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Examining Material Management in Project Performance: A Case Study of Road Constructions Projects in Solwezi

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Abstract

Over the years, Zambia's population has continued to rapidly grow, rising from 13.0 million in 2010 to 19.6 million in 2022. This rapid population growth has led to the development of new settlements and the construction of new infrastructure, including roads. However, the country has experienced significant project failures, particularly in road construction. These failures are attributed to poor material management techniques, which can result in poor quality materials, damage to materials, poor planning, late deliveries, and high costs. Therefore, proper material management is essential to prevent project failure.

This research was conducted to ascertain project material management techniques in road construction. The objectives of the study were to establish the effect of materials management on road construction projects, improve project productivity, enhance cost efficiency, and ensure timely project completion. The study focused on identifying techniques used in material management in road construction in Solwezi and determining how project material management techniques can be improved.

The study adopted a quantitative research design, focusing on 50 participants from various construction companies. The research design was descriptive. The data analysis involved coding, editing, and tabulation based on the study themes. Tools used in analyzing the data included descriptive statistics, frequency distribution tables, figures, and percentages. The study is anchored on agency theory, resource dependence theory, network theory, and relational exchange theory, all emphasizing the importance of effective resource management to prevent project failure.

The study aimed to identify factors influencing the completion of projects, focusing on planning, storage, transportation, sourcing, and purchasing of materials and how they affected project completion. The study concluded that inadequate management of materials has resulted in poor material management attributes in construction companies, especially smaller companies. The study recommends a systematic and integrated approach to managing materials to minimize costs and mitigate the effects of inadequate materials management.

Keywords: Inventory Cost Project Management, Quality of Materials, Time Management, Waste Management

1. Introduction

1.1 Overview

This chapter contains the background, statement of the problem, research objectives, research questions, research variable, and significance of the study, theoretical framework, and scope of the study, limitation of the study and operation definitions

Background

Material management is an important function in the productivity of projects. Material management strategies are scientific techniques concerned with planning, organizing, and controlling materials from their initial purchase to their destination. Boopathi (2016) conducted a study on material management using real-time residential projects. The author argued that the cost of a project increases mainly due to inappropriate material management. In this study, project planning, scheduling, and budgeting were done. Since proper scheduling methods were followed, there was no increase in the cost of the project. The material cost constituted 50% of the total cost, which is normal. According to Dipak (2014), inventory management strategies

play a significant role in planning. The research focused on determining the cost requisite for a project arising from poor planning strategies. The mathematical models of ABC Analysis and EOQ demonstrate the significance of material planning and its effects on construction costs, which translates to either successful project completion or failures. This research concluded that with proper planning on the management of materials, the cost of the project will be saved, and hence this will be considered a success.

Construction projects are some of the most common activities we encounter, yet they are known as some of the most difficult human endeavors. Each project consists of sophisticated and complex processes that need to be carried out by different individuals of different professions who have the skills and knowledge. All the talent and skills have to be channeled towards a common goal of producing the project, whereby time and money will be required. To ensure effective delivery, there have to be good controls and management of uncertainty. Therefore, one needs to identify the uncertainty related to the project and come up with the best strategy to deliver to enhance the chances of success for the project. The focus areas include transportation, sourcing, and planning. Waters (2015) observed that traditional approaches to material management use planned operations where managers design a detailed schedule for each distinct activity within the chain. By coordinating these schedules, managers control the flow of materials. The problem with the traditional approach is that it is based on a paper system, and even when firms move to automation, they often automate the same procedures. This approach has fundamental weaknesses such as taking too long, being expensive, relying on paperwork, physically moving paperwork between locations, having many people doing the administration, being unreliable, introducing errors, and having more people supervising and controlling administration. These problems can be overcome when firms move to electronic purchasing and hence adopt the material management approach.

Dobler and Burt (2016) postulate that material management provides an integrated system approach to the coordination of material activities and the total material costs. They view it as something that advocates assigning to a single operating department all major activities that contribute to the cost of materials. The objective is to optimize the performance of material systems, as opposed to sub-optimizing the performance of individual operating units that are part of the material system. Chase *et al*. (2011) contend that the objective of materials management is to ensure that the right item is at the right place, at the right time, and at a reasonable cost. The intention of having a material management system in place is to solve materials problems from a total company point of view by coordinating the performance of various materials flows. Fearon (2013) suggested that the introduction of computers was a great boost to the adoption of materials management, as the materials function has many common databases.

According to Chary (2015), material inventory is kept in operations for three reasons: Transactions, precautions, and speculation. While speculative inventory cannot be encouraged particularly in developing countries, there is a need for transaction or regular inventory due to the lack of perfect synchronization of inflow and outflow of materials and for precautionary or safety inventory to provide cover for any inability to predict the demand for materials. Ramakrishma (2015) identified that half of the sales income in a firm is spent on materials. Suppose a firm is spending 50% of its volume on material and the profits are, say, 10% of sales volume. A 2% reduction in materials cost boosts the profits to 11% of sales or the profits increased by 10%. To achieve the increase in profit through sales efforts, a 10% increase in sales volume would be necessary.

Barnes (2013) defined the supply network as the set of interconnected relationships between all the parties that supply inputs to and receive outputs from an operation. The focus is on a holistic approach, which means the entire chain from internal to external customers. The success of any supply network depends on its ability to satisfy the needs of the ultimate customer, the end-user of its products and services. Therefore, the network as a whole needs to be designed and managed in a way that enables it to do so effectively and efficiently. It is not just the firm's own operations that need to be managed strategically to meet customer needs but all the elements of the supply chain, individually and collectively. A key facet of the supply network is the nature of the relations between purchaser and supplier.

The benefits of material management to the organization were clearly explained by Siddhartha (2014) through his paper. The author also explained that the objectives of material management include regular uninterrupted supply of raw materials, maintaining high inventory turnover, providing economy in purchasing, minimizing waste, transportation, and storage, minimizing the overall cost of acquisition, and maintaining a high degree of cooperation and coordination with user departments. He concluded that the major benefits of material management were avoiding excessive investment in stock, assuring work continuity, improving productivity, and minimizing inventory losses. A comparative study was made by Jose (2013) in the analysis of inventory control techniques.

1.2 Statement of the Problem

Construction companies in Zambia suffer from several instances of project failure attributed to poor material management. Project delays occur due to transport delays, material damage due to poor storage facilities, poor initial planning, and inadequate purchasing procedures. These challenges manifest in projects in the form of stoppage of work due to material shortages, surplus materials on site, inadequate storage space for materials, uncontrolled wastage of materials, damaged materials on site, and wrongful purchase of materials. The ultimate impact is project failure.

Poor material management techniques adopted in project implementation have contributed to the increased number of abandoned projects due to increased project costs and timelines, which are unviable in the long run. Most of these incomplete projects in the construction sector pose a great risk to the livelihoods of society, considering some have collapsed, resulting in the loss of lives and property. It is also a major financial risk given the investments put into the construction works.

The study by Mac-Barango (2017) revealed that poor material handling and mismanagement were part of the reasons for incomplete projects. He delved into store management but did not focus on the transport management problems, which adversely affect the management of materials. It is also important to establish the relationship between storage and transport processes. Kioko (2014), on

the other hand, reported that material mismanagement had impacted negatively on project completion. He discussed cost variation due to damage to material but did not mention challenges arising from storage and purchasing processes.

The research focused on Zambia's construction industry, and the findings revealed that poor planning, unreliable transport, poor storage, and purchasing procedures are some of the reasons contributing to abandoned projects. These issues, however, depend on the planning, storage, transportation, and purchasing methods adopted by the organization. The overall effect of poor material attributes could significantly lead to increased time and cost overruns and poor quality of the project. At worst, for contracted projects, it could also lead to protracted legal battles and arbitration due to cost and time overruns and bad quality of the project.

1.3 Objective

1.3.1 General objective

The main objective of this study is to examining material management in project management.A case study of Road constructions projects in Solwezi.

1.3.2 Specific Objectives

1. To establish various techniques of inventory cost management of material in Road constructions
2. To examine how management of materials affects performance of Road constructions.
3. To identify challenges affecting the effectiveness of the project material management.

1.4 Research Questions

1. What are the various techniques of inventory cost management of material in Road constructions?
2. Does management of materials affect the effectiveness and performance of the Road constructions?
3. What are the challenges in project material management?

1.5 Theoretical Framework

Stephen Ross and Barry Mitnick introduced agency theory in 1973 to address conflicts of interest between owners and managers. Agency theory is relevant in situations where one party (the principal) delegates authority for control and decision-making about certain tasks to another party (the agent) (Eisenhardt, 1989). This theory is particularly effective in project implementation planning, ensuring that duties are delegated to responsible individuals who make decisions affecting the project. It emphasizes the dependent variable, project performance, and how it is affected by tasks such as material transport, storage, and purchasing.

Agency theory provides a useful framework for analyzing relationships and behaviors in supply chains, which are replete with the principal-agent dynamic. Ensuring clear communication and flow from the supplier to the construction site is crucial for receiving materials in the right quality, quantity, and at minimal cost. The theory highlights the importance of planning, storage, and transport in overall project progress, ensuring that materials are stored properly to avoid damage and facilitate easy retrieval.

The theory is relevant to this study as it underscores the need for a good relationship between the principal-agent and other parties to ensure swift communication and delivery of materials required for the project. It focuses on power relationships based on the exchange of resources (Pfeffer & Alison, 1987) and recognizes that companies often depend on each other for resources needed in the value creation process (Hunt & Morgan, 1996). This theory is particularly effective in the transport and storage of materials, which must be done effectively due to their scarcity. The main issue is how organizations manage their power dependence relationships to maintain functional and operational requirements (Pfeffer & Salancik, 1978). Resource dependence theory (RDT) assumes that organizations form coalitions to increase their power and make other organizations dependent on them (Heide, 1994). Resource manipulation and control exertion are strategies offered by RDT to manage uncertainty and dependence in business transactions. RDT highlights key project aspects such as sourcing materials and transporting materials from the supplier, directly influencing project performance. Therefore, every project depends on good material management to yield the required results.

Émile Durkheim and Ferdinand Tönnies developed Network Theory in the 1890s, providing a broader view of inter-organizational interactions in a network environment. This theory highlights the dynamics of network environments and recognizes the influence of partner-to-partner relationships on an organization's operations. According to Halldórsson *et al*. (2007), by emphasizing strong and weak ties, the theory states that a network resource view helps managers develop a more realistic assessment of individual nodes and resources. Resource accession and coordination are considered key triggers for inter-organizational connectedness and should be embraced in today's turbulent business environment (Fayezi, Zutshi & O'Loughlin, 2010). The theory is relevant to the purchasing variable, which influences the flow of materials, ensuring that the right materials for the job are ordered and delivered on time.

Relational Exchange Theory centers on the idea of embeddedness, suggesting that cooperative parties act based on norms rather than contractual obligations (Granovetter, 1985). This theory emphasizes soft control mechanisms to attenuate opportunism. According to Larson (1992), trust-based relationships are less prone to partner opportunism. Trusting relationships help allocate resources to developing and maintaining relationships rather than managing transactional tensions or abnormal behaviors in the supply chain (Joshi & Stump, 1999) [17].

1.6 Significance of the Study

Materials management is a core function of supply chain management, involving the planning and execution of supply chains to meet the material requirements of a company or organization. These requirements include controlling and regulating the flow of material while simultaneously assessing variables like demand, price, availability, quality, and delivery schedules.

1.7 Operational Definitions of Concepts

- **Materials management**

Materials management is an essential function within an organization that ensures the smooth flow of materials from suppliers to production and eventually to customers. It involves the planning, procurement, and control of materials to ensure that the right material is available at the right time, in the right quantity, and at the right cost.

- **Supply Chain Management**

One of the biggest challenges in materials management is

managing the complex supply chain. This involves coordinating with suppliers, logistics providers, and production teams to ensure that materials are delivered on time and to the correct specifications. Materials managers must also be able to respond quickly to changes in demand and adjust the supply chain accordingly.

- **Cost Control**

Cost control is another major challenge in materials management. A material manager must be able to negotiate prices with suppliers, manage logistics costs, and ensure that materials are purchased at the best possible prices**.**

- **Quality Control**

Ensuring materials meet the required quality standards is indeed a significant challenge in materials management. A material manager must collaborate with suppliers to guarantee that materials are produced according to the correct specifications and delivered in the appropriate condition.

2. Literature Review

2.1 Overview

This chapter reviews the literature from various sources to enable the researcher know what others have done about the proposed research topic. By reviewing various literatures, the researcher will be able to identify the existing knowledge gap. The chapter therefore, reviews literature from the global perspective, African perspective and then trickled down to the Zambian perspective. Areas are;

1. To establish various techniques of inventory cost management of material in Road constructions
2. To examine how management of materials affects performance of Road constructions.
3. To identify challenges affecting the effectiveness of the project material management.

The Importance of Material Management

In An Organization Material management represents an important asset and it is the largest single item of costs in almost every business organization. It is an important aspect of factory and industrial process which covers the entire spectrum of function such as material handling, material acquisition, assembly line management, storage, as well as material transport. Material management and control include several smaller components that work side by side to make the business organization more efficient and cost effective. Fadipe (1996) outlined the importance of introducing material management and control in organizations as follows; (i) Better coordination of the people and activities dealing with materials. (ii) Elimination of bulk-purchasing. (iii) Low price of material and equipment. (iv) It hastens inventory turnover. (v) Better communication and cooperation between the various departments. (vi) It reduces duplication of efforts and also facilitates the introduction of computerbased operations. (vii) It increases the morale of staff. (viii) It reduces material obsolescence. (ix) It facilitates better records and information. (x) It improves control of quality and improves profitability level. Pandey (2007) [30] explained that the question of managing materials arises only when the company holds inventories. Maintaining the inventories involved trying to hold up to organisation's funds and incurrence of storage and handling cost. He further explained three (3) motives for holding inventories which are Transaction/Production Motive: This motive emphasis the need to maintain inventories to facilitate smooth production and sales operations. Precautionary Motive: This motive necessitate the holding of inventories to guide against the risk of unpredictable changes in demand and supply forces as well as the growing level of globalization/computerization. Speculative Motive: This motive influences the decision to increase or reduce inventory level to take advantage of price fluctuation. Fadipe (1996) further highlighted two specific control methods in material control. They include: (i) Establishment of control to minimize losses from spoilage and theft and to prevent "stock out" situation as well as duplication. (ii) Issuing requisition to the purchasing department when stocks reach the recorder point or special needs arise. Lenders (1992), stated that the objective of material management are to solve material problems from a total organisational view point (optimizing) by coordinating performance of the various material functions, providing a communication network and controlling material flow. The introduction of computer into organization, provided further reasons to adopt materials management, because material function have many common data needs and can share a common data base.

2.2 Techniques for material inventory cost management

Mansour N. Jadid (2013) developed a framework using an internet-based system for material selection decision support for projects in the design or road construction phases. This framework can benefit various domains of civil engineering, with a focus on architecture, engineering, road construction, and inventory management departments. The study addresses issues such as material approval, selection, and information management, and emphasizes that the primary source of data input is from previous or current projects. The paper discusses various criteria for material selection, including maintainability, aesthetics, adaptability, durability, sustainability, cost efficiency, and lack of toxicity, all of which aid officials in finalizing material choices.

Patil and Pataskar (2013) analyzed inventory management techniques, concentrating on current practices. Their study was conducted in two phases: the first phase used S curve analysis with MSP tools to provide qualitative data, and the second phase involved ABC and EOQ analyses to address stockout issues. Data was collected from tender documents, material requisition notes, ledger registers, and interviews. The study found that the unavailability of RCC drawings poses a challenge for contractors in accurately assessing projects. Additionally, uneven geographical features can cause delays or problems in projects. The authors recommend conducting ABC and EOQ analyses before starting work and ensuring all drawings are completed or handed over to the road construction project to improve inventory management efficiency.

2.3 Management of materials affects performance of construction companies

No organization can operate without material input. The efficiency of any activity for the production of goods and services depends to a great extent on the supply of materials, equipment, and manpower made available in the right proportions. Therefore, in order to meet the needs of the customer while meeting the set objectives, there is a great need for a continuous production schedule, which is only made possible by holding the aforementioned ingredients in stock. Materials management is that aspect of business

activity that deals with the planning for purchasing, receiving, handling, storing, and releasing of materials for use in production with effective control measures.

"Materials management" refers to the management of these materials. Thus, materials management has been defined by Lee and Dobler (1997) [19] as the sum of all those tasks, functions, and routines that are concerned with the transfer of external materials and services into the organization and the administration of the same until they are consumed or used up in the process of production, operation, or sales. Materials management includes all the activities relating to the acquisition, handling, control, and movement of materials and supplies used in the production of a firm's final product. Materials management is a tool to optimize performance in meeting customer service requirements while at the same time adding to profitability by minimizing costs and making the best use of available resources.

The basic objective of materials management, as explained by Banjoko (2000) and Jacobs, Chase, and Aquilano (2009), is to ensure that the right item is bought and made available to the manufacturing operations at the right time, at the right place, and at the lowest possible cost. They stressed that without adequate planning for material resources, the overall performance of an organization may be crippled. Barker (1999) articulated those improvements in continuity of supplies with reduced lead times, reduction in inventories with reduced obsolescence and surplus, improvement in cooperation and communications with reduced duplication of effort, reduction in materials costs, improvement in quality control, improvement in status control, and quicker identification of problems are the main benefits of materials management in organizations.

In the earlier years, materials management was treated as a cost center since the purchasing department was spending money on materials while the store was holding huge inventories of materials, blocking money and space (Ramakrishna, 2005). However, as the global economy has been liberated and opened up, the business environment has changed dramatically, exposing manufacturing organizations to intense competition in the market place. Manufacturing companies around the world have been forced to devise various strategies to meet the challenges and reduce manufacturing costs in order to remain competitive. As noted by Ramakrishna (2005), progressive management has since recognized that materials manufacturing can provide opportunities to reduce manufacturing costs and can be treated as a profit center.

Barker (1989) identified five key functional areas that materials management cuts across, which include purchasing, production and inventory control, quality control, storage and warehousing, and physical distribution. Other literature (Donald, 1975; Bark & William, 1986; Linton *et al.*, 2007) expanded the areas to include forecasting demand and quantity material requirements, good supplier and customer relationships, indigenous sources of supply for foreign materials, developing the skills of workers in material management, improving departmental efficiency, and research and development (R&D) in material management.

The material management department manages these activities. The materials management department will oversee the selection of personnel for marketing, purchasing, inventory control, store management, and materials handling, as well as their training and placement. Materials are the lifeblood and heart of any manufacturing system, and no organization can operate without them. They must be made available at the right price, in the right quantity, with the right quality, in the right place, and at the right time in order to coordinate and schedule the production activity in an integrated way for an industrial undertaking. A manufacturing firm will remain shaky if materials are understocked, overstocked, or in any way poorly managed (Banjoko, 2000). According to Navon and Berkovich (2006), the main logistic responsibility in any organization is to formulate a master program for the timely provision of materials, components, and work-in-progress. According to Stevenson (2001), logistics, which includes materials and goods flowing in and out of a manufacturing facility as well as internal handling, has become critical for an organization to gain a competitive advantage as the company struggles to deliver the right product at the right place and right time.The main aim is to actually promote, with low cost, a flow whose velocity allows the execution of the manufacturing process with the expected level of satisfaction. Bowersox & Closs (2002) articulated that improvement in continuity of supplies with reduced lead times will lead to improvements in cooperation and will also enhance cooperation and communications with reduced duplication of efforts, reduction in material costs, and improvement in quality control, which are the main benefits of materials management.

2.4 Obstacles limiting the effectiveness of the project's material management

In recent years, many firms in the world have faced several challenges particularly in inventory management and control, thus affecting their operational performance. There have been cases of materials overstocking which eventually got expired or out dated, under stocking, lack of stocktaking, theft of materials by workers and delay in delivery of materials into the organizations among others. Many manufacturing firms have more than 50% of total assets invested in working capital, which includes inventory, as well as accounts receivable and accounts payable (Beheshti, 2010; Darun, Roudaki, & Radford, 2015; Gill, Biger, & Mathur, 2010). The basic method of managing stock by quantity by manufacturing firms are by means of fixing for each commodity stock levels which are recorded in the stock control system and subsequently used as a means of indicating when some actions are necessary. Most firms cannot work properly without stock and therefore they have to consider its management. There is a need for organization to maintain a minimum, ordering, hastening and maximum stock level (Harrisson, 2001 cited in to Munyao, Omulo, Mwithiga, & Chepkulei, 2015). Bainson and Bainson (2016) argue that stock levels should be carefully received at suitable intervals, such as quarterly, monthly or even weekly and adjusted to meet any changes in circumstances. If this is not done, the original fixed level will be less than expected, become outdated and the system of stock control is rendered ineffective. The amount of stocks held at the warehouse of manufacturing firms can drastically affect cost and hence finances. This therefore, demands strong monitoring of the changing conditions of stock levels in stores.

2.5 Personal critique of literature review

The literature review on material management in project management provides valuable insights into the topic.

However, upon critical examination, several areas of improvement and limitations can be identified. This critique aims to evaluate the literature review's strengths, weaknesses, and potential areas for further development. The literature review appears to have a narrow focus, primarily exploring the concept of material management within project management. While this can be helpful for readers seeking specific information, it fails to address the broader context and interconnectedness of material management with other project management aspects such as cost management, time management, and risk management. Expanding the scope to include these interconnected areas would provide a more comprehensive understanding of material management's role in project success. The literature review seems to heavily rely on older sources, with limited inclusion of recent studies or publications. Given that project management practices and technologies are constantly evolving, the absence of up-to-date sources raises concerns about the relevance and applicability of the findings. Including recent research would enhance the review's credibility and ensure its alignment with current industry practices. The literature review predominantly presents a summary of existing studies without engaging in critical analysis or synthesis of the findings. By simply summarizing the literature, it misses the opportunity to identify conflicting or complementary perspectives and provide insights into the current state of knowledge. Integrating a critical evaluation and synthesis of the literature would enhance the review's value by highlighting gaps, inconsistencies, and potential avenues for future research. Although the literature review provides a theoretical understanding of material management in project management, it falls short in discussing practical applications or providing actionable recommendations. Including real-world examples, case studies, or best practices would make the review more valuable for project managers seeking guidance on implementing effective material management strategies. Rohit S. Agawane *et al.* (2015) studied effective ways to manage procurement to optimize quality, cost, and project duration. The authors also researched modern techniques in project management, such as Microsoft Project, Primavera, and Enterprise Resource Planning. Data was collected through a questionnaire from a purchase manager in Pune. The authors identified factors affecting the procurement management process, including location, equipment availability, and raw material availability. They also outlined the data required for procurement management, such as planning, estimation, spending records, lead time analysis, and ABC analysis. Additionally, the authors ranked modern methods of procurement management.

Patil and Patil (2015) researched the application of the Just-In-Time (JIT) inventory control technique in highway construction. They conducted a case study on a company involved in highway construction in the Solapur district of Maharashtra. The authors calculated equipment productivity and the monthly consumption of each material, ultimately recommending the JIT method for highway construction. They also identified project-related problems.

2.6 Establishment of research gaps

In the final category of external factors, the following causes of delays were identified: Subsurface and ground conditions, delays in obtaining permits from the municipality, weather effects on construction activities, traffic control and restrictions at the job site, accidents during construction, changes in government regulations and laws, delays in providing services from utilities, and delays in performing the final inspection and certification.

The consequences of delays are the outcomes that will occur if the causes of delays are not identified and addressed effectively. Pourrostam and Ismail (2011: 454) identify and rank the effects of construction delays as follows: Time overruns, cost overruns, disputes, arbitration, litigation, and total abandonment of projects. These findings align with other studies by Aibinu and Jagboro (2002) and Motaleb and Kishk (2010). However, Baki (1999) also highlights claims as one of the effects of project delays.

Kaliba, Muya, and Mumba (2009) studied schedule delays in projects in Zambia and suggested the following recommendations to minimize the causes and effects of schedule delays:

1. Project timing and scheduling
2. A well-defined scope
3. An accurate cost estimate
4. Availability of funds for the project
5. Effective communication
6. A deliberate scheme to build capacity
7. Legislation and good corporate governance.

3. Research Methodology

3.1 Overview

Introduction this chapter presents the research design and methodology that was used to answer the research questions in the study. In this chapter, the sources and methods of data collection, the target population and data analysis techniques are presented.

3.2 Research Design

The research approach provided in-depth and intense knowledge regarding the impact of procurement management on the performance of building projects. This study adopted a case study research approach because it offered an in-depth analysis of the issue within a constrained period. According to Amin (2005) [1], a case study provided an in-depth analysis of the issue when there was a constrained period. The study utilized a cross-sectional survey methodology, as it was versatile in terms of gathering both qualitative and quantitative data. It allowed the study to be conducted at a specific time, and the idea of combining qualitative and quantitative data in a case study research held out the possibility of getting closer to the entirety of a case than could be accomplished by a study using just one method. The quantitative approach was used to quantify incidences in order to describe current conditions and investigate the relationship between procurement management and the performance of construction projects using information gained from the questionnaires.

3.3 Target population

The 50 employees from the Road construction companies' enterprises that were chosen made up the study's target group. The study's boundaries restricted the study's population. The population was in line with the nature of the study, which was a case study of Road construction companies in the Solwezi district of Zambia. It evaluated material management systems and their effects on project performance.

3.4 Sampling design
In that study, the random sampling technique was used to collect data. Creswell (2005) defined random sampling as a subset of individuals that was randomly selected from a population. The goal was to obtain a sample that was representative of the larger population. The researchers adopted the random sampling technique to gather respondents who answered the questionnaires. According to Kothari (2004) [18], the sampling technique was used because it guaranteed the desired representation of the relevant subgroups.

3.5 Sample size determination
A sample of a small group of respondents was drawn from a population about which a researcher was interested in obtaining information in order to arrive at a conclusion. In this study, a sample of 50 respondents from road construction companies was taken.

3.6 Data collection methods
Data analysis is the process of extracting insight and meaningful patterns from data Howell (2013) [12]. The primary data was collected through a structured questionnaire that was prepared. The questionnaire method was preferred since it ensured a high response rate and accurate sampling. The researcher directed the questions to the variables as evident in the conceptual framework. The questionnaires used both open-ended and closed-ended questions. The researcher distributed the questionnaires to the various offices of the companies. The respondents self-completed the questionnaires, and they were collected within two weeks of delivery. The data was then subjected to analysis as guided by the research objectives. The questionnaire was designed to help extract information from the various respondents regarding the facts of the projects and the reasons for the slippages they may have experienced. In order to determine the validity of the research, the researcher consulted with experts to ensure the validity of the data collection procedure.

Questionnaires were self-administered questions that came in the form of structured or closed-ended questions and unstructured or open-ended questions. Three comprehensive closed-ended questionnaires covered all the aspects of the study variables and were accompanied by a Likert scale response continuum, that is strongly agree, agree, undecided, disagree, and strongly disagree, which Amin (2005) [1] used for this study on three types of respondents. The questionnaires were first pre-tested before going for the actual data collection. The questionnaire approach was selected because it enabled the respondents to express freely their opinion about the variables under study. This was because the variables recorded what the respondents felt, thought, or believed was true or false. The questionnaire was delivered to road construction companies.

3.7 Data analysis
According to Dwamane (2020) data analysis is the process of extracting insights and meaningful patterns from data. To examine the data gathered for the study, quantitative methodologies were used. In order to analyze the quantitative data, descriptive statistics comprised of frequency, percentage, mean, and standard deviation were calculated using SPSS software. Visual tools for data presentation, such as graphs and charts, were also created using Microsoft Excel. Quantitative content analysis, which was carried out manually, was the method selected to examine the information obtained during the interview. Primarily, questionnaires were utilized in this study to gather primary data.

3.8 Triangulation
Triangulation was a technique used for analyzing the results from multiple-method research designs Denzin (1978) [7]. It was most often used as a form of cross-checking to validate the results from different kinds of methods, such as the collection of demographics and other information. This study involved the use of the survey method, the use of a structured questionnaire or interview guide in an interview, the use of a sample, and the use of a probability sampling technique to arrive at the sample. The data were coded and thematically analyzed. The collection of data by the researcher identified the complexities related to the context of the study. The surveys were supplemented by the interviews and focus groups. Each research method exposed one aspect of reality. This multi-method, multidisciplinary collaborative research was insightful.

3.9 Limitation of Study
Integrating data from different sources or methods can present challenges in interpreting results Joshi (1999) [17]. The researcher encountered problems like respondents having difficulties in understanding the questionnaire's format. Financial support was needed to enable the researcher to go around collecting data, and also, some important information was not disclosed by the respondents due to issues of confidentiality of information.

3.10 Ethical Considerations
Informed consent was obtained from all those who participated in the study. The participants were informed about the purpose of the study, and they answered the questions anonymously. They were free to skip any question they were not comfortable answering. The data collection tools were kept safely and confidentially. The information gathered was used solely for the purposes of the academic study. The necessary research authorities were consulted for permission.

4. Presentation and Interpretation of Findings
4.1 Overview
The organization of materials is a very important and fundamental subject for every company and should be handled efficiently for the successful completion of a project. The consequences of material departures are time deviations, quality deviations, quantity deviations, and product deviations. Materials are vital to the procedures in every industry since the unavailability of materials can impede production. Unavailability of materials is not the only phase that can cause problems. The study looked at;

1. To establish various techniques of inventory cost management of material in Road constructions
2. To examine how management of materials affects performance of Road constructions.
3. To identify challenges affecting the effectiveness of the project material management.

4.2 Background information of the respondent

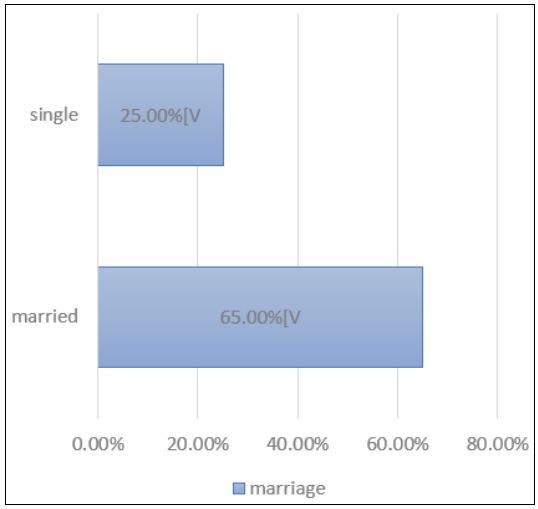

Fig 1: Marital status

The study requested respondent to indicate marital status. 65% of the majority respondent indicated married while 25% of the respondent indicated single.

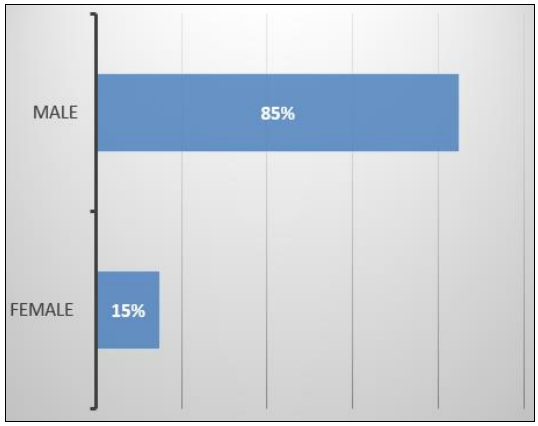

Fig 2: Gender

The study requested respondent to indicate gender. 70% of the majority respondent indicated male while 30% of the respondent indicated female.

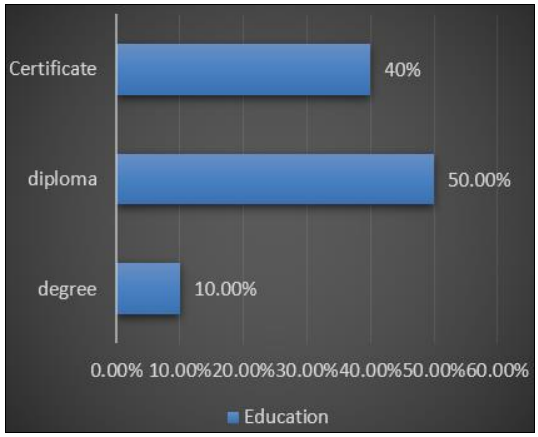

Fig 3: Education

The study requested respondent to indicate education. 50% of the majority respondent indicated diploma, while 40% had certificates and degree 10%

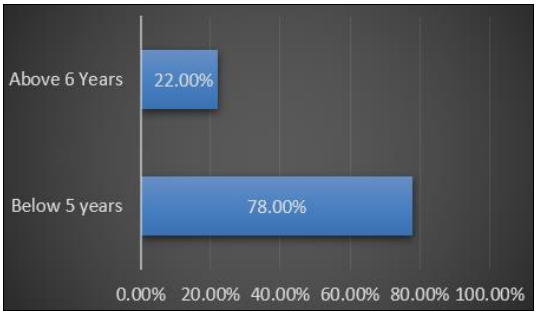

Fig 4: Work experience

The study requested respondents to indicate how long have you worked with construction company. 78% of the majority respondents indicated below 5 years while 22% of the respondents indicated above 6 years.

Theme 1: To establish various techniques of inventory cost management of material in Road constructions

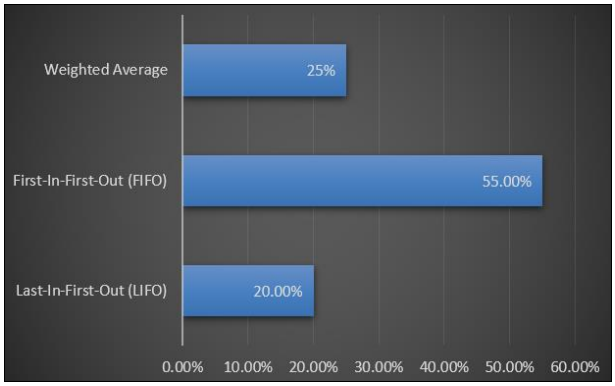

Fig 5: Techniques of inventory cost management of material in road constructions

The study requested respondent to indicate which of the following inventory costing methods is best suited for companies. 25% of respondent indicated WA, 55% of the respondent indicated FIFO and 20% of the respondent indicated last in first out LIFO.

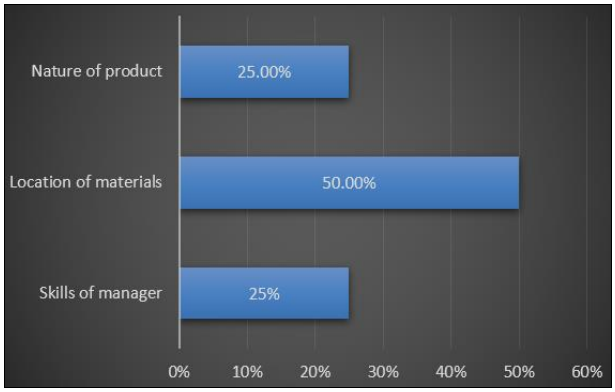

Fig 6: Factors that determine the most effective inventory cost management technique in road?

The study requested respondent to indicate key factor in determining the most effective inventory cost management technique in road. 50% of the majority respondent indicated locations of materials, 25% of the respondent indicated skills of manager and 25% of the respondent nature of product.

4.3 To examine how management of materials affects performance of Road constructions.

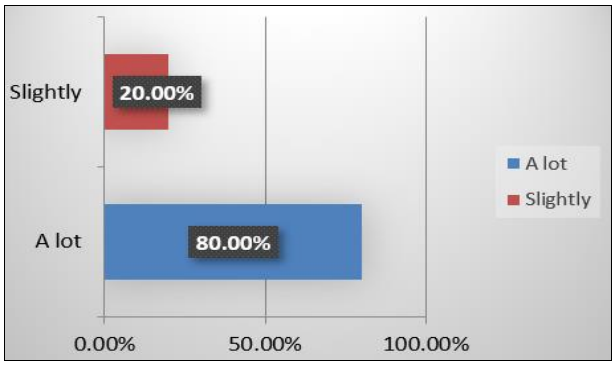

Fig 7: Do material management affect performance?

The study requested respondent to indicate what is the relationship between effective materials management and the product performance 80% while 20% of the respondents indicated that it slightly does.

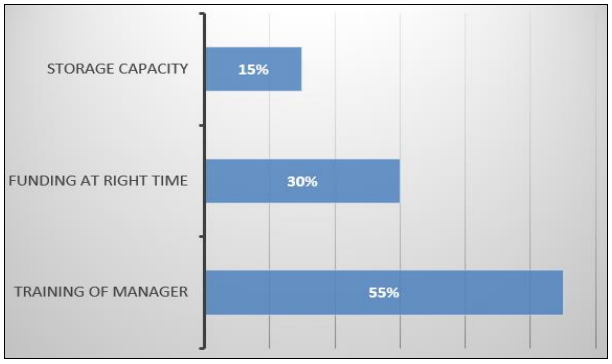

Fig 8: Which of the following factors has an effect on materials management

The study requested respondent to indicate which of the following factors has the greatest impact on the effectiveness of materials management. 30% of the respondent indicated funding at the right time, 15% of the respondent indicated storage capacity and 55% of the respondent indicated staff training.

4.4 To identify challenges affecting the effectiveness of the project material management

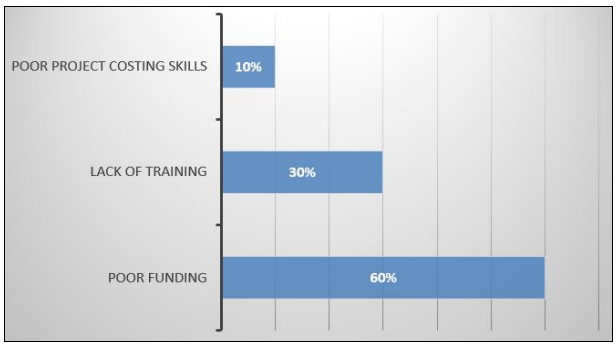

Fig 9: Challenges affecting the effectiveness of the project material management

The study requested respondent to indicate challenges affecting the effectiveness of the project material management, 10% of the respondent indicated poor project costing skills, 30% said lack of training and 50% of the respondent indicated poor funding.

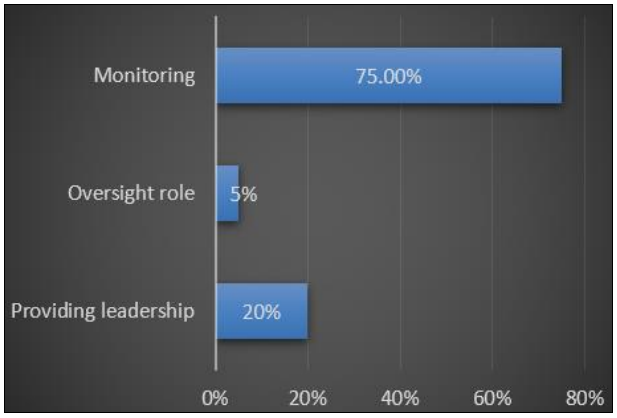

Fig 10: Role of project managers in overcoming obstacles to effective project material management?

The study requested respondent to indicate role of project managers in overcoming obstacles to effective project material management.75% of the majority respondent monitoring, 5% of the respondent indicated providing oversight and 20% of the respondent indicated providing project leadership

4.5 Discussion of the findings Background information of the respondent

The study requested respondent to indicate marital status. 65% of the majority respondent indicated married while 25% of the respondent indicated single. The study requested respondent to indicate gender. 70% of the majority respondent indicated male while 30% of the respondent indicated female. The study requested respondent to indicate education. 50% of the majority respondent indicated diploma, while 40% had certificates and degree 10% The study requested respondents to indicate how long have you worked with construction company. 78% of the majority respondents indicated below 5 years while 22% of the respondents indicated above 6 years.

Theme 1: To establish various techniques of inventory cost management of material in Road constructions.

The study requested respondents to indicate which of the following inventory costing methods is best suited for companies. The results showed that 25% of respondents indicated the Weighted Average (WA) method, 55% preferred the First-In-First-Out (FIFO) method, and 20% opted for the Last-In-First-Out (LIFO) method.

Material management is a critical aspect of construction projects, as materials account for approximately 55%-60% of the total construction cost. Efficient material planning is key to successful construction projects. Material management is defined as the process of providing the proper quantity and quality of materials at the appropriate place and time. This process includes planning, procurement, inventory control, storage, handling, transportation, and standardization of materials.

Construction projects often suffer from cost overruns and time delays. These issues can be mitigated by properly implementing material management, which ensures the timely flow of materials to the job site, increases labor productivity, and reduces project costs. Controlling material costs can significantly reduce overall project expenses.

Material planning and inventory control are two essential aspects of material management. Material planning involves determining the requirements needed to fulfill construction needs under economic investment policies. This includes activities such as identifying, quantifying, and scheduling the necessary materials.

In this paper, material planning is reviewed using S-curve analysis. The main causes for fluctuations in planned versus actual material costs were identified through interviews with contractors and engineers. The goal of inventory management is to maintain an adequate supply of materials to meet expected demand patterns within a given financial investment. Proper inventory management ensures materials are kept in good and usable condition.

The paper also employs ABC classification to categorize materials based on their importance and value, allowing for extra care in managing materials that represent a major portion of the cost. Excessive inventory can lead to higher holding costs, while insufficient inventory can result in more frequent orders and higher ordering costs. Economic Order Quantity (EOQ) analysis is used to balance holding and ordering costs, reducing overall expenditure.

Some research works on this topic provide valuable insights into the processes and challenges of construction material management.

Factors that determine the most effective inventory management technique in road construction

The study requested respondent to indicate key factors in determining most effective inventory cost management technique in road construction. 50% of the majority respondent indicated locations of materials, 25% of the respondent indicated skills of manager and 25% of the respondent nature of product Singh and Singh (2013) studied the Just in Time (JIT) strategy and mentioned the elementary method of inventory control, known as ABC analysis. The authors explained the philosophy behind the JIT strategy, stating that no activity should occur until the requirement for that activity arises. JIT helps to eliminate excess inventory, thereby automatically reducing waste. This can be achieved by simplifying the manufacturing process. As quality becomes a necessity, there will be fewer defective items in the inventory, which reduces work-in-process inventory. The authors concluded that JIT has potential and could help organizations navigate the competitive market and the dynamic environment of the construction industry.

Mansour N. Jadid (2013) developed a framework using an internet-based system for the material selection decision support system in projects under the design or construction phase. This development could benefit various domains of civil engineering, but the authors focused on architecture, engineering, construction, and inventory management departments. The authors addressed problems such as material approval, selection, and information management, mentioning that the primary source of data input is from previous or current projects. This paper discussed various criteria for material selection, including maintainability, aesthetics, adaptability, durability, sustainability, cost efficiency, and lack of toxicity, which all assist officials in finalizing decisions on material selection.

To examine how material management affects road construction performance, the study requested respondents to indicate the relationship between effective materials management and product performance. 80% of respondents indicated a strong relationship, while 20% indicated a slight relationship.

Patil and Pataskar (2013) analyzed inventory management techniques. The authors focused on identifying current inventory management techniques. The study was conducted in two phases. In the first phase, the authors used curve analysis with MSP tools to provide qualitative data. In the second phase, they employed ABC and EOQ analysis to solve the problem of stockouts. Data was collected from tender documents, material requisition notes, ledger registers, and interviews. The results indicated that the unavailability of RCC drawings caused problems for contractors in accurately assessing projects. Uneven geographical features could also cause delays or problems in projects. The authors recommended conducting ABC and EOQ analysis before starting work and ensuring all drawings are completed and handed over to contractors to increase inventory management efficiency.

Jose V. and Jayakumar (2013) studied different inventory items and performed EOQ and ABC analyses to determine which materials are important to projects and their respective quantities. They collected data on 40 materials from inventory, including demand per year, reorder cost, carrying cost, and the number of units ordered. The authors discussed safety stocks and their application in inventory management. They calculated actual demand over a period of one year, with a maximum lead time of 100 days. The authors segregated the 40 items into classes A, B, and C for ABC analysis. They found that items worth more than 100 rupees constituted 45% of total inventory, items worth 25-100 rupees made up 35%, and items worth less than 25 rupees accounted for the remaining inventory. Arunprakash and Nandhini (2013) studied the material control practices adopted by different construction companies. The authors designed a questionnaire and identified the companies for the study. Additionally, they collected data from the companies' stock books. In their paper, the authors established various criteria and analyzed them. These criteria included the types of material stock, maintaining stock for equipment spares, maintaining stock for materials such as sand, brick, aggregate, steel rods, primer, and cement, maintaining documents, reordering stocks, and stock management. The authors found that 50%-60% of companies focused only on important materials like cement and steel. The availability of other materials on-site decreased as they were considered less important and required a lot of space for storage.

Which of the following factors has an effect on materials management?

The study requested respondent to indicate which of the following factors has the greatest impact on the effectiveness of materials management. 30% of the respondent indicated funding at the right time, 15% of the respondent indicated storage capacity and 55% of the respondent indicated staff training. Samuel and Ondiek (2014) [25] studied the impact of inventory management automation on the performance of supermarkets, considering various automated systems such as Material Requirement Planning (MRP), Electronic Point of Sale (E-POS), Enterprise Resource Planning (ERP), Vendor Managed Inventory (VMI), E-procurement, and Radio Frequency Identification (RFID). The authors used a descriptive survey

design and collected data from 12 supermarkets. They recommended a decentralized management structure, which allows low-level managers to make decisions, as being more effective. The authors also suggested that supermarkets should take the initiative to collect information to accurately determine customer demand.

Pande and Sabihuddin (2015) studied the implementation of inventory management techniques and their impact on the management of items at construction sites.

To identify challenges affecting the effectiveness of the project material management

A study requested respondents to indicate the challenges affecting the effectiveness of project material management. The findings showed that 10% of respondents identified poor project costing skills, 30% pointed to a lack of training, and 50% indicated inadequate funding as the main issues.

Kameshwar and Saravanan (2017) explored effective inventory management systems in the construction industry. Their objective was to reduce the total cost of inventory and achieve optimal quantities of items at the right time. They analyzed 41 different construction materials, such as safety helmets, PVC cover blocks, measuring tapes, shovels, and mortar. The authors recommended that the inventory management team should jointly replenish multiple items to minimize ordering costs. They also suggested seven techniques for managing essential materials that are continuously used throughout a project.

V. Rathinakumar *et al*. (2018) studied material planning and inventory control, focusing on the role material management plays in efficient project management. They conducted a case study on a residential apartment building and interviewed engineers and contractors. The authors analyzed the cost performance of cement, steel, and bricks using S curve analysis, which revealed that all three materials had a cost performance index value of less than 1. The paper identified several causes for cost variance: Changes in material condition during transportation, poorly executed market anticipation, materials damaged during storage, and ineffective material utilization. Sensitivity analysis was conducted to determine how changes in demand and holding cost affect the Economic Order Quantity (EOQ). The sensitivity was found to be 0.3 for a 10% change in demand and 0.42 for a 25% change in holding cost. The research also indicated that the actual material cost was higher than the planned material cost, implying a cost overrun. The authors concluded that project efficiency could increase by 35% with proper implementation of inventory management.

Nazar Sohail (2018) examined the connection between a company's performance and material management through a case study of a small steel manufacturing industry.

5. Conclusion and Recommendations

5.1 Overview

This chapter presents the key conclusions and recommendations of the study, which aimed to examining material management in project management case study of Road constructions projects in Solwezi.

5.2 Conclusion

Inventory management plays a crucial role in the successful and timely completion of construction projects. Its primary function is to store materials on-site, ensuring they are available when needed. Inventory not only holds materials required for construction but also stores finished products, spare parts, and tools.

In the Indian construction industry, it is common for projects to suffer from cost overruns and missed deadlines. These issues can be addressed through proper implementation of inventory management, which can increase on-site productivity and ensure consistent project progress. Inventory management involves several processes, including selecting materials, procurement, transportation, and storage.

Each of these processes incurs costs that are managed within the inventory management budget. These costs include:

- **Ordering Cost:** The essential cost incurred when a company places an order.
- **Holding Cost:** The cost associated with storing materials before they are used on-site.
- **Storage Cost:** The cost associated with the storage of materials, which can be direct or indirect, including expenses such as rent and electricity.

5.3 Recommendation

Ensuring materials meet the required quality standards is indeed a significant challenge in materials management. A material manager must collaborate with suppliers to guarantee that materials are produced according to the correct specifications and delivered in the appropriate condition.

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