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Assessing the role of inventory management in construction project cost overrun in a small and medium-sized enterprise in Witbank

By

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Declaration

Declaration

I, Tebogo Hilton Majatladi, declare that:

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Acknowledgments

I dedicate this dissertation to:

I am deeply grateful to God for His guidance and strength throughout this journey. Without His blessings, this research would not have been possible. I also extend my heartfelt appreciation to my family for their unwavering support and encouragement. Their belief in me has been a constant source of motivation, and their patience and understanding have played a significant role in helping me complete this study.

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List of Acronyms and Abbreviations

CEO	Chief Executive Officer
CTC	Cost to complete
DBSA	Development Bank of Southern Africa
EOQ	Economic Order Quantity
FGD	Flue-gas desulphurisation
FIFA	Federation Internationale de Football Association
GDP	Gross Domestic Product
IDC	Interest During Construction
JIT	Just-In-Time
KZN	KwaZulu-Natal
PwC	PricewaterhouseCoopers
USD	United States dollar
VMI	Vendor-Managed Inventory

Abstract

Material inputs are an important factor in the success of construction projects, directly impacting costs and timelines. Mabhele and Associates is a small-medium enterprise supporting or subcontracting infrastructure projects. Cost overruns are a recurring issue in South Africa's infrastructure projects, affecting economic stability. This study explores how effective inventory management can mitigate cost overruns in construction projects at Mabhele and Associates in Witbank, South Africa. Eight participants were purposively selected from the 29 employees of the enterprise based on inclusion criteria, ensuring a diverse and in-depth mix of respondents capable of providing comprehensive insights. The dissertation comprises two critical parts: a comprehensive literature review and fieldwork.

This study assessed the challenges associated with inventory management in construction projects. The research employed a qualitative design, using interviews as the primary data collection method. Thematic analysis of the interviews reveals several challenges impacting project efficiency, including procurement delays, material shortages, and inadequate storage management. These issues often stem from cumbersome procurement processes requiring multiple quotations and approvals, leading to delays in material availability. Additionally, limited storage space complicates on-site material management, contributing to inefficiencies.

Findings indicate that cost overruns are exacerbated by poor project management, underestimation of project costs during feasibility studies, and scope creep. Regulatory factors like compliance sometimes result in less experienced companies securing contracts, leading to inaccurate quotes and inefficiencies. Inexperience with contract management, inaccurate project coding, and hiring uncommitted companies further contribute to project delays and increased costs.

The study showed that improving procurement processes, storage management, and project planning can significantly mitigate cost overruns. Strategic recommendations include fostering clear communication with suppliers, monitoring delivery schedules, and ensuring proper contract and project management. This research's findings may apply to similar organisations within the construction industry, providing valuable insights for improving inventory management practices and reducing project costs across the sector.

Keywords: Construction Project, Cost overrun, Inventory Management, Project delays, Stakeholder

Table of Contents

List of Tables

List of Figures

Chapter One: Introduction

1.1 Background

The construction of large-scale projects is an essential driver of economic growth, employment, and improved quality of life. These projects, such as constructing power plants and transportation systems, are key to shaping national economies. However, the execution of such initiatives often faces significant challenges of late delivery of projects, ranging from political interference and material to schedules and resources. As a result of these challenges, the projects face extended schedules, resulting in substantial cost overruns. For instance, Flepisi and Mlambo (2021) have established that Eskom has encountered many problems, including the late completion of the Medupi power station, because of mismanagement and political interference.

In South Africa's infrastructure sector, these challenges are notably prominent. For example, Eskom's Medupi and Kusile power stations experienced severe cost escalations. Medupi's costs surged from an initial estimate of R69 billion to R154 billion by 2015 (Lowman, 2015). These delays stemmed from poor planning, slow decision-making, inaccurate estimation, increased material costs, and late contract awards (Moodley & Oosthuizen, 2023).

The researcher has first-hand experience with inventory's critical role in construction projects. However, numerous studies have also investigated the factors resulting in overruns in infrastructure projects, and the inventory has been highlighted as one of the important factors (Liwan, 2015)**.** Most of these studies have been focused on significant inventory while ignoring small consumables. One key issue is poor planning when managing small consumable materials. Despite their low individual costs, improper planning can lead to significant delays. The unavailability of essential items, such as personal protective equipment (PPE), can disrupt construction activities by halting work due to non-compliance with safety site regulations. This not only causes further delays but also results in inflated project costs.

Given the lack of research regarding consumable inventory in construction, this study aims to assess those challenges emanating from the inventory of these consumables based on case firms from Mabhele & Associates and to recommend the best way of managing them to avoid delays. Mabhele & Associates is a small to medium-sized enterprise located in Witbank, specializing in installation and construction services. The company primarily manages projects in Mpumalanga, focusing on various power stations. With extensive experience in the power generation and steel industries

The chapter will introduce the study by first discussing the background and context, followed by the research problem of the study, expressing the motivation, the study focus, problem statements, and the main objectives. The proposed methodology is also highlighted in this introductory chapter.

1.2 Impetus for the Study

The author is a qualified project manager with over a decade of experience managing complex, large-scale projects. One of the key projects in the author's portfolio is Kusile, a significant initiative aimed at enhancing South Africa's power generation capacity. The project was designed to create job opportunities and stabilise the country's energy supply, addressing critical economic and infrastructure needs.

The author worked on the Kusile project for about five years, gaining direct experience with its operations, challenges, and management practices. Throughout this period, persistent inadequacies in inventory management became apparent, with issues such as poor material tracking, lack of integration between procurement and usage, and supply chain delays. These inefficiencies increased project costs and delayed critical phases of the Kusile project.

The study builds on the author's professional experience, aiming to explore and address the factors contributing to poor inventory management in large-scale infrastructure projects. The goal is to offer actionable insights and propose solutions to improve inventory management processes, leading to better project outcomes and resource utilisation in the future.

1.3 Aim of the Study

The study aims to adopt a more scientific and proactive approach to inventory management in future large-scale projects. From the perspective of Mabhele, the challenges arising from inadequate raw material inventory in large infrastructure projects will be examined, mainly focusing on the Kusile project. The research will explore the risks and impacts of poor inventory management on project timelines, costs, and overall success to improve future project management and resource allocation practices.

1.4 Problem Statement

Understanding the project and the key factors that determine its success is crucial. Various elements contribute to successful project completion, and their effective management can significantly impact the outcome. Poor comprehension of these critical factors, including material management, can lead to project failures, cost overruns.

1.5 Research Questions

1. What are the challenges confronting inventory control in large infrastructure projects within the Mabhele scope of the Kusile project?
2. What are the advantages of implementing effective inventory management practices in large-scale projects?

3. Which key role players should be involved to ensure inclusive and effective inventory management in the Kusile project?

1.6 Research Objectives

The study aims to achieve the following three research objectives.

- To identify and analyse the challenges associated with poor inventory management in the Mabhele scope at the Kusile project.
- To evaluate the advantages and impact of implementing effective inventory management practices in large-scale projects like the Kusile project.
- To identify and define the key role players required to ensure inclusive and effective inventory management in the Kusile project.

1.7 Dissertation Structure

This research is structured into six chapters. Chapter 1 aims to establish a clear rationale for the study, define its scope, and provide a roadmap for the rest of the dissertation. It sets the stage for subsequent chapters that reach the study's methodology, literature review, findings, analysis, and conclusions.

Chapter 2: Literature Review**:** This Chapter presents a narrative literature review, synthesising and critically analysing existing scholarly research relevant to inventory management.

Chapter 3: Research Methodology: Serves as a critical component of the research, providing a detailed explanation of how the research was conducted and ensuring transparency in the methods used to gather and analyse data. It lays the groundwork for Chapter 4 by explaining how findings were generated and interpreted.

Chapter 4: Presentation of results and analysis: Centres around presenting and analysing the results obtained from detailed interviews. It sets the stage for Chapter 5, where the findings will be interpreted, synthesised with existing literature, and discussed in greater depth.

Chapter 5: Discussions and interpretation of research findings: Synthesises and contextualises the dissertation's findings, providing a comprehensive analysis that links the empirical evidence with theoretical frameworks and practical implications. It aims to deepen understanding of the research topic and guide future research and applications in the field.

Chapter 6**:** Conclusion and Recommendations: serves as a conclusion of the dissertation, bringing together the findings, conclusions, and recommendations to provide a comprehensive understanding of the research topic and its implications for theory, practice, and future research.

1.8 Limitations of the Study

The researcher faced several challenges during the study, particularly with participants who held positions below the managerial level. There was a concern that these individuals might provide insights focused on operational inventory management, which could unintentionally expose sensitive information related to financial performance in procurement. Their responses were primarily centred on daily activities related to the construction team rather than strategic management perspectives. However, despite this focus, these participants still shared valuable information.

Another significant limitation of the research was that, in some projects, the company was not responsible for managing the entire project inventory or materials. In certain instances, materials were supplied by the customer, meaning the company was not directly involved in the procurement or management of these essential resources. The customer handled large materials, such as electrical equipment sourced through overseas procurement, not the company's inventory. Nonetheless, other locally procured inventories managed by the company contributed valuable data to the research.

Finally, during the research interviews, the company was winding down, leading to many team members either having been retrenched or being in the process of retrenchment, which made it challenging to reach them. Additionally, some individuals had already returned company equipment, such as laptops, further complicating the interview process.

1.9 Assumptions

The researcher operated under the assumption that participants involved in this study would provide honest, accurate, and truthful responses during the interview process. It was anticipated that participants would engage with the research questions openly and transparently, offering insights that reflect their actual experiences and perspectives. This assumption was critical to ensuring the reliability and validity of the qualitative data collected, as the integrity of the responses directly impacts the depth of the research findings.

In addition, the researcher assumed that the data required for this study would be available and accessible throughout the research process. This includes the expected availability of documentation, reports, and records relevant to the research and the willingness of participants and organisations to grant access to these resources.

1.10 Conclusion

The chapter examined the significant impact of inventory management on cost overruns in construction projects, focusing on infrastructure projects in South Africa. Poor inventory management practices led to

delays, contributing to project cost overruns. The study aims to assess the relationship between inventory management and cost overruns using data from the Mabhele Associates project as a case study. This assessment was conducted through interviews with experts involved in the project, employing a qualitative approach to gather insights and experiences. The research could highlight the prevalence of cost overruns in South African construction projects and seeks to understand how improved inventory management could mitigate these issues. By analysing the Mabhele and Associates project data and conducting interviews, the study will assess key inventory management factors contributing to cost overruns. The following chapter provides a comprehensive literature review on cost overruns in construction projects, setting the foundation for understanding the role of inventory management in project financial performance.

Chapter Two: Literature Review

2.1 Introduction

This Chapter presents a narrative literature review synthesising and critically analysing existing scholarly research relevant to inventory management. It begins by defining inventory management and explaining the techniques and systems used in construction. It also discusses the significance of material tracking and provides background information on cost overruns in construction projects.

2.2 Inventory Management Challenges

Samanta (2015) defines Inventory as materials stored, waiting for processing, or experiencing processing in construction projects and, according to Basheer et al. (2024), these projects often face challenges related to supply material management, including fragmentation, lack of trust among stakeholders, and restricted information sharing. This stakeholder is mostly the Original Equipment Manufacturers (OEM) such as Siemens, customers, the local community, installation companies, SOEs, e.g. Eskom, and material suppliers. In South Africa, the typical large-scale construction setup involves a customer subcontracting work to Original Equipment Manufacturers (OEMs), who may subcontract installation work to other companies. The OEMs are mainly responsible for managing the inventory of essential materials, while subcontracted companies handle installation materials including consumables. Both types of inventories are crucial in maintaining project timelines and ensuring smooth execution. Al-Aidrous et al. (2022) further stress the pivotal role of materials and equipment in the project, constituting 60% of a construction project's total cost, meaning any inadequate management would result in tampering with 60% of the project cost, which is a significant figure. All of these intricate stakeholders encounter various challenges, which will be explored in the remainder of Section 2.

2.2.1 Project Management in Construction Projects

Project management in construction is an essential area that encompasses the planning, coordination, and control of a project from start to finish. It is concerned with completing a project on schedule, within budget, and with the necessary quality standards. Given the complexity and multidimensional nature of the projects, efficient application of project management concepts is critical to deciding their success or failure.

Successful project execution relies on effective project management (Oh et al., 2021). This approach systematically delivers the desired business value by utilising the appropriate tools, expertise, methodologies, processes, and skills to meet the sponsor's expectations (Menon, 2024). The author highlighted that the success rate of projects increased from 29% in 2004 to 36% in 2015. Moreover, the proportion of challenged projects decreased from 53% in 2004 to 45% in 2012, although 19% of all projects

were reported as failures in 2015. These figures reflect an overall improvement in project outcomes over time, with a rise in successful projects. However, challenges such as budget overruns, delays, and occasional project failures persist, suggesting room for further refinement in project management practices.

Given these trends, it is evident that effective management is vital. As Corazza et al., (2024) emphasise, sustainable management is critical for mega-projects, underscoring the importance of stakeholder interactions and adopting an ecosystem perspective of sustainability. This highlights the role of effective communication in ensuring project success. Frameworks like the PMBOK outline ten knowledge areas essential to project management, including integration, scope, time, cost, quality, human resource management, communication, risk, procurement, and stakeholder management (PMI, 2021). PMI has developed a framework called the Project Management Body of Knowledge (PMBOK), which is a guide to best practices in project management. Studies have shown the importance of implementing best practices, which are crucial for the success of any organisation (Menon, 2024).

The 10 knowledge areas central to project management, as outlined by the PMBOK, are crucial for the successful management of any project. Enforcing the PMBOK framework, such as requiring project managers to be certified professionals, would significantly enhance project execution by applying these core knowledge areas. It is therefore recommended not just to acknowledge them, but to actively implement them throughout all stages of the project. The PMBOK itself is an extensive subject of research, and for this study, the focus will be on addressing the challenges faced by project management within the context of the Cranbrook framework. Additionally, this research will explore the insights and perspectives of participants regarding these knowledge areas.

2.2.2 Project Scope Creep

Another important aspect of project management is scope creep, which can lead to delays if not adequately controlled. Scope creep is the uncontrolled expansion of project requirements without corresponding time, cost, or resource adjustments. Research indicates that scope creep is frequently driven by inadequate initial requirement-gathering, ambiguous project goals, and changes requested by stakeholders during execution (PMI, 2021).

Scope creep refers to the gradual and uncontrolled expansion of project goals beyond the original plan, potentially impacting timelines, budgets, and overall success. To mitigate these risks and keep the project on track with its initial objectives, it is essential to implement effective project management techniques (Thomas & Amhana, 2024) .While scope creep is often expected in complex projects, the key lies in managing it.

To effectively manage scope creep, Forbes Rudder (2024)suggests implementing a change management plan. This plan outlines the process for submitting, evaluating, and approving or rejecting scope change requests, and includes details about tools, authorized individuals, fees, and deadlines. It also emphasises the importance of a signed Work Performance Statement (WPS) and a Gantt chart to maintain adherence to the original plan, while allowing flexibility for project success. It's essential to present the change management plan to stakeholders, outlining the consequences of change requests, the evaluation process, and any fees to ensure the project stays on track in terms of budget, timeline, and quality.

While scope changes can arise from both customer and internal stakeholder requests, Rudder (2024) notes that scope creep isn't always negative. Changes from customers should be compensated for and covered by the contract, while internal changes, like design revisions or new requirements, are subject to client approval. Effective project reviews during the design stage can prevent issues, ensuring client requirements are well integrated into the project. The most disruptive changes occur during construction, so minimising these is crucial. Using FIDIC contracts can help balance the risks and responsibilities between the parties involved, fostering effective project management.

Aizaz et al. (2021) identified four key categories that contribute to scope creep: people, process, project, and product. These categories encompass various elements that lead to scope creep in different aspects of a project. For example, inexperience and lack of feedback are common issues under the "people" category. Within the "process" category, project complexity plays a significant role. In the context of the "project" itself, communication challenges, as discussed extensively in our research, and the adherence to standard policies are crucial factors that contribute to scope creep, particularly in managing inventory. Lastly, the "product" category highlights unforeseen risks that may arise. The detailed breakdown of these elements is further summarised in the table below.

One of the primary causes of scope creep during the design phase is insufficient planning and inadequate gathering of requirements at the outset of the project. Constantly changing client requirements can create additional pressure on the development team and project managers, leading to scope creep. Quality concerns, often originating from the business side, can also contribute to this issue. Successful project outcomes depend on teamwork, with all stakeholders actively involved in every phase of the project. Organisations must adhere to standard policies and practices for software development, which should align with established project management standards. A clear and consistent path, such as the one offered by Agile methodology, should be followed to ensure that all standards and policies are adhered to, helping to prevent scope creep at any stage of the project.

Figure 2. 1: Categorisation of scope creep factors through 4Ps

Source:(Aizaz et al., 2021)

Robust change management practices and stakeholder engagement are essential to effectively managing evolving project needs, leading to an agile environment. Therefore, Agile principles and methodology enable and increase collaboration and communication and assist the team in reaching its goals (Kaller & Söderqvist, 2020).

2.2.3 Theft and vandalism on site

Theft within the construction and supply chain sectors, encompassing material and equipment loss, is a significant concern. Thieves and vandals can directly impact the success of a project and diminish the potential profitability of the project under construction. Theft is defined as the unauthorised removal of any material or equipment from a job site (Farinloye et al., 2013). The authors referred to theft of equipment ranging from office tools to heavy equipment on building sites. Most of the financial losses incurred by theft acts are offset by insurance, while all uninsured costs are borne by project owners. The study by Farinloye et al. (2013) mentioned that theft was mitigated through camera security systems, staff crime security awareness, and on-site security.

Causes of losses at construction sites were analysed, and the level of agreement with these causes was rated as "Agree" for all causes. Large firms were found to incur more losses than small and medium firms, with the loss per theft incident also higher in large firms. The predominant theft measures on building sites include maintaining tool inventory, marking tools, maintaining secured storage areas, and making each worker responsible for their tools. A larger proportion of large firms experienced higher total estimated

losses due to vandalism. Those identified as suspects of vandalism on construction sites often include disgruntled workers and workers who had been fired. Personal security and information security were considered important measures to address these issues. According to News24, Transnet has had to spend more than R290 million to replace and fix stolen and vandalised cables on their railway lines.

Studies by Li et al. (2020) highlight that integrating technologies such as RFID and GPS tracking can significantly mitigate these risks and further suggest that fostering an organisational culture with stringent security protocols and accountability frameworks reduces theft incidences.

	Causes of Losses	Frequency of Respondents					Average index	Category of rating scale
		1	2	3	4	5		
1	Theft or loss of equipments, tools, material and office stuffs are the main problems of site security problems.	0	0	7	31	4	3.93	4
2	Vandalism can be doing by external and internal person or group	0	0	11	19	12	4.02	4
3	Theft occasionally involving employees or labor within the project	0	0	8	26	14	4.00	4
4	In the night, holiday or out of hours working, are the best time to the thieves doing the theft	0	1	13	2	16	4.02	4
5	Poor site storage and poor check out/in system for tools and materials can improve opportunity for the theft and loss	0	2	17	14	10	3.7 9	4
6	Discharge of the employee if not doing by appropriate procedure can raise a problem to the company	0	0	11	17	13	4.05	4
7	No clearly defined roles and duties for the security officers	0	3	10	22	7	3.70	4
8	No adequate lighting in the night	1	2	10	22	7	3.76	4
9	No clearly security procedures at the site	0	2	11	17	11	3.90	4
10	Not enough support to the security policy from the senior management of the project	0	5	14	18	5	3.55	4
11	Not using security tools such as CCTV and alarm system to protect site	0	3	10	17	12	3.90	4

Note: 1= Disagree, 2 = Slightly Disagree, 3 = Partially Agree, 4 = Agree, 5 = Strongly Agre

Figure 2. 2: Causes of Losses on sites

Source: Farinloye et al. (2013)

2.2.4 Supply Chain Management

The procurement process in construction is complex, starting with identifying the need for materials, followed by acquisition, transportation, receiving, storage, and preservation throughout the project lifecycle. Improper materials management can lead to risks such as stockouts, often due to unforeseen events like transport breakdowns or labour shortages. These risks can result in not only financial losses but also project delays. Effective inventory management is vital for avoiding such delays and preventing project overruns. Additionally, it helps reduce material purchasing costs, minimises legal disputes among project stakeholders, and enhances decision-making processes.

Supply chain disruptions can severely impact project timelines and budgets. The term procurement process is used in this paper to describe the process required to supply equipment, materials, and other resources required to carry out a project. This process usually involves sub-processes such as acquisition, purchasing, logistics, monitoring, quality assurance, and contract administration (Alarcón et al., 1999).

The study by Alarcón et al., (1999)."Evaluation and Improvement of the Procurement Process in Construction Projects," highlights findings about Chilean projects. From analysis of information obtained from interviews, surveys, case studies, and overall research, it was observed that:

- Each owner presents a project organisation adapted to its reality, varying from company to company, and even from one project to another. This significantly affects procurement.
- Procurement problems are diverse in nature. Frequent issues include delays in delivery, delays in ordering, repairs and replacements at job sites (equipment), poorly planned inspections (equipment supplier), lack of site information about supply arrivals, delays in engineering (programming), and frequent changes to air transportation to expedite deliveries.
- Procurement problems are primarily related to delays in meeting project timelines and quality expectations. Extra resources (capital, personnel, time) are often required to address or avoid delays.
- The primary sources of procurement issues stem from the system itself (forms and procedures), engineering delays or errors, company policies, and suppliers.
- Analysing the value stream of an industrial project's procurement process revealed that only 18% of activities were value-adding.
- Traditional systems (telephone, fax, mail) are still widely used, and only a few projects leverage modern IT systems for procurement management.

The process illustrated in Figure 2.3 emphasises how complex procurement of consumables, such as earth clamps, can cause project delays spanning months.

Vrijhoef and Koskela, (2000) highlighted the benefits of Just-in-Time (JIT) delivery systems in reducing inventory costs. However, Ivanov (2021) noted that the COVID-19 pandemic emphasised the importance of resilient and diversified supply chain networks

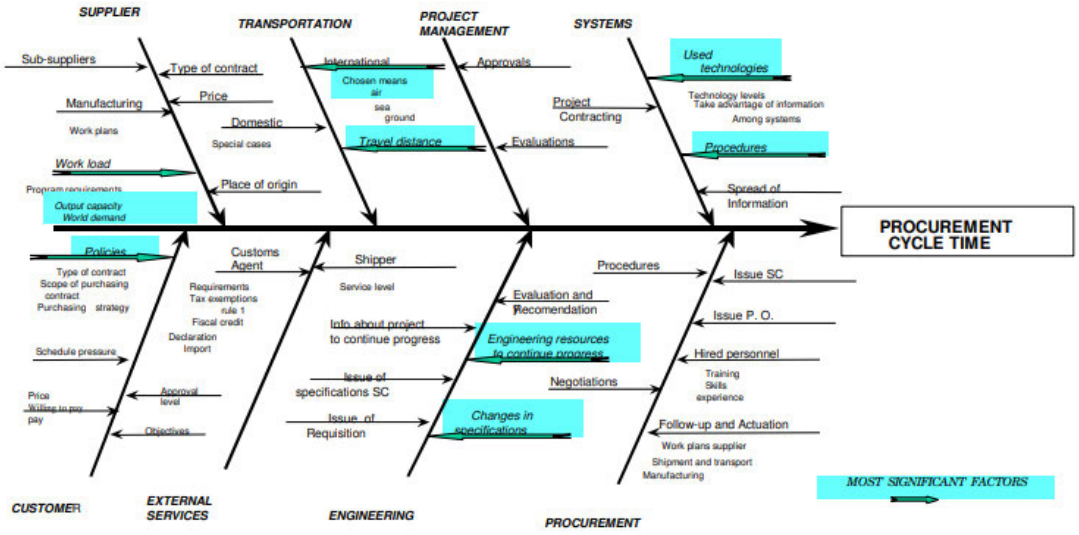

Figure 2. 3:Cause-Effect Diagram for Long Cycle Times

Source:(Alarcón et al., 1999).

2.2 Effective Inventory Management

Effectively managing inventory is essential for a firm's success and profitability, especially for those aiming to thrive amid intense market competition (Guluma, 2019). By optimising inventory control, organisations can avoid shortages and overstock, ensuring that materials are available when needed without tying up excessive capital in unused stock. This leads to timely delivery of project milestones, as suitable materials are always on hand, preventing delays that could derail the project timeline.

According to the research (Salih et al., 2023), the automated system that leverages technology to manage stockpiles could solve the problem of inefficient inventory management. Technology-driven inventory solutions enable small and medium-sized enterprises (SMEs) to optimise stock levels, reduce storage costs, and improve the efficiency of their supply chains.

The benefits of inventory management include substantially improving organisational efficiency, ultimately leading to cost savings (Wangari & Kagiri, 2015). There are numerous methods to manage inventory effectively, among these, Wangari & Kagiri, (2015) emphasises the critical role of technology. Utilising advanced inventory management systems allows organisations to automate tracking stock levels, managing orders, and forecasting demand. This reduces the risk of human error and enhances accuracy and efficiency. By integrating technology, businesses can gain real-time insights into their inventory status, streamline their supply chain operations, and respond swiftly to market changes. Consequently, adopting technological solutions in inventory management is a strategic move that can lead to improved productivity, better customer satisfaction, and significant cost savings.

The primary objective of successful inventory management is to enhance customer satisfaction while maximising profitability. This is achieved by maintaining an optimal inventory of essential items and ensuring that orders are accurately fulfilled according to customer specifications. By striking the right balance between stock availability and customer requirements, inventory management contributes significantly to the organisation's success. For effective material management in construction, it is essential to address both the limitations of manual tracking systems and the need for prompt information dissemination to ensure that project timelines and budgets are not compromised. However, Atnafu and Balda (2018) indicated that a well-organised and efficient inventory management system throughout the value chain is critical to the success of both large and small enterprises.

The primary challenge in managing inventory is finding the right balance between supply and demand. Companies aim to maintain enough inventory to meet customer needs and avoid stockouts that could result in lost sales. Ensuring this balance is vital to keep operations running smoothly and maintain customer satisfaction. Efficient inventory reduces losses and improves cash flow by optimising stock levels. It also enhances customer satisfaction by ensuring timely deliveries, as the right products are available when needed (Al-Aidrous et al., 2022).

Stephen (2022) emphasised that this deficiency in inventory management has far-reaching consequences, impacting not only customer service and revenue but also exerting a detrimental influence on project schedules. Inventory management is the process of planning, acquiring, storing, and supplying the required material, amount, and location at the right time (Gupta et al., 2020).

Research by Abd Karim et al. (2018) discovered that issues in inventory management arise from inconsistent practices resulting from non-existent standard operating procedures. Implementing a well-defined inventory management policy that outlines efficient inventory management practices allows companies to optimise operations and decrease the risk of overruns. The policy should be reviewed regularly to ensure its relevance and effectiveness in addressing evolving inventory needs and challenges.

Effective inventory management necessitates a collaboration with other relevant parties Pérez Vergara et al. (2020). Fostering stakeholder collaboration is essential for organisations aiming to optimise inventory management processes. Assigning appropriate authority and responsibilities to stakeholders involved in inventory management is paramount for ensuring smooth operations and achieving desired outcomes (De Vries, 2020). The primary challenge in inventory management includes inaccuracies in material planning, ineffective integration of software, and absence of standardised procedures (Khoa 2022). The research findings of Kritchanchai and Meesamut (2015) suggest that a one-size-fits-all inventory policy is not suitable for all types of settings; instead, an effective inventory management strategy should be based on the relevance of each material, along with the demand patterns specific to its category. The study revealed

that by implementing the inventory policy, the study observed a reduction in shortages by as much as 92.98% and a decrease in total inventory costs by 14.63% (Kritchanchai and Meesamut, 2015).

Manual inventory tracking methods have significant limitations, emphasising the need for advanced technologies to enhance accuracy and efficiency in on-site material tracking (Liwan, 2015).

The study further finds that proper inventory management is directly linked to improved logistics performance. It helps prevent overstocking, which unnecessarily ties up capital, and stockouts, which can disrupt production and result in overruns. This balance is crucial for maintaining high service quality and consistently meeting customer demands. Oluwaseyi et al. (2017)) Argue that inventory management is not merely an operational task but a strategic necessity that impacts the entire supply chain. Effective inventory management allows organisations to gain a competitive advantage through optimised processes, cost reduction and enhanced overall performance.

Ramadhan and Simatupang (2012) developed a study aiming to identify the root causes of high levels of material waste due to the perishable nature of its inventory and inefficiency. The research found that a restaurant's existing inventory management system, which relied on the executive chef's subjective judgment, led to significant waste and inefficiencies (J Žic, 2024).

The original study by Ramadhan and Simatupang (2012) proposed two alternative inventory management policies: a periodic review policy and a continuous review policy. After analysing both options, the research concluded that the constant review policy effectively reduced costs. Although the research provided valuable insights into inventory management for perishable goods, however, the study primarily focused on the periodic and continuous review policies tailored for perishable goods management without directly addressing EOQ, VMI, or JIT. The analysis was centred on optimising ordering policies to reduce waste and costs in a restaurant setting rather than exploring these broader inventory management tools.

Table 2.1 below summarises the most common challenges in inventory management identified by Liwan (2015). The challenges were divided into two categories: overseas construction projects and Malaysian projects. The studies by different authors highlight several common issues related to inventory management problems in construction projects, both in Malaysia and overseas . Across the board, there are recurring themes of material shortages and equipment/tool shortages, which are identified by multiple authors in Malaysia, including Sambasivan and Yau (2007), Alaghbari et al. (2007), and Hamzah et al. (2012), and elsewhere by Donyavi and Flanagan (2009) and Sardroud (2012) . Wastage and surplus materials are also consistently mentioned, particularly by Jang and Skibniewski (2008), El-Ghazali et al. (2011), and Sardroud (2012), as well as schedule delays and decreased productivity, which are common issues identified by several authors such as Jang and Skibniewski (2008) and El-Ghazali et al. (2011). Furthermore, problems

like lack of timely information and manual tracking (often labour-intensive and inaccurate) are noted by authors such as Jang and Skibniewski (2008) and El-Ghazali et al. (2011). Late deliveries and improper planning are significant challenges in both regions, particularly emphasised by Ibrahim (2010) and Sardroud (2012).

Overall, inventory management problems in construction projects, overseas and in Malaysia, share several common themes, such as material shortages, wastage, schedule delays, and inaccurate tracking. The critical similarities point to the need for improved planning, better information management, and more efficient systems for material tracking to enhance productivity and reduce wastage in construction projects. These issues emphasise the importance of addressing logistics and management practices to minimise operational disruptions and inefficiencies.

No.	Author	Year	Inventory Management Problems
Construction Projects Overseas			
1	Jang & Skibniewski	2008	• Manual material tracking, which is labour-intensive • Inaccurate and subject to error • Wastage, surplus materials • Schedule delay • Decreased productivity • Lack of timely information
2	Donyavi & Flanagan	2009	• Failure to order materials on time • Wrong delivery time • Over ordering • Wrong materials or rework • Double handling • Theft
3	Kasim	2010	- Inadequate site storage space
4	El-Ghazali *et al.*	2011	• Manual material tracking, • Labor-intensive, • Inaccurate, • Wastage, surplus materials, • Schedule delay, • Decreased productivity, • Lack of timely information regarding materials.
5	Sardroud	2012	• Required materials not purchased • Wrong delivery time • Late information on-site stock • Missing and surplus materials

			• Inadequate storage • Waste of time
Construction Projects in Malaysia			
1	Sambasivan & Yau	2007	• Shortage of materials • Equipment and tool shortage
2	Alaghbari *et al.*	2007	• Shortage of materials • Equipment and tool shortage
3	Ali et al.	2010	• Shortage of materials • Equipment and tool shortage
4	Ibrahim	2010	• Surplus of materials • Late delivery of material • Improper planning
5	Hamzah *et al*	2012	• Shortage of materials • Equipment and tool shortage

Table 2. 1: Inventory Management Problems in Construction Projects

Source: Liwan (2015)

Many construction sites also use job cards to document materials collected for specific tasks. However, while this method has worked in the past, it is increasingly seen as inefficient in today's fast-paced construction environment (Jusoh & Kasim, 2017).

In recent years, manual tracking has improved slightly, with data recorded in logbooks or job cards being transferred to Excel or other software for digital storage. This digitised information can help reconcile materials at the end of a project or for future reference. According to Liwan (2015), manual tracking remains labour-intensive and requires skilled personnel to manage it effectively. It also often necessitates periodic stocktaking, either monthly or at key project stages, to ensure accuracy. Despite its long-standing use, manual tracking is inefficient and time-consuming compared to modern alternatives.

2.3.1 Manual Tracking

Material tracking and location management are significant challenges in the construction industry. Ineffective handling and improper storage of materials can lead to difficulty locating items when needed, causing delays and impacting project timelines (Subramani et al., 2017)**.** Chan et al. (2023) state that companies continue to rely on manual inventory tracking methods, which are both labour-intensive and expensive.

They highlight that reliance on manual methods for inventory management is inherently labour-intensive, leading to inaccuracies and a higher likelihood of errors. This inefficiency can severely disrupt the

construction process, as construction teams depend on timely and accurate information about the availability of materials. The authors argue that manual tracking not only consumes valuable labour hours but also increases the potential for costly mistakes, such as ordering incorrect quantities or types of materials. They contend that manual tracking methods are fundamentally flawed, necessitating a shift move toward more automated and reliable systems to improve inventory management.

Effective inventory management has several benefits, including improved cash flow and reduced storage costs, by preventing stockouts and overstock situations. This balance ensures that the money is not unnecessarily tied up in inventory, leading to better overall profitability for the organisation (Mohammed et al., 2024).

Moreover, inventory management plays a crucial role in informed decision-making. Advanced tracking technologies provide near real-time data on stock levels, enabling businesses to make more strategic decisions about purchasing, production, and sales planning. This data's key performance indicators (KPIs) help organisations optimise their operations and align their inventory strategies with overall business objectives (Mohammed et al., 2024)This strategic approach ensures that inventory management supports the company's growth and operational efficiency.

Inventory management has undergone a significant transformation, with scholars emphasising the role of advanced technologies and innovative management practices in reshaping traditional methods. Kothari (2024), Frisa (2024), and Kasim (Jusoh & Kasim, 2017) identify technologies such as the Internet of Things (IoT), artificial intelligence (AI), blockchain, and the emerging potential of quantum computing as drivers of this evolution. These technologies have facilitated real-time tracking, improved accuracy, and enhanced operational efficiency, moving industries away from labour-intensive manual tracking systems. Complementing these technological advancements, management approaches like Just-in-Time (JIT), Lean Manufacturing, and Materials Requirements Planning (MRP) have gained prominence for their ability to minimise waste and maximise efficiency. Kasim (2017), in particular, highlights the use of RFID with GIS and GPS technologies in construction projects, further emphasising the integration of advanced tools to improve materials tracking and inventory control.

Despite the promise of these advancements, persistent challenges remain. Jusoh and Kasim, (2017) critiques traditional methods for being error-prone and labour-intensive, while Kothari (2024) and Frisa (2024) identify additional obstacles, such as the lack of clear implementation strategies, inaccurate stock records, and warehouse optimisation issues. These limitations highlight the complexity of transitioning to automated systems and suggest that achieving successful adoption requires addressing the unique challenges of different industries. Furthermore, solutions such as blockchain and quantum computing, while promising, remain in the developmental phase, limiting their current applicability. Influential studies by researchers

like Song (2005), Navon and Berkovich (2006), and Sardroud (2012) have provided foundational insights into the integration of advanced tracking systems, but gaps persist in scaling these innovations for widespread commercial use.

Mohamed (2024) extends the discourse by identifying key models and themes in inventory and supply chain management, emphasising their intersection with technology to improve efficiency and reduce costs. Models like Economic Order Quantity (EOQ), JIT, Vendor-Managed Inventory (VMI), and the ABC classification technique are highlighted as cornerstones of inventory management, offering tailored solutions to balancing inventory levels. The themes of demand forecasting, supplier integration, and cross-functional collaboration are seen as critical enablers of success. Mohamed (2024) also highlights recurring patterns, including the shift toward automation and the reliance on real-time data collection to optimise inventory systems, aligning with Kothari and Frisa's (2024) emphasis on emerging technologies.

A critical debate within the literature centres on the universal applicability of inventory management models, as operational constraints and market dynamics vary widely between industries. While foundational research on EOQ and JIT has laid the groundwork for best practices, gaps remain in addressing multi-echelon complexities and integrating sustainable practices into inventory management. Moreover, achieving accurate demand forecasting and overcoming inefficiencies in traditional processes continue to pose significant challenges. Scholars stress the importance of tailored strategies, such as regular inventory audits, cross-functional collaboration, and technology integration, to navigate these complexities effectively.

Existing research emphasises the continuous evolution of inventory management, driven by a convergence of technological innovation and refined management approaches. While integrating IoT, AI, and blockchain has transformed traditional practices, challenges like implementation barriers and varying industry needs persist. The findings emphasise the critical role of inventory management in achieving cost optimisation, operational efficiency, and competitive advantage, underscoring the need for ongoing research to bridge gaps in technology adoption, sustainability, and scalability.

Tesla's approach to inventory management offers valuable insights into the challenges companies face in the high-stakes manufacturing realm. As discussed by Ramadani et al. (2024) Tesla has revolutionised its supply chain by adopting innovative strategies, contributing to its success in the electric vehicle (EV) industry. However, despite these advancements, Tesla also grapples with issues similar to those in construction, namely the risks posed by disruptions in the supply chain. The automotive giant's ability to meet consumer demand and stay cost-efficient is heavily influenced by its ability to manage inventory effectively. In response to supply chain disruptions, Tesla's strategy should involve fostering stronger relationships with suppliers and diversifying its dealer network to minimise the risk of delays. While

promising, this approach adds a layer of complexity to inventory management, underscoring the delicate balance between efficiency, flexibility, and risk management.

In research by Rahman et al. (2017), it is apparent that the authors identify a lack of an efficient inventory system as a primary cause behind delays in construction projects. While this argument is valid, it is important to recognise that focusing solely on inventory management risks is oversimplifying the complexity of material shortages. Delays in construction projects are frequently influenced by various external factors, including supply chain disruptions, geopolitical issues, and fluctuations in demand — factors that Rahman et al. (2017) do not fully consider. The impact of these external variables on material procurement can be significant, often outweighing the internal challenges associated with inventory management. Therefore, a more comprehensive approach is needed, considering broader supply chain management practices, technological innovations, and strategies to mitigate external risks. Such an approach would provide a more nuanced understanding of the factors contributing to delays and offer more effective solutions for addressing them.

The concept of stakeholder collaboration, as presented by Millawati (2023) and supported by Yang et al. (2023), emphasises the importance of interdisciplinary cooperation for the successful completion of construction projects. The assertion that collaboration among various stakeholders is critical to project success is compelling; however, it is necessary to critically examine the practical realities of fostering such collaboration. Basheer et al. (2024) raise an important concern regarding the project-based nature of the construction industry, which inherently complicates the establishment of long-term collaborative relationships. Most stakeholders in construction projects engage only temporarily during the duration of a specific project, making it challenging to cultivate sustained, deep partnerships. In contrast, industries with more repetitive processes, such as manufacturing, tend to benefit from more enduring collaborations. This distinction suggests that the construction industry could potentially adapt long-term collaborative strategies from other sectors to better navigate the challenges inherent in its project-based nature.

While the theoretical benefits of collaboration — such as cost savings, improved efficiency, enhanced risk management, and innovation — are well-documented by Yang et al., (2023), the practical realisation of these benefits in the construction industry is contingent upon several critical factors. Organisational culture, the project's scope, and the stakeholders' willingness to engage with one another all play a pivotal role in determining the success of collaboration efforts. Collaboration can often be challenging in the construction industry, where competing interests are shared, and communication channels may not be effectively established. As a result, although the theoretical advantages of collaboration are clear, its practical application demands careful management, effective leadership, and a sustained commitment from all parties

involved. Missing these factors, the potential benefits of collaboration may not be fully realised in practice, and the challenges of fragmented stakeholder engagement could undermine the desired outcomes.

The study by Yuan et al., (2021) identifies the critical stakeholders such as government developers, designers, manufacturers, contractors, supervisor consultant facility managers, and users; this study further analyses the relationship between these stakeholders as shown in Figure 2.4 below.

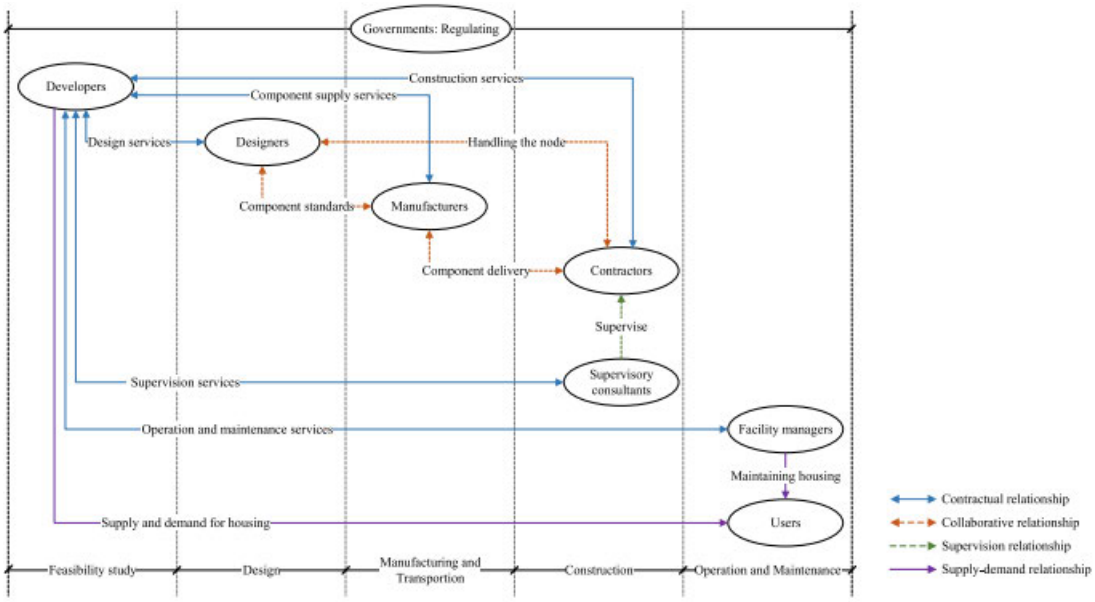

Figure 2. 4:Relationships among critical stakeholders in the life cycle of prefabricated building projects in China

Source:(Yuan et al., 2021)

On the one hand, collaborative inventory management indeed offers several key advantages that enhance operational efficiency. As GEP (2024) points out, improved visibility is a significant benefit, providing all parties with real-time data about inventory levels, demand trends, and order status. This transparency leads to better decision-making and more accurate forecasting. Greater agility is another notable benefit, as shared knowledge enables faster responses to supply chain disruptions, changes in demand, or unforeseen market conditions. In addition, cost reduction is realised through streamlined processes and shared resources, reducing the need for each partner to maintain large stockpiles. These factors ultimately contribute to a more resilient network of partners who can adapt to fluctuating conditions.

However, the complexity introduced by stakeholder interests, as noted in the second part of the passage, cannot be overlooked. The involvement of diverse internal stakeholders, each with their own set of priorities, increases the intricacy of decision-making. The range of actors — from end-users to employees, managers, and even trade unions — can create competing demands and expectations, which may hinder the

smooth execution of a project. For example, end users might prioritise product availability and quality, while managers could focus more on cost reductions and efficiency. Employees might advocate for fair working conditions, while trade unions could push for labour-related concerns.

This diversity of interests is crucial to manage effectively because, if neglected, it can lead to conflicts, delays, and inefficiencies that undermine the objectives of collaborative inventory management. As the passage suggests, project managers need to identify these stakeholders early and use frameworks or models to prioritise them based on their level of influence and criticality. This prioritisation helps allocate resources and attention where they are most needed, ensuring that high-priority stakeholders' needs are addressed in ways that do not jeopardise the project's broader goals.

In conclusion, while the benefits of collaborative inventory management in enhancing visibility, agility, and resilience are evident, the complexity introduced by stakeholder interests must be carefully navigated. Effective stakeholder management and prioritisation are essential to ensuring the collaboration remains on track and delivers the expected outcomes without being derailed by internal conflicts or competing priorities.

Figure 2. 5: The crucial role of inventory collaboration in supply chain excellence

Source: (GEP, 2024)

2.3 Project Cost Overrun

In project management, particularly in construction, engineering, and information technology, cost overruns are pervasive, often leading to significant financial strain on projects. These overruns, representing the discrepancy between the estimated and actual costs, are influenced by various critical factors and can range widely in developed and developing nations.

Plebankiewicz and Wieczorek (2020) define cost overruns in construction projects as the variance between projected and actual construction costs. In a study by Raykar and Ghadge (2016), factors such as poor site management, subcontractor issues, lack of proper planning, material management challenges, and poor coordination among stakeholders significantly contributed to delays and cost increases. Though inventory

management was not specifically highlighted, it emerges as a recurring issue across many of these factors. For example, inadequate planning often results in poor inventory management, leading to delays or higher costs when materials are unavailable or mismanaged.

Herrera et al. (2020) documented cost overruns in developed and developing countries, revealing that developed nations like the United States, Australia, the Netherlands, and South Korea experience overruns ranging from 16% to 95%, with some European projects exceeding 200%. In developing countries such as Saudi Arabia, Qatar, and Jordan, these overruns are even more pronounced, with estimates ranging from 70% to 200%. These figures emphasise the severe financial impact of cost overruns, which affect the projects' viability and place significant burdens on taxpayers, predominantly when the overruns are funded through public finance.

According to Patel and Pipaliya (2023), key factors include inaccurate project estimates, design flaws, administrative errors, hiring the wrong team, and poor site management. Inaccurate project estimates, often influenced by competitive tendering and early assumptions, can lead to inflated budgets and unrealistic timelines, setting the stage for cost overruns. Design flaws are another major contributor, with studies showing that poor designs are responsible for a significant portion of disputes in the construction industry (Patel & Pipaliya, 2023). Additionally, errors in administration, such as inadequate project management and not hiring the right team, can further exacerbate the problem, as substandard performance and lack of coordination between stakeholders can lead to delays and increased costs. Poor site management, including material price fluctuations and insufficient technical support, is also a leading cause of cost overruns (Patel & Pipaliya, 2023).

Daundkar et al. (2022) also highlight similar factors, focusing on the role of material shortages, labour shortages, and project delays due to issues like late material delivery and equipment failures. Other contributors include low labour productivity, the quality of raw materials, and the competence of the project team. Both Patel and Pipaliya (2023) and Daundkar et al. (2022) emphasise the need for effective resource planning and management to mitigate these challenges. Furthermore, Saurabh (2022) notes the influence of poor communication and coordination between project participants, inadequate planning, and financial difficulties as key factors in escalating costs.

From a broader perspective, the findings from multiple studies on cost overruns, including those by Ahady et al. (2017), Tejale and Khandekar (2015), and Rahman et al. (2013) align with the factors identified by Patel (2023) and Saurabh (2022). The escalation of material prices is ranked as the most significant contributor, followed by poor site management and project delays (Saurabh, 2022). Financial issues, such as cash flow problems and labour shortages, are critical factors affecting cost outcomes. These findings underline the complexity of managing cost overruns in construction projects and the importance of

addressing these factors through proactive planning, better communication, and sound financial management practices.

Influence Rank	Factors	Region				
		Asia	Africa	Oceania	Europe	America
1	Failures in design	✔	✔	✔	✔	✔
2	Price variation of materials	✔	✔	✔		
3	Inadequate project planning	✔	✔		✔	
4	Project scope changes	✔			✔	✔
5	Design changes	✔	✔	✔	✔	
6	Unrealistic contract duration	✔	✔			✔
7	Inadequate bidding method	✔	✔			
8	Legal issues	✔	✔	✔		✔
9	Late decision making by owner	✔				✔
10	Political situation	✔	✔			
14	Economy issues	✔	✔			
15	Poor site investigation	✔		✔		

Figure 2. 6:List of factors ranks the factors influencing project management performance across various regions

Source: Herrera et al. (2020)

Figure 2.6 shows that each row highlights a specific factor, such as design failures, price fluctuations, or inadequate project planning, with checkmarks indicating the regions where these issues are most significant. The analysis of the provided data reveals that various factors, such as design failures, price fluctuations, and inadequate project planning, significantly impact project outcomes, with regional variations in the intensity of these issues. Design failures, for instance, emerge as a common global challenge, while price variations appear to be more concentrated in regions like Asia and Africa. This indicates that particular project challenges are widespread, while others are more region-specific, suggesting a need for tailored approaches to address these issues.

A crucial aspect highlighted in the data is the influence of inadequate project definition, poor planning for and management of changes, and insufficient project scope development. As Hughes et al. (2017) noted, these factors often contribute to project failure, emphasising the importance of clear project goals and well-defined scopes. Interestingly, Africa faces fewer challenges related to project scope changes than Asia, which experiences more significant difficulties. This disparity suggests that regions like Asia may benefit from enhanced strategies for managing scope changes and ensuring that projects remain on track despite evolving requirements.

The study by Olupitan et al. (2021) investigates the critical causes and effects of cost overruns in public sector construction projects in Port Harcourt, Nigeria. The researchers identified several key factors contributing to these overruns, including variation orders, changes in project scope, cash flow issues, financial difficulties faced by contractors, and delays in decision-making and planning. The study also

highlights the significant impacts of cost overruns, such as time delays, increased project costs due to extended timelines, disputes between owners and contractors, potential bankruptcy, and misallocating taxpayer funds. To mitigate these challenges, the authors recommend employing experienced contractors, ensuring proper project planning, appointing skilled and committed design teams, implementing effective strategic planning, and adhering to proper project scheduling.

A study by (Oluyemi-Ayibiowu et al., 2019) examined the significant causes of cost overruns in Nigeria's building construction industry through a literature review and questionnaire survey. The research identified twenty critical factors contributing to cost overruns, including inaccurate project time evaluations, risks, and uncertainties associated with projects, complexity of works, weak regulation and control, and lack of financial power. The study emphasises the importance of accurate project time assessments, effective risk management, and robust regulatory frameworks to address these issues. These studies emphasise the multifaceted nature of cost overruns in Nigeria's construction industry, emphasising the need for accurate project evaluations, effective risk management, robust regulatory frameworks, and experienced project teams to address these challenges effectively.

2.4.1 South African context.

South Africa's economic context provides further insight into infrastructure development challenges. The slow GDP growth, persistent energy shortages, and transport constraints undermine the country's economic stability and limit its infrastructure capacity. The importance of infrastructure development for driving sustainable growth and improving living standards for lower-income communities is emphasised (Levy, 2016). Despite the high demand for infrastructure in South Africa, the country's projects often fail to reach the success stage due to issues such as budget overruns, as identified by the Development Bank of Southern Africa (DBSA). This addresses the systemic inefficiencies within the country's project management practices.

The examples of significant infrastructure projects in South Africa, such as the Medupi power station, illustrate the severe consequences of poor project planning and execution. The significant cost escalation from R69 billion to R154 billion over the eight-year construction period of Medupi is a striking example of the financial strain caused by mismanagement (Lowman 2015). Such project failures reinforce the need for comprehensive planning and risk management strategies to avoid cost overruns and delays in future initiatives.

Chris Yelland's analysis (2019) further highlights the challenges faced by the energy sector in South Africa, including inefficiencies in managing large-scale projects, which ultimately affect the country's energy stability. These insights point to the broader implications of poor project management on the economy and

society, stressing the importance of refining project execution strategies and fostering better coordination among stakeholders to achieve successful infrastructure outcomes. The figures hide much information, and the actual costs are shown in Table 2.2 below.

Medupi cost to completion (CTC)	Cost
Approved CTC excluding IPC and FGD	R145 billion
Estimated cost of flue gas desulphurisation plant (FGD)	R39 billion
Capitalised interest during construction (IDC)	R50 billion
Total Cost	R234 billion
Kusile cost to completion (CTC)	Cost
Approved CTC excluding IPC, including FGD	R161 billion
Capitalised interest during construction (IDC)	R65 billion
Total Cost	R226 billion

Table 2. 2:True costs of Medupi and Kusile power stations

Source: My Broadband (2019)

Gichuki (2023) examined the delay factors in the Medupi Power Station project, one of South Africa's most extensive energy infrastructure endeavours. The research identified several key contributors to the project's delays, including poor project management, labour disputes, supply chain disruptions, and technical challenges. These factors collectively extended the project's timeline and increased costs, highlighting significant issues in the planning and execution phases of such large-scale infrastructure projects.

Similarly, several stadiums experienced significant cost increases from their original budgets. According to Bekker (2016), Cape Town Stadium's initial budget was R2.9 billion, but the final cost reached R4 billion. The writer further mentioned that Durban's Moses Mabhida Stadium was initially estimated at R1.6 billion, yet the final expenditure was around R3.1 billion, as shown in Table 2.3 below. These examples highlight a pattern of substantial cost overruns in major infrastructure projects in South Africa.

Stadium	Initial budgeted cost	Indicated final cost
Soccer City – Johannesburg	R 2.2 billion	R 3.7 billion
Ellis Park – Johannesburg	R 240 million	R 253 million

Moses Mabhida – Durban	R 1.6 billion	R 3.1 billion
Mbombela – Nelspruit	R 600 million	R 1 billion
Green Point – Cape Town	R 2.9 billion	R 4 billion
Nelson Mandela Bay – Port Elizabeth	R 2.1 billion	Not known
Peter Mokaba – Polokwane	R 1.3 billion	Not known
Royal Bafokeng – Rustenburg	R 360 million	R 483 million
Mangaung – Bloemfontein	R 245 million	R 359 million
Loftus Versfeld – Pretoria	R 122 million	R 131 million

Table 2. 3: Budgeted versus indicated final costs of the ten FIFA 2010 stadium

Source: Baloyi and Bekker (2011)

The discussion above sheds light on the recurring issues of financial mismanagement and inefficiency in significant infrastructure projects, particularly in the context of cost overruns and delays. The pattern identified in several studies highlights a systemic problem that continues to plague large-scale construction initiatives globally, including in countries such as South Africa and Nigeria. The examples presented, such as the Gautrain Rapid Rail Link and the Port Harcourt infrastructure project, emphasise the serious financial repercussions of such inefficiencies, which can strain national budgets and erode investor and stakeholder confidence.

Flyvbjerg's (2017) assertion that a significant majority (nine out of ten) of major projects exceed their original budgets, reinforces the scope of the issue. It suggests that cost overruns are not merely isolated events but a pervasive trend in infrastructure projects worldwide. These overruns are not always inevitable, yet they continue to occur, causing financial strain and undermining the effectiveness of infrastructure development.

The South Africa Gautrain project is a stark example of how cost overruns can escalate dramatically, going from US$300 million to US$2 billion by 2011 (Fombad, 2015). Such a drastic increase highlights the complexity and unpredictability of large infrastructure projects, with potential causes ranging from unforeseen technical challenges to poor planning or mismanagement.

The study by Olupitan et al. (2021) provides insight into the root causes of these overruns, particularly in Port Harcourt, Nigeria. Factors such as variation orders, scope creep, cash flow issues, delays in decision-making, and poor communication between parties all contribute to escalating costs. These issues are often

interrelated, creating a snowball effect that exacerbates the problem. Effective project management, transparent communication, and realistic budgeting are key to avoiding these pitfalls.

Similarly, Morena and Amoah (2021) highlight several factors contributing to cost overruns in South Africa, such as changes in scope, poor decision-making, and planning deficiencies. The impact of rising material prices is another contributing factor that adds complexity to the budgeting process. These factors are compounded by a lack of experience among contractors in managing large-scale projects, which can lead to errors and inefficiencies. As the market becomes more volatile, the financial burden on projects increases.

It becomes clear that there is a need for greater accountability, improved planning processes, and enhanced management practices to mitigate cost overruns in infrastructure projects. Governments and stakeholders must prioritise transparency and accountability at every project lifecycle stage, from the initial planning to procurement and construction. Moreover, addressing the underlying causes of inefficiencies, such as lack of experience among contractors, poor decision-making, and fluctuating material costs, could go a long way in ensuring more sustainable and prosperous infrastructure development.

In conclusion, while cost overruns are frequent in major infrastructure projects, they are not an insurmountable challenge. Reducing the incidence and severity of these overruns is possible with a concerted effort to address the root causes through better planning, more assertive communication, and more rigorous project management practices. The broader implications of these findings call for a more strategic approach to infrastructure development, one that emphasises long-term financial sustainability and stakeholder confidence.

2.4 Theoretical and Conceptual Frameworks Underpinning this Study

The theoretical framework used in this study is Resource Dependency Theory (RDT), developed by Jeffrey Pfeffer and Gerald Salancik in 1978 (Hillman, 2009). RDT offers valuable insights into how organisations mitigate external uncertainties and enhance resilience. Inventory management, a crucial element of supply chain management, plays a central role in achieving this objective. This study examines the intersection of RDT and inventory management, emphasising the importance of effective inventory management in reducing resource dependency.

RDT highlights the critical nature of resource dependency, where organisations rely on suppliers for essential materials and components. This dependency creates potential vulnerabilities, as disruptions in the supply chain can significantly impact an organisation's operations and performance (Bode et al., 2019). Power imbalances often emerge in these relationships, with suppliers holding leverage over organisations

that heavily depend on their resources. Conversely, large organisations may exert power over smaller suppliers through their purchasing volume and market influence (Reimann & Ketchen Jr., 2017).

Organisations employ various strategic actions aligned with RDT principles to manage these dependencies and mitigate risks. These may include diversifying supplier bases to reduce reliance on a single source, forming strategic alliances or joint ventures to secure critical resources, or vertically integrating to gain direct control over key components of the supply chain. Organisations might implement just-in-time systems in inventory management to reduce dependency on large inventory stocks or maintain safety stocks to buffer against supply uncertainties. Additionally, organisations may invest in developing alternative resources or substitutes to decrease their reliance on specific suppliers, thereby altering the power dynamics in their favour (Schnittfeld, 2015).

RDT has been used to explain and predict organisational behaviour related to supplier relationships and inventory strategies. Delke (2015) studied RDT applied to four critical decision points in supply management: make-or-buy decisions, sourcing strategies, supplier strategies, and contracting decisions. The study found that RDT significantly influences supply management decision-making, particularly in reducing uncertainty and dependency in the organisational environment. Mensing (2013) also explored the application of RDT to supply management, focusing on how organisations can maximise independence and certainty in an environment characterised by dependency and uncertainty. The study advised in-sourcing the production of critical items if they can only be sourced under high dependency or uncertainty and favoured selecting suppliers equally powerful or weaker than the buying organisation. RDT has been particularly useful in explaining strategies for managing supplier relationships and inventory levels. RDT principles can be seen in the emphasis on reducing dependency and uncertainty through technology adoption. For example, implementing real-time inventory tracking systems and automated reordering processes can be viewed as strategies to reduce environmental uncertainty and dependency on manual processes, aligning with RDT's predictions.

2.5.1 Stock Diffusion Theory

Braglia et al., (2013) Pioneered the concept of stock diffusion theory in inventory management to derive the probability distribution of stock consumption and reorder time (Delke, 2015). This theory aims to assess and evaluate required inventory levels in theory and practice.

Stock diffusion theory emphasises vital factors in managing inventory efficiently. A primary consideration is the amount of storage space needed, directly affecting how much inventory a company can hold without incurring excessive storage costs. Balancing storage capacity with inventory levels is crucial to avoid overstocking, which could lead to waste or additional expenses. Additionally, the rate at which inventory

is sold or utilised is essential in planning stock levels. Fast-moving inventory requires frequent replenishment, while slower-moving items may need different handling to avoid unnecessarily taking up valuable storage space.

Another critical aspect of stock diffusion theory is implementing strategies to prevent inventory from becoming obsolete before it can be used or sold. Businesses must closely monitor market trends and product life cycles to ensure that stock remains relevant and in demand. Techniques such as just-in-time (JIT) inventory, forecasting, and dynamic restocking plans help in managing stock effectively to minimise the risk of holding outdated inventory, thereby reducing potential losses and enhancing overall operational efficiency. These considerations are crucial in preventing shortages and wasteful spending in inventory management (Delke, 2015).

The theory can be utilised to enhance several critical inventory management areas. Demand forecasting allows organisations to analyse the probability distribution of stock usage, leading to more accurate demand predictions and adjustments to inventory levels. When setting reorder points, the theory provides a framework to identify optimal timing by factoring in stock depletion rates and the necessary lead time for replenishment (Bowersox et al., 2020).

Additionally, the theory supports safety stock optimisation by modelling fluctuations in demand and lead times, enabling the calculation of suitable safety stock levels to buffer against uncertainties (Wild, 2017). The theory also contributes to cost reduction by improving stock movement predictions, as organisations can lower holding costs and reduce the likelihood of inventory becoming outdated (Guluma, 2019).

Chapter Three - Research Methodology

3.1 Introduction

The previous chapter reviewed the literature on inventory management, highlighting its role in contributing to construction project overruns. It also examined the various factors leading to cost overruns in infrastructure projects in South Africa, with a particular focus on material management. To assess the impact of inventory management on construction project cost overruns, data were collected through an open-ended questionnaire administered to respondents involved in daily construction activities at Mabhele and Associates on the Kusile project. The open-ended format allowed participants to elaborate on their responses. The collected data were analysed using thematic analysis, facilitated by the NVivo qualitative data analysis (QDA) software.

An interview schedule was developed and used to maintain consistency across all interviews. This schedule contained 14 pre-formulated questions, which were pilot-tested before the main study. Before conducting the main study, the interview questions were piloted with individuals that were not part of the data cohort, but who shared similar characteristics with the respondent panel. This pilot testing assessed the questions' clarity, relevance, and appropriateness. Feedback from the pilot participants was used to refine the interview guide, ensuring it effectively addressed the research objectives and was easily understood by the intended respondents.

All nine participants were engaged using semi-structured, open-ended questions, which supported systematic analysis and comparison of their responses while allowing for flexibility in the discussion. The semi-structured approach enabled the interviewer to explore participants' unique insights and perspectives in greater depth, as the questions were not rigidly predetermined. This flexibility encouraged participants to share their views freely, fostering a deeper understanding of their experiences and contributing to the study's overall validity. The interview guide is included in Appendix C.

3.2 Research Design

3.2.1 Quantitative and Qualitative Research Approach

Research methods encompass researchers' strategies, techniques, and procedures to collect, analyse, and interpret data to address research questions or test hypotheses (Hassan, 2023). The selection of these methods is influenced by the specific nature of the research questions, the type of data being gathered, and the overall research design. Generally, research methods can be categorised into two primary types: qualitative and quantitative. For this study, the researcher adopted a qualitative approach.

This has the crucial advantage of using qualitative data collection methods: participants are often interviewed and observed in their natural settings. They may thus be able to respond to the questions more accurately. The study is focused on the qualitative approach with the elements shown below. The significant advantage of this approach is that you could collect data with descriptions and examples, and the participants' language and concerns would be at the forefront.

3.2.2 Case firm and its location

The selected case firm for this study is Mabhele and Associates, a construction company based in Witbank. The company specialises in construction activities such as supplying equipment and consumables, provision of labour, and control and instrumentation solutions. Operating at the Kusile Power Station for over five years, Mabhele and Associates are recognised for their expertise in installation services within the construction sector. This setting provides valuable insights into material management, making it an ideal case for exploring inventory management practices.

3.2.3 Selection of case firm

The target population consists of all individuals meeting the specified research project requirements (Willie, 2022). Chaudhury (2010) defines a population as the entire group about which information is sought. At Mabhele and Associates, the population comprises approximately 20 employees, including professionals from Project Management, Supply Chain Management, Quantity Surveying, Construction, and Health and Safety teams.

3.2.4 Characteristics shared by the case firm subjects

The subjects were prequalified as appropriate for the study, ensuring that all participants met the necessary criteria to provide relevant and meaningful insights. This prequalification process helped maintain the study's focus and reliability by selecting individuals whose experiences or perspectives aligned with the research objectives.

3.3 Inclusion and Exclusion Criteria for Participants

3.3.1 Inclusion Criteria:

- Participants must have engineering, supply chain management, project management, or logistics qualifications.
- Those without formal educational qualifications should have relevant construction experience or knowledge, including roles such as construction workers, contractors, engineers, site managers, and project managers.

- Participants must be based on the Witbank project.
- Participants must be willing to engage fully in the study, including attending interviews and completing questionnaires.

3.3.2 Exclusion Criteria:

- Individuals without prior expertise or training in construction-related duties may be excluded.
- Participants unable or unwilling to meet the study's requirements, such as attending scheduled sessions or completing assigned tasks, may be excluded to enhance the reliability and thoroughness of data collection.

3.3 Data collection instrument

The primary research instrument for this qualitative study on inventory management in construction projects was a semi-structured interview guide. This instrument was devised as flexible to capture in-depth participant insights, aligning with the research's interpretive philosophy and inductive approach (Bell, 2022). The semi-structured interview guide consists of open-ended questions designed to explore participants' experiences, perceptions, and challenges related to inventory management in construction projects. The guide is structured around key themes identified from the literature review (Patton, 2015), including:

- Challenges of poor inventory management in projects
- Benefits of Effective Inventory Management
- Impact of inventory management on project timelines and costs
- Stakeholders involved in inventory management

While the guide provides a framework for the interviews, its semi-structured nature allows for flexibility in the order and wording of questions. This approach enables the researcher to probe deeper into areas of particular interest or relevance that emerge during the conversation (Saunders et al., 2019).

3.4 Pilot testing

The pilot test was conducted with three participants from the primary sample. The purpose of the pilot test was to ask participants to evaluate the effectiveness of the interview guide in gathering data about the role of inventory management in contributing to cost overruns in construction projects. Their feedback was crucial for identifying areas for improvement and ensuring the questions were clear and logically structured. This process helped refine the interview guide before collecting all the data.

Two candidates responded to the pilot study and did not identify any room for improvement. One candidate suggested that future questionnaire studies should consider including inventory managed by customers,

which is free-issue material. The question was generally well understood; however, one respondent raised a concern regarding the wording. They suggested that framing the question around qualifications could potentially intimidate construction team members who lack formal credentials. The question was proposed to be revised to focus on relevant trade experience or formal qualifications to address this issue. This approach would ensure inclusivity and better reflect the diverse skill sets present within the team without inadvertently alienating those without formal education.

3.5 Validity and Reliability

Kimberlin and Winterstein (2008) refer to validity as the degree to which an instrument accurately measures what it claims to measure. Validity necessitates the presence of reliability in an instrument, yet an instrument might possess reliability without validity. Reliability, in the context of a qualitative investigation, refers to the accuracy and preciseness of the instrument used. The reliability of a research instrument refers to its ability to consistently produce the same findings when utilised in the same circumstance several times (Twycross & Shields, 2004). For the researcher to achieve the trustworthiness of qualitative data, the researcher will use the triangulation method to increase the validity and reliability of the study. Triangulation is a research method used to improve the credibility and validity of a study by combining multiple perspectives, data sources, or methodologies.

3.4 Method of data analysis

This study employs thematic content analysis, a robust qualitative research method that combines the systematic approach of content analysis with the interpretive depth of thematic analysis, to explore inventory challenges resulting in project cost overrun. A theme is a broad category integrating multiple interrelated codes, representing a concept or idea connected to the study's research question (Saunders et al., 2019). This procedure entails giving classifications, or "codes," to specific parts of data, which aids in classification and subsequent analysis.

The advantage is that the researchers can find underlying themes and patterns in qualitative data by applying and modifying codes systematically, yielding more significant insights into the study topic. The transcripts were generated from audio recordings of the eight participants and cleaned to remove any personal identification, such as their names. Each participant received an identification, with "P1" being the first participant. Following the completion of these stages, the coding process commenced.

3.6 Field study data collection procedures

Data was collected through primary and secondary sources. The primary data was collected through interviews with nine participants via Microsoft Teams. Appointments for these interviews were scheduled in advance, with participants primarily contacted through WhatsApp messages instead of email, as this

method proved more effective in reaching them. Each participant was notified about the specific date and time of their interview.

Before the interviews, participants were informed about a consent letter, which outlined the purpose of the study, the confidentiality of the responses, and their voluntary participation. This letter ensured that each participant understood that they agreed to be interviewed and that their responses would be confidential.

The consent letter aimed to provide transparency and secure their trust regarding the privacy of the information they would share. To accurately capture their responses, participants were informed that the interviews would be recorded solely to preserve the information. They were also assured that the researcher would be available to offer further clarification or assistance if they encountered any questions they found difficult to answer. This approach was designed to create a supportive environment and ensure that participants felt comfortable throughout the interview.

This review process served to identify potential factors contributing to cost overruns, their consequent effects, and strategies for cost control and management in construction projects. The insights gleaned from the literature review informed the design of the questionnaire, ensuring its relevance and comprehensiveness in addressing the research objectives. This methodological approach allowed for a thorough examination of cost overrun issues within the construction sector, combining theoretical foundations with practical insights from industry professionals. The questionnaires were emailed to potential respondents and contained open and closed-ended questions.

Data saturation is determined when data collection stops; it refers to the point in data collection where no new themes, insights, or patterns emerge from the data, indicating that enough information has been gathered to fully understand the research topic and further data collection would be redundant; where a point has been reached and no significantly new information becomes available indicating comprehensive coverage of the subject matter. The researcher can confidently draw conclusions from the existing data set. As Naeem et al. (2024) noted, saturation is a widely recognised concept in qualitative research that marks the point when no new information or themes arise from the data.

Secondary data refers to previously collected information that was initially gathered for a different purpose but is later analysed to address new research questions or objectives, and it includes both raw datasets and published summaries (Saunders et al., 2019). This data is taken from existing sources such as online journals, public databases, and textbooks. These sources offer peer-reviewed, reliable data, which sometimes require subscriptions or institutional access because they ensure high-quality, peer-reviewed data rigorously evaluated by experts to maintain accuracy, reliability, and credibility in research.

Literature data relevant to the research questions was reviewed, collected, and explained in chapter 3. This data was used to explain or support the result analysis in chapter 4.

3.7 Ethical Considerations

The research was conducted according to a protocol approved by the UKZN HSSREC. The corresponding approval letter is included in Annexure A.

The researcher ensured that all participants were provided with a consent form to allow them to make an informed choice about their involvement in the study. Participation was entirely voluntary, with no coercion, and participants were made aware of their right to withdraw from the interview at any point if they chose. Throughout the study, all information shared by participants was treated as confidential, and no conflicts of interest were identified, maintaining transparency and trust in the research process.

Moreover, the researcher prioritised ethical considerations by fully informing participants of the study's objectives, purpose, and any potential risks associated with their involvement. Respect for participant autonomy and dignity was maintained at all stages of the study, with assurances that involvement would not result in physical, psychological, or emotional harm. Sensitive topics during the interviews were addressed with care, ensuring that participants felt comfortable and supported throughout the process. Additionally, contact information for support services was provided to participants should they wish to seek assistance following the interviews.

To safeguard participant confidentiality further, data collected during the study was stored securely, with access limited exclusively to the supervisors and the researcher. This step was essential in upholding privacy and protecting participant information, thus reinforcing the ethical integrity of the research. The researcher's adherence to these moral principles highlights a commitment to conducting a study that is respectful, transparent, and sensitive to the well-being and rights of all participants involved.

3.8 Conclusion

While the study’s methodological approach may present certain limitations, these shortcomings do not compromise the validity of the outcomes within the case firm. For example, the reliance on a participant panel of nine could be considered a constraint; however, this limitation is mitigated by the depth of the qualitative data collected through semi-structured, open-ended interviews. This approach allowed for nuanced insights and facilitated a thorough understanding of participants' perspectives. Similarly, although the findings are context-specific to the case firm and may not be easily generalised, this focus on the unique organisational environment enhances the relevance.

The systematic design of the study, including the consistency in interview questions and rigorous analysis of responses, further ensures that patterns and themes were identified accurately. Any contextual limitations were addressed through reflexivity and careful interpretation, ensuring that the data accurately represents participants' views while aligning with the study's objectives. Thus, despite these perceived shortcomings, the methodological approach supports the credibility and validity of the findings, which provide meaningful and actionable insights for the case firm, and actionable insights for the respondents who will continue to offer their services in their professional capacities in similar contexts.

Chapter Four: Presentation of Results

4.1 Introduction

This chapter presents the analysed data from semi-structured interviews aimed at investigating the effect of inventory management on construction project cost overruns. Thematic analysis was used to understand the data, and through arranging codes and themes that corresponded to the study objectives. This organised method gives a clear foundation for studying how inventory management strategies affect cost results in building projects, from a practitioner perspective.

4.2 Background of Participants

Eight individuals were invited to participate in the study, and each was assigned a unique participant code to ensure anonymity and facilitate data organisation. Table 4.1 provides a comprehensive overview of the participants' backgrounds, capturing key demographic and professional details relevant to the study. This table serves as a foundational reference, offering insights into the diversity and characteristics of the individuals interviewed, enriching the research findings' depth and contextual understanding.

4.3 Demographics Analysis

Demographic Variable	Participants
Gender	
Male	50%
Female	50%
Educational level	
Degree	25%
Diploma	50%
Certificate	25%

Table 4. 1:Demographics of the participants (%)

Table 4.1 illustrates the participants' demographic details, highlighting their gender and qualifications. The candidates were equally represented, with both males and females comprising 50% of the sample.

4.4 Results for Objective 1

A strong theme of key challenges contributed to poor inventory management practices within project contexts. Identified explicitly by seven participants.

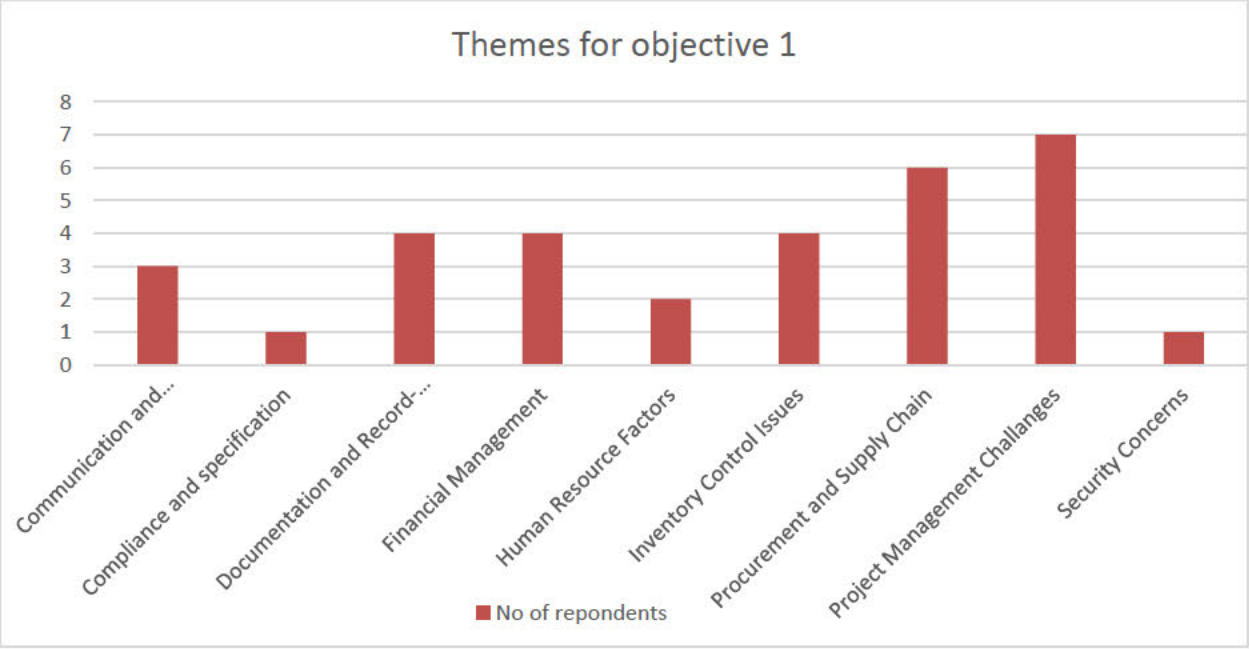

Figure 4. 1: Themes for Objective 1

Figure 4.1 above illustrates the themes that emerged in response to Objective 1, which aimed to identify the key challenges contributing to poor inventory management practices within project contexts. Nine distinct themes were identified, each reflecting critical factors that influence the effectiveness of inventory management in construction projects.

Theme 1: Compliance and specification

The theme of communication and transparency emerged from Research Objective 1, highlighting the challenges in construction projects that contribute to cost overruns. This theme was represented by two participants, P4 and P7. Participant P4 has nine years of experience in construction projects and holds a degree, while Participant P7 has six years of experience and also possesses a degree, as shown in Figure 4.2 below. Their combined experience and qualifications emphasise the critical importance of effective communication and transparency in a project. This communication is not only crucial among internal stakeholders but also extends to suppliers, enabling better monitoring of delivery schedules and helping to prevent delays.

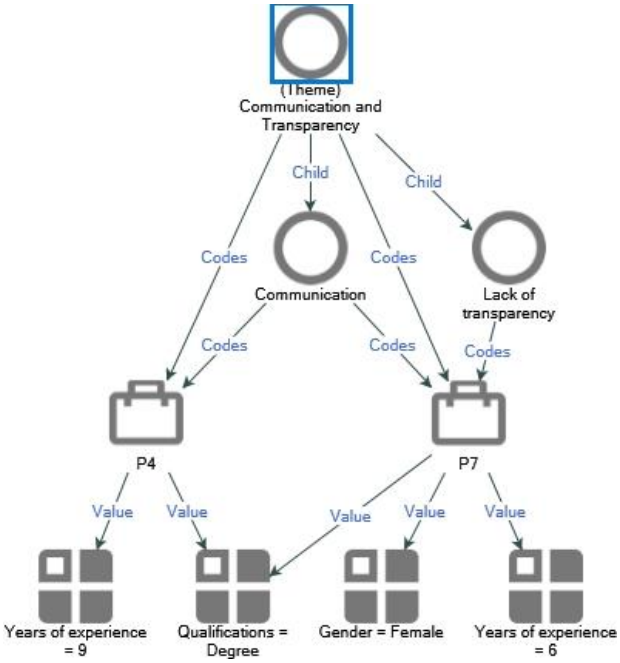

Figure 4. 2: Project Map on theme Communication and Transparency

Theme 2: Compliance and specification

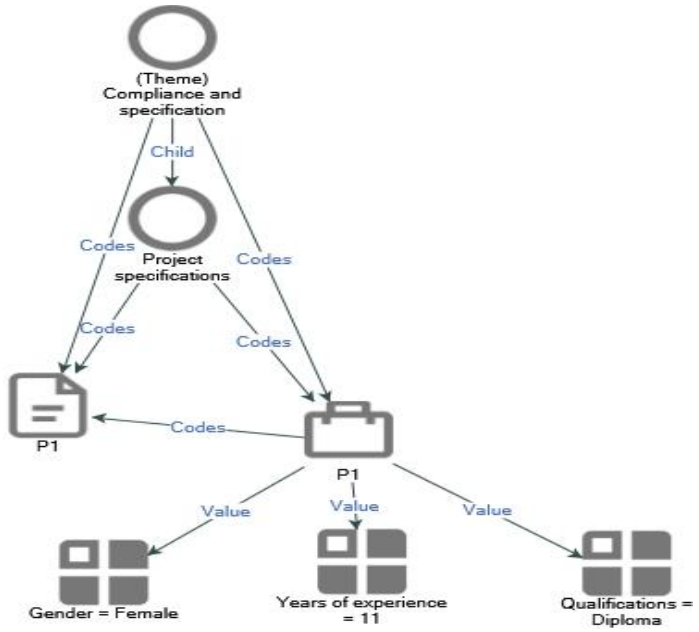

Figure 4. 3:Project map on Compliance and specification

This theme was rated by only one participant, a female with 11 years of experience and a diploma. The theme of compliance and specification refers to adhering to project requirements. According to this participant, as well as feedback from other project team members, there is often a lack of understanding of

these requirements. To improve the process, it is crucial to ensure that the project requirements, including milestones, are effectively communicated, particularly to the procurement and supply chain management (SCM) teams. This helps streamline operations and ensures everyone is aligned with the projects and the requirements.

Theme 3: Documentation and Record Keeping

According to the participants, effective document and record-keeping is essential for maintaining accurate inventory records, especially since inventory management involves extensive documentation. This includes recording information such as the receipt and issuance of materials, tracking the balance of materials on-site, determining material quantities, and noting any damaged items. To ensure accuracy and reliability, this process needs to be fully systematic or, at the very least, well-organised.

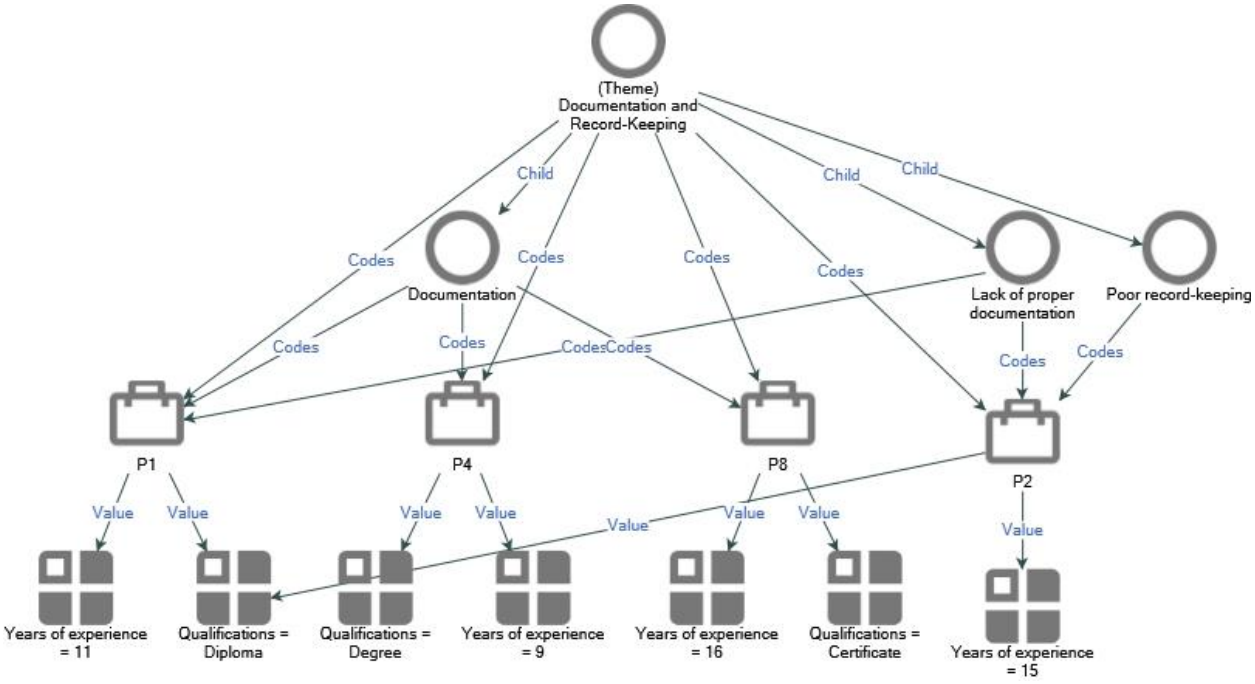

Figure 4. 4: Project map on Documentation and Record Keeping

Participants P4, P1, and P8 highlighted the sub-theme of documentation, each emphasising the importance of detailed and accurate documentation in managing projects effectively. As shown in Figure 8 above, P4, with nine years of experience and a degree, offers insights from theoretical knowledge and practical experience. P1, with a diploma and 11 years of experience, and P8, with a certificate and 16 years of experience, both stressed the role of thorough documentation in ensuring project consistency and clarity. However, the challenge of lack of proper documentation was noted by P1 and P2, who identified gaps in

maintaining comprehensive records, which can lead to confusion and inefficiency. Additionally, P2 highlighted the issue of poor record keeping, which can hinder project tracking and post-project evaluation. With a diploma and 11 years of experience, P2's observations reflect the critical need for improving documentation practices to avoid setbacks. Together, these perspectives underline the importance of robust documentation and record-keeping processes in achieving project success.

Theme 4: Financial Management

Four participants highlighted that cost underestimation emerged as a significant project management challenge. This issue arises when project costs are inaccurately assessed, leading to budget shortfalls that can hinder the purchase of materials or the maintenance of inventory. Projects often struggle to secure the necessary funds and rely heavily on customer payments. This dependency creates financial instability, disrupting project timelines and overall success.

Participants P2 and P3, who hold diplomas, and P5 and P8 who have certificates, emphasised the impact of cost underestimation on project outcomes. Despite their varying educational backgrounds, all four participants shared similar concerns about the difficulty of accurately forecasting project expenses. P5 and P8, with their hands-on experience in project execution, noted that underestimating costs leads to delays and compromises in quality due to insufficient resources. P2 and P3, with their formal training, highlighted the importance of precise budget planning and the potential consequences of financial mismanagement. These insights highlight the critical need for accurate cost estimation and proactive financial planning to ensure project success.

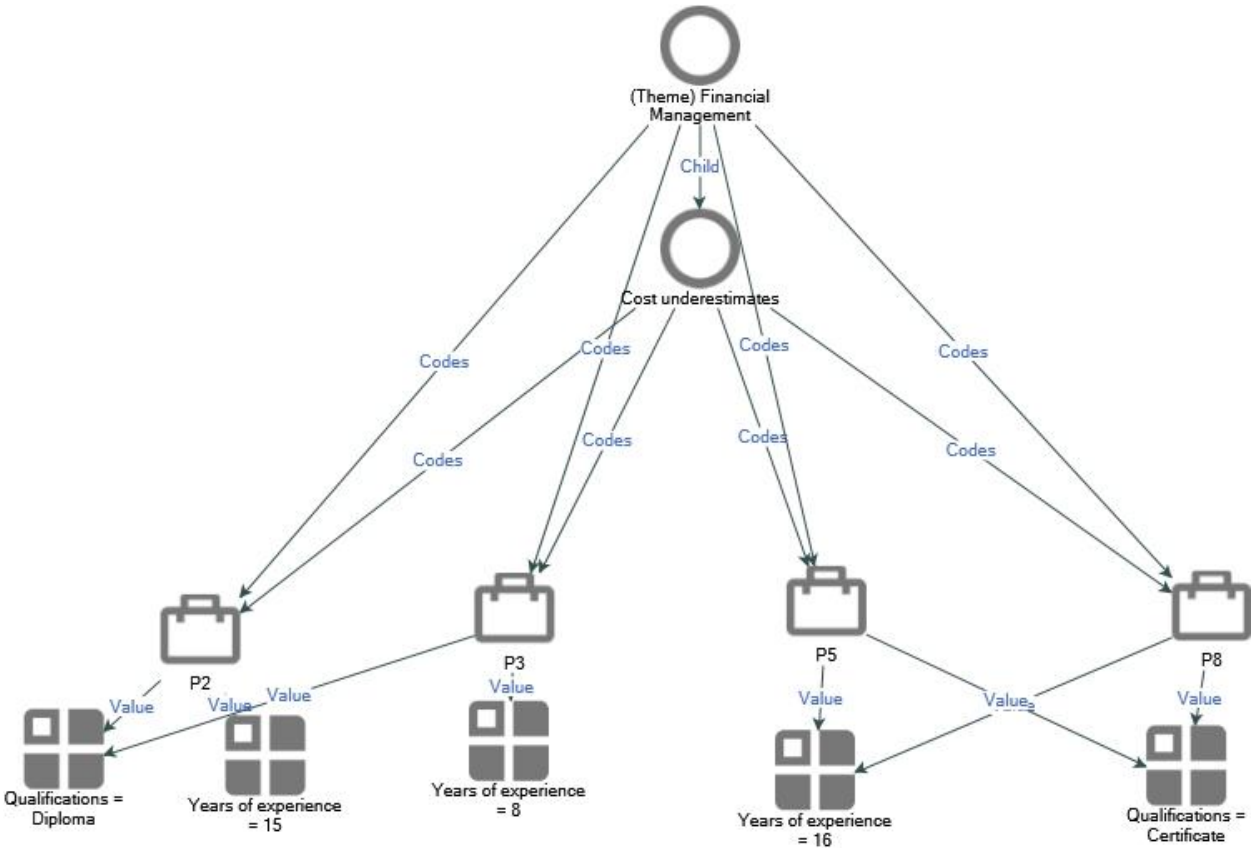

Figure 4. 5:Project map for Financial Management

Theme 5: Human Resource Factors

The theme of Human Resource Factors encompasses several critical sub-themes related to workforce dynamics in project management, as depicted in the diagram. These sub-themes include Lack of Commitment, Negligence, and Staff Training, each impacting project performance in distinct ways.

Lack of Commitment and Negligence were primarily associated with participant P2, who has 15 years of experience and holds a diploma. P2's insights suggest that lacking employee dedication and oversight can significantly hinder project success, leading to missed deadlines and reduced quality. This highlights the importance of cultivating a motivated and attentive workforce. On the other hand, Staff Training was linked to participant P4, who has nine years of experience and a degree. P4 emphasised the necessity of ongoing training to equip staff with the skills to meet project demands efficiently. The contrast between P2's and P4's experiences reflects the multifaceted nature of human resource challenges in project management, underscoring the need for engagement and continuous development to achieve optimal project outcomes.

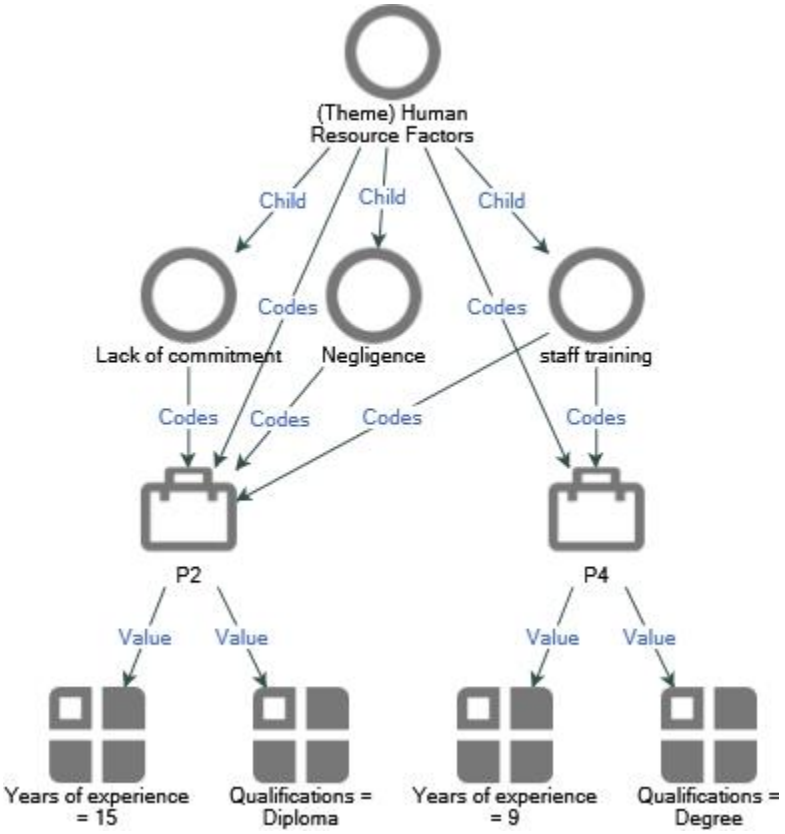

Figure 4. 6:Project map on Human Resource Factors

Theme 6: Inventory Control Issues

The central theme of Inventory Control Issues encompasses four critical subthemes: inefficiencies, lack of processes, material availability, and poor storage. These subthemes represent fundamental challenges in inventory management, as identified by experienced participants, with P5 having the most extensive experience in the field. Inefficiencies and lack of processes lead to disorganised inventory tracking and management, while material availability issues can cause project delays and disruptions. Poor storage further exacerbates these problems by increasing the risk of material damage and loss.

These subthemes are particularly significant because they form the core of effective inventory management in construction projects. Addressing these issues is crucial for optimising project execution, reducing costs, and ensuring timely completion. The insights provided by experienced participants highlight the importance of implementing robust inventory control systems, standardised processes, efficient procurement strategies, and adequate storage solutions to mitigate these challenges and improve overall project performance.

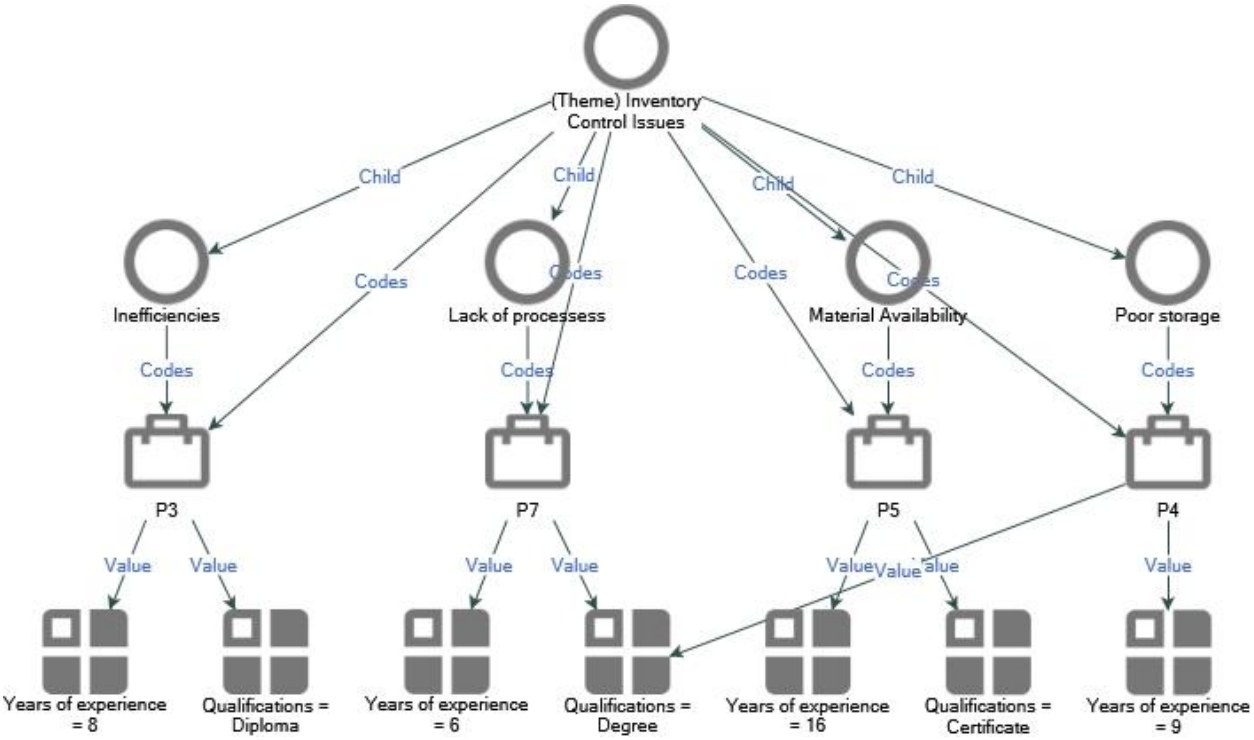

Figure 4. 7:Project map on Inventory Control Issues

Theme 7: Procurement and Supply Chain

As shown in Figure 4.8 below, 6 out of 8 responses revealed Procurement and Supply Chain as challenges during project execution; for instance, P5 mentioned that “Delays in procurement can severely impact project timelines.” Four subthemes emerged from the central theme, with "inefficient processes" being a significant contributor highlighted by all six participants. This widespread acknowledgment highlights that process-related issues are among the most critical challenges in project execution. Participants emphasised the approval and procurement processes, indicating these areas as major pain points.

Interestingly, there are notable similarities among the participants. For instance, P5 and P8 share the same qualifications and work in operations teams. Similarly, P4 and P7 have identical qualifications. These parallels in background and experience lend credibility to the consistency of their observations regarding inefficient processes, especially in approval and procurement. The shared perspectives across different roles and qualifications reinforce the pervasiveness of process-related challenges in project management and inventory control.

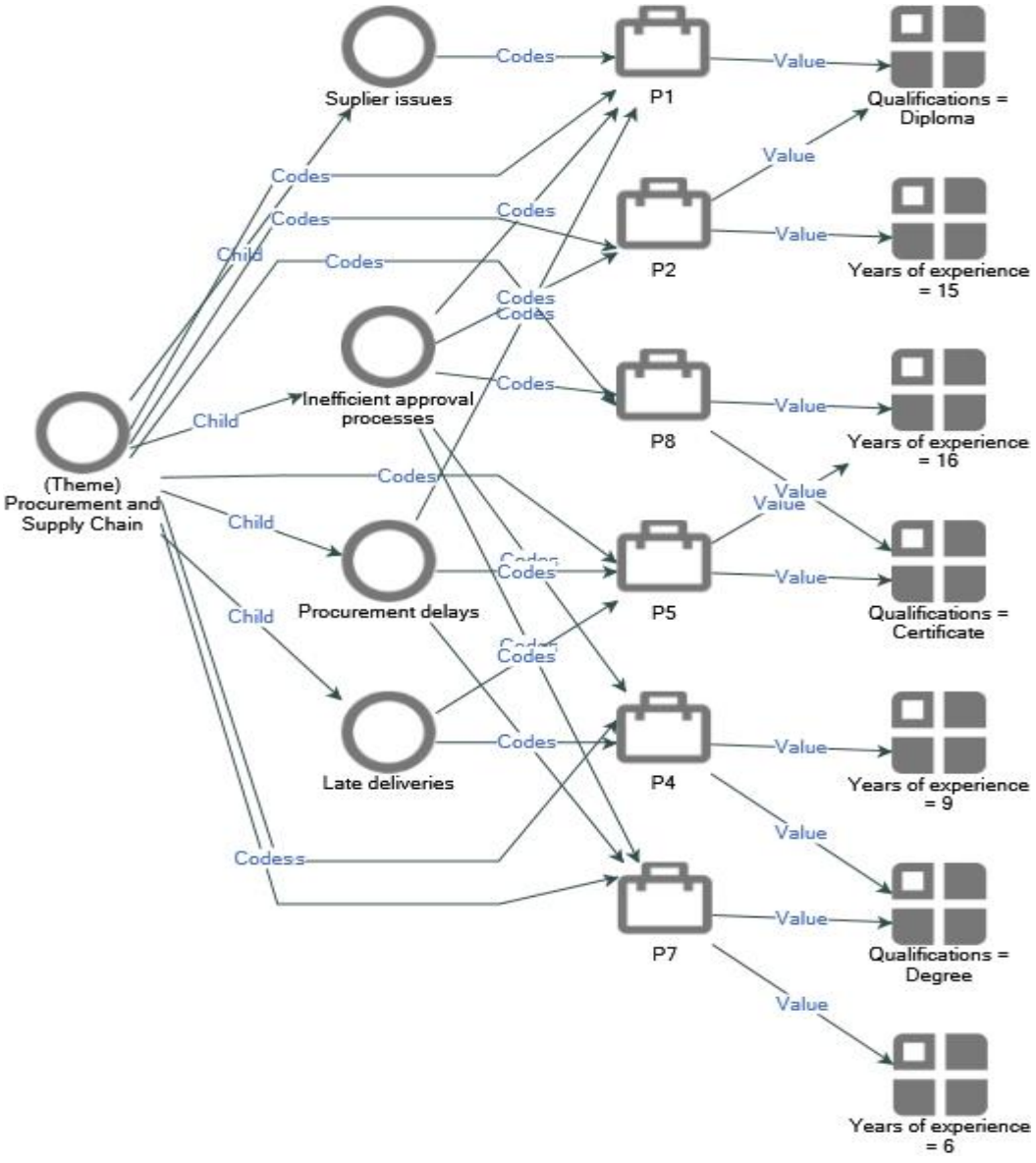

Figure 4. 8:Project map on Procurement and Supply Chain

Theme 8: Project Management challenges

Five subthemes have emerged from the project management theme: poor planning, scope creep, lack of expertise, inefficient site management, and retaining competent teams. Nearly all participants consistently mentioned these subthemes, highlighting their significance in project management challenges.

Poor planning stood out as the most prominent issue within this theme. The diversity of qualifications among participants, including degrees, diplomas, and certificates at various levels, suggests that these challenges are recognised across different educational backgrounds and roles in the construction industry.

This widespread acknowledgment of project management issues and inferior planning highlights the need for improved practices and strategies to enhance project execution and outcomes in the construction sector.

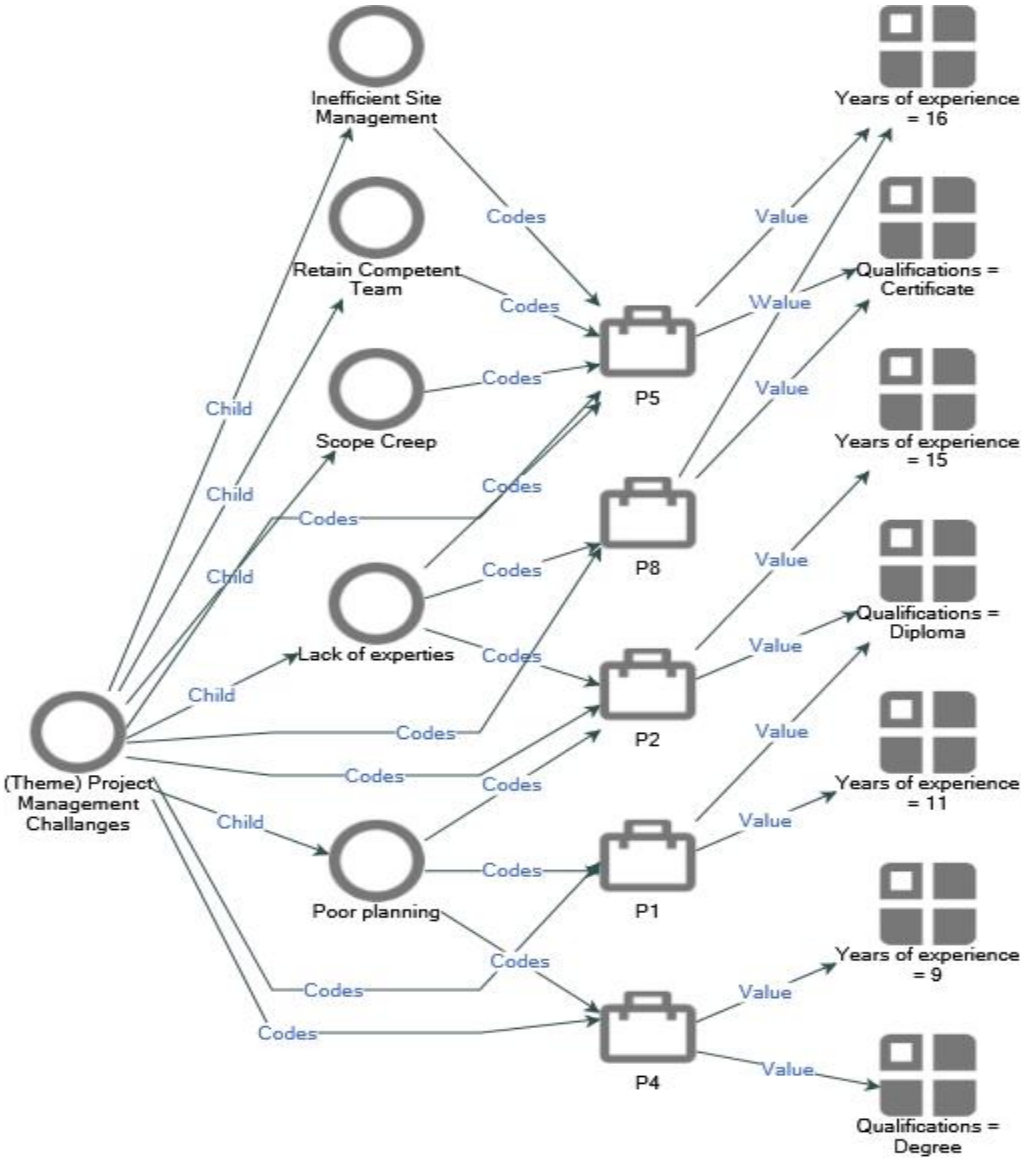

Figure 4. 9: Project map on Project Management challenges

Theme 9: Security Concern

One participant highlighted crime as a significant challenge in inventory management within construction projects. This observation is particularly noteworthy due to the potentially severe consequences of theft on project timelines. The insidious nature of some thefts means they often go undetected until materials are needed, leading to unexpected shortages. This issue is especially problematic for high-value items with extended lead times, as their absence can cause substantial delays. The impact of crime on inventory

management highlights the need for robust security measures and frequent audits to safeguard materials and maintain project schedules

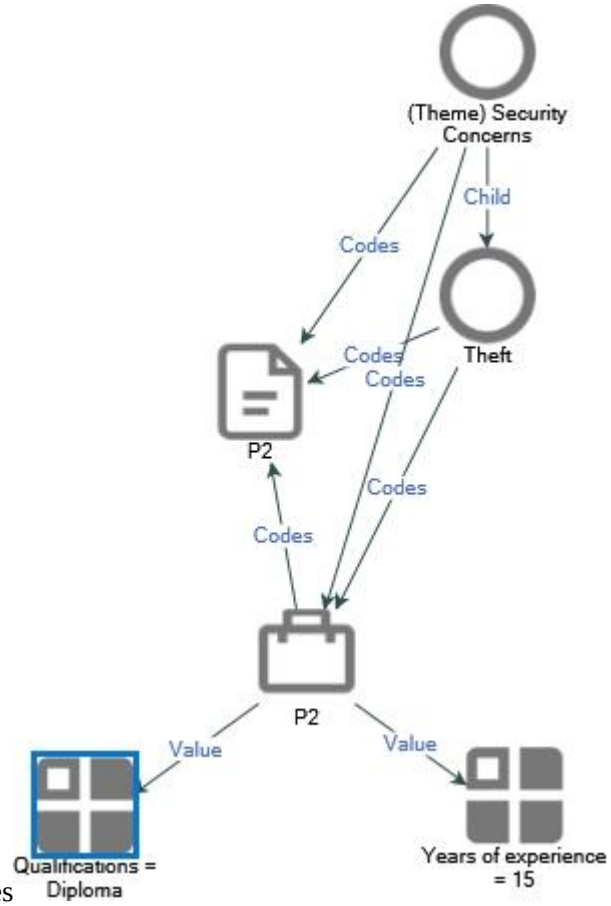

Figure 4. 10:Project map on Security Concern

4.5 Results for Objective 2

Objective: To evaluate the advantages and impact of implementing effective inventory management practices in large-scale projects like Kusile.

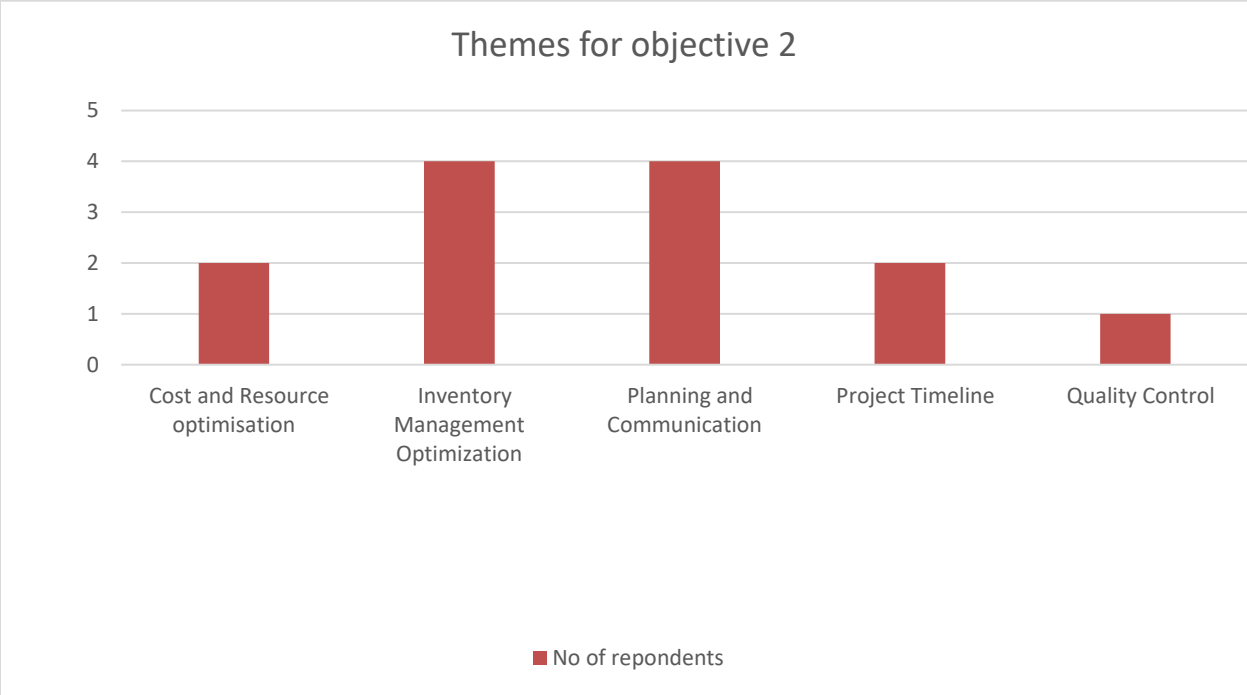

Figure 4. 11:Themes for Objective 2

Figure 4.11 illustrates the key stakeholders that should be involved in inventory management throughout the project lifecycle, from procurement to material installation. These stakeholders play crucial roles in ensuring effective inventory management. The Project Engineer oversees inventory management and coordinates with procurement teams. The Project Manager makes strategic decisions on inventory control and resource allocation. The Procurement Team handles sourcing, ordering, and timely delivery of materials. Warehouse staff manages on-site storage and materials organisation. The HR Department ensures adequate staffing for inventory management processes, while the Engineering Team is involved in material planning and forecasting. Notably, some participants noted that the specific stakeholders involved might vary depending on the nature of the project. This flexibility suggests that inventory management roles can be adaptive, with additional stakeholders potentially emerging during project execution to address unique requirements or challenges. This approach allows for a more dynamic and responsive inventory management system tailored to each project's needs.

Theme 1: Cost and resource optimisation

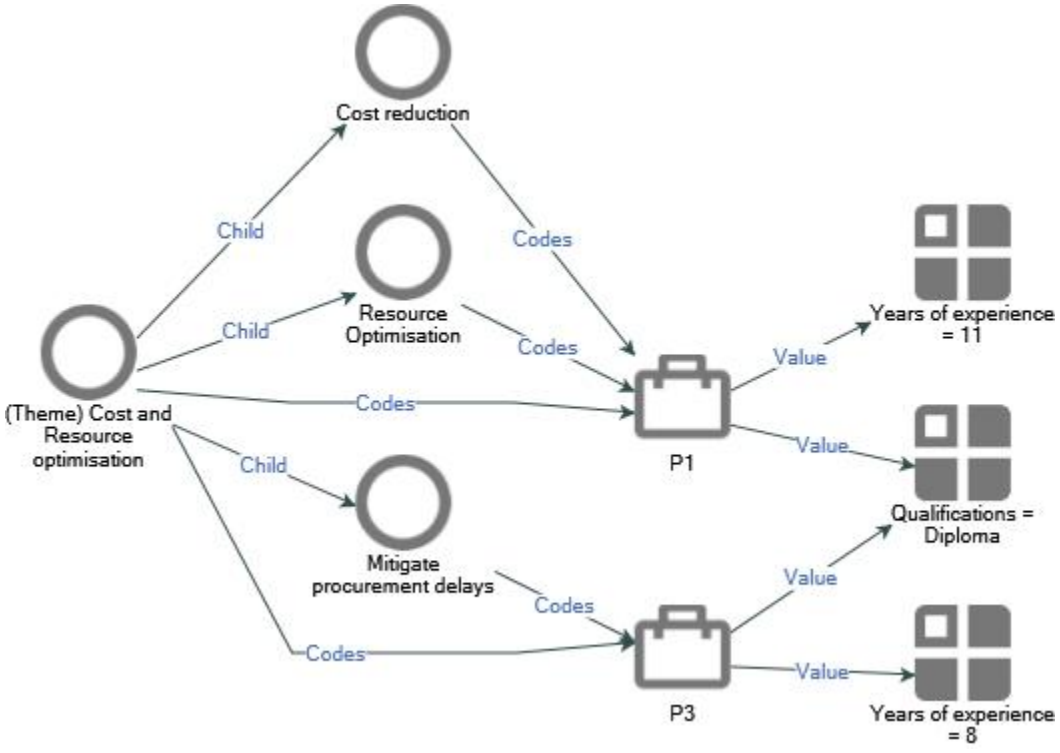

Figure 4. 12:Project Map on Cost and Resource Optimisation

Two significant sub-themes emerged from participants P1 and P3, highlighting critical aspects of project management. P1, with 11 years of experience and a Diploma, emphasised **cost reduction and resource optimisation** as a key area of focus. This sub-theme reflects the importance of efficiently managing resources and minimising expenses to ensure project viability and profitability. P1's insights highlight the necessity of strategic resource allocation and cost control to enhance overall project performance.

Similarly, P3, who has eight years of experience and a Diploma, identified mitigating procurement delays as a vital sub-theme. This highlights the challenges associated with timely procurement processes and the impact delays can have on project timelines and budgets. Both sub-themes share a common connection in their focus on improving project efficiency and minimising disruptions. While P1's emphasis is on reducing costs and optimising resources, P3's focus on procurement delays aligns with the broader objective of streamlining project operations to prevent financial overruns and resource wastage. These findings illustrate the interconnected nature of effective resource management and timely procurement in achieving successful project outcomes.

Theme 2: Inventory Management Optimisation

participants P2 and P4 reveal key insights into effective inventory management practices within project environments. P4, with nine years of experience and holding a degree, highlighted the importance of adequate storage as a critical sub-theme. This perspective emphasises the need for systematic organisation and storage practices to ensure that materials are easily accessible and well-maintained, ultimately contributing to project activities' efficiency and smooth operation.

Participant P2, who has 15 years of experience and a diploma, identified the sub-themes of aligning material orders with project timelines, avoiding unnecessary stockpiling, and balancing inventory. These insights focus on the strategic aspect of inventory management, stressing the importance of timing and quantity control to prevent overstocking and understocking, which can impact project flow and costs. The connection between P2 and P4's findings lies in their shared emphasis on optimising inventory processes to enhance project efficiency. While P4's focus on adequate storage complements P2's strategies for aligning orders and managing stock levels, both perspectives highlight the importance of precision and planning in inventory management to support project success.

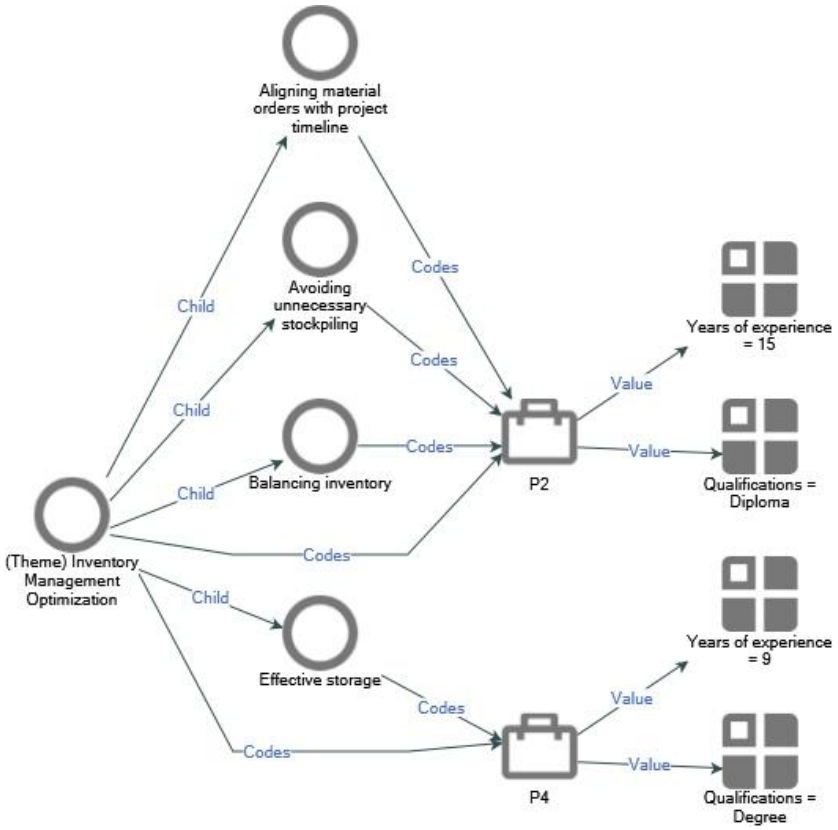

Figure 4. 13: Project Map on aligning material orders with the project timeline

Theme 3: Planning and Communication

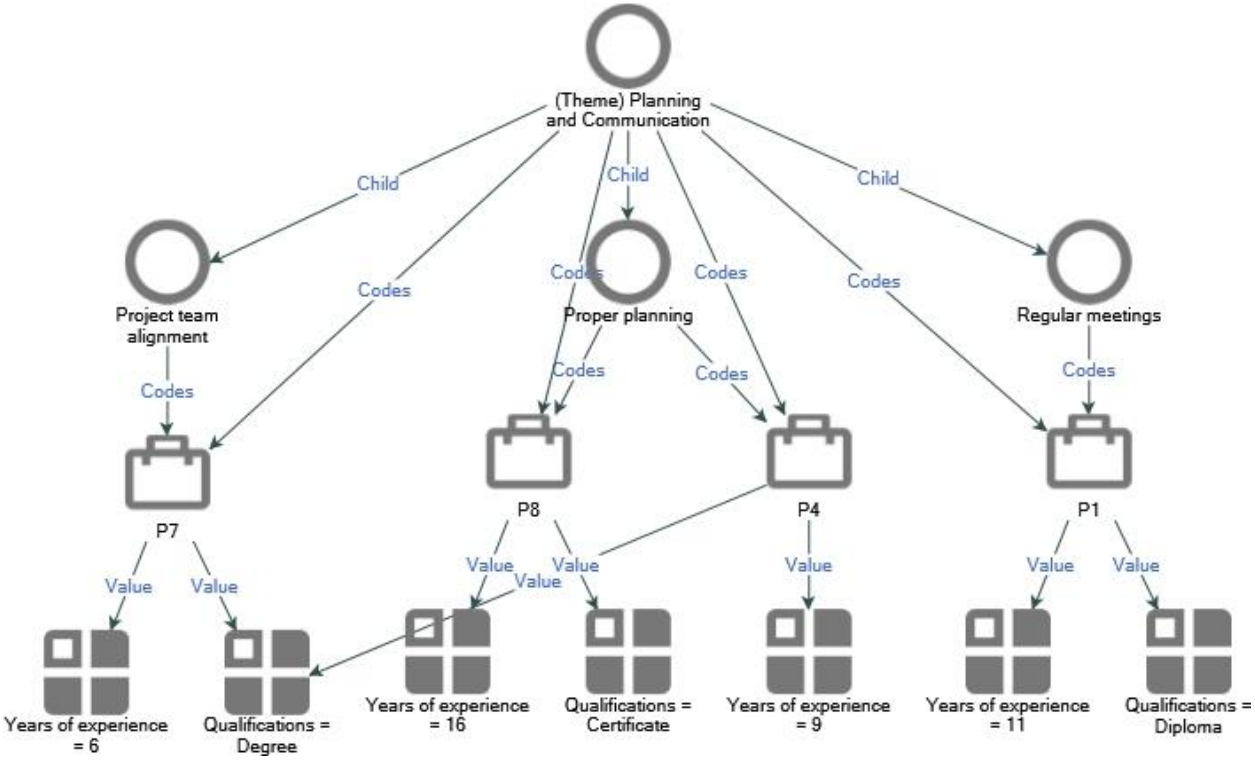

Figure 4. 14:Project Map on Planning and Communication

Theme 4: Project Timeline

The analysis of the findings from the four participants — P7, P8, P4, and P1 — revealed several important sub-themes related to effective project management. P7, with a degree and six years of experience, highlighted project team alignment as a crucial factor, emphasising the importance of ensuring that all team members are coordinated and working towards common project goals. P8, who holds a certificate and has 16 years of experience, identified proper planning as a key sub-theme, underscoring the necessity of detailed and strategic planning to avoid project delays and resource mismanagement.

Similarly, P4, with a degree and nine years of experience, also emphasised proper planning, aligning with P8's perspective on the critical role of planning in project success. P1, holding a diploma with 11 years of experience, highlighted the importance of regular meetings as a sub-theme, suggesting that consistent communication and review are essential for maintaining project progress and addressing issues proactively. A clear pattern emerges from these findings: proper planning and effective communication through regular meetings are central to successful project management. Additionally, the alignment between the perspectives of P8 and P4 on planning highlights the shared recognition of its importance across varying levels of experience and qualifications.

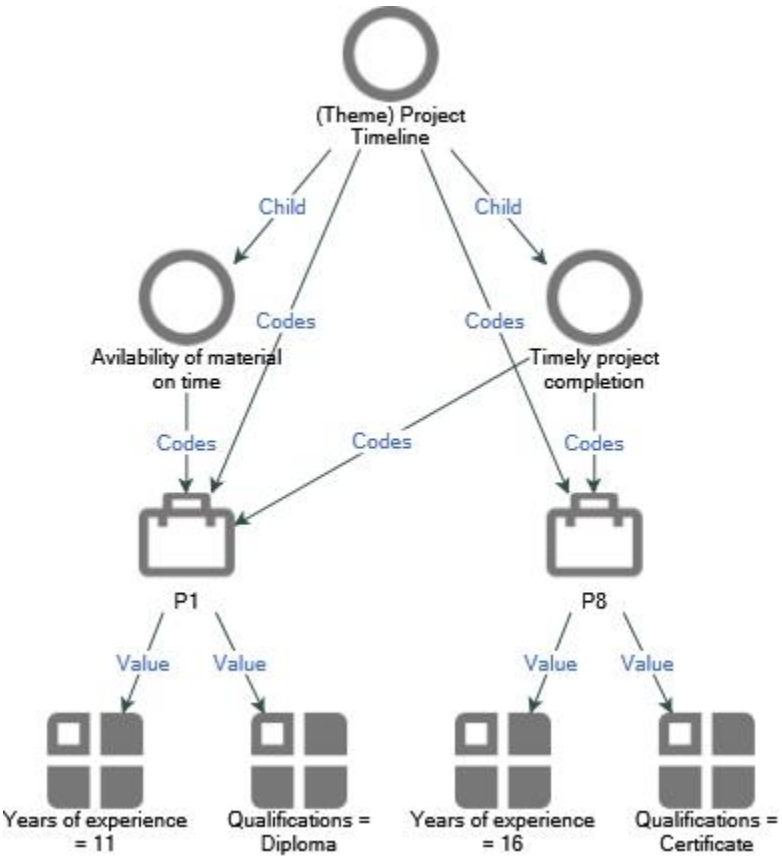

Figure 4. 15:Project Map on the project timeline

Them 5: Quality Control

Surprisingly, only one participant mentioned quality control concerning inventory management, given its critical importance in construction projects. This oversight is particularly unexpected considering the participants' qualifications, including diplomas, typically covering quality management principles. The lack of emphasis on quality control could suggest a potential disconnect between inventory management practices and overall project quality assurance in the minds of these professionals. This gap in perception might indicate a need for better integration of quality control measures within inventory management processes or improved training to highlight the direct link between effective inventory management and project quality outcomes. Future research could explore why quality control is not more prominently associated with inventory management among construction professionals and how to bridge this conceptual gap.

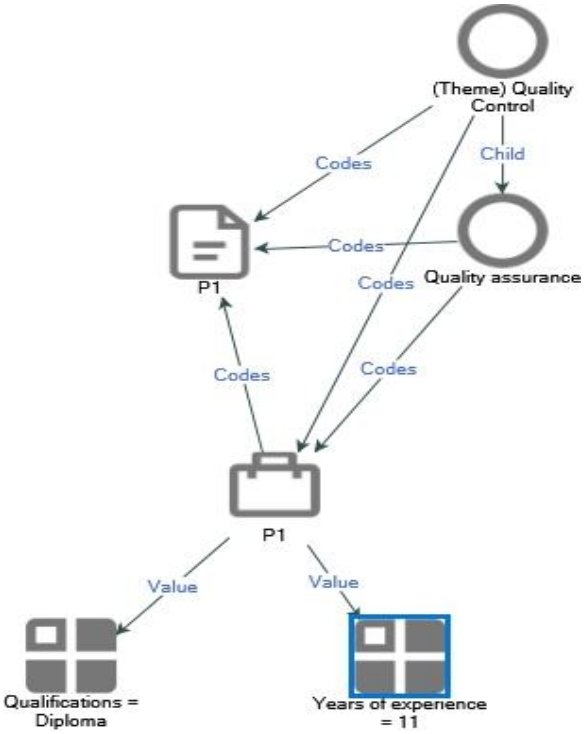

Figure 4. 16:Project Map on quality control

4.6 Results for Objective 3

Objective: Who should be involved in inventory management?

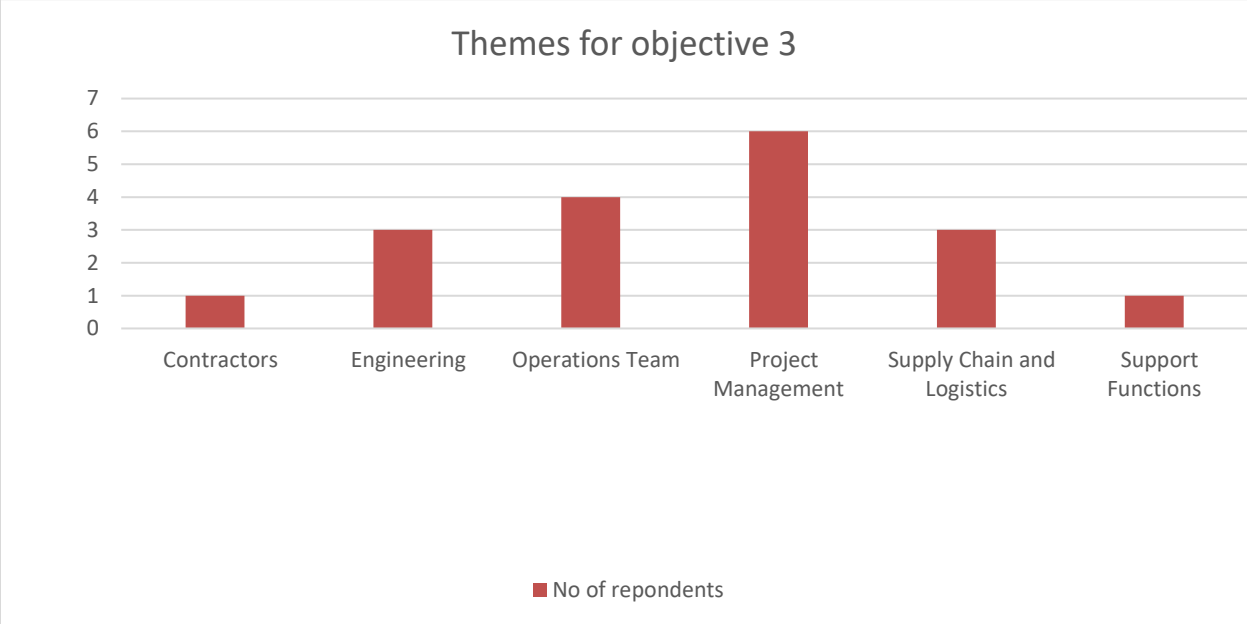

Figure 4. 17:Themes for Objective 3

Figure 4.17 illustrates six subthemes for objective 3, focusing on stakeholders who could enhance collaboration among project teams. These stakeholders include Contractors, Engineers, Operation team, Project Management, Supply Chain Management (SCM), and support functions such as Human Resources (HR) and Health, Safety, and Environment (HSE).

Project Management emerged as the most crucial stakeholder group, with six out of eight participants emphasising its importance. This highlights the central role that project managers play in coordinating efforts, making strategic decisions, and ensuring effective inventory management across various project aspects. The diverse range of stakeholders identified the need for a holistic approach to inventory management, integrating technical expertise, operational knowledge, and support functions to optimise project execution and resource allocation.

Theme 1: Contractors

Participant 8 emphasised the crucial role of contractors in project efficiency. They noted that planning can reach optimal levels by engaging skilled contractors and ensuring suppliers deliver all required materials. This approach minimises time wastage and allows for better management of delays, helping maintain project schedules. The participant suggested that this strategy not only improves project execution but also provides more opportunities for self-development, as it frees up time during the workday. Effective contractor management and supplier coordination were key factors in achieving 100% planning efficiency and keeping projects on track.

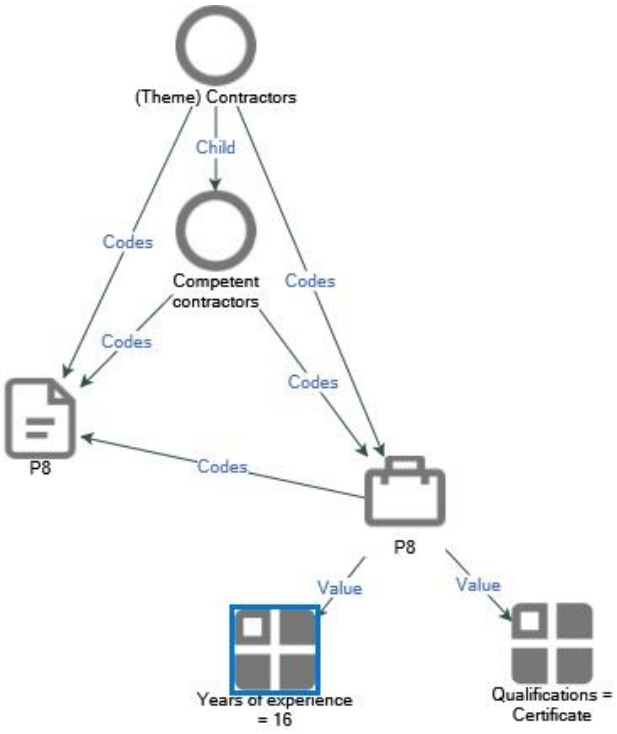

Figure 4. 18: Project Map on Contractors

Theme 2: Engineering

The responses from P7, P8, and P4 reveal a common theme emphasising the importance of engineering involvement in inventory management. Despite their varying experience and qualifications, all three participants identified the engineering team as a crucial component of the project team for effective inventory control. P7, with six years of experience and a degree, highlighted the collaboration between Project Engineers and the procurement team to ensure role clarity and streamline the procurement process. P8, who has 16 years of experience and a certificate, mentioned involving engineers for approvals when addressing issues. P4, with nine years of experience and a degree, directly stated that the engineering team should manage inventory due to their technical expertise and oversight capabilities.

A pattern emerges in the participants' responses, indicating a consensus on the engineering team's vital role in inventory management. This alignment suggests that regardless of experience level or educational background, professionals recognise the importance of technical expertise in managing construction project inventories. The similarities in their perspectives highlight the significance of integrating engineering knowledge into inventory control processes to ensure efficiency, accuracy, and proper oversight throughout the project lifecycle.

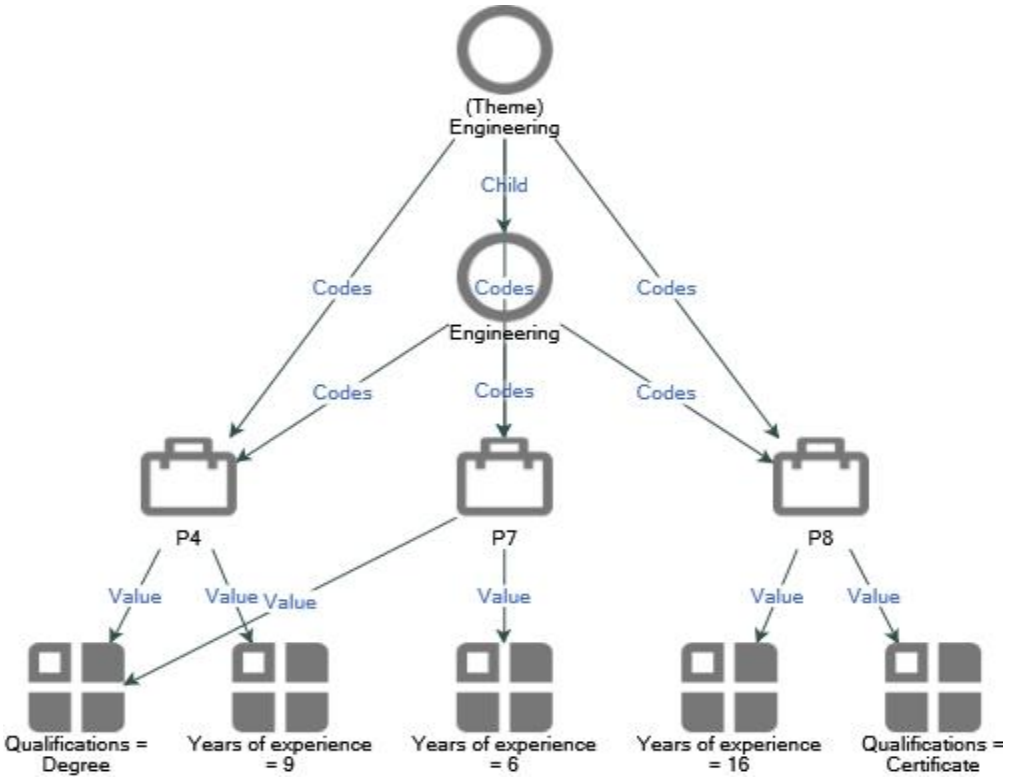

Figure 4. 19 :Project Map on Engineering

Theme 3: Operations Team

The results from four participants (P1, P2, P5, and P8) with varying qualifications and experience levels reveal a consistent subtheme: the critical role of the operations team in inventory management for construction projects. Despite their diverse backgrounds, ranging from certificates to diplomas and experience spanning nine to 16 years, all participants emphasised the importance of involving operational staff in inventory control processes. This consensus highlights a pattern recognising the practical, on-the-ground expertise that operations team members bring to effective inventory management.

The operations team, including supervisors, warehouse specialists, and construction managers, plays a vital role in inventory control. For example, warehouse specialists are crucial in organising storage areas, implementing tracking systems, and ensuring materials are easily accessible when needed. Construction managers coordinate between project needs and available resources, making real-time decisions that impact inventory levels. Supervisors oversee the execution of inventory management protocols, ensuring compliance and efficiency. The unanimous recognition of the operations team's importance by participants with different qualifications and experience levels highlights the practical significance of involving these professionals in inventory management strategies to enhance project execution and resource utilisation.

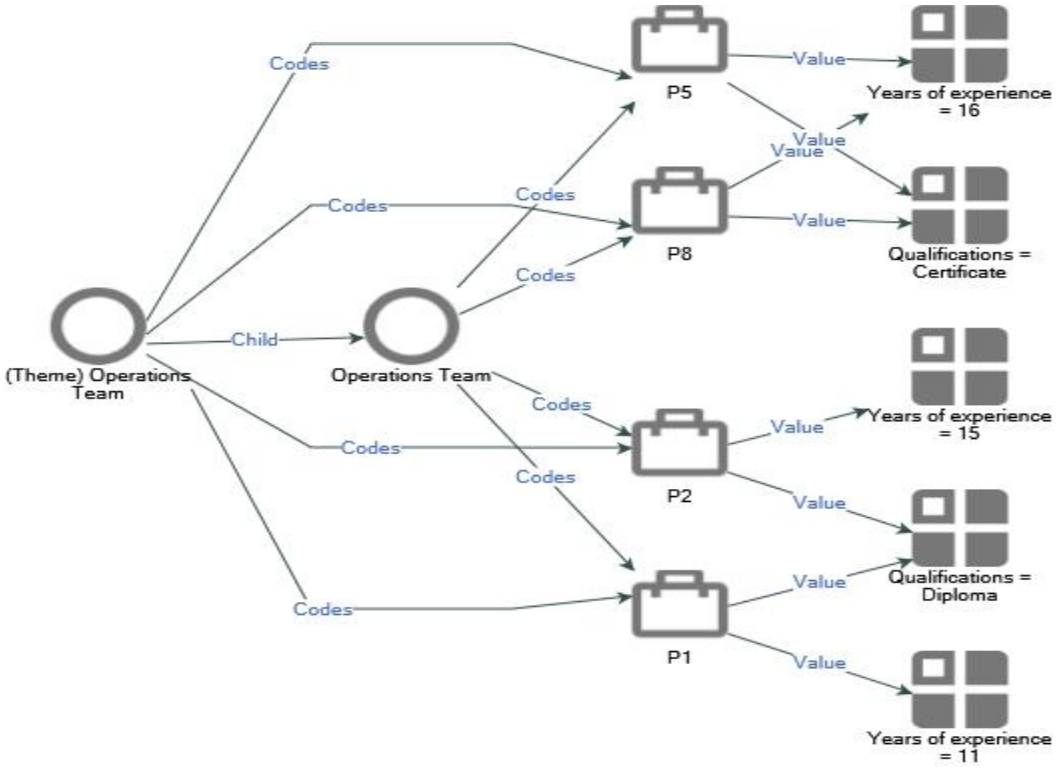

Figure 4. 20:Project Map on the Operations team

Theme 4: Project Management

The responses from six out of eight participants (P1, P2, P3, P4, P7, and P5) converged on a common subtheme: the critical role of management in inventory control. This group, comprising professionals with diverse qualifications and experience levels, unanimously emphasised the importance of senior project management, project managers, and heads of projects in effective inventory management. Their collective insight highlights the significance of leadership involvement in overseeing and optimising inventory processes within construction projects.

A notable pattern emerges in the participants' backgrounds, revealing a mix of educational qualifications and varying years of experience. P1 and P2 hold diplomas with 11 and 15 years of experience, respectively, while P7 has a degree with six years of experience. P5 brings a different perspective with a certificate and nine years in the field. This diversity in qualifications and experience levels, yet uniformity in recognising management's role, suggests that the importance of senior leadership in inventory management is a widely acknowledged principle across different career stages and educational backgrounds in the construction industry.

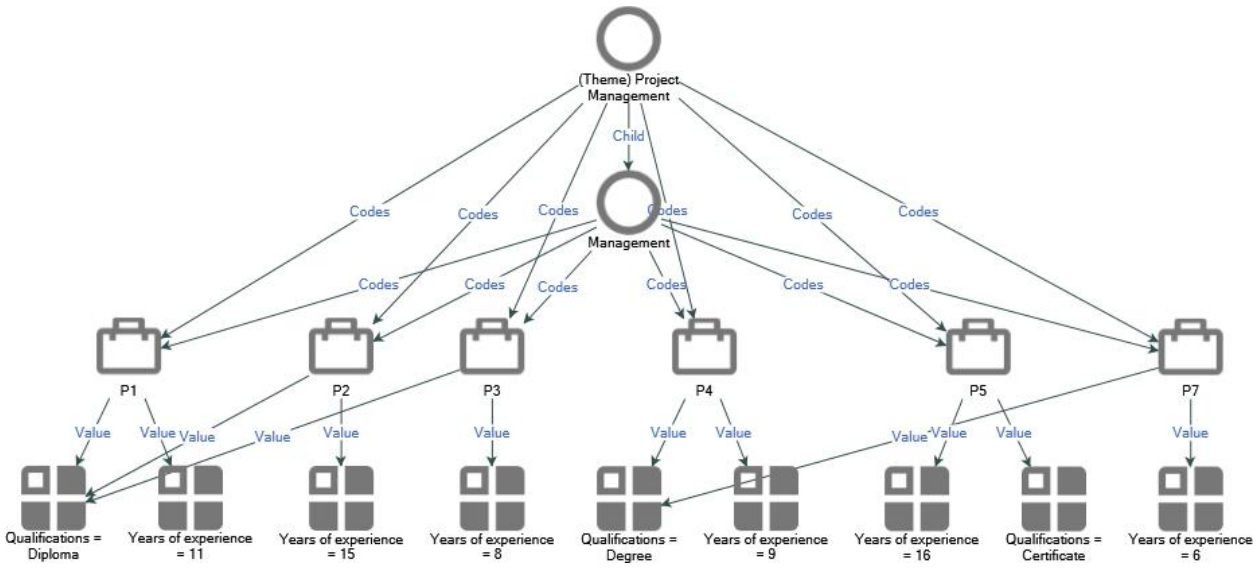

Figure 4. 21 :Project Map on Project Management

Theme 5: Project Map on Supply Chain and Logistics

The study revealed a significant pattern among participants P1, P2, and P7, who all identified supply chain management (SCM) as a crucial subtheme in inventory management for construction projects. Despite their varying experience and qualifications, these participants unanimously recognised the importance of SCM in project execution. P1 and P2, holding diplomas with 11 and 15 years of experience, respectively, and P7, who has a degree and six years of experience, emphasised the role of SCM in ensuring efficient inventory control and material flow.

The emergence of SCM as a common subtheme across participants highlights its critical role in project success. Supply chain management in construction projects involves coordinating the procurement, delivery, and storage of materials, directly impacting project timelines, costs, and overall efficiency. The consensus among participants with different backgrounds highlights the universal recognition of SCM's importance in mitigating challenges such as procurement delays, storage issues, and material shortages. This alignment suggests that effective SCM practices are essential for optimising inventory management, reducing project delays, and ultimately contributing to successful project outcomes.

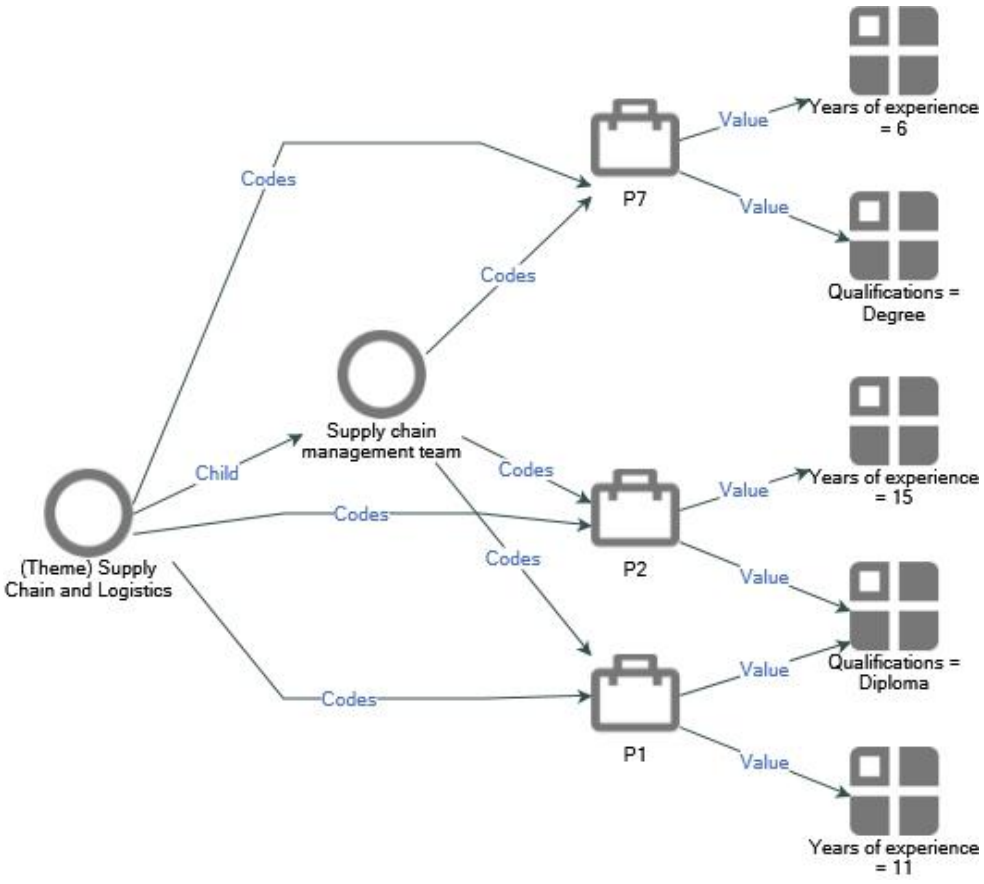

Figure 4. 22:Project Map on Supply chain and logistic

Theme 6: Support function

P8, a participant with a Certificate and 16 years of experience, uniquely highlighted two subthemes in material management: Health, Safety, and Environment (HSE) and Human Resources (HR). This perspective is significant as it emphasises the often-overlooked aspects of inventory management in construction projects.

Including HSE in material management highlights the importance of safety protocols in handling and storing materials, which can directly impact project efficiency and compliance. Similarly, the HR subtheme suggests that P8 recognises the critical role of human capital in effective inventory management, including proper staffing, training, and development of personnel involved in material handling. These insights from an experienced professional indicate that successful inventory management extends beyond mere logistics, encompassing safety considerations and human resource management to ensure smooth project execution and regulatory compliance.

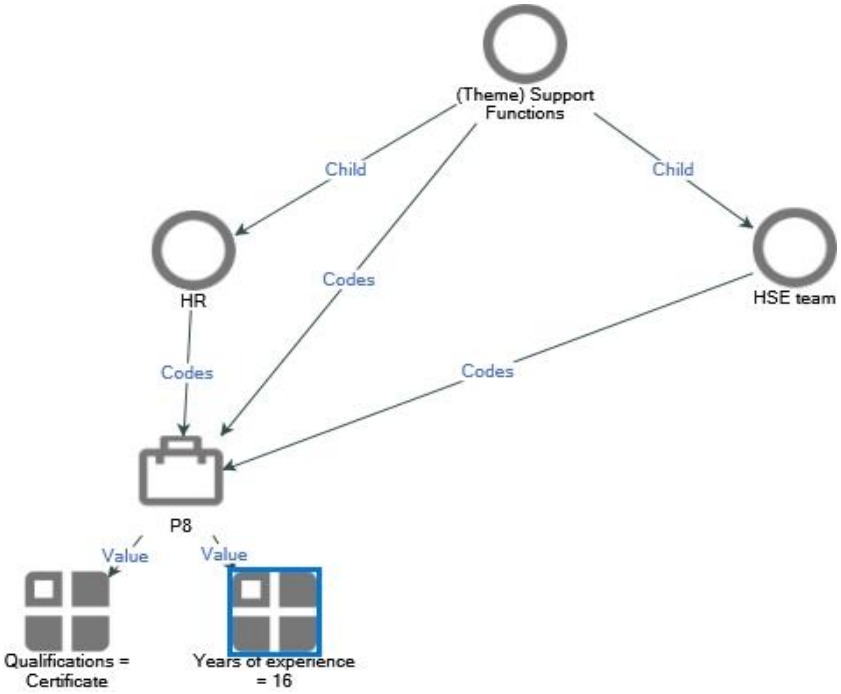

Figure 4. 23:Project Map on Support function

4.7 Conclusion

This chapter presented the findings from semi-structured interviews exploring the role of inventory management in construction project cost overruns at Mabhele and Associates. The study ensured gender balance by including male and female participants, providing diverse perspectives. Most interviewees held diploma or degree qualifications, with two participants possessing certificates but contributing extensive practical experience to the study.

The consensus among participants was that South Africa frequently experiences project cost overruns across various construction initiatives. This widespread issue highlights the importance of effective inventory management in controlling project expenses and timelines. The insights gathered from these experienced professionals shed light on the challenges and potential solutions related to inventory management in the South African construction industry, offering valuable perspectives on mitigating cost overruns through improved material handling and procurement practices.

Chapter Five: Discussion

5.1 Introduction

Projects are a cornerstone of many organisations, especially those that depend on construction projects for revenue. These projects not only provide income during their execution but also generate profits critical to the company's sustainability. Consequently, ensuring the profitability of construction projects is essential for the long-term success of such organisations.

Understanding the importance of construction projects, South Africa has established the South African Council for the Project and Construction Management Professions (SACPCMP). This regulatory body ensures that construction work complies with industry best practices, giving employers and clients confidence that their projects are managed and executed to the highest standards.

When projects are managed and executed to these high standards, the likelihood of delays is significantly reduced. Therefore, organisations need to register their employees with professional bodies like SACPCMP. This enables employees to gain a deeper understanding of construction management, which in turn helps minimise cost overruns.

The aim of this research was to assess the factors contributing to cost overruns in construction projects due to poor inventory management. While various factors affecting cost overruns have been widely researched, this study focused specifically on inventory management. The results, presented in Chapter Four will be discussed alongside the literature review and theoretical frameworks from Chapter Three, providing a comprehensive analysis of the findings.

5.2 Research Question 1

Research question 1 What is the poor inventory management in the project?

Poor inventory management poses several challenges that adversely impact project efficiency and success, and key issues such as poor record keeping and lack of proper documentation have been identified. These challenges result in disorganisation, difficulty tracking inventory levels, and potential delays in project timelines. As highlighted by Kothari (2024) in Chapter Two, effective inventory management includes tracking inventory, forecasting demand, ordering supplies, and receiving and storing goods. The misalignment of material orders with project timelines is another significant challenge noted by Subramani et al., (2017). This issue results in difficulty locating items when needed, causing delays. Excess inventory increases storage costs and risks obsolescence, while shortages delay project activities and affect productivity (Team, 2022).

The findings align with existing literature identifying poor inventory management as a major contributor to project inefficiencies. Liwan (2015) discusses how inadequate documentation and storage solutions lead to financial challenges.

Liwan (2015) highlights that planning and adequate storage are crucial for mitigating these issues. Salih et al., (2023) argue that integrating technological solutions such as discussion story management software can help maintain accurate records and align material orders with project timelines. The implications of poor inventory management are far-reaching, affecting the project's financial health, timeline, and quality outcomes.

Mismanaged inventory leads to increased project costs, resource wastage, and decreased productivity. These inefficiencies can also strain relationships with suppliers and stakeholders, further complicating project execution.

Addressing these challenges is essential for ensuring smooth project operations and achieving project goals; this is also supported by Saro et al. (2021), who explain that organisations are developing inventory control systems and adopting solutions to address current procurement challenges,

5.3 Research Question 2

Research question 2- What are the benefits of managing inventory effectively?

Effective inventory management offers numerous benefits that significantly enhance project performance. Liwan (2015) highlighted proper planning as a key aspect of managing inventory effectively, which leads to cost savings and resource optimisation. Table 2 in Chapter Two explains that proper planning ensures materials are available when needed, reducing delays and minimising storage costs.

Based on the study done by Ramadhan and Simatupang (2012) from Chapter Two, the literature supports the findings that effective inventory management improves project efficiency and reduces costs.

The benefits of inventory management include substantially improving organisational efficiency, ultimately leading to cost savings. Inventory planning helps organisations achieve optimal supply chain performance in simulation, both financially and in service delivery. There are numerous methods to manage inventory effectively, among which Salih et al., (2023) emphasise the critical role of technology.

Both Basheer et al. (2024) and Mohammed et al. (2024), highlighted in Chapter Four, emphasise that Effective Inventory Management is essential in this complex procurement process. However, the benefits

of proper inventory management mitigate these risks, helping prevent cost overruns, reducing material purchasing costs, minimising legal disputes, and enhancing decision-making. It also improves cash flow, reduces storage costs, and enhances customer satisfaction by ensuring product availability.

5.4 Research Question 3

Research question 3 - Who should be involved in inventory management?

The findings suggest that a diverse group of stakeholders should be involved in inventory management to ensure a comprehensive approach. Pérez Vergara et al. (2020) emphasise that a collaborative approach is required to manage inventory effectively, and this collaboration requires both internal and external stakeholders.

Novita Millawati's (2023) focus on meetings suggests allocating their attention effectively, focusing on the most influential or critical leading players. By involving all relevant stakeholders in these meetings, organisations can ensure that everyone is informed about inventory status and any potential issues. This collaborative approach helps make informed decisions and maintain a seamless project flow.

The literature highlights the importance of involving a multi-disciplinary team in inventory management. Taylor and Morgan (2020) discuss how collaboration among different team members enhances inventory oversight and reduces the risk of errors. Lee (2018) also highlights that involving a diverse group of stakeholders ensures that all aspects of inventory management, from procurement to storage, are adequately addressed.

5.5 Application of the conceptual frameworks

5.5.1 Resource Dependency Theory (RDT)

Resource Dependency Theory highlights how challenges related to external resources, such as materials, equipment, and supplier relationships, can impact the timely completion of projects. Multiple participants emphasised the critical role of resources as key stakeholders in project execution. This issue was particularly evident in discussions about challenges in inventory management, where material delays were a significant concern. Participants noted that materials sourced from various suppliers, especially those procuring equipment from overseas, can lead to extended delivery times if suppliers are not transparent about the availability of materials. This lack of transparency often results in misalignment with the project schedule, causing delays and ultimately leading to cost overruns.

To address these challenges, participants suggested establishing clear contractual communication with suppliers and closely monitoring delivery schedules to mitigate potential delays. They recommended that

suppliers be held financially accountable in cases of deviation from agreed timelines, ensuring a more reliable and timely supply chain, which is crucial for maintaining project schedules and controlling costs.

5.2.2 Stock Diffusion Theory

Stock Diffusion Theory explains how inventory levels evolve and fluctuate over time within a supply chain or storage system. It provides insights into the movement and distribution of stock in response to demand and supply, aiming to predict and understand inventory behaviours in different contexts. The participants echoed this theory, who identified the delivery process as a significant bottleneck. They pointed out that materials may be delivered to the primary office instead of the project site, leading to confusion and delays in locating the items. Clear communication regarding delivery locations and proper handling procedures can help alleviate these issues.

5.6 Conclusion

This chapter reviewed the feedback from participants and highlighted the key themes that are strongly supported by the literature presented in Chapter Two. Both the literature and data analysis agree that inventory management poses significant challenges, leading to cost overruns in projects: participants' insights aligned with the issues identified in the literature, reinforcing these findings. Chapter Six offers guided recommendations to address these challenges.

Chapter 6: Conclusions and Recommendations

6.1 Introduction

This chapter presents the study's key findings on inventory management challenges and their implications for project success. It explores how effective inventory management practices can mitigate common issues such as poor record keeping, improper documentation, and misalignment of material orders. The findings concern three critical themes: proper planning, team alignment, and continuous communication. This chapter also provides recommendations aimed at helping project managers and stakeholders enhance their inventory management strategies to ensure smoother project execution and optimal resource utilisation. Furthermore, the chapter addresses the implications of these recommendations, outlines the study's limitations, and suggests areas for future research.

6.2 Conclusions to the Objectives of the Research

This study aimed to identify and assess the factors contributing to construction project overruns due to poor inventory management, as outlined in the research findings in Chapter Two. The findings indicate that inventory management is critical in influencing cost overruns in construction projects. This is because if the material is unavailable due to theft, mismanagement, supplier delays, and SCM will result in installation delay, ultimately delaying the project, which will incur additional costs. Various inventory and stakeholder management challenges were highlighted as key contributors to these overruns.

Eight interviews were held with project team members to determine the research objectives highlighted in Chapter One. The participants provided insightful feedback based on the construction project experience during the interviews, which contributed to the study. It has been observed that the findings identified in Chapter Four align with the literature review presented in Chapter Two because the sample size was not that big. It can be concluded that not all participants were fully represented in identifying if any participants differed from the research objectives.

There were three research objectives highlighted in Chapter 1 end the research objective or as follows:

- Identify the key challenges contributing to poor inventory management practices within project contexts - According to the findings and the literature review, numerous challenges were identified, many of which align with the participants' perspectives. The literature review corroborates the participants' views, particularly regarding the cumbersome procurement processes that lead to material delays. These delays may arise from supplier issues or internal company procedural inefficiencies. In some instances, the literature review highlighted additional challenges not explicitly mentioned by

participants. However, overall, there is a significant overlap between the two sources, confirming the prevalence of these issues.

- The second research objective aimed to Identify various benefits associated with managing inventory effectively within the project. To further improve inventory management, it is recommended that an advanced inventory system be implemented that replaces the reliance on paperwork, reducing the risk of lost records and enhancing efficiency. Developing a formal policy document for inventory management is crucial to provide clear guidelines, standardise procedures, and ensure consistent practices across all levels. This will help solidify the benefits of improved efficiency and cost savings, as identified in the literature, and provide a more robust framework for managing inventory while minimising project overrun risk.
- The third research objective focused on identifying who should be involved in improving inventory management. While participants primarily identified the Project Manager (PM), Supply Chain Manager (SCM), and planners as the main stakeholders, similar to the literature review, there were two instances where participants also recognised engineering as a key stakeholder. It is important to note that these should not be considered the only stakeholders, as it will depend on the roles and responsibilities of each individual involved. The literature was consistent with the views of the participants. Another critical stakeholder is HR, as they play a vital role in addressing poor site management, mainly through skills development or the initial screening of project employees.

6.3 Recommendation for the institution

Recommendation 1:

Generic inventory control policy, needing a particular level of management effort and control, is used for all items in each category. This policy should dramatically reduce the number of people who require extensive management attention. Therefore, an appropriate order or reorder policy can be established for each class (Lolli et al., 2019). However, implementing such policies should be considered an on-site requirement, as different projects may have unique needs.

In addition to having sound policies in place, it is highly recommended that Mabhele and Associates appoint experienced personnel to oversee inventory management. While seasoned professionals bring valuable expertise, this alone is not sufficient. Ongoing training is necessary, as construction sites' complexity may vary, with some projects having different responsibilities for inventory control between clients and subcontractors. Furthermore, periodic inventory system reviews ensure that inventory management policies remain relevant and practical, particularly in light of technological advancements and changing site conditions.

6.4 Recommendations for future research

Further research could be conducted to explore the impact of organisational culture on the relationship between project managers and procurement teams. Most of the participants highlighted the disconnect between the SCM due to the challenges that could arise from the reporting matrix influencing the Project Manager's authority, especially in identifying who is accountable for inventory in the projects. This could be because of different reporting lines or a balance of power.

One key issue mentioned was the difference between high- and low-power distance. In organisations with a high-power distance, decision-making tends to be centralised, and a rigid hierarchical structure is often in place. In such environments, project managers may experience limited autonomy in decision-making, while strict procedures may constrain procurement teams. This can lead to tension if roles are not well-defined, or team members feel their contributions are not valued. In contrast, a low-power distance culture fosters a more collaborative environment, where project managers and procurement teams are encouraged to share their perspectives and feel that their input is equally valued.

6.5 Limitations of the study

The study encountered several challenges that limited its scope. One key issue was the timing of the interviews, which coincided with the winding down of the company as the project was nearing completion. During this period, some employees were being laid off, making it difficult to contact them. Communication was primarily through email, and when scheduling the interviews, some participants had already returned their company laptops. As a result, arranging Microsoft Teams meetings proved difficult, and many of the critical resources were unavailable for interviews. These logistical challenges impacted the study's comprehensive data gathering from other key participants. The SCM team was not included in the scope because some had already left the project.

6.6 Conclusions

The challenges stemming from poor inventory management leading to project cost overruns were thoroughly examined throughout the study, drawing from the literature review and participant feedback. The research objective was successfully achieved, as the challenges identified were well-known both to the participants and in the existing literature. It became evident that poor inventory management significantly contributes to cost overruns in construction projects, affecting timelines and budgets due to delays, stockouts, and inefficient resource allocation.

While participants highlighted some unique challenges not extensively covered in the literature, these were relatively minimal compared to the more significant, widely recognised issues. Poor inventory management exacerbates these challenges and emphasises the importance of robust inventory practices to mitigate

financial losses and project delays. Inventory management remains a critical area within project management, and despite extensive research, it warrants further exploration. A broader study with a larger sample size could provide deeper insights into the extent of these challenges and help develop more effective strategies to prevent cost overruns.

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APPENDICES

Appendix A: Research approval notification

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

02 September 2024

Tebogo Hilton Majatladi (223024675)
Grad School of Bus & Leadership
Westville Campus

Dear TH Majatladi,

Protocol reference number: HSSREC/00007370/2024
Project title: Assessing the role of inventory management in construction project cost overrun
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 12 July 2024 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

Incidents of adverse events and serious adverse events (AEs and SAEs) should be reported in writing to HSSREC, the study sponsors, and any regulatory authority (where appropriate), within 7 working days of the occurrence for local sites and 14 days for all other South African sites.

This approval is valid until 02 September 2025.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

HSSREC is registered with the South African National Health Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)
/nng

Humanities and Social Sciences Research Ethics Committee
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 8350/4557/3587 **Email:** hssrec@ukzn.ac.za **Website:** http://research.ukzn.ac.za/Research-Ethics
Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

INSPIRING GREATNESS

Appendix B: Informed Consent

Dear Interviewee

My name is Tebogo Hilton Majatladi from the Graduate School of Business and Leadership, of the University of Kwazulu Natal. My contact details are:

Email: 223024675@stu.ukzn.ac.za

Contact: [redacted]

Dr D. Engelbrech and Dr othordox are my supervisor, and they are based at the University of KwaZulu-Natal in the Graduate School of Business and Leadership. You can reach my supervisors via email at engelbrechtd1@ukzn.ac.za and teferao@ukzn.ac.za.

You are invited to consider participating in a study involving research to assess inventory management's role in construction project cost overrun. The aim and purpose of this research is to assess factors contributing to construction project overrun due to poor inventory management and compile a set of recommendations to improve inventory management and project margins. The study is expected to enrol 9 individuals. The duration of your participation if you choose to enrol and remain in the study is expected to be 45 minutes.

The study has no possible risks. We hope that the Improved inventory management will lead to projects being completed on time and within financial the budget.

This study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (approval number HSSREC/00007370/2024).

In the event of any problems or concerns/questions you may contact the researcher the UKZN Humanities & Social Sciences Research Ethics Committee, contact details as follows:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557- Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

The participation in this research is voluntary and the participants may withdraw participation at any point, and in the event of refusal/withdrawal of participation the participants will not incur a penalty.

You may withdraw from the study at any time with no negative consequence.

CONSENT

I have been informed about the study entitled assess the role of inventory management in construction project cost overrun by Tebogo Hilton Majatladi.

I understand the purpose and procedures of the study and assess the role of inventory management in construction project cost overrun.

I have been given an opportunity to answer questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time.

If I have any further questions/concerns or queries related to the study, I understand that I may contact the researcher at 223024675@stu.ukzn.ac.za

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

I hereby provide consent to:

Audio-record my interview / focus group discussion YES / NO

_____ _____

Signature of Participant Date

_____ _____

Signature of Witness (Where applicable) Date

_____ _____

Signature of Translator (Where applicable) Date

Appendix C: Interview Questions

1. What qualifications do you have?
2. What is your title in the project?
3. Years of experience in construction project

1 to 5 years	6 to 10 years
11 to 15 years	16 and above years

4. Can you describe your role and responsibilities in relation to inventory management within the project?
5. In your view, do you think South Africa has a challenge of project cost overruns and why?
6. What challenges have you encountered in managing inventory during a project, and how did you address them?
7. Based on your experience who should be involved in the process of managing inventory in the project and why?
8. Does your project have a site-specific inventory management policy,

   Yes ☐ No ☐

9. How does your project monitor and track inventory levels throughout the project's lifecycle?
10. What strategies do you use to improve communication between departments to ensure alignment in inventory management?
11. What are the common bottlenecks in your inventory management process, and how do they affect overall project efficiency?
12. How do storage and warehousing challenges contribute to inventory management issues, and what strategies do you use to address these challenges?
13. How do delays in procurement affect your inventory management, and what strategies do you use to mitigate the impact of such delays?
14. Can you provide an example of a time when effective inventory management significantly reduced project costs?

Appendix D: Ethical Clearance

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

02 September 2024

Tebogo Hilton Majatladi (223024675)
Grad School of Bus & Leadership
Westville Campus

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HSSREC is registered with the South African National Health Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)
/nng

Appendix E: Gatekeeper Permission to Conduct the Study

Mabhele and Associates cc
PO Box 4393, Middelburg, 1050
152 Cowen Ntuli Street, Middelburg, 1050

Tel: 013 243 3403
Fax: 013 243 3405
Email: [redacted]
Website: www.mabhele.co.za

16 August 2024

Mr TH Majatladi (223024675)
Graduate School of Business and Leadership (GSB&L)
University of KwaZulu-Natal
Durban
4041

Email: [redacted]

Dear Mr Majatladi

RE: PERMISSION TO CONDUCT RESEARCH

Gatekeeper's permission is hereby granted for you to conduct research at Mabhele & Associates, towards your postgraduate studies. We note the title of your research project **"ASSESSING THE ROLE OF INVENTORY MANAGEMENT IN CONSTRUCTION PROJECT COST OVERRUN"**.
Data collected must be treated with due confidentiality and anonymity.

Yours faithfully,

[redacted]