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Assessment on the Impact of Artificial Intelligence Driven Supply Chain Software's in Reducing Shipping Cost in Tanzania

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Abstract

This study is on the assessment of the impact of Artificial Intelligence (AI)-driven supply chain software on reducing shipping costs in Tanzania, a critical component for enhancing the efficiency and competitiveness of the country's logistics sector. The study adopts a descriptive research design, utilizing both qualitative and quantitative methods to capture a holistic understanding of the subject matter. A sample of 70 respondents, selected through a combination of random and purposive sampling techniques, provided insights into the current state and future potential of AI in the logistics industry.

Key findings reveal that while the adoption rate of AI-driven supply chain software is steadily increasing among Tanzanian logistics firms, driven by the need for enhanced decision-making, cost reduction, and improved demand forecasting, several formidable challenges persist. These challenges include infrastructure deficiencies, regulatory hurdles, a shortage of skilled professionals, and cultural resistance to technological change. Additionally, the study high- lights that AI-driven predictive maintenance and dynamic routing have led to significant cost savings, minimizing unplanned downtime, reducing fuel consumption, and extending vehicle lifespans.

Furthermore, the study found that traditional shipping and logistics methods in Tanzania are often hampered by inconsistent infrastructure, particularly in major hubs like Dar es Salaam, where shipping costs can range from $1,500 to $3,000 per container, depending on various factors. In contrast, AI-driven solutions offer real-time optimization, addressing these inefficiencies and contributing to substantial reductions in shipping costs. Based on these findings, the study offers several recommendations. It urges the Tanzanian government to actively promote the economic benefits of AI adoption, including cost savings, operational efficiency, and enhanced global competitiveness for local businesses. The study also advocates for the establishment of supportive policy frameworks, including incentives for AI adoption and regulatory reforms to ease the integration of these technologies.

Keywords: Artificial Intelligence, Supply Chain, Shipping Costs, Logistics AI-driven Software

1. Introduction

In recent years, many maritime industries have integrated Artificial Intelligence (AI) technology into software development to transform traditional supply chains, unlocking new opportunities for optimization and efficiency in supply chain processes. AI has emerged as a powerful tool for software-driven supply chains to reduce shipping costs, a significant component of overall expenses [1, 2] observed that, over the past decade, companies in the embedded systems sector have primarily focused their value-creating activities on physical products, particularly those involving mechanics and electronic components. This focus has been evident in industries such as telecom, automotive, defense, security, and manufacturing, where product sales continue to be the primary source of revenue [3] .

Significant advancements in optimization capabilities are achieved when AI decision- making systems are tasked with controlling Distributed Order Management (DOM) systems and involved in high-level strategic decision-making. Currently, some of these tasks are handled by rule-based decision agents, but in the future, AI systems, equipped with the ability to learn and adapt, will be responsible for making decisions in complex and dynamic environments [4]

The most advanced DOM systems available today are strong planning instruments that can resolve challenging supply and demand equations to produce an order fulfilment strategy that is both economical and satisfies customers. The way these systems operate in terms of total cost sets a new precedent. DOM systems consider all of the possibilities for completing the order rather than analysing each fulfilment decision separately, such as where to source product for a particular client purchase. Subsequently, they assess every potential combi- nation of fulfilment choices throughout the order to determine a strategy that satisfies both the customer service level agreements and the lowest feasible cost [5]

Supply chain management has evolved into a complex and intricate field of study, hav- ing undergone a significant transformation with the integration of software in the strategic planning and operational aspects. In the realm of logistics, the most notable advancement has been the extensive utilization of DOM systems, which offer the potential to deliver cost-efficient order commitment and fulfilment procedures to organizations with intricate, worldwide supply networks [6] .

The study investigated how AI has been leveraged to achieve cost savings in the maritime industry. However, this technology has had both positive and negative impacts on society. Despite potential challenges such as a lack of computer literacy among employees and tech- nological complexities, the focus has largely been on the benefits and profits. Notably, the industry has advanced significantly, addressing the need for transportation technologies and managing resources and operations across various sectors of the maritime industry.

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In response to these gaps, this paper aims to provide a detailed assessment of the impact of AI-driven supply chain software on reducing shipping costs in Tanzania's logistics sector. This research seeks to evaluate the current adoption rates of AI technologies, analyze the challenges faced by logistics firms in their implementation, and assess the effectiveness of AI solutions in optimizing supply chain processes. By addressing these questions, this study contributes to a better understanding of the potential for AI-driven technologies to enhance logistics efficiency in Tanzania, offering practical insights for policymakers, businesses, and other stakeholders

1.1. Statement of the Problem

Shipping costs can be a major burden in software-driven supply chains. Traditional methods of route planning, load management and carrier selection often lack real- time data and advanced analytics. This inefficiency translates to wasted resources and higher costs [7] . AI offers a solution by providing data- driven insights for optimizing shipping processes such as Demand Forecasting, Route Optimization, Dynamic Load Planning, Autonomous Vehicles, Automated Warehousing, Automated Transportation, Predictive Maintenance and others [8] .

AI-based technologies have been effectively applied in various domains, such as procurement, warehousing, inventory management, and transportation. Furthermore, there has been a growing interest in the integration of AI within supply chain management in recent years. The key drivers behind this success lie in the ability of AI technologies to handle vast datasets and extract essential information. Within an AI system, like a fuzzy logic system, there exists the potential to aggregate and oversee incomplete or unstructured information [9]
.

Tanzania's supply chains are increasingly reliant on software for management and optimization. This digitalization presents an opportunity to leverage AI for cost reduction, particularly in the realm of shipping. AI algorithms can analyse vast amounts of data on historical shipping patterns, traffic conditions, fuel prices, and supplier locations. This analysis can then be used to optimize routes, identify cost- effective carriers, and predict potential disruptions, leading to significant cost savings. However, the current landscape presents limitations. Local data availability and quality on factors like road conditions and fuel prices can be inconsistent. Additionally, the specific capabilities of various AI solutions for the Tanzanian context remain unexplored.

While AI's potential for cost reduction is established globally, its effectiveness in Tanzania's unique logistical environment needs testing. The success of AI hinges on the quality and comprehensiveness of data. Research is needed to assess the current state of data col- lection, storage, and accessibility in Tanzanian logistics. The upfront costs of implementing AI solutions need to be weighed against the potential cost savings in shipping. Studies are required to determine the return on investment (ROI) for different AI solutions in the Tanzanian context. In that case therefore this current study aimed to evaluate the impact of using artificial intelligence in software – driven supply chains to reduce the shipping cost in Tanzania, a case of Silent Ocean & Kilimanjaro Star Cargo in Dar es Salaam.

1.2. Research Objectives and Corresponding Research Questions

The Figure 1 illustrates the key research objectives and corresponding research questions that guide this study. The general objective is to evaluate the impact of AI-driven supply chain software on reducing shipping costs in Tanzania. This overarching goal is broken down into three specific objectives: analyzing the adoption rate of AI-driven supply chain software in Tanzanian logistics firms, identifying the challenges of implementing such software, and assessing efficiency improvements in routing and scheduling due to AI adoption.

Each specific objective is associated with a corresponding research question aimed at exploring the identified themes in greater depth. These questions seek to understand the extent of AI adoption, the challenges encountered in this process, and how AI-driven software influences operational efficiencies in Tanzanian logistics. The visual representation shows how the general objective cascades into specific objectives and research questions, providing a structured approach to investigating the impact of AI technology in the logistics sector.

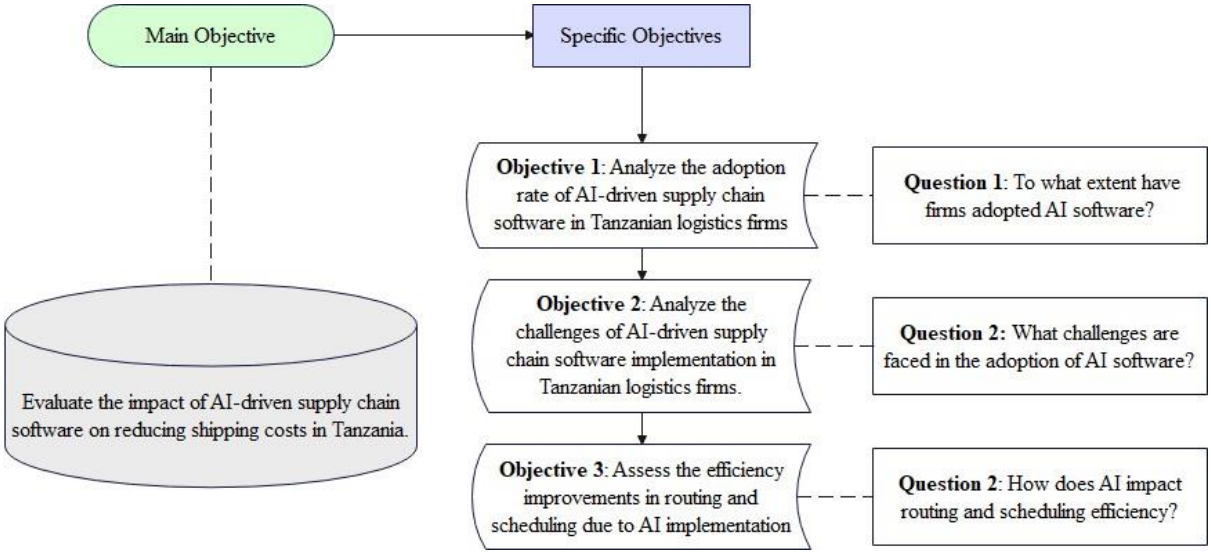


Figure 1: Research Objectives and Corresponding Research Questions

1.3. Definitions of Key Terms

AI is abbreviated as Artificial Intelligence that refers as a computer system capable of complex tasks that a human could do but in a simplified methods such as reasoning, making decision and solving problems without being tired [10] .

Software-driven refers to systems, processes, or operations that are primarily con- trolled, managed, or enhanced by software applications. In a software-driven environment, software is the central component that enables automation, optimization, data analysis, and decision-making, often reducing the need for manual intervention

A software-driven supply chain leverages advanced software applications and technologies to enhance the efficiency, accuracy, and responsiveness of supply chain operations.

This approach integrates various digital tools to automate processes, analyse data, optimize logistics, and facilitate real-time decision-making

AI-powered refers to systems, applications, or processes that leverage AI technologies to enhance their functionality, efficiency, or performance. AI encompasses a range of technologies that enable machines to perform tasks that typically require human intelligence, such as learning from data, recognizing patterns, making decisions, and understanding natural language [11] .

Machine learning (ML) is a subset of AI that involves the development of algorithms and statistical models that enable computers to perform tasks without explicit instructions. Instead, these systems learn and improve from experience by analysing and identifying patterns in data [12] .

SCM is abbreviated as Supply Chain Management that refers as a design and management of flow of products, information of funds throughout the supply chains. As SCM can help in handling entire production flow of goods and services starting from raw components to final products that can be delivered to consumers [13] .

1.4. Theoretical Review

The research can gain a comprehensive understanding of the potential impact of AI in software-driven supply chains on shipping costs in Tanzania. The theories can explain how AI can provide a competitive advantage and reduce transaction costs, while these theories can shed light on the factors influencing AI adoption and the importance of context-specific implementation strategies.

1.4.1. Technology Acceptance Model (TAM

This explored the factors influencing the adoption of AI-driven supply chain software, including perceived usefulness and ease of use. In the context of the research, AI can be seen as a valuable resource that, when integrated into software- driven supply chains, can enhance efficiency, reduce costs, and ultimately provide a competitive edge for Tanzanian businesses. AI's ability to analyze vast amounts of data, optimize routes, and predict demand fluctuations can be considered valuable capabilities that contribute to the firm's overall resource base [14]

1.4.2. Supply Chain Operations Reference (SCOR Model

This provides a comprehensive framework for evaluating supply chain performance, fo- cusing on the efficiency, reliability, and cost-effectiveness of AI-driven solutions [15] . AI- powered supply chains can significantly

reduce these transaction costs by automating processes, streamlining communication, and improving transparency. For example, AI can facilitate real-time tracking of shipments, automate customs procedures, and optimize inventory management, thereby reducing the need for manual intervention and minimizing associated costs [16] .

1.4.3. Diffusion of Innovation (DOI Theory

DOI theory explains how new technologies are adopted and spread within a social system. In this context, the adoption of AI in Tanzanian supply chains can be analyzed through the lens of DOI. Factors such as the relative advantage of AI over traditional methods, compatibility with existing systems, complexity of implementation, trialability, and observability of results were influence the rate and extent of AI adoption in the Tanzanian context. Understanding these factors can help policymakers and businesses devise effective strategies to promote AI adoption and maximize its benefits [17] .

1.4.4. Contingency Theory

Contingency theory emphasizes that there is no one-size-fits-all approach to management and that the optimal course of action depends on the specific circumstances. In the case of AI implementation in supply chains, the effectiveness of AI solutions may vary depending on factors such as the size and nature of the business, the existing infrastructure, and the level of technological expertise available. Therefore, it is crucial to tailor AI implementation strategies to the specific context of Tanzanian businesses and supply chains to ensure optimal result [18] .

1.5. Empirical Review

1.5.1. Studies in Developed Nations

Numerous studies in developed nations have highlighted the transformative potential of AI in optimizing supply chains and reducing shipping costs. For instance, DHL's 2018 research report, "Artificial Intelligence in Logistics," revealed that AI-powered predictive analytics could enhance demand forecasting accuracy by up to 90%,

leading to significant cost reductions through optimized inventory levels and transportation route. Similarly, a study by McKinsey & Company found that AI-enabled supply chains could reduce logistics costs by 15%, while simultaneously increasing inventory levels by 35% and service levels by 65% [19]

Moreover, research by Accenture demonstrated that AI could improve supply chain visibility and agility, enabling companies to respond more effectively to disruptions and unexpected event. In a practical application, Amazon's AI- powered fulfillment centers have revolutionized the e-commerce industry by automating various tasks, such as picking, packing, and shipping, resulting in significant cost savings and improved customer satisfaction . These examples from developed nations provide compelling evidence of the potential benefits of AI in supply chain management and underscore the importance of exploring its application in developing countries like Tanzania.

1.5.2. Studies in African Context

While research on AI in supply chains within the African context is still emerging, several studies have highlighted the potential for AI to address unique challenges faced by African businesses. For instance, a study by IBM and the African Union Commission explored the potential of AI to improve agricultural supply chains in Africa, focusing on enhanc- ing crop yield predictions, optimizing resource allocation, and improving market access for smallholder farmers . Another study by the World Bank examined the potential of AI to improve logistics and transportation networks in Africa, with a focus on reducing transit

times, improving infrastructure utilization, and enhancing trade facilitation.

Furthermore, research by the African Center for Economic Transformation (ACET) emphasized the importance of developing local AI capabilities and expertise to ensure that AI solutions are tailored to the specific needs and contexts of African coun. This research highlights the need for a nuanced a pproach to AI adoption in Africa, taking into account local challenges, resources, and priorities.

1.5.3. Studies in Tanzania

In the Tanzanian context, limited research has directly explored the impact of AI on shipping costs. However, a study by the Tanzania Revenue Authority (TRA) investigated the potential of AI to improve customs procedures and trade facilitation, highlighting the potential for AI to reduce delays and costs associated with cross- border trade , a report by the Tanzania Communications Regulatory Authority (TCRA) explored the state of AI adoption in various sectors in Tanzania, including logistics and transportation, finding that while AI adoption is still in its early stages, there is growing interest and potential for AI to transform these sectors .

These studies, while limited in scope, provide valuable insights into the potential of AI to address specific challenges faced by Tanzanian businesses and supply chains. However, further research is needed to quantify the potential impact of AI on shipping costs in Tanzania and to identify the most effective strategies for AI implementation in the Tanzanian context. The proposed research aims to fill this gap by providing a comprehensive analysis of the impact of AI in software-driven supply chains on shipping costs in Tanzania, drawing on lessons learned from developed nations and other African countries.

1.6. Research Gap

While previous research has explored the broader landscape of technology adoption in SCM within the World, including the potential of low-carbon SCM and the factors influencing technology diffusion , a significant gap remains in understanding the specific role of AI in reducing shipping costs within the Tanzanian context. Although [20] investigated the integration of technology and low-carbon SCM, their research did not delve into the particular AI-driven software solutions that could directly address the pressing issue of high shipping costs in the World.

Healthcare is a prime example. In its UK laboratory, GlaxoSmithKline is using the AI ystem to help scientists make better decisions around drug synthesis and, in turn, define the best mixture of humans and machines. These systems can change the way

chemicals are made, allowing us to explore new space, perhaps provide better ways to make the active pharmaceutical ingredient, and even allow simpler synthetic routes, reducing cost and speeding product to market [21] .

The intersection of AI and supply chain management is a rapidly evolving field, with numerous studies highlighting the potential benefits of AI in optimizing logistics and reducing costs. However, there are specific gaps in the literature that this research aims to address:

1.6.1. Limited Attention to Developing Countries

Most studies on AI-driven supply chain management have been conducted in developed countries with advanced technological infrastructures. There is a lack of empirical research focusing on the impact of AI in developing countries, particularly in the African context, including Tanzania. This research were provide insights specific to Tanzania, contributing to a more global understanding of AI's potential in supply chain management [22] .

1.6.2. Empirical Evidence on Cost Reduction

Scarcity of Quantitative Data: While there are theoretical discussions and case studies suggesting that AI can reduce shipping costs, there is a paucity of robust empirical data quantifying these reductions in the context of Tanzanian logistics firms. This research were fill this gap by providing concrete data on cost reductions achieved through AI implementation [23] .

1.6.3. Adoption Challenges

Barriers to Implementation: Although the benefits of AI in supply chain management are well-documented, there is limited research on the specific barriers that logistics firms in developing countries face when adopting these technologies. This includes financial, technical, and organizational challenges. Understanding these barriers in the Tanzanian context were help in developing strategies to overcome them [24] .

1.6.4. Impact on Operational Efficiency

Routing and Scheduling Efficiency: There is a need for detailed studies examining how AI-driven supply chain software specifically improves routing and scheduling efficiency in logistics operations. Existing literature often focuses on general improvements in supply chain performance without delving into specific operational metrics. This research were address this by analyzing improvements in routing and scheduling due to AI adoption [25] .

1.6.5. Stakeholder Perceptions

Perception and Attitude Studies: There is a lack of comprehensive studies on the perceptions and attitudes of stakeholders within logistics firms towards AI adoption, particularly in the African context. Understanding these perceptions is crucial for identifying potential resistance and facilitating smoother implementation processes [26] .

1.6.6. Policy and Strategic Recommendations

Guidance for Policymakers and Industry Leaders: Existing research often lacks practical recommendations tailored to the unique challenges and opportunities in developing countries. This study aims to provide actionable insights and recommendations for policymakers and industry leaders in Tanzania to support the adoption of AI in logistics [27].

By addressing these gaps, this research contributes significantly to the body of knowledge on AI-driven supply chain management, offering valuable insights and practical solutions for reducing shipping costs and improving operational efficiency in Tanzania and similar developing country contexts.

Building upon existing research, this study aims to fill a critical gap by exploring the potential of AI-driven software solutions to address unique challenges and opportunities within the Tanzanian shipping industry. Specifically, the research focuses on AI's role in optimizing transportation routes, predicting demand fluctuations, automating customs procedures, and improving supply chain visibility. By doing so, it aims to offer practical insights for businesses and policymakers

looking to harness AI for reducing shipping costs and enhancing the competitiveness of Tanzanian industries. This research contributes to the expanding knowledge base on AI applications in developing countries and serves as a valuable reference for future studies on AI-driven supply chain optimization in the African context.

1.7. Conceptual Framework

A conceptual framework is an analytical tool or a visual representation that helps researchers and academics to systematically organize and structure their ideas, concepts, and theories in the context of a research study. It serves as a foundation for understanding the relationships between various variables and constructs and guides the development of research questions, hypotheses, and methodology. The conceptual framework for this study illustrates the relationships among independent, intermediate, and dependent variables.

The framework in Figure 2 highlights that challenges like high costs, technical complexity, data quality issues, and resistance to change can limit the effectiveness of AI-driven supply chain software in reducing shipping costs. These factors hinder full adoption and prevent the software from optimizing routes, schedules, and inventory management efficiently. However, when implemented effectively, AI improves routing, scheduling, inventory turnover, and order accuracy, leading to faster deliveries, reduced fuel consumption, and fewer errors, ultimately driving significant shipping cost savings.

This section identified the research gaps, including the limited focus on developing countries, lack of empirical evidence on cost reduction, adoption challenges, and stakeholder perceptions. Finally, a conceptual framework illustrating the relationships between variables such as AI adoption rate, implementation challenges, routing efficiency, and their impact on shipping costs was developed.

2. Research Methodology

The research design employed in this study is descriptive, aiming to explore and analyze the role of AI-driven supply chain software in reducing shipping costs within the Tanzanian logistics sector. This approach allows for a comprehensive examination of the extent of AI adoption, its integration with other technologies, and the challenges encountered. By utilizing a descriptive design, the study seeks to provide insights into specific phenomena, such as how AI technologies impact efficiency and cost reduction in logistics. A case study methodology was chosen to gather empirical data from key logistics companies, ensuring a focused investigation into the application of AI in Tanzania's supply chains.

This study was conducted in Dar es Salaam, Tanzania, focusing on two leading logistics companies: Silent Ocean and Kilimanjaro Star Cargo. These companies were selected due to

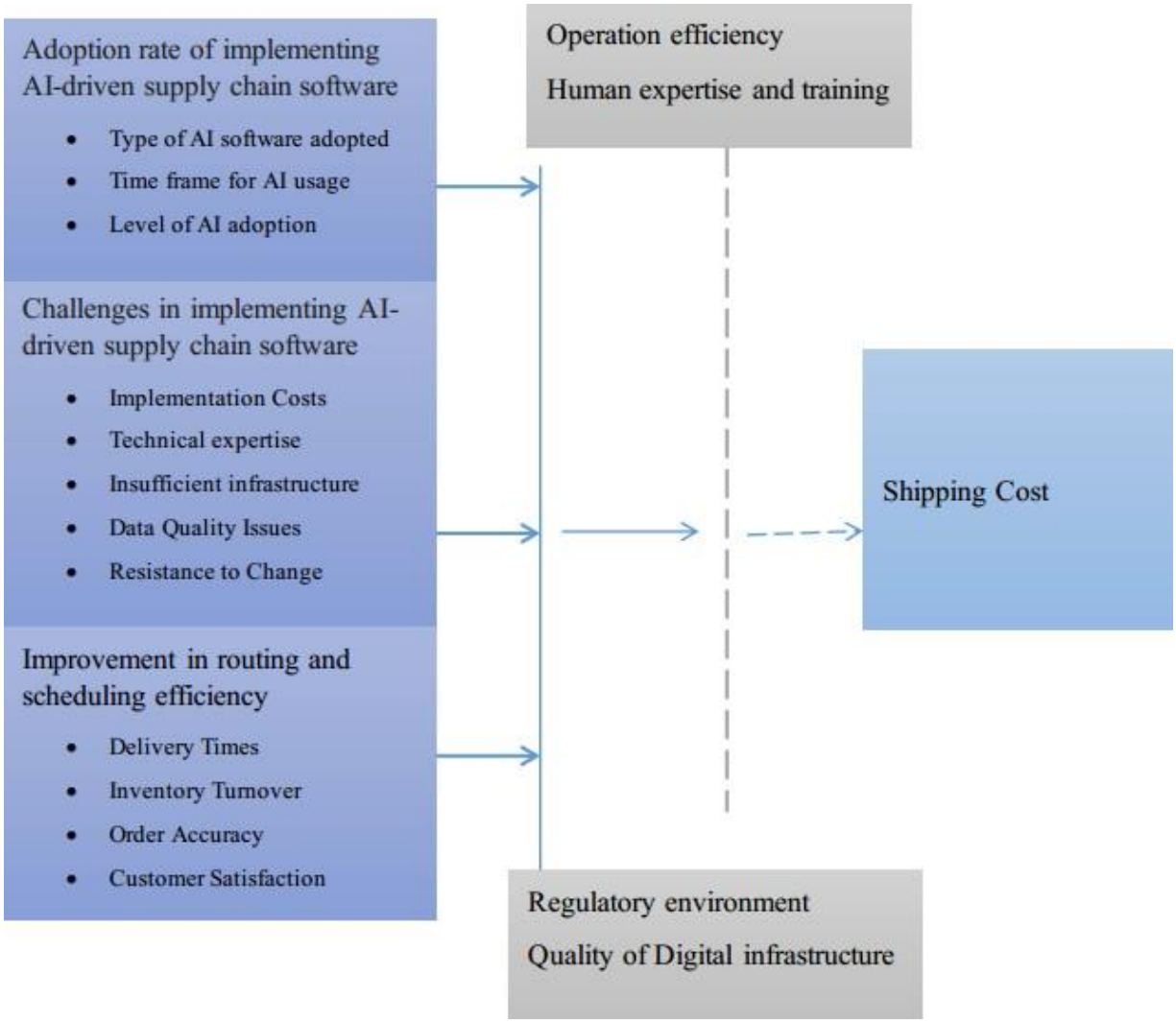


Figure 2: Conceptual Framework

their pivotal roles in Tanzania's logistics ecosystem and their connections to key international markets, including India, Turkey, the USA, and China. Dar es Salaam, as a major trade hub on the Indian Ocean and home to Tanzania's largest port, serves as a gateway for imports and exports to and from neighboring countries. Its strategic location and high level of economic activity made it an ideal setting for analyzing the impact of AI-driven technologies on supply chain optimization and shipping costs.

The study population comprised key stakeholders in the shipping and logistics industry, including personnel from shipping companies, freight forwarders, customs officials, port authorities, and government agencies. These stakeholders were instrumental in providing valuable insights into the current state of logistics operations and the adoption of AI technologies. Engaging with this diverse group helped to paint a comprehensive picture of the industry's challenges and the perceived benefits of AI-driven solutions. This approach

ensured the representativeness and relevance of the study's findings across the broader logistics ecosystem.

A sample size of 500-1000 logistics professionals was drawn from logistics companies in Dar es Salaam, particularly those that had already integrated AI solutions into their operations. Random and purposive sampling techniques were employed to select 70 respon- dents from various roles, including managers, IT specialists, and operational staff. The random sampling method ensured diversity across companies and departments, while purposive sampling targeted individuals directly involved in AI implementation. This dual approach provided a well-rounded understanding of AI's practical applications in logistics and the challenges associated with its adoption.

Data were collected through primary and secondary sources. Primary data was gathered using structured questionnaires and semi-structured interviews. Questionnaires were designed to capture key demographic information and respondents' experiences with AI technologies in reducing shipping costs. The semi-structured interviews focused on exploring AI's impact on specific shipping processes, challenges in implementation, and the benefits realized. Surveys were distributed through various channels, including emails and industry associations, to maximize participation from logistics professionals. This blend of qualitative and quantitative data collection provided a holistic view of the current state of AI adoption in Tanzania's logistics sector.

Secondary data was obtained from existing reports, financial records, and academic studies related to AI and supply chain management. This allowed for a comparative analysis of the logistics companies' performance before and after AI implementation. The combination of primary and secondary data strengthened the study's ability to address the research questions effectively.

The analysis process involved both qualitative and quantitative techniques. Descriptive statistics, such as percentages and frequencies, were used to summarize responses from the questionnaires. Thematic analysis was employed to identify patterns and themes in the inter- view data, providing in-depth insights into the experiences of stakeholders directly involved in AI integration. This mixed-method approach ensured a comprehensive understanding of both the quantitative impacts of AI and the qualitative challenges faced by logistics firms.

To ensure reliability and validity, a pilot study was conducted, and the research instruments were refined based on feedback. This helped eliminate potential biases and ambiguities in the data collection process. Furthermore, ethical considerations, including confidentiality and informed consent, were strictly observed throughout the study to maintain the integrity and privacy of the participants.

In summary, the research methodology employed was conducted as indicated in the Figure 3

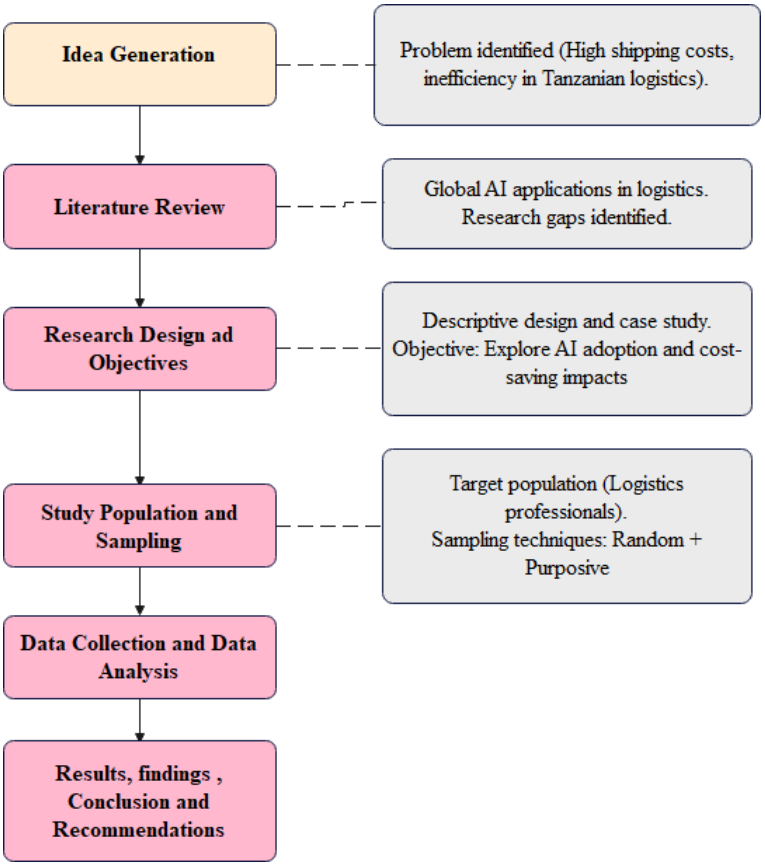


Figure 3: Research methodology

3. Results, Discussion and Findings

3.1. Response Rate

The response rate is calculated by dividing the number of completed survey responses by the number of surveys distributed. In this study, 100 questionnaires were distributed to participants, out of which 90 were returned. However, 20 questionnaires were excluded from the analysis due to incomplete sections, leaving 70 usable questionnaires. The overall response rate for the data collection was 70%, which is considered acceptable for analysis.

3.2. Demographic characteristics of respondents

This part presents the demographic characteristic of the respondent of the study, including age, gender, and education level of respondents involved in this study.

3.2.1. Age of the respondents

The age distribution of the respondents for the study as shown in table 4.1 reveals a balanced mix of early-career, mid-career, and senior professionals. The majority of the respondents, comprising 38.0%, fall within the age group of 31-35 years, suggesting that a

significant portion of the participants are likely in the prime of their professional careers, possibly occupying mid-level managerial positions. Additionally, the age groups 36-40 and 41-45 show substantial representation, accounting for 12.7% and 18.3% of the respondents, respectively. These groups likely include experienced professionals with a deep understanding of supply chain operations and AI-driven technologies. The younger age group of 25-30 and the older group of 46-50 each constitute 7.0% of the respondents, indicating participation from

early-career professionals and those nearing the end of their careers. Furthermore, respondents aged 51 and above represent 15.5% of the sample, highlighting the involvement of senior professionals. This diverse age range among respondents provides a comprehensive understanding of perspectives on AI-driven supply chain software and its impact on reducing shipping costs in Tanzania.

The finding implies that age can significantly influence how well individuals understand and adapt to AI-driven supply chain software. Younger generations, typically between the ages of 25-35, tend to have a natural affinity for technology. Having grown up surrounded by digital interfaces, they are likely familiar with AI in their daily lives, from social media recommendations to voice assistants. This comfort with technology translates into a quicker grasp of the user interface and functionalities of AI-powered supply chain software. Moreover, younger generations often view AI as a positive force, a tool to streamline processes and improve efficiency.

Conversely, older generations, typically those aged 41 and above, bring a wealth of experience in traditional supply chain management. They possess a deep understanding of the broader picture and the intricate web of relationships between suppliers, manufacturers, distributors, and customers. This experience enables them to better grasp the strategic implications of AI integration within the supply chain. However, adapting to new technology can be challenging for this group. Older workers might require more comprehensive training and support to feel comfortable navigating the software and its functionalities. Thus, while younger professionals quickly adopt and utilize AI-driven tools, the experience and strategic insight of older professionals are crucial for the successful integration of these technologies in supply chain management.

Table 1: **4.1: Age of respondents (Source: Field Data, 2024)**

	Frequency	**Percent**	**Valid Percent**
25-30	5	7.0	7.1
31-35	27	38.0	38.6
36-40	9	12.7	12.9
41-45	13	18.3	18.6
46-50	5	7.0	7.1
51 and above	11	15.5	15.7
Total	70	98.6	100.0
Total	**70**	**100.0**	

3.2.2. Gender characteristics of respondents

From the figure 4.1, 67% of respondents were male. This does not imply that women were ignored; rather, it reflects the gender distribution observed in the study sample. Men are often stereotypically viewed as more tech-savvy, which might make them initially more comfortable with the user interface and functionalities of AI-driven software. Additionally, some sectors within supply chain management, such as logistics or manufacturing, where the research was conducted, traditionally have a higher male workforce. Experience in these areas might give men a slight advantage in grasping the real-world applications of AI within the supply chain. However, this is a generalization, and women are increasingly entering these fields and gaining valuable knowledge.

Conversely, women are often noted for their strong communication and collaboration skills, which are crucial for understanding the human element within supply chain management. These skills can help women excel in appreciating the impact of AI on various stakeholders, from employees to customers. Additionally, there is no inherent connection between gender and analytical abilities. Women can be just as adept at understanding the data and algorithms that drive AI-powered software. Therefore, while the majority of respondents were male, it is important to recognize that both

men and women bring valuable and complementary skills to the implementation and optimization of AI-driven supply chain solutions.

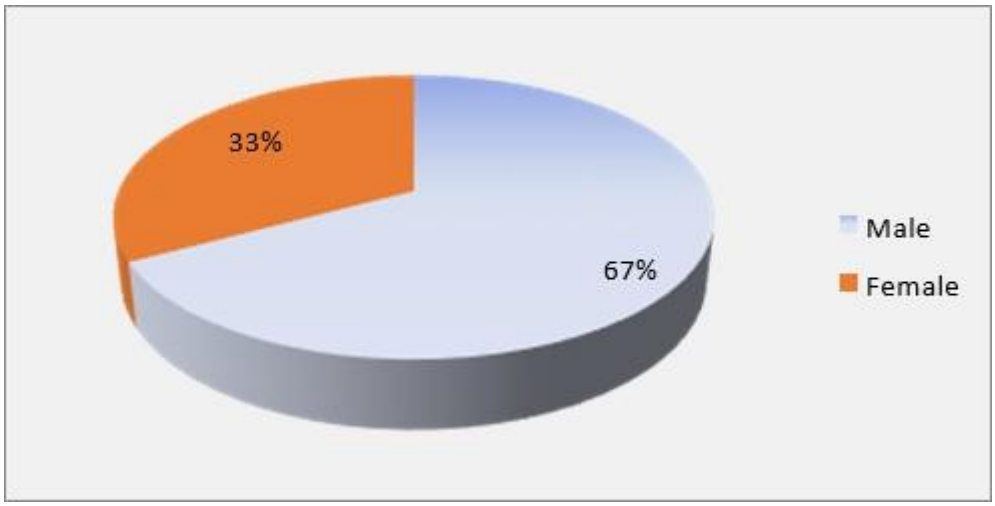


Figure 4: Gender characteristics of respondents

3.2.3. Education Level of respondents

The educational level of an individual can significantly impact their ability to work with and benefit from AI-driven supply chain software. From Table 4.2 below, 39.4% of all respondents have a bachelor's degree, followed by 32.4% with a diploma, 16.9% with a certificate, 7% with a master's degree, and only 2.8% have attained a PhD.

Individuals with higher education degrees, particularly in fields like computer science, engineering, or logistics, are more likely to possess the technical skills necessary to understand AI concepts and utilize the software effectively. They can grasp the algorithms and data analysis involved, configure the software for specific needs, and interpret the insights it generates. Additionally, higher education often fosters critical thinking and problem-solving skills, which are crucial for troubleshooting issues and adapting the software to evolving business needs.

For those with lower education levels, the barrier to entry for using AI-driven supply chain software can be higher. However, this doesn't mean they are excluded entirely. Through targeted training programs and user-friendly software interfaces, individuals with lower education levels can still benefit from AI. Training can focus on specific functionalities of the software relevant to their job roles, such as data entry or basic

analytics interpretation. Additionally, companies can invest in software with intuitive interfaces that minimize the need for extensive technical knowledge. By offering these opportunities, companies can leverage the broader workforce and ensure everyone can contribute to and benefit from the efficiencies offered by AI-driven supply chain software.

Table 2: Education Level of Respondents

	Frequency	**Percent**	**Valid Percent**
Certificate	12	16.9	17.1
Diploma	23	32.4	32.9
Degree	27	39.4	40.0
Master	5	7.0	7.1
PhD	2	2.8	2.9
Total	70	98.6	100.0
Total	**70**	**100.0**	

3.3. Research Findings

3.3.1. To analyse the adoption rate of implementing AI-driven supply chain software in Tanzanian logistics firms

The first objective of the study ought to analyse the adoption rate of Implementing AI-driven supply chain software in Tanzania logistics firm in Dar es Salaam. The study found that the adoption rate of AI-driven supply chain software in Tanzanian logistics firms is gradually increasing, driven by the need for enhanced efficiency and competitiveness in the market. This growth is influenced by several factors, including the rising awareness of the benefits of AI technologies, such as improved decision-making, cost reduction, and better demand forecasting.

Current Shipping Costs and Practices. The current shipping costs and practices aim to identify a company's average monthly shipping costs, percentage of total operational costs, and the factors

contributing to these shipping costs. By analysing these aspects, the study seeks to provide a detailed understanding of the financial burden associated with shipping operations.

- *Company's average monthly shipping costs*

From the findings, as illustrated in Figure 5 , it was revealed that the average monthly shipping costs for Simba and Kilimanjaro Cargo range between $10,001 and

$20,000. Other shipping companies have average monthly shipping costs ranging from $5,001 to $10,000, while some companies spend less than $5,000 per month. Additionally, there are companies that spend more than $20,000 per month on shipping.

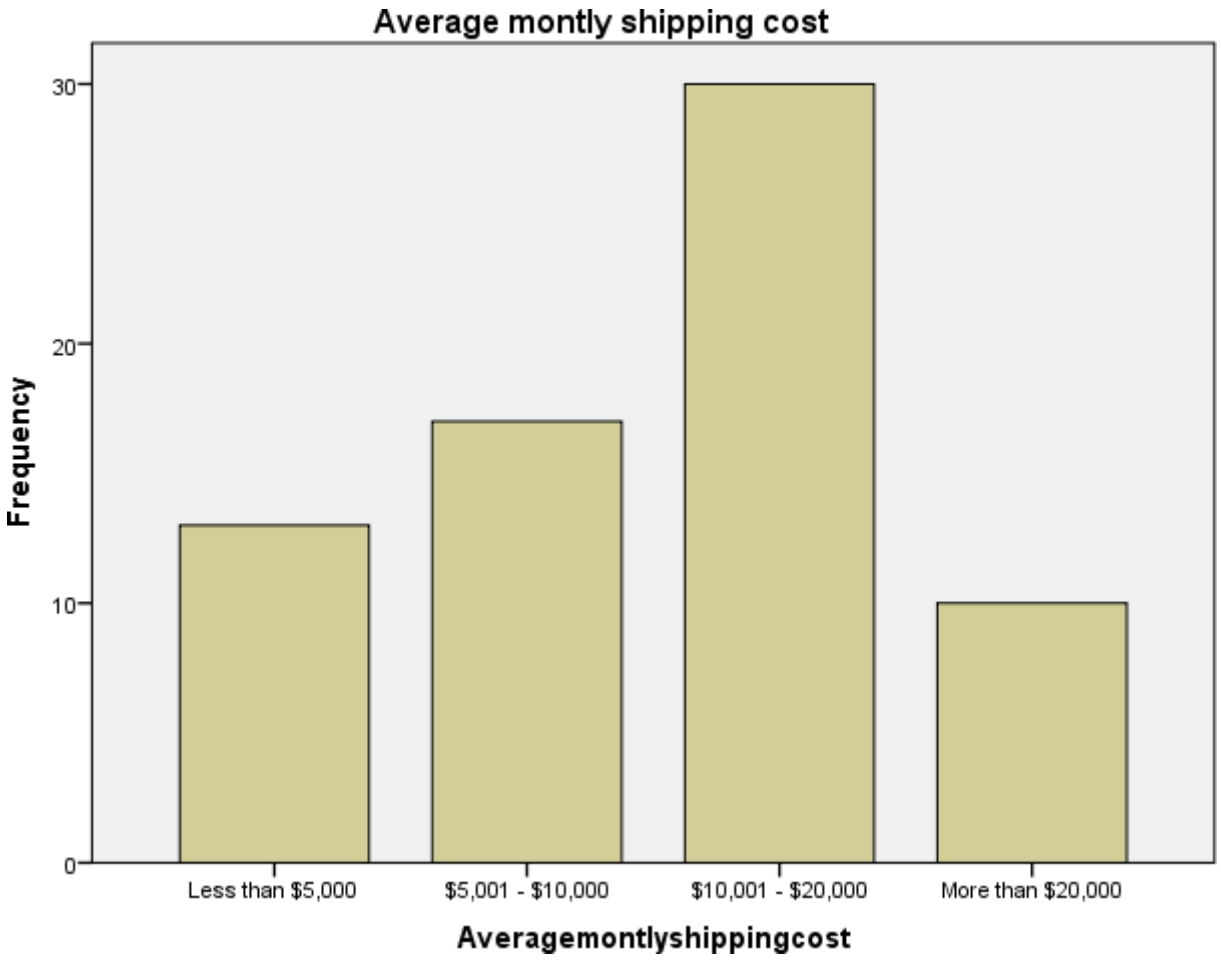


Figure 5: **Average monthly shipping cost**

Interviews with logistics officers at the Tanzania Ports Authority (TPA) established that average monthly shipping and logistics costs in Tanzania vary significantly based on factors such as the type of goods, distance, transportation mode, and service provider. For sea freight, the cost of shipping a 20-foot container ranges from $1,500 to $3,000, depending on the destination and cargo specifications. Road transport costs within the country, commonly

used for moving goods between cities like Dar es Salaam, Mwanza, and Arusha, typically range from $1,000 to $2,500 per month. These costs are influenced by factors such as fuel prices, vehicle maintenance, and road conditions. Air freight, though faster, is the most expensive option, with costs starting at around $4 per kilogram for international shipments. These costs are

subject to additional expenses such as warehousing, customs clearance, and insurance.

- *Percentage of total operational costs*

shows that for Kilimanjaro and Simba Cargo, the percentage of total operational costs attributed to shipping ranges between 31% and 40%. In contrast, other companies have shipping costs that constitute 21% to 30% of their total operational costs. Dar es Salaam's port operations are gradually improving with on- going investments in infrastructure and technology, aiming to reduce congestion and improve turnaround times. However, challenges remain, including bureaucratic delays, customs clearance inefficiencies, and occasional port congestion, all of which can impact overall shipping costs and timelines. Logistics companies in Dar es Salaam like Simba Cargo and Kilimanjaro logistics often offer integrated services, including warehousing, customs brokerage, and insurance, to provide comprehensive solutions to their clients. Despite these challenges, Dar es Salaam continues to be a critical hub for regional trade and logistics, driven by its strategic location and the increasing demand for efficient supply chain solutions in East Africa.

Table 3 shows that for Kilimanjaro and Simba Cargo, the percentage of total operational costs attributed to shipping ranges between 31% and 40%. In contrast, other companies have shipping costs that constitute 21% to 30% of their total operational costs. Dar es Salaam's port operations are gradually improving with on- going investments in infrastructure and technology, aiming to reduce congestion and improve turnaround times. However, challenges remain, including bureaucratic delays, customs clearance inefficiencies, and occasional port congestion, all of which can impact overall shipping costs and timelines. Logistics companies in Dar es Salaam like Simba Cargo and Kilimanjaro logistics often offer integrated services, including warehousing, customs brokerage, and insurance, to provide comprehensive solutions to their clients. Despite these challenges, Dar es Salaam continues to be a critical hub for regional trade and logistics, driven by its strategic location and the increasing demand for efficient supply chain solutions in East Africa.

When interviewed by researcher during field study, one of Company administrator explained that;

"The percentage of total operational costs attributed to shipping costs in our organization depending on the nature of the business, the volume of goods shipped, and the specific logistics practices employed. For businesses like ours which heavily reliant on importing or exporting goods, such as manufacturing or retail companies, shipping costs can constitute a significant portion of operational expenses. On average, shipping costs can range from 15% to 30% of total operational costs for such businesses".

Data control officer of the same company when interviewed he narrated that:

"For smaller businesses or those with less dependency on shipping, this percentage might be lower, potentially around 10% to 20%. However, for businesses like we are doing here

Table 3: Total Operational Costs(Source: Field study, 2024)

	Frequency	Percent	Valid Percent
Less than 10%	12	16.9	17.1
11-20%	13	18.3	18.6
21-30%	16	22.5	22.9
31-40%	21	29.6	30.0
More than 40%	8	11.3	11.4
Total	70	98.6	100.0
Total	**70**	**100.0**	

where logistics and transportation are critical, such as those dealing with heavy or bulky goods, perishable items, or requiring frequent shipments, shipping costs can go as high as 40% or more of total operational costs. Overall, the specific percentage of operational costs dedicated to shipping will depend on various factors, including the efficiency of logistics operations, the cost of fuel, the distance goods need to be transported, and the ability to optimize supply chain processes".

- *Primary factors contributing to your shipping costs*

Table 4 indicate Infrastructure was mentioned as the core factors that contributing to shipping cost by 42.3%, labour cost ranked number two by 28.2 % as primary factors contributing to shipping cost, Fuel cost by 14.1 contributes to shipping cost while delay and inefficiency contributed to 8.5% in shipping cost and lastly customs and duties contributed by 5.6% of shipping cost.

Table 4: The primary factors contributing to shipping costs(Source: Field Data, 2024).

	Frequency	Percent	Valid Percent	Cumulative Percent
Fuel costs	10	14.1	14.3	14.3
Labour costs	20	28.2	28.6	42.9
Infrastructure limitations	30	42.3	42.9	85.7
Delays and inefficiencies	6	8.5	8.6	94.3
Customs and duties	4	5.6	5.7	100.0
Total	70	98.6	100.0	
	70	**100.0**		

During an interview with Human Resource officer in shipping company when asked about primary factors for shipping cost, the response was:

"Customs clearance procedures in Tanzania can be lengthy and complex, often requiring extensive documentation and compliance with various regulations. This process not only delays shipments but also adds to the costs through fees, duties, and potential penalties for non-compliance. Moreover, fluctuations in fuel prices, a major cost component for both sea and road freight, directly impact shipping expenses. High fuel prices increase the cost of transportation, affecting both short-distance deliveries within the country and long- haul international shipments. Combined, these factors contribute to a higher cost structure for shipping in Tanzania, influencing the overall efficiency and competitiveness of the logistics sector".

Another administrator from TPA when responding to the question about the primary factors contributing to shipping costs he said that:

"Tanzania's vast geography, with its coastal regions, central plateau, and remote islands, creates varying distances and accessibility challenges. Shipping to Dar es Salaam, a major port city, would likely be significantly cheaper than reaching a remote village in the Kigoma Region bordering Lake Tanganyika. Transportation costs typically increase with distance, and remote locations might require specialized logistics or longer transit times, further impacting the price".

Another officer added that

"The chosen mode of transportation would be a critical factor influencing the cost. Given my hypothetical physical form, air freight might be the most efficient option, particularly for longer distances. However, air freight in Tanzania is significantly more expensive compared to road transport. Land-based options, like trucks, could offer a more economical solution, but travel times would be longer, especially for deliveries far from major transportation hubs. The final decision on the mode of transport would depend on a cost-benefit analysis, balancing speed and affordability based on the urgency of the delivery".

Consequently, the interplay between geographic location within Tanzania and the chosen mode of transport (air freight vs. road transport) would be the primary factors influencing the hypothetical cost of shipping within the country. Distance and accessibility would dictate the base cost, while the chosen mode of transport would determine the balance between speed and affordability.

3.3.2. Adoption of AI-Driven Supply Chain Software

Exploring the adoption of AI-driven supply chain software focuses on several key aspects: whether a company currently utilizes AI-driven solutions, the specific AI technologies being employed, the duration for which the company has been using these technologies, and the overall level of AI adoption within the supply chain operations. This provides insights into the extent of AI Adoption.

- *Company currently using any AI-driven supply chain software*

Table 3 illustrates that 80% of respondents, representing 57 individuals, indicated that their companies are not currently using any AI-driven supply chain software. Conversely, 20% of respondents affirmed that their companies do use AI-driven supply chain software.

This indicates that the adoption of AI-driven supply chain software in Tanzania is currently low and underscores the need for efforts to accelerate its development and integration. Implementing AI-driven supply chain software in Tanzanian shipping companies could greatly improve operational efficiency and decision-making capabilities. AI technology can enhance route planning by analysing traffic patterns, road conditions, and weather forecasts, leading to reduced fuel consumption and shorter delivery times. Such advancements can provide substantial cost benefits and operational improvements, highlighting the importance of fostering the adoption of AI solutions in the industry.

This optimization not only lowers operational costs but also improves customer satisfaction through more reliable and timely deliveries. Additionally, AI can assist in demand forecasting by analysing historical data and market trends, helping companies manage inventory more effectively and reduce the risk of overstocking or stock outs. This leads to better resource allocation and streamlined operations, ultimately boosting the company's profitability, as one of TPA administrator justified during an interview.

"AI-driven supply chain software can enhance the transparency and traceability of shipments. This level of visibility is crucial for maintaining the integrity of perishable or sensitive goods, which are common in Tanzania's agricultural exports. Moreover, AI can automate routine administrative tasks such as customs documentation and compliance checks, reducing the likelihood of errors and speeding up the clearance process. By adopting AI-driven solutions, shipping companies in Tanzania can overcome existing logistical challenges,

improve operational resilience, and stay competitive in the rapidly evolving global market".

3.4. The specific AI technologies being employed

Table 5 reveals the specific AI technologies employed by the surveyed companies. Predictive analytics is the most commonly used technology, with 32.4% of companies utilizing it. This is followed by route optimization, employed by 28.2% of companies, demand forecasting used by 17%, and inventory management implemented by 12.7%. These percentages reflect a general understanding of AI's potential to save time and reduce costs. However, it also suggests that while these technologies are introduced, they are often employed in a limited capacity, primarily for cost-saving purposes rather than fully integrating AI to enhance broader operational efficiency.

According to [2] , predictive analytics in supply chain management involves leveraging artificial intelligence and advanced analytics to forecast future events and behaviours within the supply chain. By analysing historical data, current conditions, and various influencing factors, predictive AI models can generate informed predictions regarding demand patterns, inventory levels, supplier performance, and transportation needs. This capability enables companies to make data driven decisions, optimize operations, and proactively ad- dress potential challenges.

- *Duration of AI-Driven Supply Chain Software Usage*

Table 6 reveals that 70.4% of Simba Cargo and Kilimanjaro Logistics have been using AI-driven supply chain software for less than one year. In contrast, other companies have

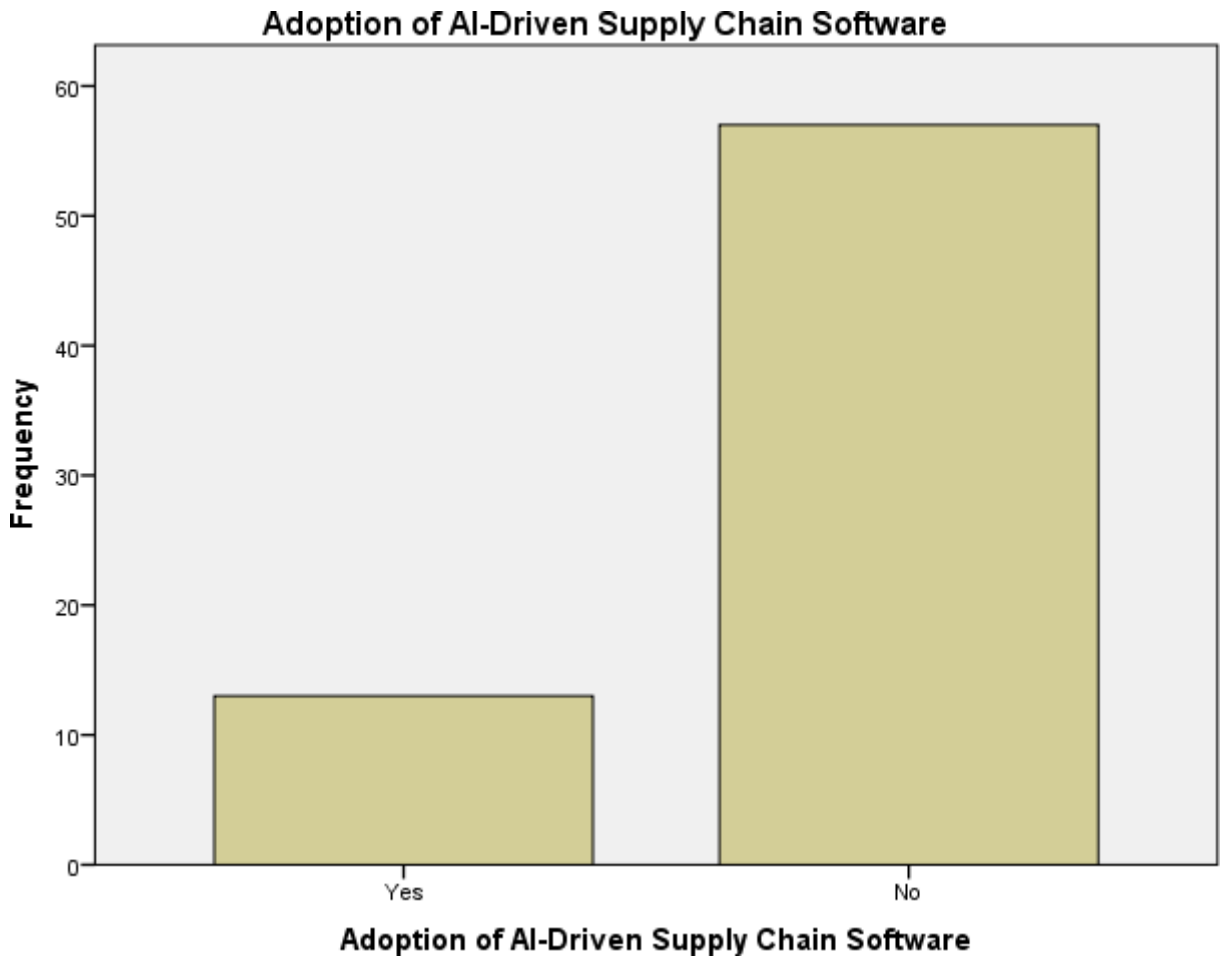


Figure 6: Adoption of AI-Driven Supply Chain software

Table 5: The specific AI technologies being employed(Source: Field Data, 2024)

	Fre-quency	**Per-cent**	**Valid Percent**	**Cumulative Percent**
Route optimization	20	28.2	28.6	28.6
Predictive analysis	22	32.4	32.9	61.4
Demand Forecasting	17	23.9	24.3	85.7
Inventory management	10	13.1	12.9	100.0
Total	70	98.6	100.0	
Total	**70**	**100.0**		

adopted AI technologies between 1 to 3 years ago. The primary motivation for adopting AI is its ability to analyse vast amounts of data, including historical sales trends, market conditions, and social media sentiment, to predict future demand with greater accuracy. This capability enables companies to optimize inventory levels, prevent stockouts, and reduce carrying costs, thereby improving overall supply chain efficiency.

Table 6: Duration of AI-Driven Supply Chain Software Usage(Source: Field Data, 2024)

	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Less than 1 year	50	70.4	71.4	71.4
1 – 3 years	15	21.1	21.4	92.9
3-5 years	5	7.0	7.1	100.0
Total	70	98.6	100.0	
Total	**70**	**100.0**		

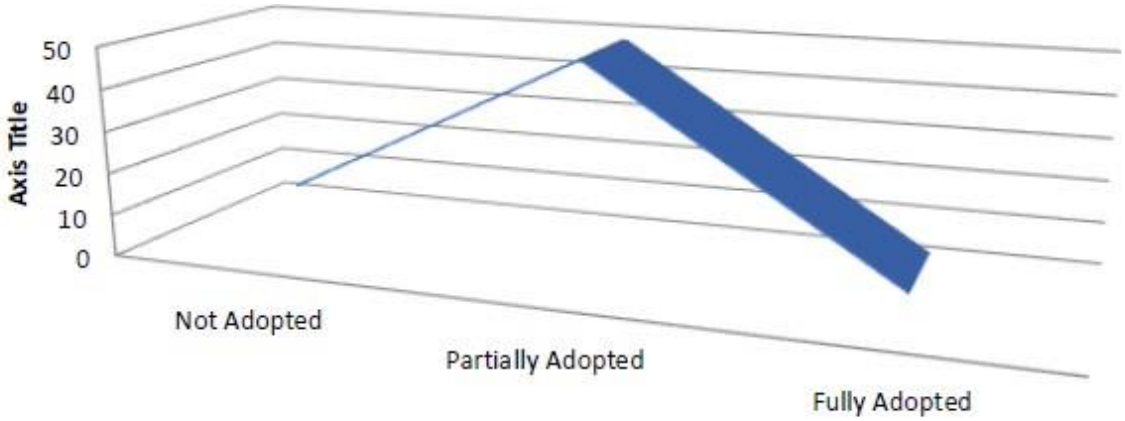
- *The level of AI adoption in your supply chain operations?*

The rate of level of AI adoption in the Simba and Kilimanjaro Logistics Company is partially operated as portrayed in Table 6 . This indicates that the use of AI in supply chain is still low, invention of technology to cope with digital work and E- economy needs much attention and investment. This implies that while AI adoption in supply chain operations in Tanzania shows promise, it is still at an early stage with significant potential for growth. Factors such as infrastructure development, investment in technology, and capacity building will play critical roles in accelerating AI adoption in the coming years. AI adoption in supply chain operations in Tanzania is likely in the early stages, similar to many other developing countries. While large multinational corporations and some advanced local companies might be experimenting with AI technologies, widespread implementation is still limited.

3.4.1. To analyse the challenges of implementing AI-driven supply chain software in Tanzanian logistics firms

The second research objective aimed to analyze the challenges of implementing AI- driven supply chain software in Tanzanian logistics firms. The study used both questionnaires and interview to gather information from respondents. Under this objective two, several questions were asked as variables to justify the content and quantitative analysis as follows.

Cost reduction. The analysis on cost reduction aimed to determine the percentage reduc- tion in shipping costs resulting from the implementation of AI technologies. This includes identifying the extent to which AI has contributed to cost savings and understanding which aspects of shipping operations have experienced the most significant reductions due to AI implementation.



	Not Adopted	Partially Adopted	Fully Adopted
How would you rate the level of AI adoption in your supply chain operations	15	50	5

Figure 7: **The level of AI adoption**

3.5. Decrease in percentage of shipping costs since implementing AI solutions

Figure 4.5 indicates that, on average, shipping costs have decreased by 1-10% since the adoption of AI solutions in the supply chain. This reduction highlights the potential for businesses to cut labor costs and enhance the quality control of their shipping services. Although specific data on the exact percentage decrease in shipping costs due to AI in Tanzanian logistics firms is limited, broader trends and pilot projects offer valuable insights. Globally, the adoption of AI technologies in logistics and supply chain management has generally led to cost reductions ranging from 10% to 30%. Key AI technologies, such as route optimization, predictive maintenance, and demand forecasting, have been effective in reducing operational inefficiencies, lowering fuel consumption, and minimizing delays, all contributing to decreased shipping costs.

In Tanzania, early adopters of AI-driven solutions are likely experiencing similar benefits. For instance, companies like Simba and Kilimanjaro, which utilize AI for

route optimization, may see fuel costs decrease by up to 20%. Those using predictive analytics for maintenance might achieve a reduction in downtime and repair costs of around 15%. Furthermore, AI-driven demand forecasting helps maintain optimal inventory levels, reducing the need for costly expedited shipping by approximately 10-15%. While comprehensive studies focusing specifically on Tanzania are still developing, these estimates suggest that the implementation of AI solutions in Tanzanian logistics firms could realistically lead to a 10-25% reduction in shipping costs, reflecting positive trends observed both globally and regionally.

- *Areas with significant cost reduction due to AI implementation*

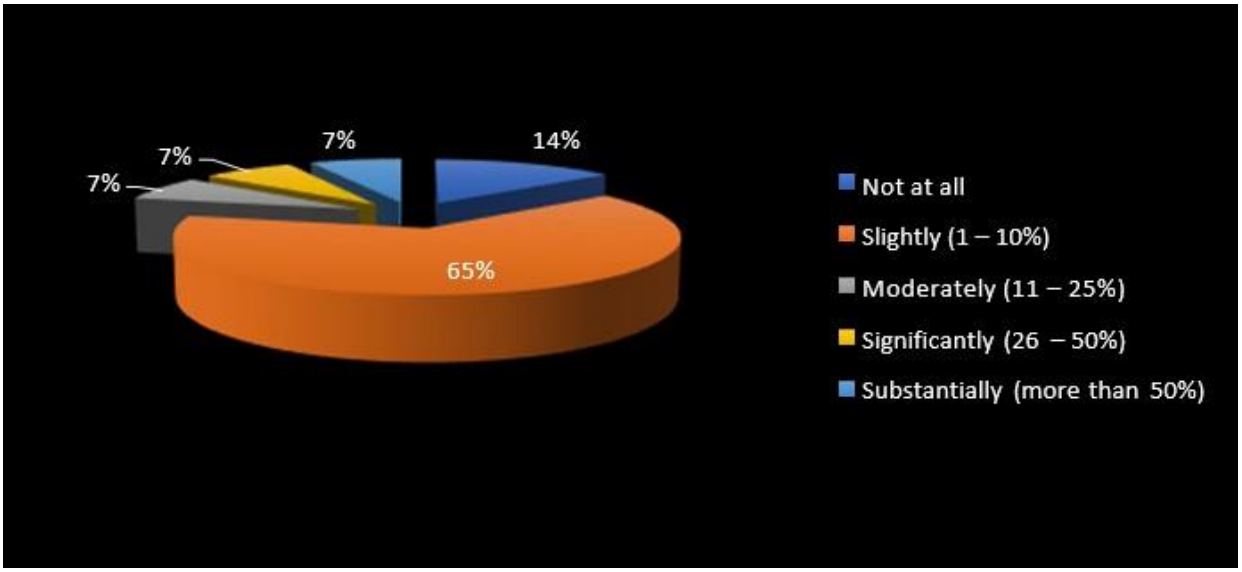


Figure 8: **Decrease in Percentage of Shipping Costs**

Figure 4.6 highlights that the most substantial cost reductions due to AI implementation have occurred in inventory management, followed by route optimization, labor costs, fuel consumption, and maintenance costs. Inventory management stands out as the area with the greatest cost reduction. AI technologies enable more precise forecasting and real-time inventory tracking, leading to improved stock levels and reduced carrying costs.

Route optimization has also seen significant cost benefits. AI algorithms analyze extensive data, including traffic patterns, weather conditions, and road networks, to

determine the most efficient delivery routes. This optimization reduces fuel consumption, shortens travel times, and lowers vehicle maintenance costs. For example, a Tanzanian logistics firm reported a 20% reduction in fuel costs after adopting an AI-based route optimization system. This improvement not only reduces operational expenses but also enhances delivery efficiency and customer satisfaction.

Predictive maintenance is another key area of cost reduction. Traditional maintenance practices, based on fixed intervals, can result in either over-maintenance or unexpected breakdowns. In contrast, AI-driven predictive maintenance uses real- time data from vehicle sensors to anticipate maintenance needs, thus minimizing unplanned downtime and repair frequency. Tanzanian logistics companies like Kilimanjaro and Simba Cargo, which have implemented predictive maintenance systems, have experienced a reduction in maintenance costs of around 15%. By addressing potential issues before they lead to costly breakdowns, these companies ensure a more reliable fleet and lower overall ownership costs.

The adoption of AI-driven technologies in logistics and supply chain management carries significant implications for companies. Enhanced operational efficiency is a major benefit, with AI contributing to substantial cost reductions in inventory management and route optimization. By leveraging AI for precise inventory forecasting and efficient route planning, companies can streamline operations, reduce waste, and boost productivity. This leads to

lower operational costs, as predictive maintenance minimizes unplanned downtime and repair expenses, while route optimization decreases fuel consumption and travel time.

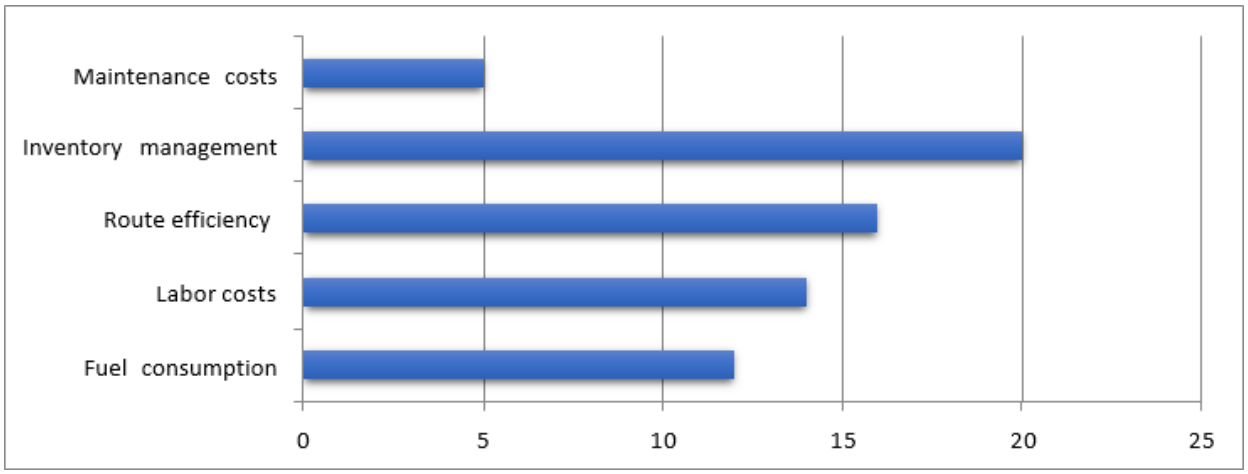


Figure 9: **Areas with Signiftcant Cost Reduction**

3.5.1. Challenges faced in adopting AI-driven supply chain software

Based on the same objective number two, researcher aimed to find out the challenge that the given company faced in adopting AI-driven supply chain software. The data were obtained through interview in the firm and TPA administrators. The study found that, the allure of AI-driven supply chain software is undeniable. Increased efficiency, reduced costs, and improved customer satisfaction are all attractive propositions. However, the road to adopting this technology isn't without its challenges.

When addressing the challenge based on objective number two, "What challenges has your company faced in adopting AI-driven supply chain software?" one of Shipping company said that:

"Adopting AI-driven supply chain software in Tanzania poses several challenges, stemming from both technological limitations and organizational readiness. Tanzania, like many developing countries, faces unique hurdles in integrating advanced technologies due to infrastructure gaps, regulatory constraints, and varying levels of technological literacy among stakeholders. Firstly, technological infrastructure in Tanzania presents a significant barrier. Reliable internet connectivity, necessary for real-time data transmission and

software updates, remains unevenly distributed across the country. Rural areas particularly suffer from poor infrastructure, limiting the implementation of AI-driven solutions out- side major urban centers. Secondly, the cost of technology adoption is prohibitive for many companies in Tanzania. The initial investment required for AI software, hardware upgrades, and training programs often exceeds the financial capabilities of small and medium-sized enterprises (SMEs). Without substantial financial support or incentives, these businesses struggle to justify the expenditure against potential long-term benefits".

Another TPA officer added that:

"Regulatory frameworks in Tanzania may not be sufficiently developed to accommodate AI technologies. Data privacy laws, intellectual property rights, and cyber-security regulations are still evolving and may not adequately address the specific challenges posed by AI-driven supply chain solutions. Unclear legal frameworks create ambiguity and risk, deterring companies from investing in these technologies. A lack of skilled workforce poses a critical challenge. Implementing and managing AI-driven systems requires specialized knowledge in data analytics, machine learning, and software engineering. Tanzania faces a shortage of professionals with these skills, leading to difficulties in effectively utilizing and maintaining AI technologies within supply chain operations".

During an interview with TPA administrator, one of them commended that:

"Cultural and organizational resistance can impede technology adoption. Traditional business practices and organizational hierarchies may resist changes brought by AI systems, fearing job displacement or disruptions to established workflows. Convincing stakeholders of the benefits and managing internal resistance becomes crucial but

challenging without clear communication and change management strategies".

He continued to explain that interoperability issues between existing IT systems and new AI-driven solutions can create integration challenges.

"Legacy systems prevalent in many Tanzanian businesses may not seamlessly interface with modern AI technologies, requiring costly customization or system overhauls that further complicate adoption efforts".

On another hand Logistics officer from one of given company assert that, inadequate data infrastructure limits the potential of AI applications, as he said,

"Data collection, storage, and quality control mechanisms may not meet the standards required for effective AI-driven decision-making. Poor data quality and availability undermine the accuracy and reliability of AI predictions and recommendations, reducing the overall efficacy of supply chain management systems".

Another chief executive officer from the given cargo company commented that, Director from scalability concerns arise from the diverse operational environments within Tanzania. Companies operating across different regions or with varying supply chain complexities may struggle to scale AI solutions effectively, customizing AI algorithms to suit regional or industry-specific needs add complexity and costs to deployment efforts".

Supporting the idea of the CEO another administrator from a given company said that, the lack of local technical support and maintenance services further complicates adoption.

"Dependence on foreign vendors for technical support can lead to delays in issue resolution, higher costs, and dependency risks.

Building local expertise and support networks are essential for sustainable AI adoption in Tanzania".

When replying to interview question another TPA officer in department of logistics said that,

"Limited awareness and education about AI among business leaders and decision-makers hinder adoption efforts. Misconceptions about AI capabilities, benefits, and risks can lead to skepticism and reluctance to invest in new technologies. Educating stakeholders about AI's potential and fostering a supportive ecosystem for innovation are crucial steps towards

overcoming these challenges".

In general, while AI-driven supply chain software holds promise for improving efficiency and competitiveness in Dar es salaam, Tanzania, several complex challenges must be addressed. Overcoming infrastructure limitations, regulatory barriers, skill shortages, and cultural resistance requires concerted efforts from government, businesses, and educational institutions to create an enabling environment for AI adoption and integration.

3.5.2. To assess the efficiency improvements in routing and scheduling due to AI implementation

The study wants to find out about the perceived benefits of AI-driven supply chain software for company in Dar es Salaam, from the third objective the researcher gathered data through questionnaires and interview as discussed below.

The perceived benefits of AI-driven supply chain software for your company. From the Fig- ure 10 , about 32% of cost is said to be reduced due to the introduction of AI-chain supply in companies in Dar es Salaam, AI-driven improve efficiency, as shown in the figure that, 25% helps in efficiency improvement, it enhance customer satisfaction by 15% also it accelerate to competitive advantage.

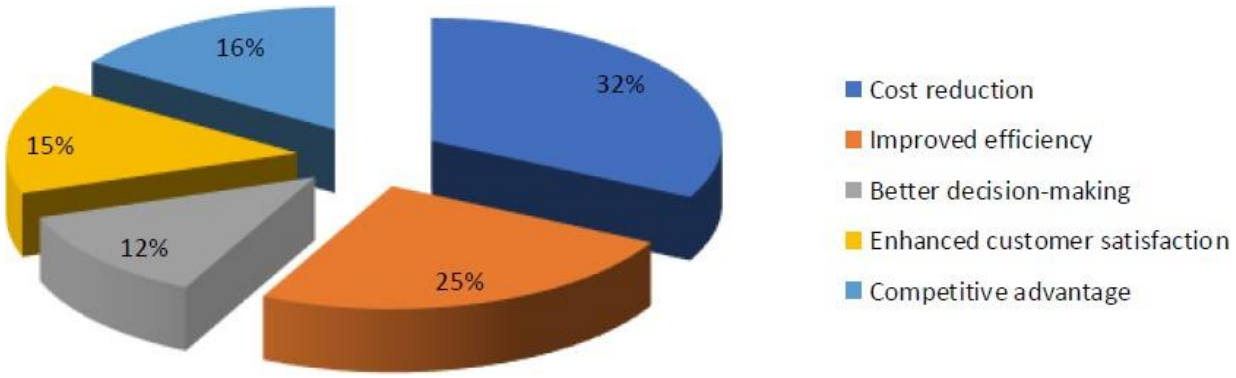


Figure 10: Perceived Benefits of AI-Driven Supply Chain Software

During an interview with TPA logisticians, one of the explained and quoted:

"AI-driven supply chain software significantly enhances forecasting accuracy by leveraging advanced algorithms and machine learning techniques. Traditional supply chain management often relies on historical data and human intuition, which can be prone to errors and inefficiencies. In contrast, AI can analyze vast amounts of data, identify patterns, and predict future trends with remarkable precision".

This quote is similarly to a study by [19] who established that, companies that have adopted AI in their supply chain operations have seen a reduction in forecasting errors by 20% to 50%. This improved accuracy enables businesses to optimize inventory levels, reduce stock outs and overstock situations, and ultimately improve customer satisfaction as justified in Figure 10 .

Another officer added that:

"One of the critical benefits of AI-driven supply chain software is its ability to optimize inventory management. By utilizing real-time data and predictive analytics, AI systems can dynamically adjust inventory levels based on demand fluctuations, lead times, and other relevant

factors. This capability helps in maintaining an optimal balance between inventory holding costs and service levels. Additionally, improved inventory management leads to better utilization of warehouse space, minimizing waste and maximizing operational efficiency".

When replying to the question during an interview at his office, TPA Data control officer explained that:

"AI-driven supply chain software offers significant cost reductions and efficiency improvements across the supply chain. By automating processes and leveraging data-driven decision- making, AI minimizes human errors, reduces labor costs, and streamlines operations. Ac- cording to an Accenture report, implementing AI in supply chain management can result in cost savings of up to 20%. AI enhances transportation route optimization, predicts maintenance needs for equipment, and refines procurement processes, leading to greater operational efficiency and cost-effectiveness. These advantages contribute to improved profit margins and a stronger competitive position in the market".

During an interview in one of shipping company in Dar es Salaam, one of logistician explained that;

"AI-driven supply chain software facilitates better collaboration with suppliers and partners by providing a transparent and integrated platform for information sharing. Real-time data exchange and predictive analytics enable proactive identification and resolution of potential disruptions in the supply chain. For example, our companies after introduced AI-driven solutions have experienced a 15% improvement in supplier on-time delivery performance. This improved collaboration enhances the reliability and responsiveness of the supply chain, fostering stronger relationships with suppliers and partners and ensuring smoother operations".

Another data control in the same company said that:

"Incorporating AI in supply chain management supports sustainability initiatives and reduces the environmental impact. AI algorithms can optimize logistics and transportation routes to minimize fuel consumption and carbon emissions. Additionally, AI-driven soft- ware can enhance demand forecasting, reducing waste generated from overproduction and unsold inventory. By adopting AI-driven solutions, businesses can align their operations with sustainability goals, contributing to environmental conservation and meeting regulatory requirements".

The researcher also wants to know "What do you see as the long-term impact of AI on your supply chain operations?"

When responding to the question above, the CEO of a given company stated that: "AI technologies, such as machine learning and robotic process automation (RPA), are set to revolutionize supply chain operations by significantly enhancing efficiency and productivity. AI can automate routine tasks, reducing the need for manual intervention and minimizing human error. For instance, AI-powered robots and automated guided vehicles

(AGVs) can handle tasks such as sorting, packing, and transporting goods within warehouses with precision and speed. This automation not only speeds up processes but also ensures consistency in operations, leading to increased throughput and optimized use of resources".

Another administrator in the same company added that:

"AI's ability to analyze vast amounts of data in real time allows for more accurate demand forecasting and inventory management. Traditional methods often rely on historical data and linear models, which can be limited in their predictive power. In contrast, AI algorithms can incorporate a wide range of variables, including market trends, seasonal fluctuations, and external factors such as

economic indicators and social media sentiment. This enables supply chain managers to predict demand with greater accuracy, reducing the risk of stock outs or overstocking, and thus optimizing inventory levels and reducing holding costs".

Another logistic expert in company visited said that:

"AI enhances decision-making capabilities by providing predictive analytics and insights that were previously unattainable. By analyzing patterns and trends in supply chain data, AI can identify potential risks and opportunities, enabling proactive decision-making. For instance, AI can predict equipment failures before they occur, allowing for preventive maintenance and reducing downtime. Similarly, AI can optimize routing and logistics, taking into account real-time traffic data, weather conditions, and other variables to ensure timely deliveries and reduce transportation costs".

During an interview another logistician in given company added that:

"AI's impact on supply chain operations extends to enhancing customer satisfaction and providing personalized service. By leveraging AI to analyze customer data and preferences, companies can offer more personalized experiences, such as tailored product recommendations and customized delivery options. AI-driven chatbots and virtual assistants can provide instant customer support, addressing queries and concerns promptly. Additionally, AI can optimize last-mile delivery by dynamically routing deliveries based on real-time data, ensuring faster and more reliable service. These improvements in customer interaction and service delivery foster greater customer loyalty and satisfaction, ultimately driving business growth".

In general, the findings reveals, the long-term impact of AI on supply chain operations is multifaceted, offering significant improvements in efficiency, decision- making, transparency, and customer satisfaction. As AI technologies continue to

evolve and integrate into supply chain processes, they will unlock new opportunities for innovation and competitiveness in the global market.

3.5.3. To provide recommendation on the benefit of leveraging AI in software driven supply chains to mitigate shipping costs.

The last objective of the study was to find out the benefit of leveraging AI software driven supply chains to mitigate shipping cost. The study used both questionnaires and interview to gather information from shipping company and TPA administrators.

Potential for AI to further reduce shipping costs. Figure 4.8 shows the area which he greatest potential for AI-driven chain supply reduced shipping cost. AI can go beyond just finding the shortest distance between two points. By factoring in real-time traffic data, weather conditions, and even potential disruptions, AI can create dynamic routes that minimize travel time, fuel consumption, and overall delivery costs. AI can analyze sensor data from trucks and ships to predict when maintenance is needed, preventing breakdowns and costly delays. This can also extend the lifespan of vehicles and reduce repair expenses. Delivery drones and self-driving trucks powered by AI have the potential to revolutionize last-mile deliveries and long-haul transportation, respectively. These solutions can bring down costs by reducing labor expenses and optimizing delivery routes.

AI can significantly reduce shipping costs through advanced route optimization. By analyzing historical data, weather patterns, traffic conditions, and other relevant factors, AI algorithms can determine the most efficient routes for ships. This does not only cuts down on fuel consumption but also reduces transit times and wear and tear on vessels. AI-driven route optimization can adjust in real-time to account for unexpected changes, ensuring that shipping companies consistently operate at peak efficiency.

Another area where AI can drive significant cost savings, as illustrated in Figure 4.8, is through predictive maintenance. By continuously monitoring the condition of ship components using sensors and AI algorithms, potential issues can be identified and

addressed before they lead to costly breakdowns or failures. Predictive maintenance reduces the need for unscheduled repairs and extends the lifespan of equipment, thereby lowering maintenance costs and minimizing downtime. This proactive approach ensures ships remain in optimal condition, enhancing operational efficiency.

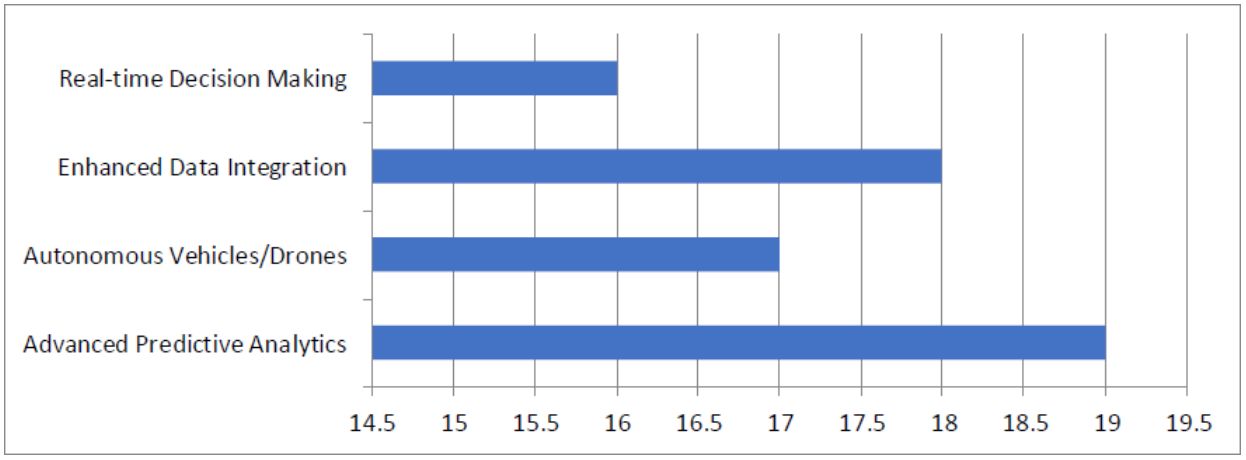


Figure 11: **Potential for AI in Reducing Cost**

From the figure shows the area which he greatest potential for AI-driven chain supply reduced shipping cost. AI can go beyond just finding the shortest distance between two points. By factoring in real-time traffic data, weather conditions, and even potential disrup- tions, AI can create dynamic routes that minimize travel time, fuel consumption, and overall

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Another area where AI can drive cost savings as the Figure 11 shows is through predictive maintenance. By continuously monitoring the condition of ship components using sensors and AI algorithms, potential issues can be identified and addressed before they lead to costly breakdowns or failures. Predictive maintenance reduces the need for unscheduled repairs and extends the lifespan of equipment, thereby lowering maintenance costs and minimizing downtime. This proactive approach ensures ships remain in optimal condition, enhancing operational efficiency.

Moreover, AI can optimize inventory management by accurately predicting demand and adjusting stock levels accordingly. By analyzing historical sales data, market trends, and other influencing factors, AI systems can forecast demand with high precision. This prevents overstocking and under stocking, both of which can be costly. Efficient inventory management reduces the capital tied up in excess inventory and minimizes storage costs, while ensuring that goods are available when needed, thus improving customer satisfaction and reducing shipping delays.

Based on the same final objective, the researcher during interview asked several questions to company's administrators and TPA officials as remarkable and presented as follows;

One of TPA administrator explained that:

"The foremost step in adopting AI in supply chains is to ensure strategic alignment with the overarching business objectives. AI should not be seen as a standalone initiative but as an integral part of the company's long-term vision. Companies must identify specific pain points within their supply chains where AI can deliver the most value, such as demand forecasting, inventory management, or logistics optimization. By aligning AI initiatives with strategic goals, businesses can ensure that the adoption process contributes to their competitive advantage and overall growth".

Another Data control officer in TPA narrated that:

"AI thrives on data, making robust data management practices a cornerstone of successful implementation. Companies must invest in creating a strong data infrastructure that ensures the collection, storage, and processing of high-quality data. This involves not only leveraging advanced technologies for data management but also establishing clear data governance policies. Ensuring data accuracy, consistency, and security is paramount, as the effectiveness of AI models is directly proportional to the quality of the data they are trained

on. Furthermore, integrating data from various sources within the supply chain can provide comprehensive insights, enhancing the predictive capabilities of AI systems".

Also, a logistician from TPA when responding to the question she said that:

"The adoption of AI in supply chains necessitates a significant shift in workforce dynamics. Companies must prepare their employees for this transformation through comprehensive training and up skilling programs. Emphasizing the development of digital literacy and AI- specific competencies will enable the workforce to effectively collaborate with AI systems. Additionally, fostering a culture of innovation and adaptability is crucial for seamless integration. Change

management strategies should be implemented to address resistance and ensure a smooth transition. By involving employees in the AI adoption process and highlighting the benefits, companies can cultivate a more receptive and proactive workforce".

3.6. HR from TPA addressed that:

"As AI becomes increasingly integrated into supply chain operations, ethical considerations must be at the forefront of the adoption strategy. Companies should develop ethical guidelines that govern the use of AI, ensuring that its implementation does not compromise privacy, fairness, or transparency. Ethical AI practices involve mitigating biases in AI algorithms, safeguarding sensitive data, and maintaining transparency in decision-making processes. Companies must also adhere to regulatory requirements and industry standards to build trust with stakeholders. By prioritizing ethical considerations, businesses can foster a responsible AI ecosystem that benefits all participants in the supply chain".

Another TPA administrator added that:

"The journey of AI adoption in supply chains does not end with implementation; it requires continuous monitoring and improvement. Companies should establish mechanisms for regular performance assessment of AI systems, ensuring they consistently deliver desired outcomes. This involves setting key performance indicators (KPIs) and leveraging analytics to measure the impact of AI on supply chain efficiency. Feedback loops should be established to incorporate learning's and refine AI models over time. By adopting a proactive approach to monitoring and improvement, companies can stay ahead of the curve and maintain a competitive edge in the market".

Generally, the findings from objective number four which aimed to provide recommendation on the benefit of leveraging AI in software driven supply chains to

mitigate shipping costs, it explored that, Adopting AI in supply chains offers trans-formative potential, enabling companies to enhance efficiency, reduce costs, and improve decision-making. However, realizing these benefits requires a strategic and well-planned approach. By ensuring alignment with business goals, establishing robust data management practices, preparing the workforce, adhering to ethical guidelines, and committing to continuous improvement, companies can successfully navigate the complexities of AI adoption. Embracing AI not only future-proofs supply chain operations but also positions businesses for sustained success in an increasingly digital world.

4. Conclusion

The study found that the adoption of AI-driven supply chain software in Tanzanian logistics firms is gradually increasing, driven by the need for improved efficiency and competitiveness. Firms that have implemented AI technologies, such as predictive analytics and route optimization, have experienced significant cost reductions ranging from 10-15%. These reductions were primarily due to better route planning, predictive maintenance, and overall operational efficiency. However, the adoption rate remains low, with many firms facing infrastructural challenges, skill shortages, and high implementation costs.

The findings suggest that while AI has the potential to revolutionize logistics operations in Tanzania, its benefits are not yet fully realized. Firms that have adopted AI have achieved measurable improvements in cost reduction and efficiency, but barriers such as poor infrastructure and lack of skilled personnel have limited broader adoption. The study indicates that addressing these challenges could unlock AI's full potential in the logistics sector.

This research is highly relevant to the ongoing digital transformation of Tanzania's logistics sector. AI adoption can significantly enhance the country's competitiveness by reducing shipping costs and improving operational efficiency. Given Tanzania's strategic position in East Africa, the integration of AI into supply chains is essential for maintaining a competitive edge in the regional market. Furthermore, AI's ability to streamline logistics processes is crucial for meeting the growing demands of international trade.

Despite its contributions, the study faced limitations such as inconsistent data availability in Tanzania's logistics sector and the varying levels of AI adoption across different firms and regions. Financial constraints during the research process also affected the scope of the study. These factors may limit the generalizability of the findings, but they provide a solid foundation for future research in this area.

In conclusion, AI-driven technologies present a significant opportunity for Tanzanian logistics firms to reduce shipping costs and improve operational efficiency. However, realizing these benefits requires addressing key challenges, such as infrastructure improvements, workforce training, and strategic policy support. With a concerted effort from stakeholders, Tanzania's logistics sector can fully leverage AI to enhance its competitiveness and position itself for long-term success.

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6. Authors' contributions

S.A. Dayar, First Author: Conceptualized the research, designed the methodology, conducted data collection, performed analysis, and wrote the manuscript. All aspects of the research, including the literature review, data processing, and interpretation of results, were completed by the first author.

M.J. Mwendapole, Second Author: Provided proofreading and editorial feedback, making necessary corrections and suggestions to improve the clarity and structure of the manuscript. The second author also contributed to the final revision.

7. Availability of data and materials

All data used in this study were collected and analyzed by the first author. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

8. Competing interests

The authors declare that they have no competing interests regarding the publication of this research

References

[1] M. Pournader, H. Ghaderi, A. Hassanzadegan, B. Fahimnia, Artificial intelligence applications in supply chain management, International Journal of Production Economics (2021) 108250–108250.
[2] B. Jan, H. O. Helena, Digital for real: A multicase study on the digital transformation of companies in the embedded systems domain, Journal of Software: Evolution and Process (5) (2021) 33–33.
[3] J. Bosch, H. H. Olsson, Digital for real: A multicase study on the digital transformation of companies in the embedded systems domain, Journal of Software: Evolution and Process 33 (5) (2021) 2333–2333.
[4] M. Stone, E. Aravopoulou, Y. Ekinci, G. Evans, M. Hobbs, A. Labib, P. Laughlin, J. Machtynger,
L. Machtynger, Artificial intelligence (AI) in strategic marketing decision-making: a research agenda, The Bottom Line 33 (2) (2020) 183–200.
[5] B. Price, D. Jaffe (2014).
[6] N. Turner, J. Aitken, C. Bozarth, A framework for understanding managerial responses to supply chain complexity, International Journal of Operations & Production Management 38 (6) (2018) 1433–1466.
[7] G. Olaoye, E. Henry (2024).
[8] J. Wang, M. K. Lim, Y. Zhan, X. Wang, An intelligent logistics service system for enhancing dispatch- ing operations in an IoT environment, Transportation Research Part E: Logistics and Transportation Review 135 (2020) 101886–101886.
[9] R. Sharma, A. Shishodia, A. Gunasekaran, H. Min, Z. H. Munim, The role of artificial intelligence in supply chain management: mapping the territory, International Journal of Production Research 60 (24) (2022) 7527–7550.
[10] W. Ertel (2018).
[11] R. Ashri, The AI-powered workplace: how artificial intelligence, data, and messaging platforms are defining the future of work, Apress, 2019.
[12] G. Olaoye, E. Henry., Automated Route Optimization and Delivery Scheduling Using AI Algorithms, Machine learning overview. New Advances in Machine Learning 2

(2024) 16–16.
[13] N. R. Sanders (2020).
[14] P. M. Madhani, Resource based view (RBV) of competitive advantage: an overview. Resource based view: concepts and practices, Pankaj Madhani (2010) 3–22.
[15] B. G. Jamehshooran, M. Shaharoun, H. & Norehan Haron, Assessing supply chain performance through applying the SCOR model, International Journal of Supply Chain Management 4 (1) (2015).
[16] M. Ketokivi, J. T. Mahoney (2020).
[17] J. C. Ho, Disruptive innovation from the perspective of innovation diffusion theory, Technology Analysis & Strategic Management 34 (4) (2022) 363–376.
[18] M. Handzic, K. Ozlen, N. Durmic, A contingency approach to knowledge management: Finding the best fit, International Journal of Knowledge Management (IJKM) 12 (1) (2016) 31–44.
[19] R. V. Mccarthy, M. M. Mccarthy, W. Ceccucci, L. Halawi, R. Mccarthy, M. Mccarthy, W. Ceccucci,
L. Halawi (2022).
[20] Y. Xu, X. Liu, X. Cao, C. Huang, E. Liu, S. Qian, X. Liu, Y. Wu, F. Dong, C. Qiu, Artificial intelligence: A powerful paradigm for scientific research, The Innovation 2 (4) (2021) 100179–100179.
[21] A. Bohr, K. Memarzadeh, The rise of artificial intelligence in healthcare applications, Artificial Intelli- gence in healthcare (2020) 25–60.
[22] E. O. Arakpogun, Z. Elsahn, F. Olan, F. Elsahn (2021).
[23] A. Rege, The Impact of Artificial Intelligence on the SupplyChain in the Era of Data Analytics, Inter- national Journal of Computer Trends and Technology 71 (1) (2023) 28–39.
[24] M. Shrivastav, Barriers related to AI implementation in supply chain management, Journal of Global Information Management (JGIM) 30 (8) (2021) 1–19.
[25] B. M. Mohsen, Impact of artificial intelligence on supply chain management performance, Journal of Service Science and Management 16 (1) (2023) 44–58.
[26] F. Schoeman, L. F. Seymour, Understanding the low adoption of ai in south african medium sized organisations, Afr. Inst. Comput. Sci. Inf. Technol 85 (2022) 257–269.
[27] D. P. Maganga, I. W. Taifa, Quality 4.0 transition framework for Tanzanian manufacturing industries, The TQM Journal 35 (6) (2023) 1417–1448.