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GREEN LOGISTICS AND OPERATIONAL EFFICIENCY OF DANGOTE CEMENT PLC, GBOKO PLANT, BENUE STATE, NIGERIA

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ABSTRACT
Nigerian cement manufacturers depend heavily on road haulage, bagging and stockholding, and the recent shift from diesel to compressed natural gas (CNG) trucks has made the efficiency of these activities a pressing concern. Yet there is little empirical evidence on how green logistics practices affect operational efficiency in a Nigerian cement plant. This study therefore examined the effect of green transportation, green packaging and green inventory management on the operational efficiency of Dangote Cement Plc, Gboko Plant, Benue State. A descriptive survey design was adopted. Primary data were collected with a structured questionnaire on a four-point Likert scale from a sample of 143 employees, determined from a population of 222 using Taro Yamane's formula. Of the 143 copies distributed, 131 were retrieved and usable, a response rate of 91.6%. Content validity was established through expert review, and a pilot test gave Cronbach's alpha values of 0.71 to 0.78. Data were analysed with descriptive statistics and multiple regression using SPSS version 25. Green transportation ($\beta = 0.188$, $p = .020$), green packaging ($\beta = 0.307$, $p < .001$) and green inventory management ($\beta = 0.139$, $p = .043$) each had a positive and significant effect on staff-perceived operational efficiency, and together the three practices explained 52.8% of its variance. The study concludes that, at the Gboko plant, green logistics practices are associated with higher perceived operational efficiency. It recommends that the company support its CNG fleet with better route planning and vehicle maintenance, use durable and recyclable packaging to reduce bag waste, and tighten stock monitoring to reduce material losses.

Keywords: Green logistics, green transportation, green packaging, green inventory management, operational efficiency, CNG trucks, cement industry, Nigeria

Introduction

In today's global economy, firms are under growing pressure to operate efficiently, lower costs, manage scarce resources and reduce their environmental impact. Rising input costs, resource scarcity and the need to shorten manufacturing lead times have pushed businesses towards practices that improve competitiveness while reducing ecological harm. As a result, many firms are adopting supply chain practices that raise operational performance and lower environmental effects at the same time (Soyege et al., 2023).

Being green in business involves reducing waste, using energy and materials more efficiently, cutting operating costs and shrinking the firm's environmental footprint. It marks a move away from resource-intensive systems towards more efficient and environmentally responsible methods, and it reflects the wider idea of sustainability, which seeks to meet present operational needs without compromising the future (Onukwulu et al., 2021).

Green logistics emerged as a way of building environmental concerns into logistics operations. It refers to the production and distribution of goods in a sustainable way that takes account of environmental and social factors (Balon, 2020; Soyege et al., 2023). Erdal and İpçioğlu (2024) note that sustainable practices can be applied across logistics operations, while Vangeri et al. (2024) stress waste reduction through the efficient use of energy and materials. Rodrigue et al. (2001) describe green logistics as efforts to reduce the environmental and energy impacts of freight distribution, with particular attention to transportation, packaging, material handling and waste management. Green logistics therefore involves managing logistics activities in ways that reduce waste and resource use while raising the efficiency of transportation, packaging, inventory and related processes.

In this study, green logistics is examined through three dimensions: green transportation, green packaging and green inventory management. Green transportation involves efficient transport methods, improved vehicle technologies and route optimisation that reduce fuel consumption, emissions and transport costs (Andem, 2026). Green packaging is the use of packaging materials and designs that protect products while reducing waste and environmental impact (Mayieka et al., 2024; Adela et al., 2024). Green inventory management is the maintenance of appropriate stock levels and the management of material storage and movement in ways that reduce waste, unnecessary resource use and related operating costs (Mbah et al., 2019). Together, these practices can improve resource use and make supply chain processes run more smoothly.

Operational efficiency is an organisation's ability to achieve its intended outputs with the least waste of resources, time and money. In this study, it is assessed through cost minimisation, resource efficiency, timely response to customer demand and customer satisfaction. Cost minimisation is the control of operating expenses without lowering quality (Oteri et al., 2023), while resource efficiency is the productive use of materials, energy and labour (Chaturvedi et al., 2023). Timely response to customer demand is the ability to meet customer orders quickly, and customer satisfaction is the extent to which products and services meet customer expectations (Akuma et al., 2025).

In Nigeria, these concerns are sharpened by the country's heavy reliance on road haulage and by recent changes in transport fuel. Road transport remains essential to the performance of cement supply chains, yet it is held back by poor road infrastructure, congestion, vehicle condition and unreliable logistics processes (Andem, 2026). There has also been a push to move Nigerian road transport towards cleaner and more energy-efficient fuels (Sa'ad et al., 2022; Akujor et al., 2022). Within this transition, Dangote Cement Plc has begun replacing its diesel

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trucks with CNG trucks: about 3,400 CNG trucks were deployed in 2025, and roughly 3,000 more were scheduled for its Nigerian operations in 2026 (CemNet, 2026).

These changes matter most in resource-intensive industries such as cement manufacturing, where transportation, packaging and inventory management are central to daily operations. Green logistics is relevant to operational efficiency because it can reduce waste, control operating costs, improve resource use and streamline the movement and storage of materials and products. At the Dangote Cement Plant in Gboko, Benue State, the company's move to CNG haulage, the bagging and dispatch of cement, and the holding of raw materials and finished stock make these three practices part of everyday operations. It is against this background that this study examines the effect of green logistics on the operational efficiency of the Dangote Cement Plant in Gboko, Benue State.

Statement of the problem

Despite the importance of efficient logistics in manufacturing, firms continue to face rising operating costs, poor resource use and weaknesses in material handling, transportation, packaging and inventory management. These problems disrupt the flow of materials and products, increase waste and operating costs, and limit firms' ability to respond quickly to customer needs. The difficulty is especially serious in cement production because of the large volumes of raw materials, finished products, packaging materials and transport movements involved. At Dangote Cement, fuel accounts for about 60% of transport costs, which is a major reason the company has turned to CNG trucks (CemNet, 2026).

Transportation, packaging and inventory activities are central to the movement and management of materials and products at the Dangote Cement Plant in Gboko, Benue State. Although green transportation, green packaging and green inventory management are increasingly promoted as ways of reducing waste, improving resource use and controlling costs, earlier studies have mostly examined green logistics in other sectors, countries and organisational settings (Mayieka et al., 2024; Adela et al., 2024; Wako & Lambaino, 2024). Studies of the Nigerian cement industry, on the other hand, have focused on the effectiveness of road transport rather than on green logistics practices (Andem, 2026).

The gap, therefore, is that there is little empirical evidence on how green transportation, green packaging and green inventory management affect operational efficiency at a Nigerian cement plant, particularly during the shift to CNG haulage. This study addresses that gap by examining the effect of these three practices on operational efficiency at the Dangote Cement Plant in Gboko, as perceived by its staff and measured in terms of cost minimisation, resource efficiency, timely response to customer demand and customer satisfaction.

Objectives of the study

The general objective of this study is to determine the effect of green logistics on the operational efficiency of Dangote Cement Company Gboko. The specific objectives are to determine the effect of:

i. Green transportation on the operational efficiency of Dangote Cement Company Gboko.
ii. Green packaging on the operational efficiency of Dangote Cement Company Gboko.
iii. Green inventory management on the operational efficiency of Dangote Cement Company Gboko.

Research hypotheses

In line with the objectives, the following null hypotheses were formulated for the study:

H01: Green transportation has no significant effect on the operational efficiency of Dangote Cement Company Gboko.

H02: Green packaging has no significant effect on the operational efficiency of Dangote Cement Company Gboko.

H03: Green inventory management has no significant effect on the operational efficiency of Dangote Cement Company Gboko.

Literature review

Conceptual review

Green logistics

Green logistics is the integration of environmental factors into logistics activities in order to reduce adverse environmental effects while maintaining economic and operational efficiency (Chepurna et al., 2025). Rodrigue et al. (2001) define green logistics as techniques aimed at reducing the environmental and energy impacts of freight distribution, with an emphasis on transportation, packaging, material handling and waste management. These definitions present green logistics as an approach to logistics management that builds in environmental responsibility. Jefimovaite and Vienazindienė (2025) describe green logistics as an organisational model that incorporates environmental considerations into logistics activities. Taken together, these views show that green logistics, when properly implemented, can contribute to effective resource use, waste reduction and cost control. This is especially important in cement manufacturing, where transportation, packaging and inventory activities affect resource consumption, operating costs and product distribution.

Green transportation

Green transportation refers to the adoption of transportation strategies that reduce fuel consumption, greenhouse gas emissions, and other environmental impacts while promoting efficient and cost-effective commodities delivery. According to Wu et al. (2023), green transportation entails incorporating environmental issues into transportation planning and logistics decisions, such as route optimisation and network design. Similarly, Miklautsch and Woschank (2022) cite alternative fuels, vehicle technologies, and changes in conventional modes of transportation as ways to reduce emissions from freight transportation. Sa'ad et al. (2022) emphasise the necessity of energy-efficient fuels and cleaner transportation systems, whereas Akujor et al. (2022) examine options for lowering transportation-related emissions through decarbonisation. These perspectives suggest that green transportation necessitates organisations taking into account both the environmental impacts and the operational costs of transporting commodities. Efficient route design, fuel-efficient vehicles, optimal vehicle utilisation, and reducing unnecessary movement can all help to limit transportation costs and emissions while ensuring timely deliveries. This is especially essential in the cement industry, since raw materials and finished products must be transported extensively. This study considers green transportation as a logistics approach that may improve resource utilisation, reduce operating costs, and promote operational efficiency at Dangote Cement Plant, Gboko.

Green packaging

Green packaging is the design and usage of packaging materials that minimise environmental impact by reducing material consumption, reusing, recycling, and preventing waste. Morashti et al. (2022) define sustainable packaging as a critical component of supply chain management, emphasising the incorporation of environmental factors into packaging decisions. Silva and Pålsson (2022) emphasise the importance of industrial packaging in promoting sustainability and continuous resource utilisation. Oluyemi and Ogbogu-nzoiwu

(2023) highlighted how reusable packaging designs can help reduce solid waste and promote more sustainable packaging practices. According to these perspectives, green packaging entails not only choosing ecologically friendly materials, but also developing packaging that allows for efficient storage, handling, and transportation. In cement manufacturing, proper packaging may protect products, reduce material waste, and increase handling and distribution efficiency.

Green inventory management

Green inventory management integrates environmental factors into inventory planning, storage, restocking, and control, reducing waste, resource consumption, and ecological expenses while preserving operational efficiency (Žic et al., 2024). This strategy encourages businesses to examine not only the quantity of resources on hand, but also the environmental and operational effects of excessive storage, material degradation, and unnecessary restocking. According to Ogumeyo et al. (2025), sustainable inventory management involves optimising raw material procurement and inventory levels in order to reduce waste, overuse of resources, and energy consumption. This approach emphasises the significance of keeping adequate stock levels to guarantee that materials are available when needed without tying up resources in superfluous inventory. Similarly, Nwaiku and Ejechi (2022) highlight inventory management methods, such as accurate inventory records and lean inventory systems, as critical components of effective resource management in industrial organisations. Such procedures can assist organisations in tracking material usage, preventing stock inconsistencies, and reducing losses caused by inadequate inventory control. Ogah et al. (2022) emphasise the importance of raw material inventory management to operational success in manufacturing, emphasising the need to coordinate material availability with production requirements. In cement manufacturing, proper inventory management can help to prevent excessive stock accumulation, material losses, unnecessary storage costs, and production disruptions.

Operational efficiency

Operational efficiency refers to an organisation's capacity to meet its operational goals by effectively utilising resources, controlling costs, and minimising waste. Imhanzenobe (2019) defines operational efficiency as the effective utilisation of organisational resources to support long-term business operations. This perspective emphasises that an organisation's efficiency is determined by how successfully it translates available resources into useful outputs while avoiding unnecessary costs. Similarly, Neely et al. (2005) define performance measurement as analysing the efficiency and effectiveness of organisational actions, emphasising the importance of resource use and meeting operational objectives. Operational efficiency consequently entails more than just cost reduction; it also includes minimising material losses, preserving production consistency, and assuring timely delivery. These elements are especially essential in cement manufacturing since transportation, packaging, and inventory processes affect the usage of fuel, materials, storage facilities, and other operational resources. Consequently, operational efficiency in this study refers to Dangote Cement Plant, Gboko's ability to decrease operating costs, effectively use resources, eliminate waste, and promote timely product delivery through green logistics practices.

Conceptual framework on green logistics and operational efficiency

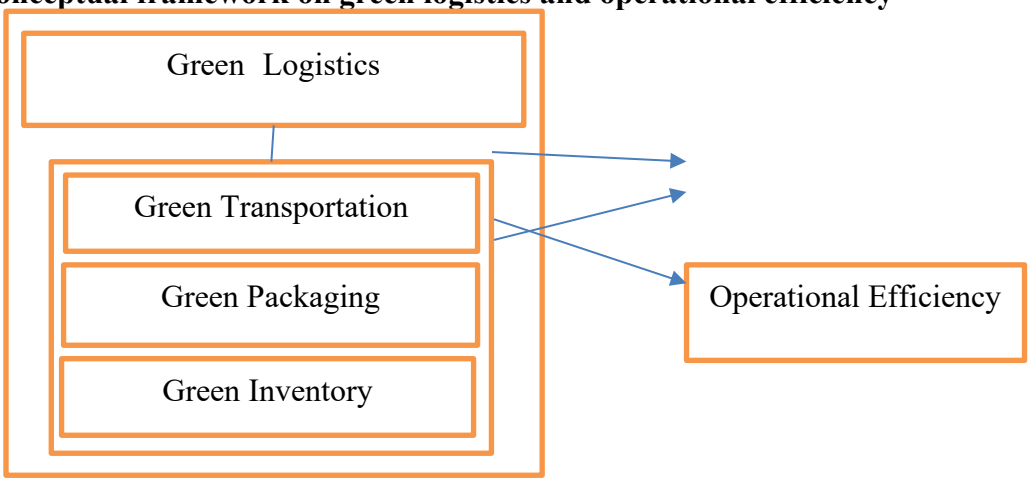


Figure 1: Conceptual Framework of the study
Source: Researchers' conceptualisation, 2026

The conceptual framework in Figure 1 shows the hypothesised effects of green logistics on operational efficiency at Dangote Cement, Gboko, Benue State. Green logistics is the independent variable and is measured through three dimensions: green transportation, green packaging and green inventory management. Operational efficiency is the dependent variable and is measured through cost minimisation, resource efficiency, timely response to customer demand and customer satisfaction. Each arrow represents one of the three null hypotheses (H01 to H03), so the framework links the objectives of the study directly to the tests reported in Section 4.

Theoretical framework

This study is based on Hart's (1995) Natural Resource-Based View (NRBV). The theory expands on a resource-based view of the firm, recognising that an organisation's relationship with the natural environment can influence its capabilities and competitive advantage. Hart describes three interwoven strategic capabilities: pollution prevention, product stewardship, and sustainable development. Pollution prevention focuses on lowering emissions, waste, and resource losses; product stewardship considers the environmental impact of products and their associated processes; and sustainable development emphasises organisational strategies that address long-term environmental issues.

The Natural Resource-Based View is appropriate for this study because green logistics involves building environmental considerations into transportation, packaging and inventory management. Green transportation relates to pollution prevention, since lower fuel use, better route planning and cleaner vehicles reduce emissions. Green packaging relates to product stewardship, achieved through the careful selection and use of packaging materials to reduce waste and resource consumption. Green inventory management also relates to pollution prevention, because it reduces material losses, excess stock and waste caused by poor inventory control. Each of these practices may, in turn, improve operational efficiency by lowering operating costs and encouraging the effective use of organisational resources (Hart, 1995).

The theory thus provides a foundation for explaining the predicted benefits of green transportation, green packaging, and green inventory management on operational efficiency at the Dangote Cement Plant in Gboko, Benue State. Although the study assesses operational

efficiency through respondents' perspectives rather than directly measuring environmental performance or competitive advantage, the NRBV provides a theoretical explanation for how environmental management practices may influence resource efficiency and logistics operations. As a result, the theory informs the study's investigation of the implications of the three green logistics aspects on operational efficiency.

Empirical review

Green transportation and operational efficiency

Andem (2026) investigated the effect of road transportation on supply chain effectiveness in Nigeria's cement company. The study utilised a quantitative survey design, and a purposive sampling to identify respondents with relevant industry knowledge, and SPSS descriptive statistics to analyse questionnaire data. Poor road infrastructure, transport policies, traffic congestion, vehicle condition, cargo tracking, and logistics reliability were identified as significant issues influencing transportation efficacy in cement supply chains. To increase transportation efficacy in Nigeria's cement business, the study proposed road infrastructure modifications, better policy execution, regular vehicle maintenance, shipment tracking, and improved logistical coordination.

Sida (2022) evaluated the effects of logistics practices on the operational performance of Habesha Cement Share Company in Ethiopia. The study used an explanatory research design and collected survey responses from 118 employees in the company's logistics department. The data were analysed using descriptive statistics, correlation and multiple regression. The findings showed that inbound, internal and outbound logistics practices were positively and significantly associated with organisational performance. The regression model had an adjusted R^2 of 0.502, indicating that the logistics factors explained 50.2% of the variation in organisational performance. Although the study did not isolate green transportation, it shows that logistics activities can contribute to performance in cement manufacturing. The study recommended that the company improve its inbound, internal and outbound logistics through better logistics planning, coordination of material movement and distribution management.

Green packaging and operational efficiency

Mayieka et al. (2024) investigated the effect of green packaging on firm performance among soft-drink manufacturing enterprises in Kenya. The study used a mixed-methods methodology and included a population of 460 managers and 92 chief executive officers. Data were gathered through structured surveys and interviews and analysed using standard linear regression and thematic analysis. Green packaging exhibited a positive and statistically significant effect on company performance, with the model explaining 39.4% of the variation. The authors suggested that managers and industry stakeholders embrace ecologically responsible packaging procedures in order to boost firm performance.

Adela et al. (2024) investigated the effect of green products and packaging on business performance of medium- and large-scale manufacturing enterprises in Ethiopia's Sidama region. The study gathered data from 301 manufacturing enterprises and analysed them using structural equation modelling using AMOS version 23. The research findings demonstrated that green packaging indicated a substantial impact on corporate performance and competitiveness. To increase corporate performance, the authors suggested that manufacturers implement green marketing strategies, such as ecologically responsible packaging.

Green inventory management and operational efficiency

Mbah et al. (2019) investigated inventory management and operational performance among quoted manufacturing firms in Southeast Nigeria. The study adopted a descriptive survey

design with 538 sampled respondents, 371 of whom offered useful responses from four manufacturing organisations. The data were examined using descriptive statistics and regression analysis. The study demonstrated substantial positive correlations between operational performance and inventory cost management, just-in-time methods, materials requirements planning, and strategic supplier alliances. The researchers recommended that manufacturers implement these methods to improve operational performance.

Wako and Lambaino (2024) investigated the influence of sustainable procurement practices on the performance of cement manufacturing firms in Kenya. The study employed a descriptive cross-sectional design and a census of 126 procurement and logistics officials from seven cement manufacturing firms. The data were analysed using descriptive statistics, correlation and regression analysis. Findings revealed that green inventory management significantly improved procurement performance. The study suggested broader waste management and recycling programmes, including arrangements for returning unwanted or surplus cement and packaging materials, in order to reduce waste.

Nwaiku and Ejechi (2022) examined inventory management practices and organisational productivity in five manufacturing firms in Benin City, Nigeria, using a survey of 216 employees drawn from the commercial, finance, production, distribution and inventory departments. Regression results showed that inventory record accuracy, lean inventory systems and information technology had positive and significant effects on productivity, but buffer stock management had no significant effect. In a mixed-methods study of 22 Nigerian manufacturing firms, Ogah et al. (2022) surveyed 703 inventory and supply chain managers and interviewed 25 of them. They found that poor raw material inventory practices reduced the quality, speed and flexibility of operations, while the effects on cost and dependability were not significant. These two Nigerian studies show that inventory practices do not improve every dimension of performance equally.

Green supply chain practices and performance: Mixed evidence

Soyege et al. (2023) studied green supply chain management and organisational performance among quoted fast-moving consumer goods firms in Lagos, Nigeria. Using total enumeration of 418 middle and top-level managers and multiple regression, they found that green procurement, green distribution, green warehousing, materials management and reverse logistics jointly had a positive and significant effect on performance (adjusted $R^2 = 0.482$). Not all studies, however, report gains from every green practice. Setyono et al. (2025) surveyed 122 batik micro, small and medium enterprises in Yogyakarta, Indonesia, and found through structural equation modelling that green purchasing and eco-design improved operational performance, while green manufacturing did not. They attributed this to the limited capital, technology and resources of small firms. This mixed evidence suggests that the benefits of green practices depend on the context in which they are applied.

The empirical studies reviewed provide useful evidence on the effect of transportation, packaging and inventory practices on organisational performance. However, gaps remain in terms of the specific green practices examined, the industrial context and the performance outcomes measured. Andem (2026) studied road transport in Nigeria's cement industry but focused on transport effectiveness rather than on environmentally responsible transport practices and their effect on operational efficiency. Similarly, Sida (2022) examined general logistics practices in an Ethiopian cement company without treating green transportation as a separate variable. These studies leave open the question of how green transportation affects operational efficiency in cement manufacturing.

Mayieka et al. (2024) and Adela et al. (2024) showed that environmentally responsible packaging improves firm and business performance. However, their studies focused on soft-drink manufacturers in Kenya and medium and large manufacturing firms in Ethiopia rather than cement manufacturers in Nigeria. Their findings may therefore not fully reflect the operational efficiency effects of green packaging in the cement business, which has different packaging, handling and distribution needs.

Mbah et al. (2019), Nwaiku and Ejechi (2022) and Ogah et al. (2022) studied general inventory management practices in Nigerian manufacturing firms but did not examine environmentally responsible inventory methods, while Wako and Lambaino (2024) examined green inventory management in Kenya's cement industry but measured procurement performance rather than operational efficiency. More research is therefore needed on how green inventory management affects operational efficiency in the Nigerian cement industry.

Taken together, the reviewed studies reveal a contextual and variable-specific gap: no study reviewed has examined the combined effects of green transportation, green packaging and green inventory management on operational efficiency in a Nigerian cement plant, particularly during the shift to CNG haulage. The present study addresses this gap by examining these three dimensions at the Dangote Cement Plant in Gboko, Benue State, Nigeria, with operational efficiency as the outcome variable.

Methodology

The study adopted a descriptive survey research design, which was appropriate because data were collected through questionnaires from respondents who represent the population, without manipulating any variable. The study was carried out at the Dangote Cement Plant in Gboko, Benue State. The population comprised 222 junior and senior staff members, according to records of the company's Human Resource Unit (2026). The sample size was determined using Taro Yamane's (1967) formula for a finite population, $n = N / (1 + Ne^2)$, where $N = 222$ and $e = 0.05$. This gives $n = 222 / (1 + 222 \times 0.0025) = 222 / 1.555 = 142.8$, which was rounded up to 143 employees. Simple random sampling was used to give every staff member an equal chance of selection.

Primary data were collected with a structured questionnaire on a four-point Likert scale: Strongly Disagree (SD) = 1, Disagree (D) = 2, Agree (A) = 3 and Strongly Agree (SA) = 4. Apart from items on the demographic characteristics of respondents. Operational efficiency was measured through respondents' perceptions of cost minimisation, resource efficiency, timely response to customer demand and customer satisfaction, not through plant performance records; company records were used only to obtain the population figure. Content validity was established by experts, who reviewed the items for relevance and clarity. The instrument was then pilot tested with 30 employees of Mikap Nigeria Limited (Miva Rice), Makurdi, Benue State, a manufacturing firm outside the study population, and these respondents did not take part in the main study. Reliability was established using Cronbach's alpha, with coefficients of 0.78, 0.71, 0.74 and 0.72 for green transportation, green packaging, green inventory management and operational efficiency respectively, all above the 0.70 threshold for acceptable internal consistency. Data were analysed using descriptive statistics (means, standard deviations, frequencies and percentages) and multiple regression analysis. Hypotheses were tested at the 0.05 level of significance, and a null hypothesis was rejected where $p < .05$.

Model of the study

$$OE = \beta_0 + \beta_1 GT + \beta_2 GP + \beta_3 IM + u$$

Where:

GT = Green transportation
GP = Green packaging
IM = Green inventory management
OE = Operational efficiency
β_0 = intercept; β_1, β_2 and β_3 = slope coefficients
u = stochastic error term

A priori, $\beta_1 > 0$, $\beta_2 > 0$ and $\beta_3 > 0$; that is, each green logistics practice is expected to raise operational efficiency.

Data presentation and analysis

Out of the 143 copies of the questionnaire distributed, 131 were retrieved duly completed, giving a response rate of 91.61%. This rate was considered sufficient for analysis. The number of valid responses used for all analyses is N = 131.

Table 1: Descriptive Statistics of Study Variables

Variable	N	Mean	Std. Deviation
OE	131	3.0263	.33309
GT	131	3.0226	.31037
GP	131	3.0753	.33219
IM	131	3.0148	.36530

Source: SPSS V25, 2026

The descriptive statistics in Table 1 show that all variable means are approximately 3.0 on a four-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree). With a midpoint of 2.5, a mean of about 3.0 indicates that respondents agreed with the statements on green transportation, green packaging, green inventory management and operational efficiency. Because the means lie only slightly above the Agree point of 3.0, this agreement should be read as moderate rather than strong.

The standard deviations range from .310 to .365, which shows that responses clustered closely around the means.

Table 2: Multicollinearity Diagnostics

Variable	Tolerance	VIF
GT	.975	1.026
GP	.988	1.012
IM	.975	1.025

Source: SPSS V25, 2026

Table 2 presents the multicollinearity diagnostics for the three independent variables. All tolerance values (.975, .988, .975) are above the recommended threshold of .10, and all VIF

values (1.026, 1.012, 1.025) are below the recommended threshold of 10. These results confirm that there is no significant multicollinearity among the independent variables, and the data are suitable for multiple regression analysis.

Table 3: Normality Test

Test	Statistic	df	Sig.
Kolmogorov-Smirnov	.081	131	.200
Shapiro-Wilk	.984	131	.312

Source: SPSS V25, 2026

The normality test results show that the significance values for both the Kolmogorov-Smirnov test (.200) and the Shapiro-Wilk test (.312) are greater than .05. This indicates that the residuals do not significantly deviate from a normal distribution. The assumption of normality is therefore satisfied.

Table 4: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.726[a]	.528	.517	.23410

[a] Predictors: (Constant), GT, GP, IM

[b] Dependent Variable: OE

Source: SPSS V25, 2026

The model summary shows a strong relationship between the predictors (GT, GP and IM) and operational efficiency, with R = .726 and R^2 = .528. This means that about 52.8% of the variance in operational efficiency is explained by the three green logistics practices. The adjusted R^2 of .517 is close to R^2, which suggests that the explained variance is not inflated by the number of predictors.

Table 5: ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	5.385	3	1.795	47.24	.000[b]
Residual	4.822	127	.0380		
Total	10.207	130			

[a] Dependent Variable: OE

[b] Predictors: (Constant), GT, GP, IM

Source: SPSS V25, 2026

The ANOVA table shows that the regression model significantly predicts operational efficiency, $F(3, 127) = 47.24$, $p < .001$, with the three predictors (GT, GP and IM) jointly accounting for a substantial share of the variance in OE.

Table 6: Coefficients[a]

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	1.095	.492	—	2.226	.028
GT	.188	.080	.175	2.350	.020
GP	.307	.074	.285	4.149	.000
IM	.139	.068	.130	2.044	.043

[a] Dependent Variable: OE

Source: SPSS V25, 2026

Test of hypotheses

H01: Green transportation has no significant effect on the operational efficiency of Dangote cement company Gboko.

The coefficient for green transportation (GT) is .188 (SE = .080), t(127) = 2.350, p = .020. Since the p-value is less than .05, the null hypothesis is rejected. Green transportation therefore has a significant positive effect on the operational efficiency of Dangote Cement Company Gboko.

H02: Green packaging has no significant effect on the operational efficiency of Dangote cement company Gboko.

The coefficient for green packaging (GP) is .307 (SE = .074), t(127) = 4.149, p < .001. Since the p-value is less than .05, the null hypothesis is rejected. Green packaging therefore has a significant positive effect on the operational efficiency of Dangote Cement Company Gboko.

H03: Green inventory management has no significant effect on the operational efficiency of Dangote cement company Gboko.

The coefficient for green inventory management (IM) is .139 (SE = .068), t(127) = 2.044, p = .043. Since the p-value is less than .05, the null hypothesis is rejected. Green inventory management therefore has a significant positive effect on the operational efficiency of Dangote Cement Company Gboko.

Summary of results and findings

The study investigated the effect of green logistics practices on the operational efficiency of Dangote Cement Company Gboko. The key findings were as follows:

i. Green transportation has a positive and significant effect on operational efficiency (β = 0.188, p = .020).
ii. Green packaging has a positive and significant effect on operational efficiency (β = 0.307, p < .001).
iii. Green inventory management has a positive and significant effect on operational efficiency (β = 0.139, p = .043).

Together, the three practices explain 52.8% of the variance in operational efficiency (R^2 = .528). Green packaging has the largest coefficient, followed by green transportation and green inventory management.

Discussion of findings

The study found that green transportation has a positive and significant effect on operational efficiency (β = 0.188, p = .020). A likely explanation is the company's ongoing replacement of diesel trucks with CNG trucks. Fuel accounts for about 60% of the company's transport costs, and CNG is reported to save about 60% compared with diesel (CemNet, 2026), so staff who see lower fuel costs and steadier deliveries are likely to rate transport efficiency more highly. The result agrees with Andem (2026), who identified vehicle condition, shipment tracking and the reliability of logistics processes as key influences on road transport effectiveness in Nigeria's cement industry, and with Sida (2022), who found that logistics practices had a significant positive effect on the operational performance of Habesha Cement Share Company in Ethiopia. It is also consistent with Soyege et al. (2023), who reported that green supply chain practices, including green distribution, improved the performance of fast-moving consumer goods firms in Lagos. In terms of the Natural Resource-Based View, the finding reflects pollution prevention, since lower fuel use and better route planning reduce both emissions and operating waste (Hart, 1995).

Green packaging had the largest effect on operational efficiency (β = 0.307, p < .001). One reason may be that packaging is the logistics activity plant staff handle most directly, since bagged cement must be filled, handled and loaded, and packaging that tears less and uses material efficiently reduces product loss and rework in ways staff can see. The finding agrees with Mayieka et al. (2024), who found that green packaging significantly improved the performance of soft-drink manufacturers in Kenya, and with Adela et al. (2024), who reported a significant effect of green packaging on the performance of manufacturing firms in Ethiopia. Silva and Pålsson (2022) likewise conclude from their review that industrial packaging affects both resource use and handling efficiency. The result supports the product stewardship capability of the Natural Resource-Based View, which links responsible product and packaging decisions to lower environmental and operating costs (Hart, 1995).

Green inventory management also had a positive and significant effect on operational efficiency (β = 0.139, p = .043), although it was the weakest of the three practices. Effective stock control can reduce material losses, avoid excessive holding costs and keep raw materials available for production. The finding is consistent with Mbah et al. (2019), who found that inventory practices such as inventory cost management and just-in-time methods improved the operational performance of manufacturing firms in South-East Nigeria, and with Wako and Lambaino (2024), who found that green inventory management improved procurement performance in Kenyan cement firms. The smaller coefficient, however, is in line with Nwaiku and Ejechi (2022) and Ogah et al. (2022), who found that some inventory practices, such as buffer stock management, had no significant effect on certain performance outcomes in Nigerian manufacturing firms. It may also reflect the fact that inventory decisions at a large plant are less visible to most staff than transport and packaging. More broadly, Setyono et al. (2025) found that green manufacturing did not improve the operational performance of small batik firms in Indonesia because they lacked the capital and technology to implement it, which suggests that a large firm such as Dangote Cement is better placed to gain from green practices. In terms of the Natural Resource-Based View, the finding reflects pollution prevention through less material waste and more efficient resource use (Hart, 1995).

Conclusion

This study examined the effect of green logistics practices on the operational efficiency of Dangote Cement Company, Gboko. Green transportation, green packaging and green

inventory management each had a positive and significant effect on staff-perceived operational efficiency, and together they explained just over half of its variance. Green packaging had the largest coefficient, followed by green transportation and green inventory management. The study concludes that, at the Gboko plant, environmentally responsible logistics practices are associated with better resource use, less waste and more efficient logistics operations, as perceived by staff.

Recommendations

Based on the findings, the following recommendations are made for Dangote Cement Company Gboko:

i. In line with the finding on green transportation, the company should continue the shift from diesel to CNG trucks and support it with route planning, regular vehicle maintenance and better dispatch coordination, so as to reduce fuel use and delivery delays.
ii. In line with the finding on green packaging, which had the largest effect, the company should reduce bag breakage and packaging waste by using durable and recyclable packaging materials and by improving the handling of bagged cement during loading.
iii. In line with the finding on green inventory management, the company should strengthen stock monitoring and inventory planning to prevent material losses, avoid excessive holding costs and keep materials available for steady production.

Limitations of the study

The study has four main limitations. First, it covered only the Dangote Cement Plant in Gboko, so its findings cannot be generalised to other cement plants or manufacturing firms. Second, operational efficiency was measured through staff perceptions rather than plant records such as fuel cost per tonne, delivery time or material losses, so the results reflect how staff view efficiency rather than measured performance. Third, the cross-sectional design captures views at one point in time and cannot establish cause and effect. Fourth, the study examined only three green logistics practices, leaving out others such as reverse logistics and green warehousing.

Suggestions for further studies

The following areas are suggested for further study:

i. Extending the study to other cement plants and manufacturing industries in Nigeria to allow comparison and wider generalisation.
ii. Using objective performance indicators, such as transport cost per tonne, inventory turnover, material waste and delivery time, alongside questionnaire data.
iii. Examining other green logistics practices, such as reverse logistics and green warehousing, and comparing operations before and after the shift to CNG trucks.

Contribution to knowledge

This study provides evidence from a cement plant in Benue State on the effect of green logistics practices on operational efficiency during the shift from diesel to CNG haulage. It examines green transportation, green packaging and green inventory management together in a single study and adds to the limited empirical literature on green logistics in Nigerian heavy manufacturing. It also shows managers which of the three practices staff associate most strongly with efficiency, with packaging ranking first.

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