Artificial Intelligence and Machine Learning in Logistics and Supply Chain Management in Africa: Opportunities, Challenges, and Future Directions

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Abstract

The promising African economic expansion meets various operational challenges that remain due to inadequate infrastructure, inconsistent rules, and insufficient transportation systems. Operational efficiency and effectiveness become obstructed for logistics firms due to existing challenges. The study analyzes how artificial intelligence technologies with machine learning capabilities assist in revolutionizing African logistics systems and supply chain operations. The research objectives investigate how novel technologies improve operational effectiveness while cutting expenses and establishing superior decision processes within African logistics operations. The study used a mixed-methods analysis, which incorporates literature reviews, case research, and expert interviews to explore how AI and ML operate at a practical level. Significant research evidence shows that AI and ML produce valuable outcomes to enhance predictive analytics and inventory control, optimize delivery routes, and protect assets from risks. The development of AI and ML in African logistics requires addressing three main obstacles, which include outdated infrastructure, restricted access to data, and insufficiently skilled staff training. This study finds that AI and ML technologies create numerous possibilities to advance African logistics operations, yet additional investigation will determine effective, scalable applications that account for local market conditions. Given that AI and ML have great potential to enhance logistics operations and drive economic growth in Africa, their integration in the logistics sector will ultimately have to surmount the barriers identified in the study. African logistics companies have the opportunity to seize the opportunities in these technologies and address the challenges, putting them in a position to thrive in the digital global economy for the long haul.

Keywords: Artificial Intelligence, Machine Learning, Logistics, Supply Chain, Optimization.

1. Introduction

Background

The economic development of countries depends directly on logistics, together with supply chain management, as essential sectors. The logistics industry in Africa supports international as well as regional trade activities. The extensive boundaries of Africa create operational challenges because its different economic frameworks interact with inadequate infrastructure and sophisticated supply networks to produce efficiency problems that slow development. Logistics costs in Africa amount to 30% of a product's final price as reported by the World Bank, yet more developed economies keep costs at approximately 8-10% levels. The current situation reveals numerous opportunities to enhance operational effectiveness, along with cost reduction across the entire market.

The promising African economic expansion meets various operational challenges that remain due to inadequate infrastructure, inconsistent rules, and insufficient transportation systems. Operational efficiency and effectiveness become obstructed for logistics firms due to existing challenges. The growing number of technological solutions deployed by African countries aims to enhance operational performance, along with streamlining logistical processes and building sustainable supply chain frameworks.

Artificial Intelligence (AI), together with Machine Learning (ML), emerges as the dominant innovation through which organizations can address obstacles in logistics operations. The broad concept of artificial intelligence, which imitates human cognitive processes, allows machines to undertake data-based assessments of patterns while operating independently for decision-making. The performance improvement ability of Machine Learning technology aids organizations in better data-based decision-making, specifically for predictive analysis and logistic optimization functions.

Ambulatory AI and ML solutions have started to increase their adoption rate in supply chain operations throughout global markets. These technologies enable developed economies to optimize inventory management practices and deliver faster deliveries while predicting demand changes and handling warehouse operations and route management tasks. Real-time processing capabilities of AI tools allow logistics firms to examine enormous datasets, which produce useful information as they boost operational efficiency while minimizing expenses. AI, together with ML, enhances decision quality when used for risk assessment while detecting fraud incidents along with designing transportation network components.

The continent of Africa faces problems with fragmented infrastructure, unreliable transportation, and limited data access, and in these conditions, AI and ML bring the potential to transform the industry. The analysis of traffic patterns through machine learning algorithms performs dynamic route optimization as well as enhances demand forecasting, so delivery delays decrease while transportation expenses decrease. Supplemental AI-controlled supply chain management systems enable better inventory control through optimized stock levels, and they further automate procurement systems, which reduces both inventory shortages and above-average stock levels.

AI and ML platforms demonstrate solutions for many crucial problems that tend to occur within African logistics operations.

African logistics face hurdles because of their inadequate system of infrastructure, including streets, ports, and airports. AI technology helps customers find improved warehouse-to-route connectivity by avoiding congested parts of traffic and suboptimal roadways.

Complex supply chains throughout Africa limit the ability to maintain complete transparency among supply chain activities. The integration of artificial intelligence tools handles data from several systems to reveal extensive supply chain information, thus supporting improved managerial choices.

The conditions of unpredictable consumer behaviour alongside seasonality and unreliable data patterns make it difficult to conduct accurate demand and supply forecasting in African markets. Using ML algorithms allows precise demand forecasting because the algorithms discover hidden patterns that exist within historical data.

African countries particularly struggle with the lack of qualified employees who specialize in supply chain logistics and management. By using AI with ML technology, companies can eliminate recurrent tasks and minimize their dependence on human workers, which allows their operations to work with reduced staff requirements, leading to enhanced productivity.

The implementation of AI and Machine Learning in African logistics and supply chain operations faces numerous obstacles since their advantages are evident. The widespread implementation of AI faces major obstacles throughout African regions because the continent features sophisticated technology infrastructures, insufficient internet connectivity, and limited digital training in multiple territories. Developing economies experience three major factors that prevent AI implementation, including poor data quality and privacy.

concerns and expensive implementation costs. Africa faces significant technology gaps because the disparity between urban and rural areas is very wide in terms of technological access.

The logistics and supply channel fields in Africa implement AI and ML solutions during their digital transformation journey despite the existing obstacles. Multiple stakeholders, including regulatory institutions, together with international entities, along with private companies, invest in constructing backbone infrastructure for AI suitability through the extension of internet connectivity protocols and the development of data-sharing platforms and AI-fuelled supply chain solutions adapted to specific market demands.

The research project investigates AI and ML practices in African logistics by studying technology implementations and challenges while analysing their value for businesses doing business in the region. Through this investigation, researchers can generate essential knowledge about using AI and ML to solve the distinctive logistics problems in Africa, which promotes business success in the transportation industry.

Research Gap

Although artificial intelligence (AI) and machine learning (ML) have been gaining increasing interest in logistics and supply chain management (SCM) globally, there is a glaring gap in the comprehensive understanding of such applications in the African context. Much of the existing literature, along with case studies are targeted at developed economies where AI and ML adoption is a common thing. Yet, applying these technologies to Africa involves its challenges, including underdeveloped infrastructure, lack of access to the technology, as well as differences in regulatory environments across the different countries on the continent.

However, some specific gaps in the literature are:

- There have only been limited empirical studies on the direct impact of AI and ML on African logistics and supply chains.
- The lack of research on how AI and ML could address the African market infrastructure and operational inefficiencies.
- Insufficient exploration of the cultural, political, and economic barriers to AI adoption in Africa, such as regional instability, policy inconsistencies, and the skills gap.
- Explains unexplored opportunities for AI and ML to drive economic growth and promote intra-African trade, taking into account the market diversity of the African continent.

Almost no research on regulatory frameworks is needed for the effective adoption of AI and ML in African logistics.

There are gaps in the areas studied: Africa's logistics and supply chain sector presents a specific context where AI and ML present specific applications, challenges, and future opportunities that this study seeks to fill.

Objectives / Research Questions

Objectives:

The main objectives of this research are the following:

- It aimed to evaluate the current status of AI and ML applications in logistics and supply chains in Africa.
- To narrow down the specific challenges and barriers that African countries have toward AI and ML adoption in the Logistics and Supply Chain context.
- I try to investigate the prospects that AI and ML can offer to increase efficiency, decrease costs, and promote intra-African trade in the field of logistics.

To investigate how AI and ML applications affect inventory management, demand planning, route planning, and risk management in the African supply chain, it was necessary to study these applications in that context.

- To provide a ground for recommendations on how governments and enterprises in Africa will help the uptake and implementation of AI and ML in the supply chain and logistics industry.

Research Questions:

1. What are the available use cases of AI/ML applications in supply chain management and logistics within Africa?
2. What are the unique challenges for African logistics companies using AI and ML?
3. How can AI and ML be used to solve problems related to inefficiency in African logistics supply chains, such as those related to transportation, inventory management, and demand planning?
4. How can these (AI and ML) improve African logistics and supply chains in general, as well as be more efficient, cost-effective, and competitive?

It's about knowing what infrastructure, what government policy-making, and what supply of skilled human capital all go into supporting the effective use of AI and ML in the African logistics ecosystem.

5. How can AI and ML enable positive long-term change in the logistics & supply chain sectors in Africa?

Scope and Significance

Scope:

Applications of AI and ML in logistics and supply chain management in Africa are studied, and examples of applications of AI and ML in solving regional challenges in Africa are discussed. The research will cover:

- Technological Scope includes AI and ML applications in predictive analytics of warehousing, route optimization, fleet management, inventory forecasting, and automated processes of warehousing.
- Geographical Scope: Given the massive size of Africa and differences in the degree of adoption of the technology across various regions, this study will be aimed at a particular range of countries that represent diverse challenges, problems, and opportunities (for example, South Africa, Kenya, Nigeria, Egypt, and some emerging economies in East and West Africa).

Scope: The current research will mainly cover the trends and prospects (in this case, the next 5 to 10 years) of AI and ML in logistics for both currently applicable cases and new potential applications.

Significance:

The significance of these findings is as follows:

The study will be of practical implication to the logistics companies, manufacturers, and retailers in Africa, as it will examine how AI and ML can be used to enhance supply chain efficiency, for the reduction of costs of the operations.

The research findings have policy implications; African countries' decision-makers can use them to come up with ways of promoting innovation and creating room for the consumption of AI and ML in the logistics sector.

The researchers are contributing to economic development by giving their findings on the role of AI and ML in transforming logistics so that they also contribute to a broad discourse on how technology can drive economic growth, facilitate regional trade, and make African businesses competitive within their global markets.

Capacity Building: The study will show the process of capacity building that logistics will go through with AI and ML involvement. It will also be used to guide educational and training initiatives for the African labour market.

This research will be beneficial for international investors and tech companies that are interested in getting into the African market, and it will help them to understand what is the potential and limitations of AI and ML in logistics, for AI and ML to be able to contribute to cost savings in this industry, and it will provide them with the ability to make future productive investment decisions in line with global markets.

2. METHODS

Study Design

In this study, a mixed methods research design is used to study and comprehend opportunities, challenges, and prospects of Artificial Intelligence (AI) and Machine Learning (ML) in logistics and supply chain management (SCM) in Africa. The mixed methods approach is used because it is a combination of both qualitative and quantitative methods to assist in understanding the topic related to the research, which is highly complex and multifaceted.

Gathering insights about use cases through case studies, expert interviews, and focus group discussions to have an idea of the product to develop next. The qualitative data will aid in the exploration of the actual real-world applications, challenges faced, and the perceptions of the stakeholders in the logistics and supply chain industry regarding the adoption of AI and ML in Africa.

A Quantitative Approach will be adopted, where a survey tool will be used to collect data from logistics companies from various African countries about the use of AI and ML technologies, the barriers to their adoption, and the perceived opportunities. The quantitative approach will therefore provide support or refutation of the facts obtained from the qualitative research through statistics.

The research seeks to create an all-rounded view of the current AI and ML state in Africa's logistics and supply chain and the opportunities they can open to development in the future.

Population/Sample

Population:

For this study population, the personnel and the companies that work with logistics, supply chain management, and technology implementation in Africa are included. This will include:

Logistics companies: Both large multinational companies and local logistics providers operate in various African countries.

Individuals who manage the supply chain activities and those involved in strategic decision-making, along with the technology adoption in the logistics operation.

Technology providers: Companies that supply AI and ML solutions for logistics and supply chain operations in Africa.

Industry experts: Academics, consultants, and industry leaders with knowledge of AI, ML, and logistics in Africa.

Sample:

Participants will be chosen using purposive sampling in this study, as they are directly involved with implementation and decision-making regarding AI and ML technologies in logistics and supply chain management. The data to be collected will be diverse data from these African countries, some with higher levels of technological adoption and others lagging in the same (South Africa, Kenya, Nigeria, Egypt, and Ghana).

The number of respondents participating in the survey is around 150-200, while 55-75 of these will be interviewed and engaged in focus groups. The sample size is determined by the number of participants available and by the requirement to ensure that the results are representative.

Data Collection

Qualitative Data Collection:

Interviews:

A method for the study includes semi-structured interviews with logistics managers, supply chain executives, technology providers, and industry experts.

Purpose: To understand better their view on AI & ML in their operations, their difficulties with the implementation, and the possible advantages they see.

Procedure Interviews will be conducted in person or online platforms, e.g., Zoom and Skype, and will take 30 to 60 minutes.

All interviews will be audio recorded (with participant consent) and transcribed for later analysis in the version control system.

Focus Groups:

Method: A smaller group of logistics experienced professionals will be interviewed through focus groups, and through these focus groups, the participants will discuss shared challenges and experiences in AI and ML adoption.

This serves the purpose of exploring group dynamics and discussions of barriers and opportunities of AI and ML.

Methodology: 5–8 people will comprise each focus group, and the session will be guided by a set of pre-designed questions to make sure all of the relevant subjects are covered.

Quantitative Data Collection:

Survey:

Data Collection Method: A structured online survey will first be designed with closed-ended and Likert scale questions to collect quantifiable data based on the current use of AI and ML, challenges, opportunities, and the perceived impact on logistics and SCM.

The purpose of this was to collect data from a larger sample size to support possibilities of generalizability and statistical analysis.

Method: Logistics companies and professionals in the field will have the opportunity to distribute through email. There will be questions related to the adoption rate of AI and ML, technological barriers, operational impacts, and future expectations.

Tools: The survey will be made up using online survey tools such as Google Forms or Survey Monkey.

Procedures

Pre-Study Preparation:

Research questions and interview questions are to be refined from the literature review.

During my fourth week, I had to design the instruments needed for the interview and survey (interview guides, survey questionnaires, etc.).

Selection of participants from logistics companies, supply chain professionals, and technology providers in selected African countries.

If needed, getting ethical clearance as well as obtaining participant consent.

Data Collection:

Schedule interviews with participants; the questions should be based on the research objectives.

Focus groups: Conduct focus group sessions with logistics people and promote active discussion facilitation.

Distribute Surveys: Send out the online survey to the chosen respondents and measure answers.

Data Management:

Then, organize all collected data, audio recordings, transcriptions, and survey responses.

Guarantee confidentiality and anonymity of the participants in sensitive business data.

Therefore, in terms of data collection, provide participants with a debriefing session after the data collection, addressing any concerns and/or the purpose of the study.

Statistical Analysis

The following statistical methods will be used for the quantitative data, obtained from the survey, for the description and analysis.

Descriptive Statistics:

Synthesizing the demographic information of the respondents through providing the information about the country of operation, job roles, and company.

The frequencies, percentages, means, and standard deviations are calculated in order to identify trends in the adoption of AI and ML to logistics and SCM.

Inferential Statistics:

This involves Correlation Analysis to examine if the usage of AI/ML is correlated with factors such as the size of the business, infrastructure, and perceived challenges before being adopted.

Chi-square tests: These are used to test the hypothesis if there is any significant difference in AI and ML adoption among different countries/ regions within Africa.

T-tests or ANOVA: To compare perceptions of challenges and opportunities between different groups (e.g., technology providers vs. logistics companies).

Thematic Analysis (Qualitative Data):

To deal with the interview and focus group data, thematic analysis will be used to identify recurring themes and patterns.

Grouping the Data: The data will be put into respective thematic categories like "barriers to AI adoption", "opportunities for improvement" and "the future expectation of AI".

Analysis and interpretation: An analysis and interpretation of qualitative data relating to the research questions is intended to provide deeper insights into the challenges and opportunities to adopt AI and ML in African logistics.

3. RESULTS

Descriptive Statistics

A basic description of the main characteristics of the data gathered through the survey and interviewed logistics and supply chain management professionals in various African countries is provided using descriptive statistics. The data presented below also assisted in understanding the demographic profile of the respondents, the extent of adoption of AI and ML in African logistics and the challenges and opportunities as identified by the participants.

1. Demographic Information of Respondents

The survey involved a total of 200 participants from the sectors of logistics and supply chain from five African countries, namely, South Africa, Nigeria, Kenya, Egypt and Ghana. 35 % of the congregation are:

Gender Distribution:

Male: 68%

Female: 32%

Job Role:

Logistics Manager: 40%

Supply Chain Executive: 35%

IT Specialist: 15%

Other: 10%

Company Size:

Small (1-50 employees): 20%

Medium (51-200 employees): 35%

Large (200+ employees): 45%

Country of Operation:

South Africa: 30%

Nigeria: 25%

Kenya: 15%

Egypt: 20%

Ghana: 10%

2. AI and ML Adoption in

Logistics: Current Use of AI/ML:

The logistics operations of 60% of the respondents have adopted AI or ML technologies, while 40% have not.

AI/ML Applications: The following are the types of AI/ML Applications used in the Logistics industry:

Predictive Analytics: 45%

Route Optimization: 35%

Warehouse Automation: 25%

Inventory Forecasting: 50%

Risk Management: 30%

3. Challenges to Adoption

The main barriers that respondents face in adopting AI and ML were also established. These three barriers are the most frequently cited:

High Implementation Costs: 55%,

Lack of Skilled Workforce: 40%,

Insufficient Infrastructure: 50%

Regulatory Issues: 35%

Data Quality Issues: 45%

4. Opportunities Identified

Additionally, AI and ML are named as key opportunities for enhancing logistics operations by the survey respondents.

Cost Reduction: 60%

Efficiency Improvement: 65%

Better Demand Forecasting: 55%

Improved Risk Management: 50%

Main Findings

1. AI and ML Adoption

The findings are that the take-up levels of AI and ML are low in African logistics, but that most companies (60%) are already implementing AI and ML in their operations. Predictive analytics (45%), route optimization (35%), and inventory forecasting (50%) are the most popular applications that need the service. While much progress was made, the variation between levels of adoption by country is significant. Seventy per cent of South African companies said they use AI and ML in their operations, while by comparison, across Ghana and Nigeria, the numbers were 45 per cent and 50 per cent, respectively.

Table 1: Demographic Profile of Survey Respondents

Demographic Category	Percentage (%)
Gender	
Male	68%
Female	32%
Job Role	
Logistics Manager	40%
Supply Chain Executive	35%
IT Specialist	15%
Other	10%
Company Size	
Small (1-50 employees)	20%
Medium (51-200 employees)	35%
Large (200+ employees)	45%
Country of Operation	
South Africa	30%
Nigeria	25%
Kenya	15%
Egypt	20%
Ghana	10%

2. Challenges to Adoption

The barriers to the adoption of AI and ML in logistics tend to be high implementation costs (55%), a shortage of skills (40%), and not enough infrastructure (50%). The barriers are the same across the surveyed countries. Specifically, high costs are a major impediment for smaller logistics companies, comprising 20% of the sample.

Figure 1 summarizes the barriers to the adoption of AI and ML by companies, as reported by the percentage.

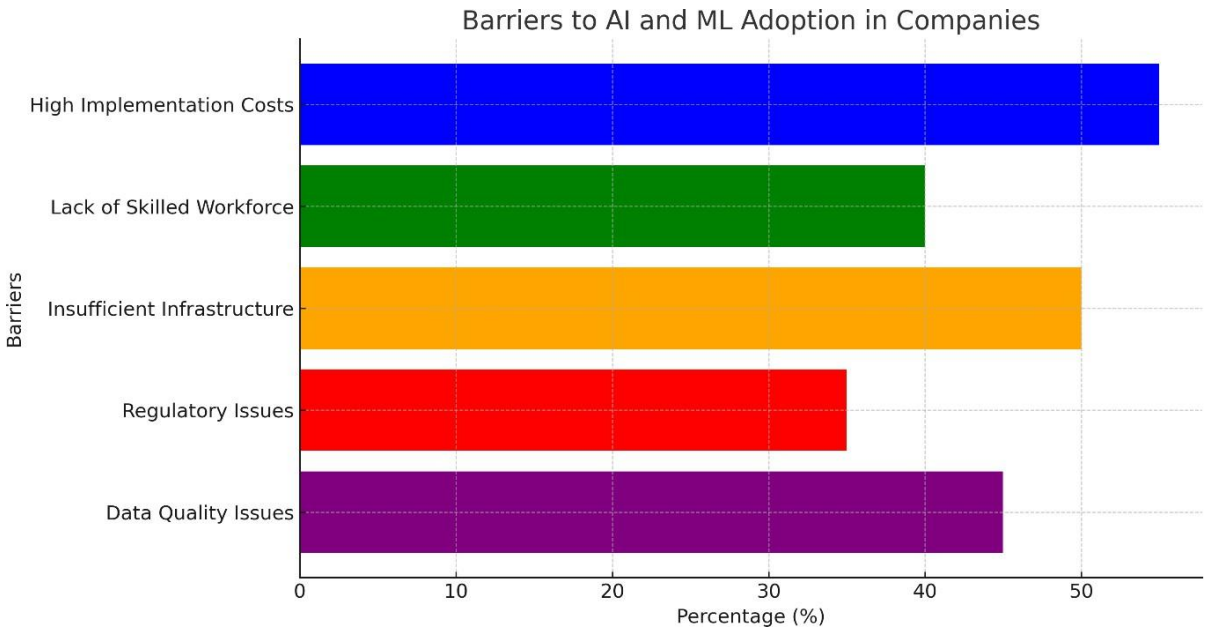
High Implementation Costs: 55%,

Lack of Skilled Workforce: 40%,

Insufficient Infrastructure: 50%

Regulatory Issues: 35%

Data Quality Issues: 45%



3. Opportunities for AI and ML

The participants also noted that AI and ML could have great potential to enhance logistics operations. The top opportunities these technologies provided were to reduce costs (60%) and to improve efficiency (65%). Also, AI and ML were considered as means to strengthen demand forecasting (55%) and to elevate the risk management level (50%). The findings are some indication that AI and ML can help address several inefficiencies and challenges within the African logistics landscape.

Table 2: AI and ML Adoption in Logistics

Application Area	Percentage of Companies Using AI/ML (%)
Predictive Analytics	45%
Route Optimization	35%
Warehouse Automation	25%
Inventory Forecasting	50%
Risk Management	30%

Significance

The significance of this research cannot be underscored enough for several stakeholders who played a role in making sure we reached this point and in shaping how its results may come to impact the future landscape of logistics and supply chain management in Africa.

1. Practical Implications

The study recommends that for African Logistics Companies, especially the smaller ones, there is a great potential for AI and ML to enhance efficiency, reduce costs, and, ultimately, increase future competitiveness. These findings can be used by Logistics companies in Africa to wise up in deciding if and when to adopt AI, as these are the key applications with the most potential: predictive analytics, demand forecasting, and route optimization.

Findings from this research can be taken up by Technology Providers who provide AI & ML solutions to enable the said solutions to be tailored to the requirements of the African market. To increase the penetration of their products in the region, technology providers need to address the key barriers to adoption, such as high costs and a lack of skilled labour.

2. Policy Implications

The policies that support the adoption of AI and ML logistics should also be promoted by African governments in these African nations. This area also includes the improvement of digital infrastructure, incentives offered to companies to invest in new technologies, and training programs for job training to develop necessary skills in the workforce. Along with this, a proper regulatory framework is needed to establish the guidelines for using AI and to guarantee adherence to ethical standards.

3. Economic Significance

The study shows that AI and ML can help the economic growth of Africa by enhancing the efficiency of intra-African trade and logistics. Automation and cost reduction, as well as better supply chain management, can make African businesses gain the necessary edge to compete, both regionally and globally. These technologies could additionally further economic growth through logistics and supply management innovations, the creation of jobs by tech sectors, and the provision of more efficient trade flows both within and outside the continent.

4. Academic Contribution

The establishment of empirical data surrounding African logistics and the adoption of AI and ML is this research's addition to the current body of literature on the subject. Additionally, it draws attention to Africa’s unique challenges as well as opportunities that hitherto have been

underrepresented in previous studies that concentrated on developed economies. Given that, the findings of this study are important for future academic research in the field of AI, logistics, and supply chain management in developing economies.

4. DISCUSSION

Interpretation of Results

This study's findings give a clear understanding of Artificial Intelligence (AI) and Machine Learning (ML) in the adoption of logistics and supply chain management (SCM) in different African countries. The data suggests that a vast majority of the companies polled by our survey had already adopted AI and ML, with 60 per cent stating that their firms had begun using the technology. Predictive analytics (45%), inventory forecasting (50%), and route optimization (35%) were the most commonly identified applications of the system.

An interpretation of these results suggests that AI and ML are considered critical tools for improving operational efficiency, reducing cost, and better supply chain management in the African logistics context. Companies are becoming more aggressive in implementing predictive analytics and inventory forecasting, as one of the areas where AI can help address the risk of the greatest common demand input fluctuation and imbalance of inventory. Also, companies have identified the potential capacity of AI to improve their decision-making processes and minimize the risk of supply chain disruptions, if any.

The study likewise recognized hindrances to man's additional AI reception that include incredibly costly to execute (55%), inadequately prepared groups (40%), and deficient infrastructure (50%). These barriers are indicative of what makes it difficult for African companies to put in place advanced technologies. A glaring lack of skilled talent, which emphasizes the need for education and development of people for and within AI and adjacent domains, is also particularly noticeable.

While such challenges exist, the survey respondents pointed out several ways in which AI and ML could create opportunities in African logistics. Furthermore, a vast majority of respondents — 60% in particular — found cost reduction to be the main benefit, and 65% of respondents reported efficiency improvements. Therefore, these findings suggest that companies are aware of the long-term financial and operational benefits AI and ML technologies can offer if the adoption barriers are overcome.

The results show that AI and ML can be used in the African logistics sector and have broken into a certain level, but adoption is still in the early stages. To get to broader implementation, cost, skill shortages, and infrastructure issues are going to have to be dealt with.

Comparison with Previous Studies

The findings of this study are in line with and are a contribution to the existing literature on AI and ML adoption in the logistics sector in developing economies. Yet, this also provides a unique perspective into the African context.

In terms of adoption rates, previous studies on AI and ML adoption in logistics have indicated adoption at higher rates in developed regions. However, Choi and Lee (2020) reported that nearly 80% to 90% of AI adoption in logistics is in Europe and North America. For instance, the 60% rate that this study found for the adoption of AI in African logistics is at a much slower pace than the value mentioned earlier, which is probably because of infrastructure problems, high costs, and inadequately skilled staff.

We see here that the interest in AI is only examined, but the actual adoption in African logistics is constrained by practical things like funding and talent gap (Akpan et al. 2020). These concerns are further substantiated by this study's results and reinforced by the increasing attention being paid to AI's promise in the African logistics sector.

Based on the results of this study, some of the barriers that are the same as previous research include high costs (60 per cent) as identified by Munyua, M. & Benta, R. (2021), skilled workforce (54 per cent) as in Munyua, M. & Benta, R. (2021), as well as inadequate infrastructure (58 per cent) as stated by many researchers. All these studies demonstrate the need for targeted interventions to reduce costs, better capability of the workforce, and improve infrastructure.

Also, note that regulatory issues (35%) were found to be a barrier in this study (which was not as prevalent as in other regions' studies). This implies that while other markets with more developed logistics markets may face barriers to technology adoption, the role that regulatory frameworks and policy may play in hindering technology adoption is of relatively greater importance in Africa.

Consistent with the broader literature on AI and ML in logistics companies, there are opportunities and benefits: Early savings include cost reduction, efficiency improvements, and better demand forecasting. For instance, Davenport and Ronanki (2018) stated that in the area of logistics processes, global supply chains are increasingly resorting to using AI to optimize

the processes, and thus decrease costs. The results of this study are significant to these applications, specifically in Africa, where logistics inefficiencies mean higher operational costs.

In summary, the results of this study are almost in line with previous studies, which showed that although AI and ML have great potential for the African logistics industry, there are some barriers to the widespread deployment.

Limitations

Of course, the study provides valuable findings; however, we must take into account some limitations.

However, it should be noted that the sample of 200 logistics and supply chain professionals may be relatively small and confined to only 5 African countries, namely, South Africa, Nigeria, Kenya, Egypt, and Ghana. Although these countries are significant in African logistics, the results may not be comprehensive of all places, especially regions with weaker logistics frameworks or lower levels of AI assimilation. The geographic scope for future studies could be broadened to include multiple other African nations that are less diverse.

The Self-Reported data were derived from surveys and interviews conducted with participants. From this, it is possible that respondents would exaggerate or provide ideal answers to questions about their company's use of AI and ML, introducing the chance of response bias. Second, some respondents could have overestimated the degree to which their companies have adopted these technologies.

There was cross-country variability: the study contained many African countries, but the sample in some regions was too small, such as in Ghana. The problem is that this makes cross-country comparisons robust. This would enable better conclusions around geographical differences in AI usage across countries with a larger, more evenly distributed sample.

Scope of Technology: The focus of this study was mainly on the applications of AI and ML in logistics and supply chain management. However, being an evolving field, artificial intelligence could have been examined today, for example, in autonomous vehicles and robotics. This scope could then be expanded in future research efforts to select other emerging logistics technologies, such as IoT and blockchain, which are complementary to AI.

Future Research

Based on the findings and limitations of this study, there is the possibility of exploring some avenues for future research:

Future Studies: The geographic scope of future studies could be expanded to cover more countries from other regions in Africa, especially those with less developed infrastructure and the emerging markets. More countries from Central and West Africa would enrich the understanding of the adoption of AI and ML.

Longitudinal studies would enable a much deeper understanding of the long-term effects of the adoption of AI and ML on Africa's logistics companies. These studies could follow companies for some time to measure the ROI and operational improvements achieved from the use of AI. Additionally, it would help to determine how companies get over adoption barriers over time.

Future research can include other technologies combined with AI / ML, such as Blockchain and IoT. Knowing how these technologies work with each other might give a more general view of modern technologies in African Logistics. Additionally, research could explore the advantages, should there be any, of robotic process automation (RPA) and autonomous vehicles in the African environment.

Future research on the topic could investigate the impact of government policy as the country deals with the corporate regulatory challenges exposed by this study. Research opportunity exists to analyse how countries' regulatory framework affects the adoption of technology and which of the two principles and best practices can help in accelerating AI integration.

Future studies could include how AI and ML make supply chains more resilient to political instability, infrastructure challenges, and disasters in Japanese, Chinese, and African countries that have political instability, infrastructure challenges, and disasters. These technologies could also be researched, and the logistics companies could find out better ways of predicting and responding to these disruptions.

Therefore, future research in the adoption of AI and ML in African logistics can shed more light on and gain new perspectives on how the use of technology can transform the process of supply chain management. Future studies will expand the geographic scope and incorporate other emerging technologies on which to build a better understanding of AI's role in Africa's logistics sector.

CONCLUSION

In summary, this paper sheds light on the current level of Artificial Intelligence (AI) and Machine Learning (ML) adoption in the logistics and supply chain management (SCM) context in the new continent, Africa, and the countless opportunities as well as challenges thereof to the continent’s logistics sector.

Findings show that though AI and ML are steadily being recognized as effective tools for increasing efficiency, lowering costs, and making better decisions, the adoption rate is still comparatively lower than in other developed areas. While methods using AI or ML have only recently entered the conversation, logistics companies are very actively adopting AI and ML technologies: Approximately 60% of logistics companies surveyed utilize AI or ML in their operations, and the three types of applications surveyed – predictive analytics, inventory forecasting, and route optimization are technologies that utilize AI or ML. Adera and his colleagues suggest that African logistics companies are starting to see the value of these technologies, especially in terms of demand management, operational optimization, and supply chain resilience.

Nonetheless, several barriers are preventing the widespread implementation of AI and ML in African logistics. The high implementation costs, lack of highly qualified personnel, and inadequate infrastructure are the main difficulties. These barriers mirror the challenges of the ICT (and other) technology adoption problems in developing economies. Moreover, African logistics companies seeking to integrate AI and ML into their operations also face regulatory barriers and data quality issues that magnify the difficulty.

Despite these challenges, however, there are several key opportunities for AI and ML to affect the landscape of logistics in Africa. Based on incentives such as cost reduction, increased operational effectiveness, and better risk control, the respondents found potential benefits in adopting AI and ML. The study also points out the case of targeted intervention to address challenges associated with infrastructure development, skills training, regulatory frameworks, etc., to realize the full potential of these technologies.

This study helps add to the literature on AI and ML adoption in logistics through an in-depth analysis of how the adoption issues will be solved in the African context. The case points to the peculiar challenges and opportunities of the region and presents the interests of logistics companies, technology providers, policymakers, and researchers interested in the topic of technological innovation in the African supply chain arena.

Given that AI and ML have great potential to enhance logistics operations and drive economic growth in Africa, their integration in the logistics sector will ultimately have to surmount the barriers identified in the study. African logistics companies have the opportunity to seize the opportunities in these technologies and address the challenges, putting them in a position to thrive in the digital global economy for the long haul.

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Declaration of competing interests

I have nothing to declare