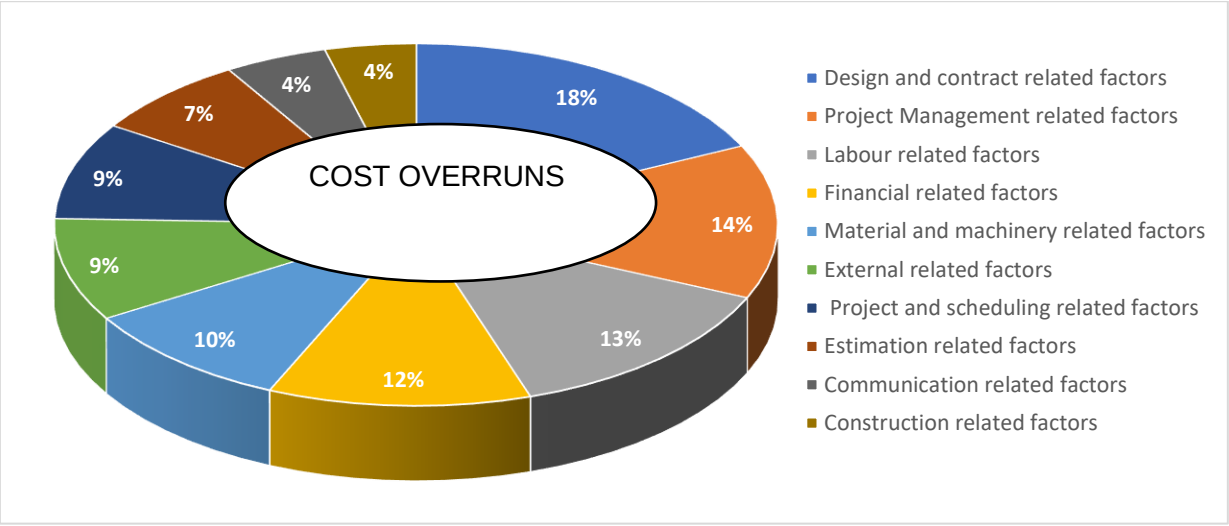

Figure 3 – Graphic presentation of the distribution of primary factors

Some might contend that these elements are not independent and that several factors may combine to produce cost overruns in the end. A client's request for extra work, for instance, might cause a delay in the purchase of materials, which could lead to price rises or shortages in that period. Aside from stakeholders "shifting the blame" and protecting their operational domain, the opinions of customers, contractors, and consultants regarding the causes of cost overruns may also be at odds.

2.4 Chapter Summary

This chapter explores the existing literature pertaining to cost overruns. The most prominent or frequently encountered factors that are accountable for cost overruns are delineated, encompassing design- and contract-related factors, project-management-related factors, labour-related factors, financial-related factors, and ultimately material- and machinery-related factors.

The next chapter defines the method that this research would adopt in collecting the data, analysing and interpreting the data. The various data-collection methods will be discussed.

CHAPTER THREE – RESEARCH METHODOLOGY

Introduction

In general, research is synonymous with a thorough and thoughtful investigation – diligent and analytical investigation or scrutiny focused on uncovering and understanding fresh information (Obilor, 2023). For this study, research can be defined as a structured method of obtaining information. This chapter includes information on various research methods and designs. The study design requires making a number of challenging but crucial decisions. These include the research questions to be addressed, the theoretical framework that will guide the investigation, the best way to reliably and accurately measure important constructs, the subjects or objects to sample and observe, the number of subjects, locations, or objects that must be sampled to obtain adequate statistical information, and the data-analytic techniques that will be employed.

3.1 Research approach

Research methodology, in the words of Sarantakos (1998, p. 465), is "the theory of methods" it is the process by which the subject of the investigation is understood. The procedures that were followed to address the research design, as well as the techniques for gathering and analysing data, will be demonstrated.

3.2 Types of research

Depending on the kind of study and the data needed, there are three different research design to research technique (Tiffin University, 2024).

3.2.1 Quantitative research

A quantitative research methodology focuses on measuring and testing numerical data. This approach is good for reaching many people in a short amount of time. This type of research helps in testing the causal relationships between variables, making predictions, and generalising results to wider populations (Sreekumar, 2023).

3.2.2 Qualitative research

A qualitative research approach looks at people's beliefs, actions, and life experiences. It gathers and examines textual data and words. Because each participant needs to spend a significant amount of time, this study approach uses fewer individuals but still takes more time. When the study issue being explored is not well defined, this strategy is employed in exploratory research (Sreekumar, 2023). Bhandari (2024) defines qualitative research as the process of gathering and evaluating non-numerical data. The methodical nature of the research process is demonstrated by the way the goal is defined, data is managed, and findings are communicated within pre-existing frameworks and rules. The frameworks and

guidelines provide researchers with an indication of what to include in the research, how to perform the research, and what types of inferences are probable based on the data collected (Williams, 2007).

3.2.3 Mixed-method research

In a single study, a mixed-method research approach combines the best features of quantitative and qualitative research methods. By employing both approaches, researchers may confirm their findings, see if the results are complimentary, and use the second way to explain any unexpected outcomes from one method (Sreekumar, 2023).

Bhandari (2024) defines qualitative research as the process of gathering and evaluating non-numerical data. It is useful for determining averages and trends, formulating hypotheses, examining causality, and extrapolating findings to larger groups. Thus, it is recognised that the goal of a qualitative research design is to ascertain the potential thoughts, behaviours, or emotions of participants. Large sample sizes are utilised in quantitative research, which focuses on the volume of replies rather than the more focused or emotional understanding that qualitative research seeks to achieve (Bhandari, 2024).

There are four main quantitative research design types used in industry by researchers (Ghanad, 2023). These design types are briefly listed and discussed:

- Descriptive research
- Correlational research
- Causal comparative / quasi-experimental research
- Experimental research

3.2.4 Descriptive research

Giving a summary of a variable's status is the aim of descriptive research (Williams, 2007). These investigations aim to provide systematic information about a phenomenon. Typically, a hypothesis is not developed at the outset of the study. Instead, it is most frequently developed after evidence is gathered. The hypothesis is tested through the synthesis and analysis of data. Careful selection of the units of study and meticulous measurement of every variable are necessary for systematic information gathering. Moreover, “descriptive studies may be characterised as simply the attempt to determine, describe or identify what is, while analytical research attempts to establish why it is that way or how it came to be” (Ethridge, 2004, p. 24). Three main purposes of descriptive studies can be explained as describing, explaining, and validating research findings. This type of research is popular with non-quantified topics.

Descriptive research is “aimed at casting light on current issues or problems through a process of data collection that enables them to describe the situation more completely than was possible without employing this method” (Fox, 2007, p. 45). Consequently, it is acknowledged that descriptive research is employed to characterise different facets of a phenomena. Descriptive research is commonly employed to characterise the traits and/or actions of a representative group. It's a useful way to gather data that you may use to formulate theories and suggest connections. According to Ghanad (2023), descriptive research includes quantitative data that may be compiled in numerical form, such as test results or the frequency with which a user utilises a certain multimedia programme feature. Accurately describing a population, circumstance, or occurrence is the goal of descriptive study, which is more interested in "what, where, and when" than "why" something occurred (Ghanad, 2023).

The three main data-collection methods in descriptive research, according to Cherry (2023) are:

3.3.4.1 Observational method

With no direct input from the respondents, the observational approach enables researchers to gather data based on their perception of the respondent's conduct and features. A quantitative observation must be interpreted in terms of a number and necessitates the collecting of data in numerical form. Statistical survey data is utilised for analysis in quantitative observations (Ghanad, 2023).

Being among the best techniques for carrying out descriptive research, it is also a crucial component of physical scientific study. According to Cherry (2023), this procedure can be classified as either quantitative or qualitative. The objective gathering of numerical data, the outcomes of which can be examined using statistical and numerical techniques, was a prerequisite for quantitative observation. A typical example of this type of research would be a researcher observing how many children would prefer using a slide rather than a swing in a play park.

Comparatively, qualitative observation focuses on the observation of traits rather than numerical values. From a distance, the researcher makes his observation, documents it, and uses it to support his findings (Cherry, 2023).

3.3.4.2 Case-study method

An individual, group of individuals, organisation, event, etc. that serves as a sample group whose traits are utilised to characterise the traits of a larger group of which the case study is a subgroup is called a case study. To benefit the greater group, the data acquired from looking into a case study may be generalised. Case-study research, which uses reports from previous studies, enables the investigation and comprehension of difficult situations. It can be regarded as a reliable research approach, especially when a comprehensive, in-depth enquiry is needed (Zainal, 2007).

However, this generalisation can be problematic because case studies are insufficient to draw firm conclusions about broader populations. The use of case studies to generalise is flawed.

3.3.4.3 Survey research

This is a highly used technique for gathering data for research ideas. In survey research, investigators prepare a questionnaire or survey and send it to participants who provide responses (Bhattacherjee, 2012). Typically, it is employed to perform thorough quantitative and qualitative research as well as to quickly collect information straight from the original source. Survey research occasionally combines quantitative and qualitative methods. Self-administered postal, group, or internet-based surveys are reasonably inexpensive and useful for a large sample since every survey participant receives the same set of questions (Check, 2012). Using a survey allows the researcher to get information from a representative sample of a larger population, which is one of its benefits. Large dataset analysis accurately captures the variety of the population, and data acquired via these methods can more reliably be generalised to a wider population than data gathered through case studies (Ghanad, 2023).

3.2.5 Correlational research

Statistical data is used in correlational research to assess the strength of a link between two or more variables. The researchers can then examine how the variables are connected to one another. If two variables are connected or correlated, we may use one to predict the value of the other. The higher the correlation, the more accurate our forecast will be (Sumeracki, 2018). Links between and among various facts are looked for and understood in this kind of design. Though it does not go so far in its analysis as to show causation for these observed patterns, this form of research will identify trends and patterns in the data. For this kind of observational study, cause and effect are not the foundation. Variable distributions, relationships, and data are examined. A natural context is the sole one in which variables are recognised and examined; they are not altered in any way (Busayo.Longe, n.d., 2024). Since correlational

research does not include the manipulation of any variables, it is occasionally seen as a kind of descriptive study rather than as a distinct research style (Busayo.Longe, n.d., 2024).

3.2.6 Causal comparative / quasi-experimental research

According to Oppenhimer (2022), an approach for determining cause-and-effect linkages between independent and dependent variables is called causal-comparative research. With a few significant exceptions, some designs resemble actual experiments to a considerable extent. The investigator identifies an independent variable, measures its effects on the dependent variable, and does not change the independent variable. The groups must be pre-existing or spontaneously established; the researcher is not allowed to assign groups at random. Determining the reasons of the findings must be done carefully, since there is still a chance that other factors, known and unknown, will have an impact.

3.2.7 Experimental research

True experimentation, also known as experimental research, employs the scientific method to determine the cause-and-effect relationship between a set of factors that comprise a study (Zubair, 2023). A real experiment has nothing to do with a laboratory environment, even though it is frequently conceptualised as laboratory research. Any research in which every other variable is left uncontrolled and every attempt is made to identify and control it qualifies as a real experiment. The impacts on the dependent variables are ascertained by manipulating an independent variable (Zubair, 2023). Rather than being grouped together as they would in nature, subjects are randomly allocated to experimental treatments.

3.3 Research design

Closed-ended questions are typically preferred in quantitative research designs (Mohajan, 2020). Respondents typically won't be able to provide long, open-ended answers when given a predetermined selection of options. With this approach, quantitative research is conducted considerably more efficiently than it would be if open-ended, qualitatively styled questions were used (Mohajan, 2020).

It saves time by eliminating the need to code a large number of open-ended replies, which makes it more efficient (DJS Research, 2024). When suitable, a quantitative research design does, however, frequently permit the addition of a "Other" category to the list of potential answers to questions. This enables respondents who do not fall neatly into one of the primary groups to nonetheless have their exact answers noted and utilised for the examination of the study project outcomes (DJS Research, 2024).

According to Satpathy et al., (2023), in 2014, a research design is a master plan specifying the methods and procedures for collection and analysing needed information. The research design follows the quantitative approach where the data collected from the population are analysed statistically from the survey as the data-collection instrument. The framework, structure, and technique of an enquiry devised in order to gain answers to the research questions and the control variance is what Kerlinger (1973), offers in his well-known description of a research design.

To provide a fair analysis of the full data sample, a quantitative research design often consists of asking the identical questions to every responder (Jongbo, 2014). The data may be quantified by statistical methods and is provided in a numerical format for analysis.

The research will make use of purposive convenience sampling that is stratified, whereby the number of participants, based on their characteristics, experience and knowledge, will be sampled from the population, as detailed in Figure 4. The subject of this study centres around project management. It was essential that the population was filtered to those professionals having a background in project management. As the study requires input from individuals having a PM background, the population chosen was specific to PMs, line and department managers, directors, and original equipment manufacturers (OEM). Figure 4 is a graphical representation of the potential participants that satisfies the population sample as discussed.

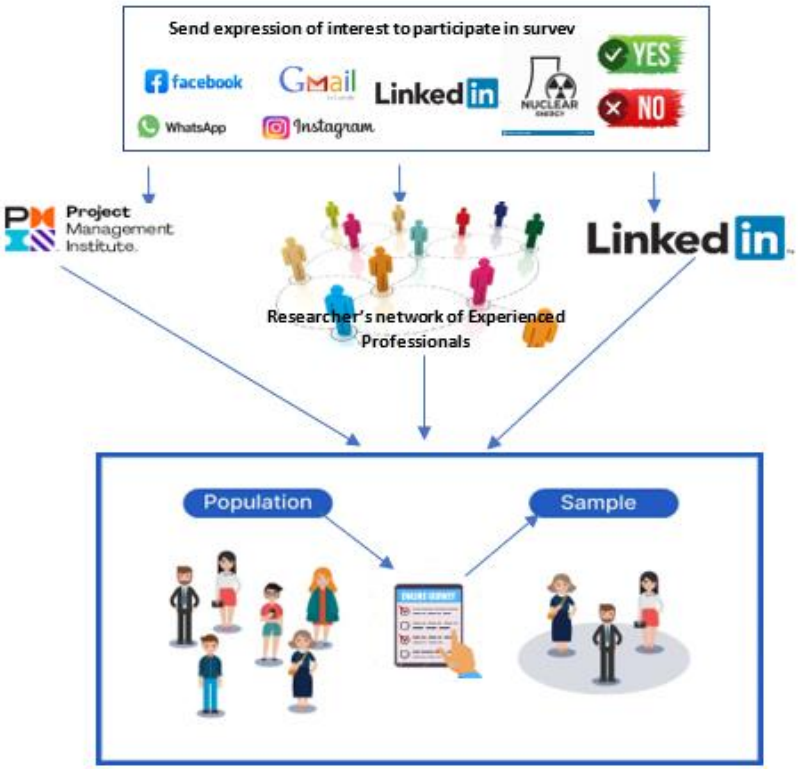

Figure 4 – Population and sample groups

Cochran (1977) stated that the timelines allocated for 'Findings' and 'Conclusion' should not be rushed, as population size and sample size are important to obtain a level of confidence when sampling. This is to allow for the determination of the sample size from the sampling method, develop a survey questionnaire, distribute it, receive responses, analyse, and provide recommendations as part of the discussion points.

3.4 Population and sampling strategy

The research will use purposive convenience sampling to determine participants to survey, as illustrated by Figure 5.

Purposive sampling is an economical method of selecting a sample, by which members who align with the study are chosen, excluding any unnecessary individuals from the population. By selecting individuals in the population, this helps to cut down on the time that would have otherwise been taken up. By gathering data from the most suitable participants, the researcher decreases the sampling error margin, resulting in findings that are highly applicable to the research environment (Obilor, 2023).

The total number of participants in a study, known as the sample size, is often divided by demographics like age, gender, and location to ensure it accurately represents the entire population. Deciding on the correct sample size is crucial in statistical analysis.

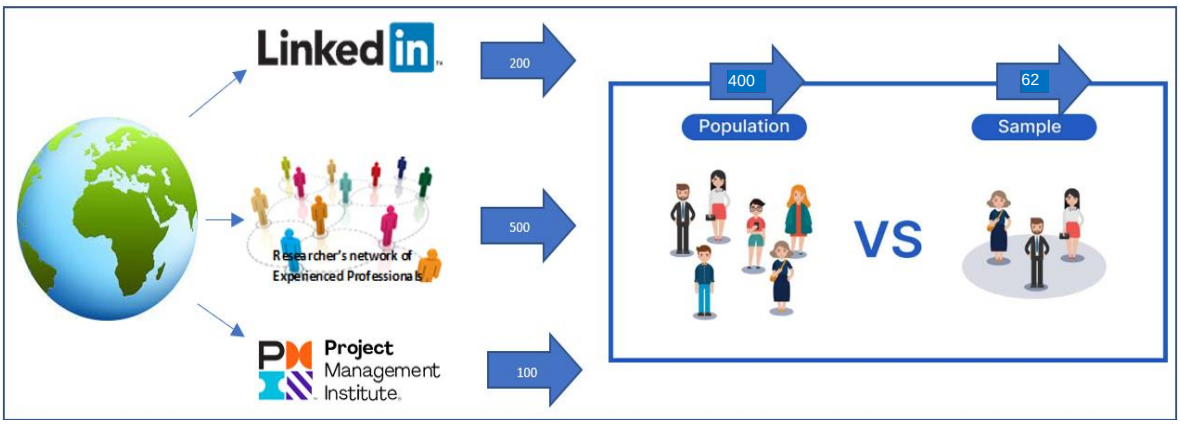

Figure 5 – Population and sample size

Cochran (1977), in his statistical formula in Figure 6, calculates the sample size needed from the population:

$$Sample\ Size = \frac{\frac{z^2 p(1-p)}{e^2}}{1 + (\frac{z^2 p(1-p)}{e^2 N})}$$

Equation 1 – Cochran's statistical formula for sample size

Definition of parameters:

Z – z-scores – the z-score is the number of standard deviations a given proportion is away from the mean. The right z-score is associated with the level of confidence; a high percentage level indicates the researcher's confidence that the population would select an answer within a certain range.

P – Population proportion – a percentage of the population that has professions within the PM and BD domains.

E – Margin of error – a statistical measurement that accounts for the difference between actual and projected results in a random survey sample.

N – Population sample size – the total number of people who responded with their interest to participate in the survey questionnaire.

Variable calculated	Scenario 1	Scenario 2	Scenario 3
z (CL=95%)	1.96	1.96	1.96
z^2	3.8416	3.8416	3.8416
p	0.95	0.95	0.95
(1-p)	0.05	0.05	0.05
e	0.05	0.05	0.05
e^2	0.0025	0.0025	0.0025
e^2*N	1.25	1	0.75
z^2*p*(1-p)	0.1825	0.1825	0.1825
[z^2*p*(1-p)]/e^2	73	73	73
1+[z^2*p*(1-p)]/(e^2*N)	1	1	1
N (Population size)	500	400	300
Min sample size	64	62	59

Figure 6 – Calculation of sample size according to Cochran's statistical formula

A confidence level of 95% is deemed appropriate and renders a z-score of 1.96. The margin of error is at 5% (0.05). Figure 7 details the calculation parameters used to determine the population and minimum sample size.

This study utilises a purposive convenience sampling method from the population with experience in project management, programme managers, portfolio managers, OEMs, and business analysts. A minimum sample size of 62 is required when using Cochran's formula.

This means that to assure a confidence level of 95% with a 5% margin of error related in the results when the data is analysed, the research needs a total of 62 respondents from a population of 400 professionals from the PM and BD domains.

3.5 Data-collection instrument

The information gathered from respondents to the survey questionnaire will be analysed to understand and/or predict some aspects of the behaviour of the population of interest. Creswell (2014) noted that the systematic gathering of information from the surveyed population will test the research questions and support the study statistically, numerically, or empirically. A survey or questionnaire will be used in this study to gather data. The tool utilised to collect this data must be dependable, practical, and globally applicable. QuestionPro, a web-based survey creation and distribution tool, will be used to reach the field. It includes tools to distribute your survey via email or your website, an easy-to-use wizard interface for authoring survey questions, and tools to analyse and display your findings. Those who are invited to engage in

this research may do so in a safe and secure manner since QuestionPro complies completely with the General Data Protection Regulation (GDPR).

3.6 Research process

The survey is split into phases, with the first phase being an invitation to participate in the survey, namely, the initial question posed to the population was merely a post that was advertised to professional contacts viewing the post on LinkedIn. The survey objective was explained in that post. The survey and the data collected must provide answers to the following background questions which contribute towards the research questions:

1. What are the professions of the respondents?
2. How many years of project-management experience do they have?
3. How many years of experience when cost overruns were experienced?

The use of multiple-choice options allows participants to select the best suitable option for them. It also allows for several accurate answers, which increases the study's reliability. Additionally, tick boxes enable exploratory research without the use of open-ended questions, resulting in information from participants that is useful and comparable in a variety of ways.

3.7 Data collection

Data for this study were collected through a survey questionnaire to 900 professionals. A survey package containing a cover letter and consent to participate in the survey with no obligation was submitted to each respondent.

New data will be collected with the survey that has been compiled in the QuestionPro software. Raw data must be categorised and findings compared. Data processing is the conversion of raw data into words or numbers that can be analysed. The approach is beneficial when there are a high number of responses. The analysed data can then be presented in the form of charts, tables, and graphs. Relationships, correlations, and inferences can be derived when raw data has been categorised and put into a workable format. This process is referred to as data interpretation. The data was collected and analysed with QuestionPro software.

3.8 Survey questions

The survey instrument for this study was developed and followed a particular design by first gathering the data regarding the role of the respondent and experience levels, as well as instances when cost overruns were experienced. Thereafter, it was important to determine the magnitude of cost overruns and in which phase in the lifecycle of projects were cost overruns experienced. A sequence of structured questions regarding factors responsible for cost

overruns was presented to the respondents to determine the reasons for these overruns and what measures could be put in place to prevent these overruns from being experienced.

Several types of close-ended questions styles were used to extract the data from the respondents. These included:

- Demographic questions
    - Demographic survey questions are used if one is interested in gathering information about a respondent's background (Smart Survey, 2024). When utilised correctly, these types of question in a questionnaire enable one to obtain more insightful information about one's target audience. Demographic questions serve as powerful tools for segmenting one's audience based on their characteristics and activities, thereby allowing for a more thorough analysis of data.
- Matrix questions
    - One kind of closed-ended question that gives responders a choice of replies inside a single topic is the matrix question. A matrix question, in contrast to other closed-ended inquiries, consists of several distinct questions with a common set of response alternatives (Zivkovic, 2024).
- Likert scale questions
    - Likert-scale questions provide respondents with a variety of options, such as ranging from "not at all likely" to "extremely likely" , or "rarely" to "often". One kind of scale used in survey research to gauge respondents' opinions on a particular topic is the Likert scale. Likert scale questions are closed-ended, single-choice questions. The main advantage of employing a Likert scale over a basic yes/no question type is that it gives more detailed information about people's opinions towards a subject. Researchers can evaluate different degrees of agreement, relevance, quality, and other characteristics by utilising a likert scale (Elliott, 2021).
    - The original 5-point Likert scale used by respondents to rate their responses was re-organised into three categories, low, medium, and high, to simplify the analysis of their responses and make inferences easier to explain in the following narrative. An additional column was added to this categorisation. The 5-point scale was divided into three categories: for mean responses ≤1.67, the classification was 'low,' for mean responses >1.67 to ≤3.33 were regarded as 'medium' and mean responses >3.33 were regarded as 'high'. Apart from showing the statistical central measures of the tendency of responses in tables, the categorisation was also included.

- Slider questions
    - These types of questions provide the respondents the opportunity to assess something on a numerical scale using a slider-type question. These interactive questions can be enjoyable to respond to and provide the ability to measure respondent sentiment on both an individual and aggregate basis. In circumstances when it would be too difficult to ask individuals directly how they feel, sliding scale surveys can be helpful for learning about their thoughts (Emmanuel, 2024).

3.9 Chapter summary

This chapter defined the research approach used in this study. It detailed the steps taken from the start to the end of the study. It depicted many types of research designs available and those used in the study. It examined the determination of the population and sampling approach used for the study. The chapter then discussed the instrument, its design, development, implementation, and analysis, as well as how the data was analysed. The following chapter presents the data analysis and interpretation, as well as how they relate to the study.

CHAPTER FOUR – PRESENTATION OF RESULTS AND ANALYSIS

4.1 Introduction

The primary purpose of this chapter is to analyse the data collected in the questionnaire survey to identify the factors responsible for project-cost overruns, the strategies used to mitigate these factors and develop an alternative approach to address the issue of cost overruns more effectively.

4.2 Response Rate

Four hundred survey invitations were sent out, and 69 complete responses were received, giving a response rate of 17%. The survey collected data from a diverse group of respondents, with 76 responses received. Of these, 69 responses were fully completed, and seven were incomplete. The incomplete surveys were not considered.

Table 12: Survey response data

Response Status	Number of Responses	Percentage
Issued - 400	69	17%
Completed	69	90.79%
Incomplete	7	9.21%
Total	76	100.00%

4.2.1 Categorising responses

The original 5-point Likert scale used by respondents to rate their responses was re-organised into three categories, low, medium, and high, to simplify the analysis of their responses and make inferences easier to explain in the following narrative. An additional column was added to this categorisation. The 5-point scale was divided into three categories: for mean responses ≤1.67, the classification was ‘low,’ for mean responses >1.67 to ≤3.33 were regarded as ‘medium’ and mean responses >3.33 were regarded as ‘high’. Apart from showing the statistical central measures of the tendency of responses in tables, the categorisation was also included.

4.3 Sample Demographics

4.3.1 Respondents' roles and involvement frequency

In examining the factors responsible for cost overruns in projects within the manufacturing industry, the involvement frequency of various roles was assessed using a 5-point Likert scale where 1 = never, 2 = seldom, 3 = sometimes, 4 = often and 5 = always.

Table 13: Frequency of involvement in cost overrun management (N=69).

	Mean	Std Deviation	Category
Project Manager	3.3768	1.17700	High
Business Developer	1.9565	1.19355	Medium
Financial Manager	1.7971	1.00849	Medium
Procurement Manager	1.6667	.98020	Low
Original Equipment Manufacturer	1.3768	.90913	Low
Project Sponsor / Executive	2.1159	1.20704	Medium

Table 13 shows that project managers had the highest level of engagement in addressing cost overruns. Project sponsors or executives, business developers, and finance managers had medium levels of engagement in addressing cost overruns. Procurement managers and original equipment manufacturers (OEMs) had low levels of engagement in addressing cost overruns. These classifications show that cost overrun management is a task that project managers do the most often. In contrast, engagement levels in this area are noticeably lower for jobs like procurement and finance managers and OEMs. These findings imply that other roles in the organisation were not engaged or involved with managing cost overruns as much as they should have, suggesting that this lack could have caused the cost overruns evident throughout their organisations.

4.3.2 Respondents' years of experience

How cost overruns are managed is impacted by the levels of experience of stakeholders. As stakeholders gain more experience or become more experienced in their organisations, they are expected to be more aware of and involved with managing costs within their departments and divisions. This experience enables a better approach to risk management, problem-solving, and decision-making, improving the organisation’s capacity to control cost overruns effectively.

Table 14: Years of experience (N=69).

	Mean	Std Deviation	Category
Project Manager	2.6667	1.40028	Medium
Business Developer	1.5942	1.08897	Low
Financial Manager	1.4928	.97954	Low
Procurement Manager	1.4638	1.00849	Low
Original Equipment Manufacturer	1.2174	.74497	Low
Project Sponsor/Executive	1.6812	1.14395	Low

According to Frimpong et al., (2003) and Doloi et al., (2012), the significance of experienced project leadership in successful project delivery is that project managers tend to have higher average experience compared to other roles, suggesting a potential advantage in their ability to manage and mitigate cost overruns. However, among business developers, finance managers, procurement managers, and original equipment manufacturers, the significantly lower experience levels point to a greater vulnerability to inefficiencies or inadequate planning, which is consistent with findings from studies such as Kaliba et al., (2009) that emphasise the relationship between experience and project performance. Furthermore, as seen in studies like Aziz (2013) and Apolot et al., (2013), the moderate experience levels of project sponsors/executives may affect strategic decision-making and supervision efficacy. Comprehensive project-cost management may need assistance and training to close the experience gap among other positions, even if experienced project managers may play a critical role in reducing cost overruns.

4.4 Frequency of Cost Overruns by Project Type and Project Duration

Respondents were asked to indicate the frequency of cost overruns across various project types and timeframes on a scale of 1 to 5, where 1 represents projects with cost overruns occurring within ≤ 5 years, 2 represents projects with overruns within > 5 and ≤ 10 years, 3 represents overruns within > 10 and ≤ 15 years, 4 represents overruns within > 15 and ≤ 20 years and 5 represents overruns within > 20 years. The findings are presented in Table 14.

Table 15: Cost overruns by project type and duration (N=69).

	Mean	Std Deviation	Category
Like for like replacement projects	2.0870	1.36919	Medium
Plant improvement projects	2.5217	1.26734	Medium
Process improvement projects	2.4783	1.36779	Medium
Modification projects	2.3623	1.33913	Medium
New build projects	2.0580	.99829	Medium
Leveraging new technologies	2.0000	1.04319	Medium

It is evident from Table 15 that all project types with durations exceeding five years had a medium likelihood of experiencing cost overruns, according to the respondents.

4.5 Cost Overruns in the Project Lifecycle

In examining the factors responsible for cost overruns in projects in the manufacturing industry, participants were asked to rate the frequency of cost overruns in each project phase on a 5-point Likert scale where 1 = never, 2 = seldom, 3 = sometimes, 4 = often, and 5 = always.

Table 16: Frequency of cost overruns in project phases (N=69).

	Mean	Std Deviation	
Concept phase	2.2754	.98345	Medium
Initiation phase	2.5072	1.03786	Medium
Planning phase	2.6667	.98020	Medium
Execution phase	3.6812	.88272	High
Monitoring and controlling	2.9855	1.06402	Medium
Closure	2.6087	1.20315	Medium

The responses in Table 16 suggest that cost overruns were most likely to occur (high) during the execution phase. Cost overruns were likely to occur during the other project lifecycle phases but were less likely than the execution phase (medium). These findings suggest that the execution phase is the most critical phase to address cost overruns, although it is probable that cost overruns also occur during the other phases. Therefore, cost overruns must be addressed in all lifecycle project phases.

4.6 The Frequency of Cost Overruns

In exploring factors contributing to cost overruns in manufacturing industry projects, respondents were asked to assess the frequency of occurrence on a 5-point Likert scale where 1 = never, 2 = seldom, 3 = sometimes, 4 = often, and 5 = always. Their responses are shown in Table 4.7.

Table 17: Frequency of occurrence of cost overruns (N=69).

	Mean	Std Deviation	Category
1. Design- and contract-related factors / i.e. design changes or scope creep	3.3188	.89923	Medium
2. Project manager experience, i.e. experience level of PM resulting in overruns	2.9855	.86590	Medium
3. Labour-related factors, i.e. unskilled workforce or availability	3.1594	.94904	Medium
4. Financial-related factors, i.e. project funding or payment issues etc.	2.7971	1.02297	Medium
5. Materials- and machinery-related factors, i.e. availability of raw materials or machinery for the tasks	2.9855	1.05011	Medium
6. External factors, i.e. country limitations, weather, political influence	2.6087	1.00319	Medium
7. Planning and scheduling factors, i.e. planning and sequencing of activities	3.0290	.85700	Medium
8. Estimation-related factors, i.e. estimating materials, equipment, resources etc.	3.1884	1.00404	Medium
9. Communication-related factors, i.e. internal team or external stakeholder communication	2.8986	1.04523	Medium
10. Construction-related factors, i.e. errors during construction or execution.	3.2609	.97998	Medium

Table 17 shows that respondents rated all the factors as having a medium likelihood of cost overruns. Design- and contract-related factors, i.e. design changes or scope creep and construction-related factors, i.e. errors during construction or execution, were the most likely factors to influence the occurrence of cost overruns. The remaining eight factors were also rated as influencing the frequency of cost overruns but less so than the design and construction-related factors. Effective management of all these factors by all stakeholders in the project delivery process is required to prevent cost overruns.

4.7 Preventing Cost Overruns

Since cost overruns in projects within the manufacturing industry can be attributed to several factors, respondents were asked to indicate their levels of agreement with eight relevant

statements on a 5-point Likert scale where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. Their responses are shown in Table 18.

Table 18: Cost overrun prevention (N=67).

	Mean	Std Deviation	Category
1. Scope creep adds functions or features to the new product, work, or requirements beyond the agreed-upon scope.	3.9104	.88303	High
2. Once the project requirements and customer needs are known, resources with the right skills should be acquired.	3.7761	.79431	High
3. Risk management plays a vital role in keeping the project under budget	4.0149	.92920	High
4. The negative impact of untrained people could be insignificant but also be disastrous for the project.	3.6866	.85651	High
5. Unrealistic project duration imposed by client or management.	3.8507	.87479	High
6. One of the first actions to minimise cost overruns related to materials is having an accurate estimate of the required materials.	3.7313	.94680	High
7. Underestimation is placing too low a value on size, quantity, or number.	3.7612	.88915	High
8. Investing in effective training, development and mentoring programmes and appropriate staffing will ensure project managers have the skills and knowledge to execute projects successfully.	3.6716	1.07855	High

The responses in Table 18 indicate that participants reported high levels of agreement with all eight statements. The statements they agreed most with are risk management plays a significant role in keeping the project under budget (mean = 4.01) and scope creep is adding additional work, or requirements beyond the agreed-upon scope (mean = 3.91).

4.8 The Factors Responsible for Cost Overruns

Cost overruns in projects within the manufacturing industry can be attributed to various factors. Participants were asked to rate the level of influence of these factors on cost overruns using a scale ranging from 1 to 20, where 1 represents the least influence (10%) and 10 the most influence (100%). The responses are presented in Table 19. Unlike the 5-point scale categorisation used previously, the 10-point scale was similarly developed. The scale was reduced to three categories, low, medium, and high, to simplify the analysis of their responses and make inferences easier to explain in the following narrative. The 10-point scale was divided into three categories: for mean responses ≤3.33, the classification was ‘low’, mean responses >3.33 to ≤6.67 were regarded as ‘medium’, and those >6.67 were regarded as ‘high’. Apart

from showing the statistical central measures of the tendency of responses in tables, the categorisation was also included. Additionally, a rank was determined based on the mean values.

Table 19: Factors responsible for cost overruns (N=69).

	Mean	Std Deviation	Category	Rank
1. Design- and contract-related factors	6.0580	2.62837	Medium	3
2. Project manager experience	5.5507	2.39814	Medium	5
3. Labour-related factors	5.5217	2.10468	Medium	6
4. Financial-related factors	4.7536	2.32256	Medium	9
5. Materials- and machinery-related factors	5.3333	2.07695	Medium	8
6. External-related factors	4.5362	2.29821	Medium	10
7. Planning and scheduling factors	5.9275	2.53400	Medium	4
8. Estimation-related factors	6.3768	2.27584	Medium	2
9. Communication-related factors	5.4203	2.45192	Medium	7
10. Construction-related factors	6.5507	2.22642	Medium	1

The findings in Table 19 show that all the factors had a medium influence on cost overruns. By ranking the means of the responses, it is evident that construction-related factors had the most dominant influence (mean = 6.55 or 65.5%), followed by estimation-related factors (mean = 6.37 or 63.7%) and design- and contract-related factors (mean = 6.05 or 60.5%). The factors with the least influence were financial-related factors (mean = 4.75 or 47.5%) and external-related factors (mean = 4.54 or 45.6%).

4.9 Interventions to Reduce Cost Overruns

Several interventions can be considered to reduce cost overruns when planning project budgets. Respondents were presented with ten interventions and asked to indicate the level of importance of each intervention using a 5-point scale, where 1 = not important, 2 = slightly important, 3 = moderately important, 4 = important, and 5 = very important. Additionally, a rank was determined based on the mean values. The responses are presented in Table 20.

Table 20 : Interventions to reduce cost overruns.

	N	Mean	Std Dev	Category	Rank
1. When estimating project budgets, always allow scope changes, project risks and possible scope creep.	68	4.0441	.92129	High	6
2. When developing a project quality plan to avoid scope creep, ensure adequate time is spent during the front-end-loading stage.	68	4.1765	.79064	High	3
3. Ensure that a proper stakeholder engagement and communication plan is developed to clarify roles and responsibilities to avoid conflict, misunderstanding and defining the project requirements.	67	4.2090	.86230	High	2
4. Clearly define project scope and deliverables to be met with required project resources with clear key project success factors based on key performance indicators.	68	4.5000	.68021	High	1
5. Develop a risk management plan that identifies, evaluates and has mitigation actions with estimated risk allowance within the budget when considering all types of risks.	67	4.1493	.83944	High	4
6. Perform EVS and planning as part of the project's controls function that indicates project performance based on schedule adherence and cost control as a tool.	68	3.6176	.89825	Medium	10
7. Conducting a detailed WBS with associated cost estimates with durations and the various phases of the project lifecycle is vital.	68	4.1029	.90008	High	5
8. Ensure a backup plan is in place or on standby for critical equipment and machinery in case of breakdown or maintenance.	67	3.9851	.82559	Medium	8
9. It is essential to monitor the project performance by tracking the individual project managers' outcomes, communicating regularly, and identifying areas for improvement.	67	3.8507	.92530	Medium	9
10. Use the right skill resource for the job. The cost of using untrained people could require product repair or rework, leading to project cost overruns.	68	4.0000	.86387	High	7

Table 20 shows that seven of the ten interventions had high levels of importance, and the remaining three had medium importance. When ranking the responses by their means, the most critical intervention was 'clearly define project scope and deliverables to be met with required project resources with clear key project success factors based on key performance indicators' (mean = 4.50), followed by 'Ensure that a proper stakeholder engagement and communication plan is developed to clarify roles and responsibilities to avoid conflict, misunderstanding and defining the project requirements' (mean = 4.21), and 'When developing a project quality plan to avoid scope creep, ensure adequate time is spent during front-end-loading stage' (mean = 4.18). The intervention regarded as the least important was 'Perform EVS and planning as part of the project's controls function that indicates project performance based on schedule adherence and cost control as a tool' (mean = 3.62).

4.10 Discussion of Findings

Aziz (2013) and Flyvbjerg et al., (2002) have noted that these findings concur with prior research regarding estimation factors, construction-related errors, and estimating concerns. This underscores the critical importance of effective project planning and implementation. While financial factors and external influences are generally regarded as having the most significant impact on cost overruns, the comparatively lower mean scores of these influences in this study may suggest that their impact on cost overruns in manufacturing projects is less than in other industries. This finding contradicts the conclusions drawn by Flyvbjerg et al., (2002) and Frimpong et al., (2003). The findings underscore the necessity for a comprehensive and proactive project-management strategy and the complexity of the interrelationships among numerous factors contributing to cost overruns in manufacturing endeavours.

The research outcomes about construction-related factors, estimation, design- and contract-related factors, planning- and scheduling-related factors, the experience of the PM, labour, communication, materials, and machinery, financial and, to a lesser degree, external-related factors, align with the existing corpus of knowledge concerning cost overruns across diverse sectors, including construction and the public sector. The adverse effects of scope creep on project budgets align with the widely accepted consensus that scope creep contributes to cost overruns (Flyvbjerg et al., 2002; Frimpong et al., 2003). The concerns regarding accurate material estimation, underestimated project size and resource allocation are consistent with those raised in prior studies by Frimpong et al., (2003) and Kaliba et al., (2009). The importance of efficient project scope management and scope creep and design modifications found in this study are supported by studies by Doloi et al., (2012) and Apolot et al., (2013).
Consistent with the body of knowledge in construction and project management, the findings regarding the primary contributors to cost overruns in manufacturing projects are estimation-, design- and contract- and construction-related factors. Additional studies conducted by Frimpong et al., (2003) and Doloi et al., (2012) identified design modifications, inaccurate estimates, and construction delays as significant factors contributing to cost overruns in construction projects. While the results presented demonstrate a broader understanding of the factors that influence project costs by emphasising labour-related variables and materials- and machinery-related factors, further investigation may be warranted due to the significantly lower mean scores compared to factors associated with design and estimation.

The study found that the control of cost overruns is the principal responsibility of project managers, emphasising their pivotal function in implementing and administering projects. The significance of efficient project management in mitigating delays and cost overruns was identified by Apolot et al., (2013) and Doloi et al., (2012). The lower frequency of engagement

among business developers, finance managers, procurement managers, and original equipment manufacturers (OEMs) does not align with the generally accepted notion of collaboration between all role players. Frimpong et al., (2003) highlight the criticality of collaboration and the active involvement of all stakeholders to ensure the successful resolution of project challenges. The disparity found in this study may indicate that project stakeholders are not cooperating and communicating effectively, which could exacerbate cost overruns. Therefore, it might be necessary to enhance collaboration and communication among all parties involved to effectively manage cost overruns in manufacturing projects, notwithstanding the criticality of the active involvement of project managers.

The findings of this study highlight the temporal and environmental factors that influence project outcomes by disclosing nuanced patterns of cost overruns across a range of project categories. Comparable to studies which indicate that there are frequent risks involved in the initiation and early phases of implementation, the moderate cost overruns observed in replacement projects are indicative of common challenges that may arise within the time frame of one to five years (Flyvbjerg et al., 2002; Kaliba et al., 2009). The complexity of infrastructure enhancements and the long-term maintenance requirement could potentially account for this finding (Frimpong et al., 2003).

Process improvement initiatives indicate ongoing challenges in optimising operational efficiencies and incorporating technological advancements (Doloi et al., 2012). Apolot et al., (2013) report that modification initiatives frequently experience moderate cost overruns. This finding hints at the cumulative impact of ageing infrastructure and shifting requirements. On the other hand, construction projects demonstrate a reduced occurrence of moderate to minor cost overruns. This phenomenon could be attributed to the increased clarity of project scopes and reduced reliance on pre-existing structures (Aziz, 2013). Saunders et al., (2019) observed that the implementation of novel technologies in projects resulted in a reduction in cost overruns. This finding underscores the importance of risk mitigation strategies and innovation in diminishing project uncertainties. In summary, the study's findings underscore the fluid nature of cost overruns across various project types and emphasise the necessity for tailored risk-management approaches to address specific project challenges.

The study emphasises critical junctures in which effective cost management strategies are required by distinguishing distinct patterns of cost overruns throughout the various phases of manufacturing endeavours. As indicated by the comparatively low mean scores in the concept and initiation phases, cost overruns are infrequent during the initial stages of project development, which stresses the importance of comprehensive planning and feasibility assessments to reduce uncertainty (Flyvbjerg et al., 2002; Doloi et al., 2012). Caution and

proactive risk mitigation strategies are required to address emerging cost concerns during the progression of projects, as evidenced by the moderate mean scores observed during the planning and closure phases (Aziz, 2013; Apolot et al., 2013).

Notably, during the execution phase, cost overruns are frequently encountered throughout the implementation phase of a project. This finding underscores the criticality of effectively managing cost risks during the implementation stage by establishing streamlined project controls, collaboration with stakeholders, and judicious resource allocation (Frimpong et al., 2003; Kaliba et al., 2009). Saunders et al., (2019) assert that cost concerns frequently arise during the monitoring and controlling phase. Therefore, it is essential to implement real-time performance monitoring and adjustment to avert potential cost overruns. In general, the study's findings illustrate the dynamic nature of cost management across multiple project phases and underscore the importance of employing proactive, integrated approaches to address cost considerations at each stage of the project’s lifespan.

Additionally, Apolot et al., (2013) and Doloi et al., (2012) support the notion that the level of experience of project managers impacts cost overruns. Seasoned and knowledgeable project leadership play critical roles in mitigating cost overruns. Further, substantiating the importance of proficient labour and effective workforce management concerning project outcomes is the correlation between cost overruns and labour-related factors, including the availability and proficiency levels of the workforce (Kaliba et al., 2009). In contrast to research that attributes significant cost overruns to financial constraints, financial-related factors in this study suggest that obstacles such as payment challenges and project financing may manifest less frequently, as also found by Aziz (2013).

Labour-related considerations, such as the accessibility of adequately trained personnel, corroborate the findings of research conducted by Kaliba et al., (2009) and Frimpong et al., (2003), which underscore the pivotal significance of human resource management in ensuring project success. Nevertheless, the frequency of issues with materials and machinery aligns with findings from studies that emphasise the criticality of resource accessibility and administration in implementing projects (Frimpong et al., 200.3). Although the existing body of literature concerning the causes of cost overruns in manufacturing projects has been predominantly corroborated by the study findings, additional research is required to comprehensively understand the financial ramifications of the discrepancy between the findings of other studies and this one.

The misallocation of resources further corroborates the findings of Doloi et al., (2012). The correlation between unrealistic project durations and the subsequent escalation of costs has been established in studies conducted by Kaliba et al., (2009) and Doloi et al., (2012), who identified staff competency as a pivotal element in ensuring project success. Apolot et al., (2013) contributed substantially to the consensus regarding the criticality of effective risk management by highlighting its capacity to avert project setbacks and budgetary excesses. The lower impact of incompetent personnel in this study contradicts the severity attributed to this aspect in previous studies (Aziz, 2013). Ultimately, the responses provided reflect the divergent viewpoints regarding the effectiveness of personnel and training that have been extensively documented in other studies by, for example, Frimpong et al., (2003) and Kalibah et al., (2009).

The significance of material and labour expenses concerning project overruns is stressed by Kaliba et al., (2009) and Aziz (2013), which suggest an intricate interplay among various components. It is imperative to confront construction, design, and estimation obstacles to mitigate cost overruns in manufacturing endeavours. It is necessary to consider an extensive array of influencing elements, including labour, materials, planning, and external influences. It is imperative to conduct an in-depth examination of all pertinent factors to develop a comprehensive approach to mitigating cost overruns in manufacturing projects, notwithstanding the findings of this study.

The study's findings underscore the importance of incorporating provisions for scope modifications, project hazards, and scope expansion. These results are consistent with other studies on project management in various sectors, such as construction and public administration. Doloi et al., (2012), Apolot et al., (2013), and Frimpong et al., (2003) have demonstrated the significance of proactive risk management and scope definition in preventing cost overruns. The emphasis on stakeholder engagement and communication found in this study aligns with the findings of Aziz (2013) and Kaliba et al., (2009), who underscore the criticality of effective communication to prevent misunderstandings and conflicts that could lead to project setbacks and increased costs.

Despite being ranked somewhat lower than other aspects in this study, EVS and planning are acknowledged for their value. This research presents a more nuanced perspective on the importance of EVM in mitigating cost overruns within the manufacturing industry, in contrast to the emphasis placed on the notion in the literature on project controls (Saunders et al., 2019). The results underscore the importance of employing contextualised techniques across

different project contexts, confirming the overall significance of proactive planning and management strategies in mitigating cost overruns.

4.11 Chapter Summary

This chapter presented and discussed the study findings. The findings were referenced to other research and studies reported in the literature and underlined the need to implement provisions for scope revisions and extensions and project hazards. The next chapter concludes the study.

CHAPTER FIVE – CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarises the key findings of this study, makes recommendations for possible improvement in the management of projects to prevent cost overruns, identifies areas for future research and concludes the study.

This study was conducted to seek responses to the problem of managing costs on projects to prevent overruns. The research problem was stated as follows:

Determine what factors are primarily responsible for cost overruns and analyse their contribution to developing a strategy to mitigate their influence.

Through a critical review and analysis of literature and previous studies, this study aimed to identify the most dominant factors responsible for and their contribution to cost overruns and to develop a strategy to mitigate their influence on cost overruns. The research objectives of the study were to:

1. Determine which factors are responsible for cost overruns.
2. Identify the strategies currently used to mitigate these factors.
3. Develop an alternative strategy to mitigate these factors.

5.3.1 Objective 1: Determine which factors are responsible for cost overruns

The primary objective of the research was to identify and classify the elements contributing to cost overruns in manufacturing projects. The results of this enquiry have shown that all the aspects considered impact cost overruns to varying degrees. However, the three primary factors with the highest impact on cost overruns are construction, estimation-, design- and contract-related factors. Other factors have a lesser impact on project budgets and deadlines.

The study highlighted the critical role of design- and contract-related factors. Cost overruns were caused mainly by frequent design alterations and scope creep. These lead to significant increases in costs as well as delays in the completion of the project. Expenses and durations that were not anticipated are the results of the ongoing modifications to project designs and the extension of project scope without implementing comprehensive evaluation and control procedures. Additionally, inaccurate estimates could result in extra unbudgeted expenditures that strain the budgets of the projects.

The research findings indicated that budgeting and resource allocation techniques lead to cost overruns. Consequently, insufficient planning and unforeseen financial shortfalls occur during the execution of the project, which is caused mainly by inaccurate estimates of the required resources and inaccurate budget predictions. Accuracy is needed during the early phases of project planning, when precise projections may help eliminate financial disparities and enable smoother project execution. In addition, construction challenges impact cost overruns. An increase in cost inefficiencies was caused by problems during the actual execution phase, such as execution failures. The ineffective implementation of the project, faults in the building processes, and poor oversight contribute to delays and incur extra expenditures. It is necessary to have efficient management and monitoring throughout the execution phase to eliminate these inefficiencies and ensure that projects remain within their budgetary constraints.

Labour-related factors, particularly the availability and skill level of the labour force, were found to impact cost overruns. There could be delays and a rise in expenses if there is a scarcity of trained workers or inadequate management of the labour force. There has to be an adequate and skilled labour force available to keep project timetables and budgets on track. Additionally, other aspects related to materials and machines had contributory impacts. The timely availability of raw materials and the cost of essential equipment modestly impacted cost overruns. Budget overruns occur when there are delays in the acquisition of and variations in the pricing of supplies. It is crucial to implement effective procurement procedures and prepare for price fluctuations to lessen the severity of these effects.

While less common, external considerations such as political and national limitations can impact a project's expenses. Several factors, including political instability, changes in regulatory policies, and national constraints, may cause interruptions and cost increases. While these causes are less prevalent, their potential impact requires proactive risk-management measures to minimise the consequences. The research findings highlight the complicated nature of cost overruns in manufacturing projects. It will be necessary to take a diverse strategy to address these concerns adequately. It is vital to have comprehensive planning, precise resource assessment, effective contract administration, and robust execution techniques to reduce the impact of the highlighted issues. Project managers can control and consider these costs and techniques effectively.

5.3.2 Objective 2: Identify the strategies that are currently used to mitigate these factors

Several factors that contribute to project-cost overruns were identified. These include scope creep, resource acquisition, risk management, the influence of untrained staff, unrealistic project durations, materials estimate, underestimation, and investment in training and development.

There were several approaches that were being used to eliminate the factors leading to cost overruns. Risk management was one of the strategies implemented at the project level. At every stage of the lifespan of projects, it was critical to detect, evaluate, and take preventative measures against risks. Project teams can predict probable problems and prepare contingency plans via early risk management. These strategies help reduce the possibility of unplanned expenses and delays occurring throughout the project.

Setting reasonable project timeframes and ensuring that material estimates are accurate are two additional significant strategies. The implementation of these strategies is essential to reduce cost overruns. Unrealistic timeframes and faulty projections often result in hurried work and shortages of resources, which in turn potentially drive-up costs. Maintaining project schedules and budgets is made easier by establishing attainable timetables for the project and providing precise needs for the materials.

Further, comprehensive front-end loading is necessary to prevent scope creep and its associated challenges. Implementing this strategy requires careful planning and quality control of the project, which must be carried out throughout the beginning phases. This will ensure that all components of the project are clearly defined. Implementing front-end loading will prevent expensive adjustments and future delays. It was discovered that effective communication techniques and stakeholder participation are of utmost importance in minimising misconceptions and disagreements. It is helpful to have communication routes that are very clear and well-defined roles and duties to ensure that all stakeholders are working towards the same goals. This results in a smoother execution of the project and better control of costs, as it decreases the likelihood of disputes and increases the level of collaboration.

It is possible for projects to keep their quality standards high and avoid the expenditures that are associated with fixing errors if they make use of the knowledge of qualified individuals. When taken as a whole, these strategies illustrate a proactive approach to managing the expenditures associated with the project. These strategies, which emphasise extensive planning, rigorous risk assessment, and efficient communication, can prevent the high-impact

elements that contribute to cost overruns. The results underscore the need for an organised and strategic approach to project management. This strategy ensures that possible problems are handled early and efficiently, increasing the possibility that the project will be successful within the allotted budget and within the project schedule.

5.3.3 Objective 3: Develop an alternative strategy to mitigate these factors

This research highlighted the need for: calculating project costs, ensuring stakeholder participation, establishing project scope, building risk-management strategies, and carrying out work breakdown structures (WBS). These techniques are essential for ensuring that complete planning and execution are carried out, as well as for retaining control over the project variables. A high level of adherence to these practices indicates a strong dedication to efficient project management, which is vital for minimising cost overruns and guaranteeing the project's success.

Other less impactful strategies included executing earned value scheduling, monitoring project performance, and guaranteeing the availability of trained workers. Although these strategies were executed with a reasonable level of consistency, they were also very significant. This finding indicates areas where adjustments may be made to strengthen project supervision and control. Other least impactful strategies were the procedures relative to backup plans for essential pieces of equipment. This finding suggests possible weaknesses in the design and administration of their respective projects. When reducing delays and extra expenses that may be incurred because of equipment failures or shortages, it is essential to ensure proper contingency plans are in place for crucial equipment.

Evaluating different techniques to mitigate cost overruns provides evidence of the need to adopt more inventive and thorough approaches. The study highlighted the possibility of combining advanced project-management strategies, such as earned value management (EVM), to improve monitoring and controlling projects. EVM offers a systematic approach to measuring the performance and development of a project, providing significant insights that may assist in managing expenses more efficiently. Introducing comprehensive work breakdown structures (WBS) could potentially improve cost prediction and adherence to the budget further. A comprehensive WBS makes it possible to improve planning and resource allocation, making it easier to generate more accurate cost estimates and carry out projects effectively. Using this method guarantees that all aspects of the project are precisely specified and accounted for, hence lowering the probability of incurring unanticipated costs.

Additionally, project managers and other essential workers should participate in continuing training and development. Continuous professional development helps project managers improve their knowledge and abilities, enabling them to manage difficulties connected to costs more effectively. Project managers can increase their capacity to control costs and eliminate risks by remaining current with the most recent methods and best practices in project management. Further, there were advantages of using flexible frameworks for project management that allow for alterations to be made depending on data collected in real-time. These frameworks provide a more responsive approach to controlling cost overruns, enabling project managers to make choices and modifications based on accurate information as the project progresses. Increasing the accuracy of cost forecasts and monitoring may be accomplished using technology, such as real-time analytics and software for project management, which has been highlighted as a potential strategy. These technical solutions provide improved insight into the project's performance and allow proactive control of any possible cost difficulties that may arise.

In conclusion, these diverse strategies hint at a project-management approach that is both adaptable and dynamic to reduce cost overruns in manufacturing projects. Project managers can improve their abilities to control costs and achieve success in their projects by incorporating sophisticated methodologies for project management, engaging in continual professional development, and using technology. The study highlighted the need to adopt a complete strategy that blended conventional project-management approaches with creative solutions to successfully manage and mitigate difficulties linked to costs.

5.4 Recommendations

5.4.1 Enhance design and contract management

Improving the strategies linked to design and contract management could contribute to efficiently control cost overruns. Because frequent design modifications often result in unplanned cost increases, one of the most critical areas to focus on is minimising project scope changes. Implementing stringent processes for controlling design revisions and scope creep is necessary to reduce the likelihood of these factors occurring. It is essential to guarantee that the design and contract criteria are accurate and exhaustive from the very beginning of the project.

A comprehensive change management plan is required to maintain complete control over any changes that may occur throughout the project. Clear procedures and processes must be established for authorising and recording modifications. This will help to reduce unanticipated

expenses and delays. Additionally, it is recommended to make a significant investment in front-end loading, often known as complete front-end planning. Before beginning the project, it is necessary to devote time and resources to properly comprehend and record all the project's needs and any possible hazards. This lays a solid basis for the control of overall costs. With this proactive strategy, you can be confident that every facet of the project is meticulously planned and accounted for, lowering the probability of experiencing expensive surprises in the future. Furthermore, integrating all the essential stakeholders in the early phases of project planning may assist in generating a more accurate and comprehensive knowledge of the project's requirements, ultimately leading to an improvement in the overall execution of the project.

5.4.2 Improve estimation accuracy

Accurate cost estimation is crucial for efficiently managing project budgets. Using advanced estimating methods and tools can significantly enhance the accuracy of resource and budget estimates. Predictive analytics and historical data can inform these projections, leading to more reliable financial planning. Predictive analytics can provide insights that improve the precision of cost estimates by analysing past project data, trends, and patterns. Regular evaluations and revisions of cost estimates are essential throughout the project's lifecycle. This process ensures that estimates remain current and accurate, considering any changes in scope, market conditions, or unforeseen challenges. Continuous monitoring and updating of cost estimates help maintain financial control and avoid budget overruns.

Additionally, fostering a culture of transparency and communication within the project team can further enhance the accuracy of estimates, as it encourages sharing information and collaborative problem-solving. By adopting these practices, project managers can improve their ability to control costs and achieve successful project outcomes. Enhanced design and contract management and improved estimation accuracy form the cornerstone of effective cost management in manufacturing projects. These strategies help mitigate risks and contribute to the overall efficiency and success of project execution.

5.4.3 Strengthen risk-management practices

Implementing a thorough risk-management approach is necessary to successfully reduce the impact of cost overruns. It is essential to conduct exhaustive risk assessments at each step of the project to identify probable reasons for cost rises. The management of the project can predict problems that might influence the project's finances and devise measures to reduce these risks if they conduct a systematic evaluation of the risks.

EVM is a tool for monitoring the performance of a project in comparison to the baseline plan. EVM offers an all-encompassing perspective on the project development by integrating cost,

schedule, and scope measurements. It is possible to identify deviations from the plan early using this method, which allows prompt corrective steps to be taken to maintain the project's financial stability. By regularly monitoring the project's performance using EVM, project managers can control the budget and timeframes, ultimately resulting in a more predictable end for the project.

Another term related to EVM is earned value analysis (EVA). EVA is a quantitative method that analyses schedule and cost variances to evaluate project performance. According to thorough research by Fleming and Koppelman (2010), you may use your present performance to anticipate the project's future with a plus or minus 10% fluctuation after you're 20% into it. EVM enables this powerful predictive power, which makes it one of the best project-cost management solutions out now.

5.4.4 Enhance stakeholder engagement and communication

Effective communication and stakeholder participation is essential to align expectations and prevent misconceptions that might lead to cost overruns. It is vital to build thorough communication strategies to guarantee all parties involved are consistently updated on the advances, dangers, and changes occurring with the project. These plans should include the frequency of communications, the means of communication, and the substance of communications. This will ensure that stakeholders get information that is both timely and relevant.

It is beneficial to engage stakeholders in collaborative efforts throughout the planning and execution stages of the project to foster a feeling of ownership and commitment. Including important stakeholders in the decision-making process for a project helps to guarantee their perspectives and concerns are taken into consideration, resulting in more informed and effective choices. The alignment of project objectives is improved using this collaborative method, and the chance of disputes and concerns connected to costs is considerably reduced.

There is a correlation between clear communication and the definition of roles and duties, which is essential in preventing disagreements and improving cooperation on projects. It is easier to develop an atmosphere conducive to collaboration when every team member is aware of their responsibilities and how their work contributes to the broader project. By ensuring that everyone is working towards the same goals and increasing overall project efficiency and cost management, this clarity aids in managing expectations. It ensures that everyone is working towards the same goals.

Finally, establishing risk-management procedures and improving stakeholder participation and communication are essential in controlling and reducing cost overruns in manufacturing projects. A complete risk-management strategy helps predict and mitigate possible financial

implications. On the other hand, effective stakeholder involvement encourages alignment and collaboration. Combined, these strategies help regulate and effectively execute the project, reducing the possibility of cost overruns.

5.4.5 Leverage technology for project management

The use of technology in project-management procedures has the potential to greatly improve both the oversight of costs and the overall effectiveness of the project. Investing in powerful project-management software that provides capabilities such as automatic reporting, monitoring progress, and real-time data analytics has the potential to alter the way projects are managed. Because of the essential insights they give and the numerous parts of project supervision that they automate, these technologies lead to more accurate decision-making and allow for more precise cost monitoring. The time and effort needed to create frequent project updates are reduced thanks to the automated reporting features included in project-management software. These technologies guarantee that stakeholders receive timely and accurate information, promoting transparency and accountability. Project managers can monitor milestones and deliverables in real-time because of the tools that track progress. This allows them to rapidly identify and handle any deviations from the plan that may occur.

The contemporary software used for project management has a sophisticated component known as real-time data analytics. The proactive management of project variables is made possible by these technologies, which include the continuous integration and analysis of data on project performance. Project managers can make decisions more quickly because of this continuous monitoring feature, which gives them rapid access to the most significant data. The use of real-time analytics helps in the early identification of patterns and prospective problems, which enables prompt responses that contain the potential to avoid cost overruns. In addition to enhancing project management's flexibility and responsiveness, real-time data integration solutions are further enhanced. Using these solutions guarantees that the project's performance and costs are continually monitored, offering an all-encompassing perspective on the project’s financial health. Project managers can make well-informed choices in a short time when they have access to current information. This allows them to respond to changes and unexpected obstacles more effectively. Having real-time access to project KPIs enables dynamic and adaptable project management, which is necessary to keep costs and timelines under control.

In conclusion, using technology for project management provides substantial benefits for controlling costs and monitoring the project's progress. Deploying sophisticated software for project management and solutions for real-time data integration allows more accurate

decision-making at the appropriate moment. Using these technology solutions offers project managers the essential assistance to retain control over project expenses, ensuring that projects are effectively completed within the restrictions of their budgets. Using these technologies, organisations can improve their project-management skills, which ultimately results in the execution of projects that are more efficient and effective.

5.5 Areas for Future Research

While this study relied heavily of a quantitative approach to gathering data, it is recommended that because of the complex nature of managing costs and preventing cost overruns, methodologies that enable a deeper examination of the study area should be considered in future studies. These would most likely enable a deeper and better understanding of the dynamics that drive stakeholder decisions, attitudes, and experiences concerning cost management. Interviews, focus groups, and case studies are examples of other methods of gathering data on the organisational and human elements affecting cost overrun incidents. These techniques can also highlight decision-making procedures, organisational culture, and project team dynamics. Future studies might give a more thorough knowledge of cost overrun occurrences by integrating quantitative analysis with qualitative investigation in a mixed methods approach, providing valuable insights for manufacturing sector practitioners and policymakers.

It is also recommended that the manufacturing project environment be expanded to include a larger and more diverse sample frame to validate the findings of this particular study. The study can also be further enhanced by incorporating specific examples of where recommendations are or have been successfully implemented in industry.

5.6 Conclusion

Controlling cost overruns in manufacturing projects requires a multidimensional strategy taking into account several aspects that lead to financial inefficiencies. The most significant causes of cost overruns are problems with construction, estimation-, design- and contract-related issues, planning and scheduling and project manager experience: inaccurate estimations and construction-related issues, underscoring the need for more exact planning and implementation. Project managers are the most often engaged and experienced, making them better able to handle cost overruns than other jobs. The engagement levels and experience of other project roles are also significant. Proactive risk management, precise material estimates, and reasonable project schedules are the main focuses of current mitigation measures. It is necessary for extensive front-end loading and efficient stakeholder interaction. Employing

knowledgeable staff and ensuring they receive ongoing training is another essential strategy that lowers the possibility of expensive mistakes and rework.
Moreover, other approaches, such as incorporating sophisticated project-management techniques like EVM, comprehensive WBS, and real-time project-management software, may considerably improve the capacity to control expenses. Flexible frameworks responsive to real-time data and continuous training for project managers could be adopted.

It is difficult to in control cost overruns in manufacturing projects without thorough planning, clear communication, and ongoing project-management development. Manufacturing projects may produce better financial results and reduce the risk of cost overruns by addressing the identified issues and using current and alternative techniques.

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Appendix 1

Data-collection Instrument

Participant Information Sheet (Invitation to participate) and Consent Form

This will be the front page of the online QuestionPro 10-Question Survey that will be sent to participants inviting them

Dear Respondent,

My name is Muhammad Fazl-Ur-Rahman Rawoot and I am a Masters Business Administration Student at Cape Peninsula University of Technology (CPUT) in the Cape Town, South Africa. In partial fulfilment of this degree, I am conducting a research study to assess the factors impacting the manufacturing and production industry causing cost overruns when executing a project. The main objective of the research study is to sensitise PMs to the precursors in order to avoid cost overruns and meeting customer expectations.

I am, therefore, requesting you to kindly take 10 to 15 minutes out of your time to help me in this endeavor and complete this 10-Question Survey. By completing this survey, you can be assured of the following:

- Your privacy, anonymity, and confidentiality
- You can refuse to participate in this survey and/or withdraw from it at any given point in time
- Your participation is entirely voluntary and that you will not be incentivized for participation in the survey
- You do not have to provide any information that can lead to your identification
- There are no questions that will compromise your confidentiality agreement with the organization
- You will not be exposed to or subject to any harm
- Your responses will be handled with the utmost consideration to privacy of data
- All raw data will be trashed completely, five years after the submission of the final thesis manuscript.

If you would like to be informed of the final research findings, please contact me on rawootmf@gmail.com. The findings will be available in the second Quarter of 2023.

Kindly share your consent to participate. By continuing with this survey, you are stating that you have read and understood the above and agree to voluntarily participate in this survey.

Thank you for taking time to read this information sheet and for participating in this research.

(•) Yes, I consent

( ) No, I do not consent

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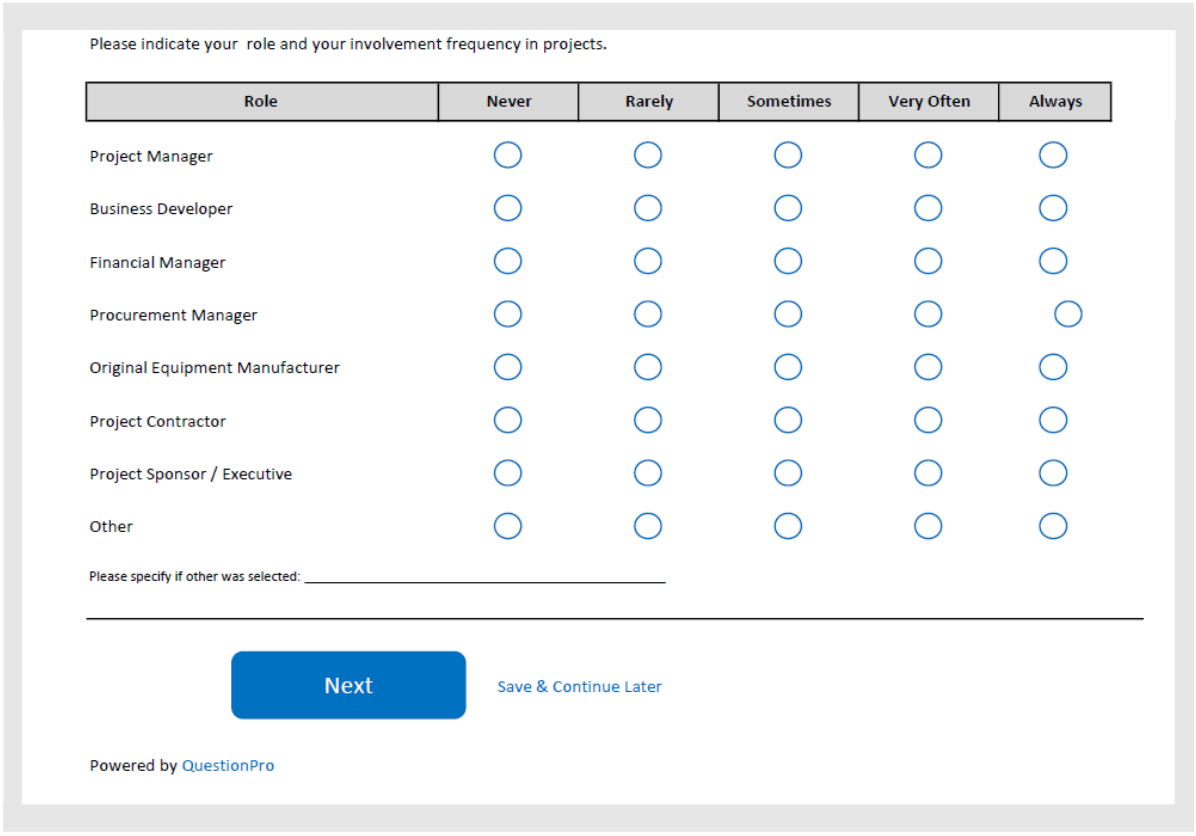
Survey Question 1



Please indicate your role and your involvement frequency in projects.

Role	Never	Rarely	Sometimes	Very Often	Always
Project Manager	○	○	○	○	○
Business Developer	○	○	○	○	○
Financial Manager	○	○	○	○	○
Procurement Manager	○	○	○	○	○
Original Equipment Manufacturer	○	○	○	○	○
Project Contractor	○	○	○	○	○
Project Sponsor / Executive	○	○	○	○	○
Other	○	○	○	○	○

Please specify if other was selected: _____

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Survey Question 2

Please indicate your years of experience you fulfilled of each role with your involvement in projects.

Role	≤ 5 years	> 5 and ≤ 10 years	> 10 and ≤ 15 years	> 15 and ≤ 20 years	> 20 years
Project Manager	◯	◯	◯	◯	◯
Business Developer	◯	◯	◯	◯	◯
Financial Manager	◯	◯	◯	◯	◯
Procurement Manager	◯	◯	◯	◯	◯
Original Equipment Manufacturer	◯	◯	◯	◯	◯
Project Contractor	◯	◯	◯	◯	◯
Project Sponsor / Executive	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯

Please specify if other was selected: _____

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Survey Question 3

Please indicate your years of experience you have with the following type of projects that experienced cost overruns.

Project types	≤ 5 years	> 5 and ≤ 10 years	> 10 and ≤ 15 years	> 15 and ≤ 20 years	> 20 years
Like for like replacement projects	○	○	○	○	○
Plant Improvement projects	○	○	○	○	○
Process Improvement projects	○	○	○	○	○
Modification projects	○	○	○	○	○
New plant projects	○	○	○	○	○
Leveraging New Technologies	○	○	○	○	○
Infrastructure upgrade projects	○	○	○	○	○
Other, _____	○	○	○	○	○

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Survey Question 4

Please indicate the frequency per phase in the project lifecycle you have encountered the need to increase the budget due to cost overruns.

Phases of a project	Never	Almost Never	Sometimes	Almost Always	Always
Concept Phase	○	○	○	○	○
Initiation Phase	○	○	○	○	○
Planning Phase	○	○	○	○	○
Execution Phase	○	○	○	○	○
Monitoring and Controlling	○	○	○	○	○
Closure	○	○	○	○	○

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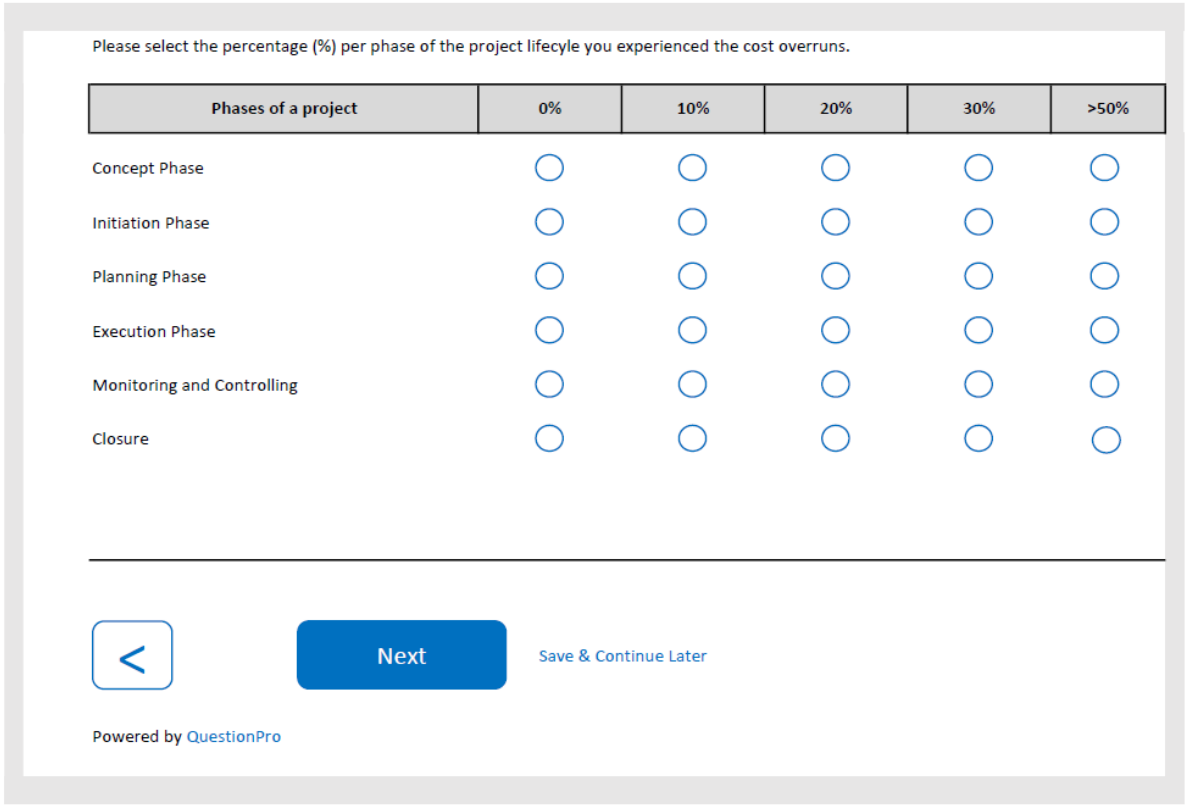
Survey Question 5



Please select the percentage (%) per phase of the project lifecyle you experienced the cost overruns.

Phases of a project	0%	10%	20%	30%	>50%
Concept Phase	○	○	○	○	○
Initiation Phase	○	○	○	○	○
Planning Phase	○	○	○	○	○
Execution Phase	○	○	○	○	○
Monitoring and Controlling	○	○	○	○	○
Closure	○	○	○	○	○

Survey Question 6

It is generally understood that a cost overrun is the sum of unpredicted expenses that exceeds initial budget estimates at any point throughout the course of project realization. Please indicate he following factors would be the mostly responsible.

Primary Factors	Never	Almost Never	Sometimes	Almost Always	Always
Design and contract related factors	◯	◯	◯	◯	◯
Estimation related factors	◯	◯	◯	◯	◯
Project and scheduling related factors	◯	◯	◯	◯	◯
Project Management related factors	◯	◯	◯	◯	◯
Labour related factors	◯	◯	◯	◯	◯
Financial related factors	◯	◯	◯	◯	◯
Material and machinery related factors	◯	◯	◯	◯	◯
Construction related factors	◯	◯	◯	◯	◯
Communication related factors	◯	◯	◯	◯	◯
External related factors	◯	◯	◯	◯	◯

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Survey Question 7

In order to prevent cost overruns, please indicate your level of agreement with the following statements.

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Scope Creep is basically adding additional functions or features to the new product, work, or requirements that are beyond the agreed-upon scope.	◯	◯	◯	◯	◯
Risk management plays a very important role in keeping the project under budget	◯	◯	◯	◯	◯
The negative impact of untrained people could be insignificant, but it could also be disastrous for the project.	◯	◯	◯	◯	◯
Unrealistic project duration imposed by client / management	◯	◯	◯	◯	◯
One of the first actions to take to minimize cost overruns related to materials is having an accurate estimate of the required materials	◯	◯	◯	◯	◯
Underestimation is the placing of too low a value on size, quantity, or number.	◯	◯	◯	◯	◯
Investing in effective training, development, mentoring programs, and appropriate staffing will ensure that project managers have the skills and knowledge they need to successfully execute projects.	◯	◯	◯	◯	◯

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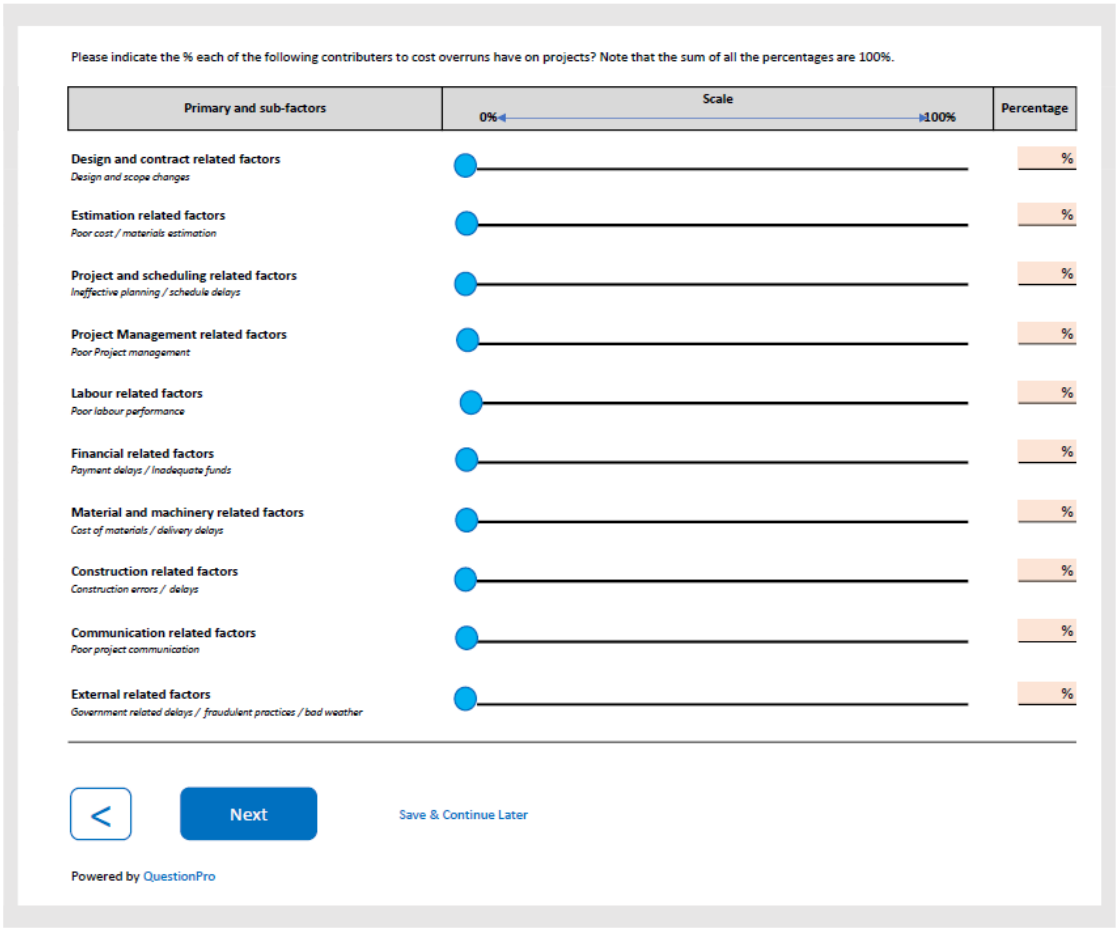
Survey Question 8



Please indicate the % each of the following contributers to cost overruns have on projects? Note that the sum of all the percentages are 100%.

Primary and sub-factors	Scale 0% – 100%	Percentage
Design and contract related factors *Design and scope changes*		%
Estimation related factors *Poor cost / materials estimation*		%
Project and scheduling related factors *Ineffective planning / schedule delays*		%
Project Management related factors *Poor Project management*		%
Labour related factors *Poor labour performance*		%
Financial related factors *Payment delays / Inadequate funds*		%
Material and machinery related factors *Cost of materials / delivery delays*		%
Construction related factors *Construction errors / delays*		%
Communication related factors *Poor project communication*		%
External related factors *Government related delays / fraudulent practices / bad weather*		%

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Survey Question 9

Please indicate the level of importance each of the following statements have when considering planning project budgets and risks.

Statements	Not Important	Slightly Important	Moderately Important	Important	Very Important
When estimating project budgets, always make allowance for scope changes, project risks and possible scope creep.	○	○	○	○	○
Ensure adequate time is spent during front-end-loading stage when developing project quality plan to avoid scope creep.	○	○	○	○	○
Ensure proper stakeholder engagement and communication plan is developed to clarity roles and responsibilities to avoid conflict, misunderstanding and defining the project requirements.	○	○	○	○	○
Clearly define project scope, deliverables to be met with required project resources with clear key project success factors based on key performance indicators.	○	○	○	○	○
Develop risk management plan that identifies, evaluates and have mitigation actions with estimated risk allowance within the budget when considering all types of risks.	○	○	○	○	○
Perform Earned Value scheduling and planning as part of projects control's function that provides an indication of project performance based on schedule adherence and cost control as a tool.	○	○	○	○	○
It is vital to conduct a detailed work breakdown structure (WBS) with associated cost estimates with durations and the various phases of the project Lifecyle.	○	○	○	○	○
For critical equipment and machinery, ensure a backup plan is in place or on standby in the event of breakdown or maintenance.	○	○	○	○	○
It is essential to monitor the project performance by tracking the individual project managers outcomes, communicating regularly, and identifying areas for improvement.	○	○	○	○	○
Use the right skill resource for the job. The cost of using untrained people could require product repair or rework. This would consequently lead to project cost overruns.	○	○	○	○	○

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Survey Question 10

10. Please provide additional recommendations that you would consider preventing cost overruns.

(free text)

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