



## Assessing the Effect of Ai-Driven First-to-Expire first out (FEFO) Automation on Inventory write-off Costs: Evidence from Listed Nigerian Pharmaceutical Firms

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### Abstract

The study was an assessment of the impact of First-to-Expire First-Out (FEFO) automation using Artificial Intelligence (AI) on the cost of inventory write-off in listed pharmaceutical companies in Nigeria between 2021 and 2025. The research dealt with the long-term issue of stock leakage as a result of stock obsolescence existing in a fluctuating macroeconomic environment. The study was conducted with the help of two particular objectives: the assessment of the decrease in the volumes of expired inventory and the determination of the influence on the costs of monetary write-offs. The research design adopted the ex-post facto research design where secondary data were used in a census sample of 5 listed firms. The Multiple Regression analysis was employed to analyse the data and triangulate them with Technology Acceptance Model (TAM) and Resource-Based View (RBV). The results showed that there was a strong and statistically significant negative relationship between AI-based FEFO and inventory write-off costs  $\beta = -0.612, p < 0.05$ ). The regression model had an  $R^2$  value of 0.748, which explained 74.8% of the variation in write-off costs ( $R^2 = 0.748$ ), which means that automation is a major factor contributing to reduction in wastes. The authors found that AI-based FEFO is a powerful strategic financial resource that maintains firm capital. It is suggested, that pharmaceutical boards should make capital investment in AI-integrated ERP systems one of their priorities to balance the profit margins with the loss associated with inventory.

**Keywords:** AI-driven FEFO, inventory write-off costs, Nigerian pharmaceutical sector, capital protection, digital accounting

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### 1. Introduction

#### 1.1. Background to the Study

The pharmaceutical industry of the world is highly sensitive to the product shelf life and its strict regulation. In contrast with other manufacturing industries, the poor management of pharmaceutical products inventory does not only lead to the loss of money; it is a huge threat to the health of the people. Conventionally, companies have been using the First-to-Expire, First-Out (FEFO) approach, which is a technique of selling or consuming goods with the nearest expiry dates first, irrespective of their time of receipt. The Artificial Intelligence (AI) is an emerging trend in supply chain management in the past couple of years due to the advent of the Fourth Industrial Revolution. Automation via AI makes use of machine learning algorithms and data tracking in real time to eliminate the human error that is part of a manual FEFO system. In developing markets such as Nigeria where inadequate infrastructure and extreme weather conditions can increase the rate of spoilage, intelligent, automated systems have ceased being a luxury and become a strategic need to survive.

#### 1.2. Statement of the Problem

Nigeria pharmaceutical industry is an extremely unstable economic landscape that the listed pharmaceutical companies have to operate in. The price of imported raw materials and finished drugs has been exorbitant because of high inflation and certain changes in the foreign exchange. Though these costs are increasing, large amounts of inventory are also wasted each year to inventory write-offs- the financial procedure of depreciating inventory that has expired, of inventory damaged, or inventory

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outdated. The key issue is that the process of manual or semi-automated FEFO is inefficient. Human control usually causes the forgotten batches which are at the rear of the warehouse, lack of tracking of the batches by use of batch numbers, and inadequate prediction analytics to determine the demand before the products go out of their expiry dates. Although there is literature about AI in the Nigerian manufacturing sector, there is no specific research conducted on the direct effect of the specific AI-driven FEFO automation in reducing these write-off costs in the pharmaceutical sub-sector of the Nigerian Exchange Group (NGX).

### 1.3. Research Objectives

The primary aim of this study is to investigate the influence of AI-integrated inventory systems on financial losses. Specifically, the study seeks:

1. To evaluate the effect of AI-driven FEFO automation on the reduction of expired inventory volumes.
2. To analyze the impact of AI-driven FEFO implementation on the total value of inventory write-off costs reported by listed Nigerian pharmaceutical firms.

### 1.4. Research Questions

The study will address the following questions:

1. To what extent does the adoption of AI-driven FEFO systems reduce the physical volume of expired inventory in listed Nigerian pharmaceutical firms?
2. How significant is the reduction in annual inventory write-off costs following the implementation of AI-driven FEFO automation?

### 1.5. Research Hypotheses

1. **H0:** AI-driven FEFO automation does not significantly reduce the volume of expired inventory.  
**H1:** AI-driven FEFO automation significantly reduces the volume of expired inventory.
2. **H0:** There is no significant relationship between the implementation of AI-driven FEFO automation and the reduction of inventory write-off costs.  
**H1:** There is a significant relationship between the implementation of AI-driven FEFO automation and the reduction of inventory write-off costs.

### 1.6. Significance of the Study

The importance of the work is due to the fact that the research deals with the important cross intersection of financial management and technological innovation within the high-stakes industry. Its results will prove useful to the following groups:

**Pharmaceutical Sector Management:** In the case of the CEOs and Supply Chain Managers of such firms as Fisons, May and Baker, and Neimeth, the research will give them a cost-benefit rationale to invest in AI. It provides a path of abandoning the expensive manual tracking and automated systems that ensure that the profit margins are not being eroded by unnecessary wastage.

**Investors and Financial Analysts:** Investors in the Nigerian Exchange (NGX) are becoming more concerned with operational efficiency. The current study offers the evidence about the adoption of technology as a proxy of good governance and use of assets so that investors can refer to the firms with the best risk management practices.

**Regulatory Bodies (NAFDAC & PCN):** This study can be utilised by the National Agency for Food and Drug Administration and Control (NAFDAC) to learn how the automated FEFO systems can be used to improve the drug safety by making sure that the expired or degraded drugs do not get into the Nigerian market.

**Government and Policy Makers:** It avails information towards the push by the federal government towards the "Digital Economy." The results might affect the policy of providing tax incentives or grants to pharmaceutical companies adopting modern technologies to enhance drugs security in the country.

### 1.7. Contribution to Knowledge

The current work has a number of contributions to the existing academic literature: Although the traditional theory of First-to-Expire, First-Out (FEFO) is documented well, this research is unique in that it combines it with the Artificial Intelligence (AI) algorithms. It takes the discussion out of a manual logistical rule to a dynamic, predictive financial strategy. Majority of the AI studies conducted in Nigeria are dedicated to general production or the banking industry. The work offers isolated and industry-focused empirical data on the pharmaceutical sub-sector, bridging a local knowledge gap in African knowledge on supply chains. Also, the research adds value to the Digital Accounting discipline by numerically defining the correlation between a technology input (AI-Driven FEFO) and a particular financial output (Inventory Write-off Costs). It is not restricted to theoretical benefits but it shows measurable financial statement effect. The study, by focusing on the specific limitations of the Nigerian setting, that is, the issue of infrastructure and FX fluctuation, creates a map of how companies operating in the emerging economies can use AI to address the risks of the local environment.

## 2. Literature Review

### 2.1. Conceptual Framework

The essence of this system is that the closer a firm will shift its traditionally manual and error-prone inventory counting to an AI-based system, the more accurate the tracking of the First-to-Expire will become, and the financial losses due to the lack of expired goods will be directly reduced.

#### 2.1.1. The Independent Variable: FEFO Automation AI-Driven.

AI-based FEFO is not a software only, it is more an ecosystem. It has been conceptualised in the context of this study in three main dimensions: Real-Time Batch Tracking: It is applied to track the expiry date of each batch using IoT or RFID sensors without any human intervention. Predictive Demand Analytics: Machine learning algorithms based on predicting the specific products that will be expired soon depending on sales velocity and then early discounts or transfers. Automated Alert Systems: To give warning to the managers of the warehouse, there will be digital triggers that will alert them months before the product expired and it will be in the red zone.

#### 2.1.2. The Dependent Variable Inventory Write-off Costs.

This is the financial point of pain to the pharmaceutical companies in Nigeria. It is measured by: Value of Expired Stock: It is the actual financial loss of the items that could not

be sold anymore. Disposal Costs: This cost is the administrative and logistical costs of the safe destruction of the expired pharmaceutical waste according to NAFDAC guidelines. Devaluation Charges: The reduction of the inventory value to the Statement of Financial Position (Balance Sheet) when the stock is found to be almost out of date and the inventory has to be sold at a significant loss.

### 2.1.3. The Moderating/Intervening Variables.

The attainment of AI and reduction of cost is usually a

product of external shock in the Nigerian context. These should be admitted within the system: Infrastructure Reliability: AI synchronisation can be interrupted by power blackouts or a weak network connexion. FX Volatility: This is because most drugs are imported and thus a sharp decline in the Naira may cause the value of the write-off to soar, despite the amount of expired drugs being minimal. Regulatory Compliance: NAFDCA or PCN alterations in terms of shelf-life.

Table 1:

Category	Variable	Indicator/Measurement
Independent	AI-Driven FEFO	Level of AI integration (Automation Index)
Dependent	Inventory Write-off Costs	Annual Write-off Value (Naira)
Control	Firm Size	Total Assets
Control	Revenue Growth	Annual Sales % Change

## 2.2. Theoretical Framework

### 2.2.1. Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) is a model of information systems theory that was developed by Fred Davis in 1989 describing the manner in which users accept and adopt new technology. It assumes that two factors, Perceived Usefulness (PU) (the belief that it enhances performance) and Perceived Ease of Use (PEOU) (the belief that it is simple to study and use) are the drivers of adoption.

- **Connexion to Objective 1 (Reduction of Expired Inventory):** Within the framework of the pharmaceutical companies in Nigeria, TAM suggests that, in case the warehouse managers understand that AI-driven FEFO is useful (i.e., it will help them make more accurate counts of the expired inventory compared to the manual one), they will tend to fully adopt it into their daily routine. When the AI system is fully accepted and used, the inventory discipline improves. When the technology is regularly utilised in the monitoring of near-expiry batches,

- the physical volume of the expired inventory will automatically reduce since the system will have the effect of pushing the issuance of the oldest stock first.

### 2.2.2. Resource-Based View (RBV)

Developed primarily in the 1980s and 1990s by Birger Wernerfelt and Jay Barney, RBV suggests that companies should assess their own resources rather than solely analyzing competitors. RBV suggests that firms achieve a sustainable competitive advantage and superior financial performance by acquiring and controlled bundles of resources that are Valuable, Rare, Inimitable, and Non-substitutable (VRIN).

- **Link to Objective 2 (Reduction of Inventory Write-off Costs):** RBV treats AI-driven FEFO resource. By utilizing this digital asset to optimize stock rotation, the firm reduces "leakage" in the form of write-offs. According to RBV, the direct result of managing resources more efficiently than competitors is improved financial performance.

### 2.2.3. Theoretical Integration Table

Table 2:

Theory	Relevance to the Study	Link to Research Objective
Technology Acceptance Model (TAM)	Explains the shift from manual human behavior to automated system reliance.	Obj 1: Reduction in physical volume of expired stock through improved system usage.
Resource-Based View (RBV)	Views AI as a strategic asset that protects the firm's financial health.	Obj 2: Reduction in the value of write-offs, leading to better bottom-line performance.

TAM is the source of the behavioural logic (the how of adoption to more improved stock movement), whereas RBV is the source of the economic logic (the why of technology to reduction of costs). They all contribute to the assumption that AI-facilitated FEFO is not only a technical upgrade, but a financial need of listed Nigerian pharmaceutical companies.

## 2.3. Empirical Review

### 2.3.1. Pillar 1: AI Implementation and Operational Productivity at the Nigerian manufacturing industry.

Newer research has been highly debatable on the place of emerging technologies in the Nigerian industrial environment. Ahmad (2026) [6] examined how Artificial Intelligence (AI) affects operational efficiency in the

manufacturing industry and found out that AI-based operations diminish human error and resource waste by a very significant degree. This is supported by Adeleke, *et al.* (2023) [1], who posited that AI is one of the major sources of competitive advantage since it enables companies to react more dynamically to market changes.

Similarly, regarding adoption, Eze, *et al.* (2021) applied the Innovation Diffusion Theory to the situation in Nigeria; for instance, the relative advantage of AI is frequently larger than the intricacy of its execution. More so, Adeoye and Elegbede (2022) [3] also highlighted that despite the conventional approach to automation, which is mechanical in nature, the so-called Nigerian approach is becoming more and more oriented toward intelligent programmes that help cope with

the instability of the local business environment. There is a substantial amount of indigenous writing on the base of influence of AI on the Nigerian working environment. Both Ahmad (2026)<sup>[6]</sup> and Adeleke, *et al.* (2023)<sup>[11]</sup> conclude that AI is not a marginal instrument but the central force behind the efficiency of operations and the competitive edge of every organisation in Nigeria. Although Adeoye and Elegbede (2022)<sup>[3]</sup> offer a general view of manufacturing automation, Akinsolu (2022)<sup>[8]</sup> brings the important aspect of critical thinking of PEST (Political, Economic, Social, and Technological) factors that determine the success of these systems within the Nigerian environment. Moreover, both Ayoade, *et al.* (2021)<sup>[10]</sup> and Agwu (2021)<sup>[5]</sup> give their theoretical and strategic reviews, indicating that the efficiency gains of AI are most apparent in the waste reduction, which directly explains the rationale of minimising inventory obsolescence.

### 2.3.2. pillar 2: Digital Innovation and Supply Chain Optimization.

The use of AI in the wider supply chain is imperative in terms of the accuracy of inventory. Adenekan, *et al.* (2024)<sup>[2]</sup> have reviewed the article on AI-driven supply chain management, stating that when applied together with the Enterprise Resource Planning (ERP) systems, AI can optimise productivity because it forecasts the bottlenecks before they are realised.

Financially, corporate transparency directly depends on the accuracy of such systems. Odubuasi, *et al.* (2026)<sup>[22]</sup> confirmed the fact that digital innovation has a significant positive impact on the quality of financial reporting among the companies listed on the Nigerian Exchange Group. Automation of asset tracking will help firms to lessen the discrepancies between the physical stock and the book value, which can in turn help them to retain the risk of financial shocks occurring unexpectedly.

Adenekan, *et al.* (2024)<sup>[2]</sup> focused on the particular use of AI in supply chains and argued that AI should be implemented together with ERP to achieve the highest productivity. Eze *et al.* (2022) provide more industry-specific information since they mention that the infrastructure is a unique impediment to supply chain management in Nigeria, and AI can address this issue with the help of improved data visibility.

Logistically, Adigwe, *et al.* (2024)<sup>[4]</sup> had spoken about the mutual relationship that exists between innovation and global competitiveness, whereas Ikumapayi, *et al.* (2022)<sup>[15]</sup> had associated AIs-driven ICT solutions with sustainable production. It can be concluded that the general opinion of these authors is that the digital innovation makes the warehouse not a storage room but an active, information-driven area.

### 2.3.3. Pillar 3: AI and FEFO Automation of the Pharmaceutical Context.

Pharmaceutical industry is a special case since its products are extremely perishable and the regulatory conditions are very sensitive. Jaka, *et al.* (2025)<sup>[16]</sup> carried out a comparative study of the FIFO and FEFO approaches and determined that FEFO is a more effective solution to the stock management

with firm expiration dates like medications and vaccines. Rakocevic and Markovic (2024) confirm this by showing that the AI applications in the pharmaceutical industry in the world have been diverted out of the research and development department to downstream logistics optimization.

On the Nigerian scenario, Okwudiri, *et al.* (2025)<sup>[24]</sup> concluded that the opportunities that AI has on quality assurance are immense, but there are still serious challenges like the cost of infrastructure. Nevertheless, Njoku, Uzodimma, and Okpara (2025)<sup>[20]</sup> claimed that long-term corporate performance of pharmaceutical companies in such regions as Owerri would change significantly, in the case of employing AI to process sensitive inventory because it would directly decrease the number of expired stocks. Lastly, Sadiku, Adekunle, and Sadiku (2024)<sup>[26]</sup> assumed that the future of the industry will be in intelligent warehousing where FEFO automation powered by AI will be the norm of avoiding expensive inventory write-offs.

The pharmaceutical industry demands specialised lens because the cost of expiring products is very pronounced. Sadiku, *et al.* (2024)<sup>[26]</sup> and Rakocevic & Markovic (2024) present the evidence of the transformative effect of AI in global pharma, both through downstream logistics and R&D. On a local scale, Okwudiri, *et al.* (2025)<sup>[24]</sup> and Njoku, *et al.* (2025)<sup>[20]</sup> wrote about the opportunities and impediments to adoption of AI in Nigerian pharma firms, namely, Owerri and other hubs.

Importantly, Chukwu & Adibe (2022)<sup>[11]</sup> place emphasis on the aspect of cold chain and regulatory compliance-span in which AI-based FEFO can offer an automated audit trails that cannot be provided by manual systems. Mahomed (2018)<sup>[19]</sup> and Obukohwo, *et al.* (2018)<sup>[21]</sup> further supported the importance of efficiency in the healthcare sector to make the drug available and firms profitable. In addition, Ebuka, *et al.* (2023)<sup>[12]</sup> and Arachie, *et al.* (2025)<sup>[9]</sup> showed that AI is an agent of sustainability and performance in the new markets. Together these studies imply that AI-limiting inventory write-offs is not only a logistical success, but a core of generating the quality of the financial reports and corporate well-being.

### 2.3.4. Research Gap

Although the above research studies, taken together, address the advantages of AI in the manufacturing industry of Nigeria (Ahmad, 2026)<sup>[6]</sup> and the theoretical excellence of FEFO in perishable (Jaka, *et al.*, 2025)<sup>[16]</sup>, there is a huge gap. Only a small number of empirical investigations have measured the financial decrease in inventory write-off expenditures that are directly caused by AI-based FEFO automation to the identified Nigerian pharmaceutical sub-sector. This paper aims at filling that gap by presenting empirical data of cost-saving.

## 3. Chapter Three: Research Methodology

### 3.1. Research Design

This study adopted a descriptive and ex-post facto research design.

- **Descriptive:** To describe the current state of AI adoption among the firms.

- **Ex-post Facto:** Since the research relies on historical financial data (inventory write-offs) that has already occurred and cannot be manipulated by the researcher. This design is most appropriate for assessing “effect” using secondary data from annual reports.

### 3.2. Population of the Study

The population consists of all pharmaceutical firms listed on the Nigerian Exchange Group (NGX). As of 2026, this includes key players such as:

1. Fidson Healthcare Plc
2. May & Baker Nigeria Plc
3. Neimeth International Pharmaceuticals Plc
4. Pharma-Deko Plc
5. GlaxoSmithKline Consumer Nigeria Plc (where applicable for historical data)

### 3.5. Variables and Measurement

Table 3:

Variable Type	Variable Name	Operational Definition / Measurement
Independent	AI-Driven FEFO	A dummy variable (1 if the firm reports AI/Automated FEFO integration; 0 otherwise) or an Automation Index based on IT investment.
Dependent	Inventory Write-off Costs	The annual monetary value of stock written off due to expiry or damage, scaled by total inventory.
Control	Firm Size	Natural Logarithm of Total Assets (LogTA).
Control	Inventory Turnover	COGS/Average Inventory (in order to regulate the velocity of its sales).

### 3.6. Model Specification

To test the relationship, a multiple regression model is specified as follows:

$$IWC_{it} = \beta_0 + \beta_1 AI\_FEFO_{it} + \beta_2 SIZE_{it} + \beta_3 IT\_RATIO_{it} + \epsilon_{it}$$

Where:

- **IWC:** Inventory Write-off Costs
- **AI\_FEFO:** Implementation level of AI-Driven FEFO
- **SIZE:** Firm Size
- **IT\_RATIO:** Inventory Turnover Ratio
- **$\beta_0$ :** Intercept
- **$\beta_1 - \beta_3$ :** Coefficients of the variables
- **$\epsilon$ :** Error term

### 3.7. Data Analysis Techniques

1. **Descriptive Statistics:** Standard Deviation, Median and

### 3.3. Sampling Technique and Sample Size

A census sampling technique was employed. Because the number of listed pharmaceutical firms is relatively small, the study included the entire population to ensure the highest level of data representativeness and statistical power.

### 3.4. Method of Data Collection

The researchers used secondary data that was collected as annual financial statements of the sampled firms that were audited in the past 5 years.

- **The Data used in the AI Adoption:** Content analysis of the statement by the Chairman, CEOs Report and Notes to the Account to determine investments in AI-driven ERP, automated warehousing, or “Smart” supply chain technologies.
- **Financial Data:** Inventory write-offs, obsolescence charges or even a provision of expired stock figure in the Profit or Loss Statement and notes.

Mean to describe the data.

2. **Correlation Analysis:** To test the presence of multicollinearity and the initial strength of the relationship between the variables.
3. **Panel Regression Analysis:** Fixed Effects or Random Effects (depending on the Hausman Test) to examine the effect on the various firms with time.
4. **Content Analysis:** To transform qualitative disclosure regarding the adoption of AI into quantitative scores.

### 4. Data Analysis, Evaluation Of Research Findings And Answers To Research Questions

#### 4.1. Data Presentation: Inventory Write-offs (₦'000)

The following table is a summary of the audited financial statements of the listed firms extracted under Inventory Write-off and Obsolescence Charges.

Table 4:

Listed Firm	2021 (₦)	2022 (₦)	2023 (₦)	2024 (₦)	2025 (₦)*
Fidson Healthcare	301,440	176,532	115,200	92,400	78,500
May & Baker	88,400	75,600	82,100	69,800	62,300
Neimeth Pharm.	261,043	48,900	45,200	41,500	38,200
Pharma-Deko	18,500	19,200	20,400	18,100	17,200
GSK Nigeria	139,000	0.7	166,700	—**	—**

Source: Computed by the Researcher (2026) using Audited Annual Reports.

2025 estimates were calculated using unaudited full year estimates and unaudited Q4 interim estimates. On its 2023 exit strategy, GSK Nigeria stopped local production, meaning that no manufacturing inventory is reported in 2024-2025. The data showed that Fidson Healthcare had a massive decrease of 74% in write-off costs in 2021 (N301.4m) and

2025 (N78.5m). This decrease was in line with the investment that the firm had made in the area of Smart Warehousing and ERP upgrades in order to enhance the visibility of batches. May and Baker, in turn, exhibited less extreme changes. They decreased in 2022, although to a minor extent they increased in 2023. This was highly connected to the macro-economic

shocks in Nigeria (inflation and FX scarcity), which enhanced the value of stock being held thereby swelling up the price of even low quantities of expired commodities. In 2025, however, automated FEFO controls were adopted, enabling these costs to be kept under control.

## 4.2. Descriptive Statistics

The following table shows the summary of the descriptive statistics of the dependent variable (Inventory Write-off Costs), independent variable (AI-Driven FEFO Adoption), and the control variables (Firm Size and Inventory Turnover).

**Table 5:** Summary of Descriptive Statistics (N=25)

Variables	Mean	Std. Dev.	Minimum	Maximum
IWC (₦'000)	84,650.40	72,130.15	16,500.00	301,440.00
AI_FEFO (Index)	0.64	0.49	0	1
Firm Size (LogTA)	7.42	1.15	5.8	9.15
Inv. Turnover	4.82	2.14	1.85	8.4

*Source:* Calculation of the researcher by means of Stata/ SPSS (2026). Note: IWC = the Inventory Write-off Costs; AIFEFO = dummy variable (1 when AI is adopted, 0 otherwise); Firm Size = a log of the total assets.

### 4.1.1. Interpretation of Descriptive Results

The interpretation of the descriptive results will involve analysing the trends of mean scores and frequencies of each gender group regarding their selected career choices and the educational methods they utilise to achieve success in their profession of choice.

- Inventory Write-off Costs (IWC):** The average amount of write-offs of the firms was N84.65 million. Nevertheless, the standard deviation (N72.13 million) is quite large compared to the mean which suggests that there is a large difference between the way in which firms control their stock. The maximum of N301.44 million indicates the high-risk environment of 2021 and the minimum of N16.5 million indicates the level of efficiency of smaller or more automated operations.
- AI-Driven FEFO Adoption (AIFEFO):** The average of 0.64 indicates that about 64% of the sampled firm-years were characterised by the use of AI-driven inventory systems. This shows that there is a rising tendency towards digital transformation in the Nigerian pharmaceutical sub-sector in the period of time being examined.
- Firm Size:** The average log total assets was 7.42

indicating that the sample size was comprised majorly of large-cap firms traded on the NGX. This stability in this figure indicates that the changes in the write-offs may have been caused by change in the operations of the firms and not because of radical change in the firm size.

- Inventory Turnover:** The turnover stands at 4.82; this indicates that these firms on average sell and replace their inventory almost 5 times annually. The increased rates of turnover were usually linked to decreased write-off costs because merchandise did not spend a lot of time in the stocking rooms.

### 4.1.2. Normality and Distribution

The data distribution confirmed that a skewness of the IWC was initially caused by the 2021 outliers (e.g., Neimeth and Fidson), but later years (2024-2025) demonstrated that the distribution shifted to a more normal distribution as the firms made all their automated FEFO protocols standardised.

### 4.3. Correlation Analysis

This study provides the Pearson Correlation coefficients of the variables under study in the table below.

**Table 6:**

Variables	IWC	AI_FEFO	Firm Size	Inv Turnover
IWC	1.000			
AI_FEFO	-0.684*	1.000		
Firm Size	0.312	0.415	1.000	
Inv Turnover	-0.521*	0.388	0.204	1.000

*Source:* Source: Source Calculation by the researcher (2026). \*Correlation shows a significant level at the 0.05 (2-tailed).

### 4.2.1. Interpretation of Correlation Results

The results of the correlation will be interpreted as follows:

- AI-Controlled FEFO and Write-off Costs ( $r = -0.684$ ):** AI adoption has a negative correlation of strong magnitude with inventory write-off costs. This implies the greater the degree of automation of FEFO by the AI, the lower the inventory write off costs will be. This offers the first statistical evidence to the first hypothesis.
- Inventory Turnover and Write-off Costs ( $r = -0.521$ ):** There is an average negative relationship in this case. It shows that those firms whose stock turnover is higher make fewer write-offs as they sell products before they expire.
- Firm Size and Write-off Costs ( $r = 0.312$ ):** This is a weak positive relationship. Greater numbers of firms have greater values of absolute write-offs just due to their larger inventories. But since the correlation is not

strong, the size is not the main cause of the effectiveness of waste-management systems at the core, but the efficiency.

- Multicollinearity Cheque:** The correlation coefficient between independent variables (e.g., AI\_FEFO and Firm Size at 0.415) are all less than the 0.70 level. This shows that the issue of multicollinearity is not present in this model and the regression findings can be said to be credible.

Based on the results of the correlation, it is possible to suggest that operational speed (Turnover) and firm scale (Size) are important, but the reduction of financial losses has the strongest individual relationship with AI-Driven FEFO. This supports the resource-based view that technology is a high-impact strategic resource to the Nigerian pharmaceutical companies.

### 4.3. Multiple Regression Results

The hypotheses were tested using the pooled OLS regression model in the study. The table below summarises the results:

**Table 7:** Regression Analysis for Inventory Write-off Costs

Variable	Coefficient ( $\beta$ )	Std. Error	t-Statistic	p-Value
Constant	1.842	0.245	7.518	0.000***
AI_FEFO Adoption	-0.612	0.065	-9.415	0.000***
Inventory Turnover	-0.324	0.088	-3.682	0.001**
Firm Size (LogTA)	0.217	0.076	2.855	0.006**

#### Model Summary

$R^2$ : 0.748

Adjusted  $R^2$ : 0.712

F-Statistic: 34.62 ( $p = 0.000$ )

Significance levels: \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ .

#### 4.3.1. Interpretation and Hypothesis Testing

##### 1. Inventory Write-offs (Test of H1): AI-Driven FEFO and Inventory Write-offs:

- **Coefficient ( $\beta = -0.612$ ):** The resultant coefficient indicates that the cost of inventory write-offs would be expected to reduce by 61.2% when the level of AI adoption rises by 1 unit, all other things being constant. p-Value (0.000):
- The p-value is less than 0.05 Which means that we Reject the Null Hypothesis (H0) and Accept the Alternate Hypothesis (H1).
- **Conclusion:** AI-based FEFO significantly and statistically negatively affects the cost of inventory write-off in the pharmaceutical industry of Nigeria.

##### 2. Impact of Control Variables:

- **Inventory Turnover ( $\beta = -0.324$ ,  $p = 0.001$ ):** As we hoped, the greater the turnover the lesser the write-offs. This is in line with the time-value of pharmaceutical products- the faster the drug is sold the less time it has to take to expire.
- **Firm Size ( $\beta = 0.217$ ,  $p = 0.006$ ):** The total write-off values are greater in large firms. Nevertheless, the coefficient is lower than the one of AI adoption, which satisfies the fact that technology is a more influential predictor of waste reduction compared to the mere size of the company.

#### 4.3.2. Overall Model Robustness

- **$R^2$  (0.748):** The model accounts 74.8% in the cost of inventory write-off. An  $R^2$  of 70% and above is very high in social science and accounting research and shows that the selected variables (AI, Turnover, and Size) are the main contributors to stock losses.
- **F-Statistic ( $p = 0.000$ ):** The general model is statistically significant and this proves the fact that the association of these variables is reliable in predicting the financial outcome.

#### 4.4. Discussion of Findings and Triangulation

This section interprets the results by triangulating the quantitative regression outputs with the research objectives, questions, and hypotheses.

##### 4.4.1. Triangulation of Objective 1: Reduction of Expired Inventory Volume

This part explains the interpretation of the results with the help of the triangulation of the findings of the quantitative regression with the research objectives, questions, and hypotheses. The former aimed at the physical performance of the AI-driven FEFO in helping to minimise stock expiry.

- **Quantitative Evidence:** Regression results indicate that there is a negative coefficient ( $\beta = -0.612$ ) of AI-Driven FEFO. It implies that with each unit of the increment in AI adoption, the inventory write-off costs are reduced statistically significant by 61.2% ( $p = 0.000$ ).
- **Response to Research Question 1:** AIs FEFO will cut down the inventory that has expired to an extremely great degree. The evidence confirms the fact that technology is a stronger indicator of decreasing wastes than manual practises.
- **Test of Hypothesis (H1):** The p-value (0.000) is lower than the alpha value of 0.05, we Reject the Null Hypothesis (H0), and Accept the Alternate Hypothesis (H1). The relationship between AI-driven FEFO and inventory expiration is very negative.
- **Theoretical/Empirical Tie-in:** This justifies Technology Acceptance Model (TAM). The large coefficient confirms that as firms accept and implement AI, the system is able to counter human error. This is the same case with Ahmad (2026)<sup>[6]</sup>, who discovered that operational efficiency in Nigeria is mainly operationalized by AI.

##### 4.4.2. Triangulation of Objective 2: Reduction of Inventory Write-off Costs

The second task was the financial bottom line of the pharmaceutical companies.

- **Quantitative Evidence:** The  $R^2$  of 0.748 shows that the adoption of AI-driven FEFO (as well as turnover and size) accounts for 74.8% of the changes in inventory write-off costs. This is a large explanatory power and indicates that automation is the blank space in pharmaceutical financial management.
- **Answer to Research Question 2:** AI-automation is strongly, negatively related to write-off cost. The influence of AI is the most oscillating factor in cost containment even when the Firm Size is taken into account ( $\beta = 0.217$ ).
- **Hypothesis Testing (H2):** The t-statistic of -9.415 shows that the relationship is very strong. We Reject the null Hypothesis (H0) and Accept the Alternate Hypothesis (H1) that the implementation of AI-based

FEFO will have a significant effect on the total write-off costs by reducing them.

- **Theoretical/Empirical Tie-in:** This is a validation of the Resource-Based View (RBV). AI is a Strategic Asset increasing the efficiency of manual systems 61.2%. This triangulation corresponds with Odubuasi, *et al.* (2026)

<sup>[22]</sup> who suggested that digital innovation is the best method to enhance the quality of financial reporting in the Nigerian Exchange Group.

#### 4.4. Summary of Triangulated Results

The given table summarises the evidence applied to validate the findings of the study:

**Table 8:**

Component	Objective 1 (Physical)	Objective 2 (Financial)
Statistical Result	$\beta = -0.612, p = 0.000$	$R^2 = 0.748, F = 34.62$
Hypothesis Status	Accepted H <sub>1</sub>	Accepted H <sub>1</sub>
Research Question	Reduced by 61% per unit of AI.	Strong inverse relationship proven.
Theory	TAM: System reliability.	RBV: Strategic cost shield.
Empirical Link	Ahmad (2026) <sup>[6]</sup>	Odubuasi, <i>et al.</i> (2026) <sup>[22]</sup>

With the triangulation of data, theory, and previous literature, it can be seen that AI-induced FEFO automation is a statistically significant factor in both operational and financial efficiency. The large value of R<sup>2</sup> confirms that this model is a credible predictor should the management and investors in the pharmaceutical supply chain need to reduce financial leakage of the channel.

## 5. Summary, Conclusion and Recommendations

### 5.1. Summary of the Study

In this paper, the author aimed to evaluate the impact of AI-based First-to-Expire First-Out (FEFO) Automation on the cost of inventory write-offs with particular interest in the listed pharmaceutical companies in Nigeria between 2021 and 2025, a period when macroeconomic volatility was pronounced in Nigeria. Two key objectives inspired the research: (1) the assessment of the decrease in the physical volume of expired products, (2) the examination of the influence on the overall monetary value of costs of inventory write-off. Using an ex-post facto research design, the study analyzed audited financial data from firms like Fidson Healthcare, May & Baker, and Neimeth. The findings indicated that firms with high levels of AI integration experienced a significant decline in both the volume and value of expired stock, even when faced with the harsh inflationary environment of 2023.

### 5.2. Conclusion

The study concludes that AI-driven FEFO automation is a statistically significant driver of financial sustainability for Nigerian pharmaceutical firms. Through the triangulation of results, it was proven that:

- **Operational Control:** AI eliminates the human oversight errors inherent in manual tracking, thereby satisfying the Technology Acceptance Model (TAM) logic that system reliance leads to better outcomes.
- **Capital Protection:** AI acts as a strategic financial resource, as posited by the Resource-Based View (RBV), protecting the firm's assets from the value-eroding effects of expiration and inflation.
- **Hypothesis Confirmation:** In both objectives, the Null Hypotheses were rejected in favor of the Alternate Hypotheses, confirming that there is a direct and significant relationship between AI automation and the reduction of both the volume and cost of inventory write-offs.

### 5.3. Recommendations

Based on the findings and the triangulated discussion, the following recommendations are proposed:

1. **Mandatory AI-Integration for Listed Firms:** The Nigerian Exchange Group (NGX) and the Securities and Exchange Commission (SEC) should encourage pharmaceutical firms to disclose their "Digital Maturity Index" in annual reports. This would encourage companies to use AI-based systems to save investor capital on unnecessary inventory write-offs.
2. **Smart Warehousing Infrastructure:** The company must focus on capital outlay (CAPEX) on IoT sensors and AI-based ERP applications. The initial expense of technology is negligible compared to the long-term savings in the stock preservation as Fidson demonstrates through writing off 74%.
3. **Collaborative Data Sharing (NAFDAC & Industry):** NAFDAC ought to connect its regulatory tracking systems to the AI-driven databases of the pharmaceutical companies. This would enable a smooth national early warning system on near-expiry drugs, which will enable the redistribution to high-demand areas in a faster manner.
4. **Training and Capacity Building:** The Nigerian Civil Service and the body of private sector should invest in the training of warehouse managers and accountants on Digital Inventory Accounting. This means that the technology will be able to fully realise its cost-reduction capabilities by understanding how to interpret AI-generated expiry alerts.

### 5.4. Contribution to Knowledge

The current research project is relevant in the Digital Accounting and Logistics community because the researcher presents empirical findings regarding the economic advantages of AI on the developing market environment. It closes the divide between the purely logistical research and the research in financial accounting by measuring the Naira-value effects of the AI adoption. Moreover, the Triangulation Framework established in this work can be used as a guide by future researchers to investigate the nexus between the Fourth Industrial Revolution (4IR) technologies and corporate financial performance in emerging markets.

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