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AUTOMATED MATERIAL HANDLING AND OPERATIONAL EFFICIENCY OF INDUSTRIAL GOODS MANUFACTURING COMPANIES IN SOUTH-WEST, NIGERIA

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ABSTRACT: *This study examined automated material handling and operational efficiency of industrial goods manufacturing companies in South-West Nigeria. The study adopted the correlational research design and the quantitative research approach. The population of the study consisted of 42 registered industrial goods manufacturing companies in South-West Nigeria. Thirty-one (31) industrial goods manufacturing companies were selected for the study using purposive sampling method. The sampling unit consisted of managers of the 31 selected industrial goods manufacturing companies in South-West Nigeria. A sample size of 155 managers was drawn from the 31 selected industrial goods manufacturing companies on the ratio of 5 managers per company. A structured questionnaire was used as the main instrument for data collection. The data collected were analyzed statistically while the hypotheses were tested using the Spearman Rank Order Correlation Coefficient (rho). The SPSS version 24 was used for data processing. The findings revealed that automated material storage has significant relationship with operational efficiency (time efficiency and cost efficiency) of industrial goods manufacturing companies. The study also found a significant relationship between automated material movement and operational efficiency (time efficiency and cost efficiency) of industrial goods manufacturing companies. Based on these findings, it was concluded that automated material handling such as automated material storage and movement is significantly related to operational efficiency of industrial goods manufacturing companies in South-West Nigeria. Therefore, it was recommended that industrial goods manufacturing companies in Nigeria particularly those that are yet to apply modern technology in their material handling processes should automate their material handling processes as it would enhance operational efficiency.*

KEYWORDS: Automated material handling, automated material storage, automated material movement, operational efficiency, time efficiency and cost efficiency.

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INTRODUCTION

In a country where there is scarcity of resources, there is need for industrial companies to handle their available resources effectively and achieve operational efficiency. Achieving operational efficiency is the cornerstone to business growth and survival. Without attaining efficiency, it will be difficult for a company to grow and survive in a resource constrained and competitive environment (Kishore & Anand, 2025). Therefore, industrial goods manufacturing companies in Nigeria need to intensify their efforts to achieve operational efficiency. Achieving operational efficiency is not an easy task as it requires industrial companies to handle their materials properly to ensure that these materials are well protected, stored, controlled and moved from their warehouse facility to production site in a timely and cost effective manner. However, the way and manner in which materials are handled in industrial organizations has changed in recent years due to the emergence of technology. Therefore, industrial goods manufacturing companies in Nigeria need to embrace the changes that have taken place in the business environment and automated their material handling to achieve operational efficiency.

Automated material handling is the application of modern technology in the protection, storage, control and movement of materials to different departments such as production, warehousing, distribution, logistics and marketing departments amongst others for smooth operations (Dinesh & Vanithamani, 2023). Traditionally, material handling is done manually using labour which often slows material movement, increase costs and generate higher level of risks, resulting to operational inefficiency (Kishore & Anand, 2025). With the emergence of modern technologies and its application in the business world, many companies have made a switch toward an automated material handling system where robotics, sensors, AI-based tracking, real-time tracking such as GPS, RFID and simulation software are used to handle materials and streamline their business operations (Munga et al, 2023). Some companies have adopted a semi-automated system of material handling while others have fully-automated their material handling operations (Kisioya & Moronge, 2019). Rone and Musau (2020) stated that fully automated handling system ensures that materials are delivered to the production line and other relevant departments without any form of manual intervention.

The adoption of automated material handling system can help companies to achieve operational efficiency. According to Kathurima et al (2016), automated material handling system enhance accuracy, reduce errors, minimize costs and ensure timely delivery of materials to various departments and units within an organization. It also makes materials easy to locate, move and ship out without wasting time. Unlike the manual system of handling materials where there is high frequency of accidents and material damages, the automated system of material handling reduce the degree of accidents and material damages, thus avoiding costly losses and waste (Ansah, 2025). By adopting an automated system of material handling, companies can minimize human error, increase speed of material movement and facilitate smooth operations (Khod & Baviskar, 2025). It is against this backdrop that this study examines the relationship between automated material handling and operational efficiency of industrial goods manufacturing companies in South-West Nigeria.

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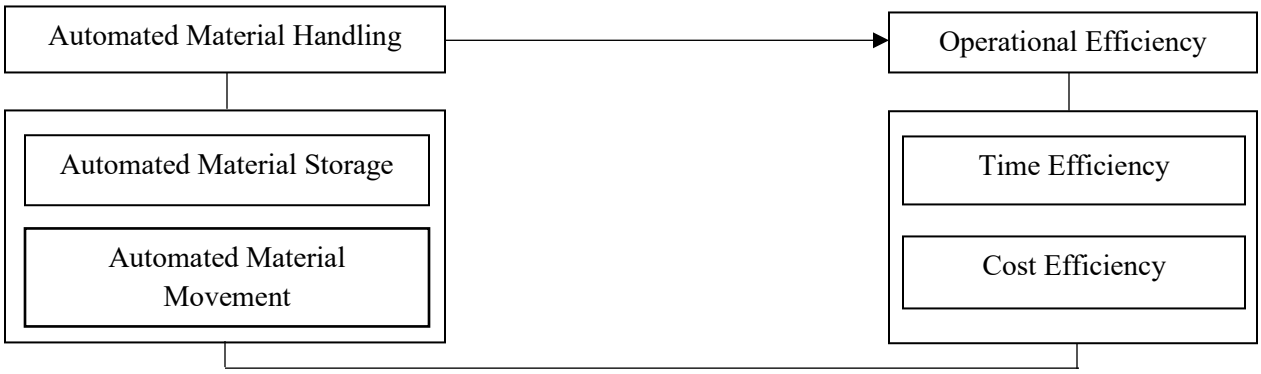
Statement of the Problem

Achieving operational efficiency has become a challenging task to many industrial goods manufacturing companies in Nigeria. Many industrial goods manufacturing companies in Nigeria are experiencing high degree of accidents in handling materials, excessive material damages, frequent human errors, excessive material waste and high operational costs, resulting to operational inefficiency. This situation occurs as a result of the manual system of handling materials in these companies over the years. With the emergence of technologies, some of these companies have switched from their manual system of material handling to automated material handling system by automating their material storage and movement to achieve operational efficiency. However, ever since these companies adopted an automated system of material handling, it is still not clear whether such move has yielded the desired result of achieving operational efficiency as empirical studies that examined the relationship between automated material handling and operational efficiency of industrial goods manufacturing companies in Nigeria are absent or scanty in literature. This has created a gap in material handling literature which this study is motivated to bridge.

CONCEPTUAL FRAMEWORK

The conceptual framework of automated material handling and operational efficiency of industrial goods manufacturing companies is shown in figure 1 below:

Fig 1: Conceptual framework of material handling strategies and operational efficiency of industrial goods manufacturing companies in South-West Nigeria



Source: *Author's Conceptualization*

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Aim and Objectives of the Study

The aim of this study is to examine the relationship between automated material handling and operational efficiency of industrial goods manufacturing companies in South-West Nigeria. To achieve this broad aim, the study intends to:

1. ascertain the relationship between automated material storage and time efficiency of industrial goods manufacturing companies in South-West Nigeria;
2. determine the relationship between automated material storage and cost efficiency of industrial goods manufacturing companies in South-West Nigeria;
3. ascertain the relationship between automated material movement and time efficiency of industrial goods manufacturing companies in South-West Nigeria;
4. determine the relationship between automated material movement and cost efficiency of industrial goods manufacturing companies in South-West Nigeria.

Research Questions

The study raised the following research questions:

1. What is the relationship between automated material storage and time efficiency of industrial goods manufacturing companies in South-West Nigeria?
2. To what extent does automated material storage relate to cost efficiency of industrial goods manufacturing companies in South-West Nigeria?
3. What is the relationship between automated material movement and time efficiency of industrial goods manufacturing companies in South-West Nigeria?
4. To what extent does automated material movement relate to cost efficiency of industrial goods manufacturing companies in South-West Nigeria?

Research Hypotheses

The following hypotheses were postulated to guide this study:

Ho_1: There is no significant relationship between automated material storage and time efficiency of industrial goods manufacturing companies in South-West Nigeria.

Ho_2: There is no significant relationship between automated material storage and cost efficiency of industrial goods manufacturing companies in South-West Nigeria.

Ho_3: There is no significant relationship between automated material movement and time efficiency of industrial goods manufacturing companies in South-West Nigeria.

Ho_4: There is no significant relationship between automated material movement and cost efficiency of industrial goods manufacturing companies in South-West Nigeria.

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REVIEW OF RELATED LITERATURE

Concept of Automated Material Handling

Automated material handling is a fully integrated solution that uses software, robotics and smart equipment for the movement, storage, retrieval and control of materials without the direct involvement of human beings (Saffar et al, 2016). Qin et al (2021) defined automated material handling as any technology driven system that eliminates the need for human intervention in the process of receiving, storing, picking, packing, protecting, controlling and moving of materials throughout the manufacturing, warehousing, distribution and disposal operations of a firm. Pop and Mailat (2011) described automated material handling as the use of automated system and equipment to store, sort, organize and transport materials within manufacturing facilities, warehouse facilities and distribution centers. Examples of automated material handling equipment include conveyors, automated guided vehicles, robotic palletizers, automated storage/robotic storage, automated cranes and hoists, automated picking system, specialty lifters for unique materials (e.g. Aardwolf Slab Lifters, Vacuum Lifters and Jib Cranes).

Automated material handling system operates faster when moving and storing materials with less material damage when compared to the human and mechanized system (Lee et al, 2021). Bashar, et al (2024) stated that automated system of handling materials operates 24 hours daily with consistent speed and accuracy, thereby keeping up with modern demand. Fully automated material handling system ensures that materials and components are delivered to the production line when required without manual intervention (Kathurima et al, 2016). Alumbugu et al (2019) posited that automated material handling system reduces costs, increase output rate, save time and enhance operational efficiency of firms. It also prevents human errors and minimizes the risk of accidents, injuries and damages to material during movement and storage operations.

Dimensions of Automated Material Handling

The dimensions of automated material handling investigated in this study are automated material storage and automated material movement.

Automated Material Storage

Automated material storage is an integrated solution that leverage on software, robotic and equipment for storing materials in a firm (Roodbergen & Vis, 2009). Automated material storage system is designed to streamline and simplify complex activities involved in the storage of materials (Davis & Taylor, 2016). The activities involved in material storage include receiving of materials, organizing storage space, sorting of materials, protecting materials, managing material inventory and fulfilling orders (Ait-Bella et al, 2014). By automating storage activities, companies can reduce labour costs, prevent human errors, ensures material accuracy, and minimize material damages in warehouse (Kishore & Anand, 2025). Automated system of material storage integrate all the processes for material storage together to speed up storage operations, keep costs low and increase productivity (Arshed et al, 2016). Examples of automated material storage system and equipment are: stackers, reclaimers, and bucket elevators. Stackers is used for lifting and stacking heavy loads on the dock or in the warehouse; reclaimers

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machines are used to recover bulk materials from a stockpile; while bucket elevators are used to haul bulk material vertically (Dinesh & Vanithamani, 2023). However, high-density storage solutions and vertical AS/RS systems make the most of every square meter.

Automated Material Movement

Automated material movement refers to the use of software solution and equipment to organize and move materials within manufacturing, warehouse and distribution centers (Saffar et al, 2016). Automated system of material movement minimizes human errors and increases the speed of material movement (Pinagapani et al, 2024). Examples of automated system and equipment used for material movement are conveyor belts, rollers, cranes, towlines, robotic delivery system, automated guided vehicles (AGV), blockchain technology, etc. Conveyors are used to move heavy and large volume of materials to specified destinations using belts, live rollers and flexible chains (Muhati & Abuga, 2023). Conveyors are used when material is to be moved frequently between specific points over a fixed path and when there is a sufficient flow volume to justify the fixed conveyor investment (Kathurima et al, 2016). AGVs can move items across factory floor without direct involvement of human effort, while robot delivery system can move materials along an assembly line or around a facility (Davis & Taylor, 2016). AVGs follow specific markers or wires in the floor to move large materials around a manufacturing or warehouse facility. However, when moving high pallet volume with regular deliveries to predetermined locations, AGVs can be a good alternative to forklift and milkrun (Mulcahy, in Kathurima et al, 2016). Many companies have automated their material movement using robotics and automated guided vehicles (AGVs) to move materials within their facilities. For example, Amazon uses robotic and AGVs to convey shelves of materials straights to human pickers, thereby eliminate the need for workers to walk lengthy distances to gather items. The use of AGVs reduces efforts and time required for picking operation, ensure accuracy, lower labour costs and increase operational efficiency (Bashar et al, 2024). Blockchain technology is another automated system and technology used for tracking the origin and movement of materials (Qin et al, 2021). This technology is integrated to material handling because it provides a more secure and efficient movement of material throughout manufacturing, warehouse and distribution centers.

Concept of Operational Efficiency

Operational efficiency is the ability of a firm to optimize its processes to reduce costs, increase speed and produce quality output (Kishore & Anand, 2025). Operational efficiency is the cornerstone to sustain and improve business performance. According to Arshed et al (2016), operational efficiency translates to increased productivity, quality output, lower operational costs and timely delivery of products and services while operational inefficiency brings about bottlenecks, delays, higher labour costs and increased safety concerns all of which undermines corporate goals. Operational efficiency is a strategic requirement and a path way to achieving operational excellence and competitive advantage (Rono & Musau 2020). However, operational efficiency can be achieved when firms utilize both traditional business approach and cutting-edge technologies (Alumbugu et al, 2022). Meanwhile, Gwynne (2014) noted that firms can

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achieve operational efficiency using strategy approach to business, streamline operations and adapt to modern method of carrying out business activities.

Measures of Operational Efficiency

Operational efficiency is measured using several indicators in literature. However, this study measures operational efficiency using time efficiency and cost efficiency.

Time Efficiency

Time efficiency is the ability of an individual or firm to get certain activities or job done within a shortest possible time while maintaining quality (Kishore & Anand, 2025). It shows the degree of time resourcefulness of an individual or firm in reaching their highest goal. Time efficiency is all about getting certain activities done without wasting time. It demonstrates the degree of time consciousness of an individual or firm when carrying out their daily activities. Gwynne (2014) opined that time efficiency can be achieved if firms streamline their operations by eliminating unnecessary processes and automate repeated activities. When a firm streamlines and automate repetitive operations, it will save time and increase operational efficiency (Saffar et al, 2016). Lee et al (2021) posited that time efficiency is a pre-requisite for achieving operational excellence and a vital tool for gaining competitive advantage.

Cost Efficiency

Cost efficiency is a deliberate effort by an organization to reduce the costs of carrying out its business operations (Gwynne, 2014). It involves producing high quality products and services using fewer financial resources. A company can achieve cost efficiency by optimizing its processes and automate repetitive activities (Ross, 2010). However, Rajeev (2010) argued that a company can reduce its operating costs if it localized its sources of raw materials, streamline its processes and reduce waste. When a company is able to achieve cost efficiency, it will gain competitive advantage over its rivals, maximize profit and experience business growth (Pienaar, 2016).

Theoretical Review

This study is guided by technological determinism theory which was propounded by Thorstein Veblen in 2001. The theory states that emergency of technology and technological changes are the most critical factors responsible for the changes in society. The technological determinism theory explains how the emergence of technology has impacted human thoughts and actions (Hauer, 2017). It has changed the way people do things including the way materials are handled in business organizations. The theory argues that technological emergency drives social, economic, political and organizational change (Green, in Felix, 2017). The idea behind this theory is that technology changes determine social change i.e. the way people see things as well as the way they handle materials in their organization. By relating the technological determinism theory to the present study, it can be argued that technology emergence has changed the way in which materials are handled in organizations. The theory argues that the emergence of technology has led to the automation of material handling in business organizations. With the

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introduction of modern technology, materials can be stored and moved automatically without human intervention, thereby reducing delay and labour cost, and promoting operational efficiency.

Empirical Review

Some related empirical studies have been conducted on automated material handling and operational efficiency of companies. For instance, Muhati and Abuga (2023) explored the influence of material handling automation on profitability of medium-scale manufacturing firms in Nairobi County, Kenya. Their study adopted the descriptive research design where a semi-structured questionnaire was used to collect data from 194 employees of medium sized manufacturing firms in Nairobi. The data collected were analysed using mean and standard deviation while the hypotheses were tested using regression analysis. The findings revealed that material handling automation such as material store mechanization, use of conveyors and electronic data interchange have significant influence on profitability of medium sized manufacturing firms in Nairobi County.

Alumbugu et al (2022) examined efficient utilization of automation in construction materials-handling processes. The researchers adopted the case study research design and used a structured observation to collect data from 32 manufacturers of construction materials who were purposively selected from North Central Nigeria. The data collected were analysed using descriptive statistics such as percentage, frequency count and bar chart. After analyzing the data collected, the researchers found out that there is low level of automation utilization in order picking, storage, loading and off-loading of materials in construction materials manufacturing firms in North Central Nigeria.

Kathurima et al (2016) examined the effects of materials handling systems on performance of cement manufacturing firms in Machakos County. The study employed the descriptive correlational research design where data were collected from 60 employees drawn from various departments of cement manufacturing firms in Machakos County using a structured questionnaire. Data collected were analyzed using mean and standard deviation while the hypotheses were tested using regression analysis. The findings revealed that material handling system (automated material handling system, information direct system, semi-automated system and mechanized material handling system) has significant effect on the performance of cement manufacturing firms in Machakos County.

Munga et al (2023) carried out a study to determine the influence of material handling practices on the performance of formal manufacturing firms in Mombasa County, Kenya. Their study adopted the descriptive research design where a structured questionnaire was used to collect data from 150 respondents comprising managers, engineers, operators and truck drivers drawn from manufacturing firms in Mombasa County. The data collected were analysed using percentage and frequency tables while the hypotheses were tested using Pearson correlation, regression analysis and SPSS. The findings revealed that material flow has significant influence on the performance of formal manufacturing companies in Mombasa County.

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Ansah (2025) explored the impact of material handling on business profitability. Their study adopted the exploratory and descriptive research design alongside with the mixed methods approach. Data were collected from procurement officers, warehouse employees, material handlers, logistics managers and operations managers of manufacturing, retailing and logistics organizations in Ghana using a structured questionnaire and interview. The qualitative data collected for the study were analysed using content analysis while the quantitative data were analysed using Pearson correlation and regression analysis. The findings revealed that material handling has significant impact on business profitability.

Rono and Musau (2020) examined the effect of material handling practices on supply chain efficiency of flour processing firms in Eldoret. Their study adopted the descriptive research design where questionnaire was used to collect from 77 employees comprising branch managers, store clerks, procurement officers, finance officers and logistics staff drawn from flour processing firms in Eldoret. The data collected were analyzed using percentage and frequency analysis while the hypotheses were tested using regression analysis. The findings revealed that material handling practices (manual handling, automated handling, material flow and material oriented system) have positive and significant effect on supply chain efficiency (environmental conservation, risk reduction, cost reduction and lead time) of flour processing firms in Eldoret.

Dinesh and Vanithamani (2023) conducted a study to determine the effectiveness of material handling and storage in Blue Force Logistics. Their study adopted the survey research design where an online structured questionnaire in Google form was used to collect data from 120 employees working with Blue Force Logistics in Coimbatore. The data collected were analyzed using percentage analysis while the hypotheses were tested using Chi-square statistical tool. The findings revealed that material handling and storage in Blue Force Logistics is satisfactory in terms of achieving the desired result.

Gap in Literature

Two major gaps were identified from the literature reviewed. First, it was observed that most of the previous studies conducted on automated material handling among business organizations in Africa are conducted in Kenya and Ghana while studies that examined automated material handling of firms in Nigeria are limited. Secondly, it was observed that none of the previous studies relate automated material handling (automated material storage and automated material movement) to operational efficiency (time efficiency and cost efficiency) of industrial goods manufacturing companies in Nigeria. This has created gap in existing empirical literature which the present study intends to fill.

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METHODOLOGY

This study is a correlational research that utilizes the positivist research philosophy and the quantitative research approach. The study population consisted of forty-two (42) industrial goods manufacturing companies that are duly registered with the Manufacturers Association of Nigeria (MAN) in South-West Geopolitical Zone. However, thirty-one (31) registered industrial goods manufacturing companies were selected for the study purposively based on the criteria that they automate their material handling operations. The sampling unit consisted of IT managers, warehouse managers, procurement managers, logistics managers and operational managers of the 31 selected industrial goods manufacturing companies in South-West Nigeria. A sample size of 155 managers of the above categories was drawn from the 31 selected industrial goods manufacturing companies on the ratio of 5 managers per company. A structured questionnaire was used to collect data from the respondents after the instrument has been validated using content validity and its reliability determined using Cronbach Alpha method. A total of copy of 155 questionnaires was administered to the respondents across the selected companies in the five States that make up the South-West Zone of Nigeria. Out of the 155 questionnaires administered to the respondents, 121 copies were collected which represents 78% collection rate. The data collected were presented and analyzed in tables while the hypotheses were tested using Spearman Rank Order Correlation Coefficient (rho). The data were processed using a computer software program known as SPSS version 26.

RESULTS AND DISCUSSION

The results of the bivariate analysis carried out on the predictor and criterion variables in this study are presented in the tables below:

Table 1: Result of bivariate analysis between automated material storage and time efficiency of industrial goods manufacturing companies

			Automated Material Storage	Time Efficiency
Spearman (rho)	Automated Material Storage	Correlation Coefficient	1.000	.594**
		Sig. (2 tailed)	.	.001
		N	121	121
	Time Efficiency	Correlation Coefficient	.594**	1.000
		Sig. (2 tailed)	.001	.
		N	121	121

**Correlation is significant at 0.01 levels (2 tailed)
*Correlation is significant at 0.05 levels (2 tailed)

Source: *SPSS-Generated Output*

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Table 1 indicates that automated material storage is moderately and positively correlated to time efficiency of industrial goods manufacturing companies (rho = .594**) and this correlation is statistically significant at 0.01 level. Based on this result, we then reject the null hypothesis (Ho_1) and accept the alternate hypothesis which states that there is significant relationship between automated material storage and time efficiency of industrial goods manufacturing companies in South-West Nigeria.

Table 2: Result of bivariate analysis between automated material storage and cost efficiency of industrial goods manufacturing companies

			Automated Material Storage	Cost Efficiency
Spearman (rho)	Automated Material Storage	Correlation Coefficient	1.000	.538**
		Sig. (2 tailed)	.	.001
		N	121	121
	Cost Efficiency	Correlation Coefficient	.538**	1.000
		Sig. (2 tailed)	.001	.
		N	121	121

**Correlation is significant at 0.01 levels (2 tailed)
*Correlation is significant at 0.05 levels (2 tailed)

Source: *SPSS-Generated Output*

Table 2 reveals that automated material storage has a moderate and positive correlation with cost efficiency of industrial goods manufacturing companies (rho = .538**) and this correlation is significant at 0.01 level. As a result of this the null hypothesis (Ho_2) is rejected and the alternate hypothesis is accepted. This means that there is significant relationship between automated material storage and cost efficiency of industrial goods manufacturing companies in South-West Nigeria.

Table 3: Result of bivariate analysis between automated material movement and time efficiency of industrial goods manufacturing companies

			Automated Material Movement	Time Efficiency
Spearman (rho)	Automated Material Movement	Correlation Coefficient	1.000	.817**
		Sig. (2 tailed)	.	.001
		N	121	121
	Time Efficiency	Correlation Coefficient	.817**	1.000
		Sig. (2 tailed)	.001	.
		N	121	121

**Correlation is significant at 0.01 levels (2 tailed)
*Correlation is significant at 0.05 levels (2 tailed)

Source: *SPSS-Generated Output*

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Table 3 shows a very strong and positive correlation between automated material movement and time efficiency of industrial goods manufacturing companies (rho = .817**) and this correlation is statistically significant at 0.01 level. Therefore, the null hypothesis (Ho_3) is rejected and the alternate hypothesis is accepted. This implies that we then accept that there is significant relationship between automated material movement and time efficiency of industrial goods manufacturing companies in South-West Nigeria.

Table 4: Result of bivariate analysis between automated material movement and cost efficiency of industrial goods manufacturing companies

			Automated Material Movement	Cost Efficiency
Spearman (rho)	Automated Material Movement	Correlation Coefficient	1.000	.882**
		Sig. (2 tailed)	.	.001
		N	121	121
	Cost Efficiency	Correlation Coefficient	.882**	1.000
		Sig. (2 tailed)	.001	.
		N	121	121

**Correlation is significant at 0.01 levels (2 tailed)
*Correlation is significant at 0.05 levels (2 tailed)

Source: SPSS-Generated Output

Table 4 indicates that automated material movement has a very strong and positive correlation with cost efficiency of industrial goods manufacturing companies (rho = .882**) and this correlation is statistically significant at 0.01 level. Based on this result we then reject the null hypothesis (Ho_4) and accept the alternate hypothesis which states that there is significant relationship between automated material movement and cost efficiency of industrial goods manufacturing companies in South-West Nigeria.

DISCUSSION OF FINDINGS

This study discovered a significant relationship between automated material storage and time efficiency of industrial goods manufacturing companies in South-West Nigeria. This finding was deduced from the result of the bivariate analysis carried out on the two variables. The result revealed that automated material storage is moderately and positively correlated to time efficiency of industrial goods manufacturing companies (rho = .594**) and this correlation is statistically significant at 0.01 level. Based on this result, the null hypothesis (Ho_1) was rejected and the alternate hypothesis was accepted. This means that there is significant relationship between automated material storage and time efficiency of industrial goods manufacturing companies in South-West Nigeria. This finding is in line with the research conducted by Kisioya and Moronge (2019) and Khod and Baviskar (2025) as both studies revealed that the application of modern technologies in material storage operations such as receiving of materials, sorting, storing, picking and packing operations significantly save time and increase efficiency.

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This study also found a significant relationship between automated material storage and cost efficiency of industrial goods manufacturing companies in South-West Nigeria. This finding was obtained from the result of the bivariate analysis carried out on the two variables. The result revealed that automated material storage has a moderate and positive correlation with cost efficiency of industrial goods manufacturing companies (rho = .538**) and this correlation is significant at 0.01 level. As a result of this we then rejected the null hypothesis (Ho_2) and accepted the alternate hypothesis which states that there is significant relationship between automated material storage and cost efficiency of industrial goods manufacturing companies in South-West Nigeria. Pinagapani et al (2024) and Kishore and Anand (2025) agreed with this finding as their studies revealed that automated storage and retrial system significantly reduce operational costs of firms.

This study equally reported a significant relationship between automated material movement and time efficiency of industrial goods manufacturing companies in South-West Nigeria. This finding emerged from the result of the bivariate analysis carried out on the two variables. The result showed a very strong and positive correlation between automated material movement and time efficiency of industrial goods manufacturing companies (rho = .817**) and this correlation is statistically significant at 0.01 level. Consequently, the null hypothesis (Ho_3) was rejected and the alternate hypothesis was accepted. This implies that we then accept that there is significant relationship between automated material movement and time efficiency of industrial goods manufacturing companies in South-West Nigeria. This finding is supported by Alumbugu et al (2019) and Ansah (2025) as both studies revealed that automated material movement enhance time delivery of materials throughout the manufacturing, warehouse and distribution centers of an organization.

Finally, it was discovered that automated material movement has a significant relationship with cost efficiency of industrial goods manufacturing companies in South-West Nigeria. This finding was obtained from the result of the bivariate analysis carried out on the two variables. The result revealed that automated material movement has a very strong and positive correlation with cost efficiency of industrial goods manufacturing companies (rho = .882**) and this correlation is statistically significant at 0.01 level. Based on this result we then rejected the null hypothesis (Ho_4) and accepted the alternate hypothesis which states that there is significant relationship between automated material movement and cost efficiency of industrial goods manufacturing companies in South-West Nigeria. This finding is in line with the research conducted by Kathurima et al (2016) and Nguyen (2020) as they revealed that automated material movement reduce labour costs and increase operational efficiency of firms.

CONCLUSIONS

Considering the increasing rate of technological advancement and its application in business operations, it becomes imperative for manufacturing companies in Nigeria to automate their material handling processes to achieve operational efficiency. This study has proven that automated material storage has significant relationship with time efficiency of industrial goods

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manufacturing companies. The study also found a significant relationship between automated material storage and cost efficiency of industrial goods manufacturing companies. A significant relationship was equally reported between automated material movement and time efficiency of industrial goods manufacturing companies. The study also discovered a significant relationship between automated material movement and cost efficiency of industrial goods manufacturing companies. Based on these findings, it was concluded that automated material handling such as automated material storage and movement is significantly related to operational efficiency of industrial goods manufacturing companies in South-West Nigeria.

RECOMMENDATIONS

The following recommendations are provided for the study:

1. That, industrial goods manufacturing companies in Nigeria particularly those that are yet to apply modern technology in their material handling processes should automate their material handling processes as it would enhance operational efficiency.

2. That, industrial goods manufacturing companies in Nigeria should automate their storage processes such as receiving of materials, sorting, picking and packing processes as it would save time and costs in handling storage operations.

3. That, industrial goods manufacturing companies in Nigeria particularly those that experiencing constant delay and high costs of moving materials across departments should automate their material movement processes as it would enable them move materials in a timely and cost-effective manner.

4. That, industrial goods manufacturing companies in Nigeria should apply modern technologies and equipment such as stackers, reclaimers, bucket elevators, conveyor belts, rollers, cranes, towlines, robotic delivery system, automated guided vehicles (AGV), and blockchain technology in their material storage and movement operations as it would enhance operational efficiency.

5. Finally, it is recommended that industrial goods manufacturing companies in Nigeria should collaborate with technology companies and IT experts as it would enable them implement automated material handling effectively and achieve their operational efficiency.

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