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Assessment of the Operational Characteristics of Petroleum Product Distribution and Logistics in Lagos State, Nigeria

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Abstract. This study evaluates the operational characteristics of petroleum products distribution in Lagos state. The study utilised a systematic-random sampling which was used to select 1,000 tanker drivers. Descriptive and inferential statistical techniques were used to evaluate the operational characteristics of petroleum distribution, including factors like the volume of products transported, travel distances, and route preferences. Findings from this study reveals that majority of drivers operate high-capacity tankers (45,000 litres, 41.4%), and that 45.9% of drivers work over 12 hours daily, raising concerns about fatigue, safety, and the need for regulatory enforcement of work-hour limits. Moreover, the low frequency of trips, with 63.7% of drivers completing only 1–2 trips weekly, suggests inefficiencies and delays in deliveries that could be mitigated through better scheduling and reduced downtime at depots. The analysis also shows that 59.2% of drivers operate outside Lagos, indicating a significant portion of the distribution network extends beyond the state, adding complexities such as longer delivery times and higher transport costs. Operational characteristics of petroleum product distribution showed that high-capacity tankers, long working hours, and low-trip frequencies dominate the petroleum logistics landscape in Lagos State. These factors contribute to inefficiencies and safety risks, requiring better scheduling, work-hour regulation, and investment in inter-modal means. This study thus recommended that policymakers should establish formal training centres, provide subsidies for low-income drivers, and develop gender-inclusive policies to encourage female participation in the sector. Training programs should focus on safety protocols, vehicle maintenance, and regulatory compliance to improve operational efficiency.

Keywords: Operational characteristics, Operational efficiencies, Petroleum products, Lagos State.

1. Introduction

Petroleum products play a pivotal role in driving global economic progress by fueling key sectors such as manufacturing, transportation, and power generation (OPEC, 2013). As the dominant source of energy worldwide, petroleum products are essential to sustaining daily activities and industrial operations across nations (OPEC, 2013; World Bank, 2023). Ensuring the smooth and efficient distribution of these products is vital for maintaining economic resilience and meeting energy demands. Moreover, strategic logistics management within the petroleum supply chain helps optimize delivery, lower operational costs, minimize supply disruptions, and strengthen energy security (Lisitsa et al., 2019; World Bank, 2023).

Petroleum logistics in Nigeria are plagued by a range of longstanding and interconnected challenges. These include deteriorating infrastructure, limited investment in multimodal transport systems, an overwhelming dependence on road tankers, and mismatches between supply centers and areas of high demand. Compounding these issues are rampant oil theft and lapses in regulatory oversight, all of which contribute to erratic fuel supply, elevated distribution costs, and broader economic instability. According to the World Bank's 2023 Logistics Performance Index, Nigeria—and many of its African counterparts—continue to rank poorly due to weak transport systems, inadequate storage capacity, and the slow pace of digital integration (World Bank, 2023). These shortcomings point to deeper structural problems within the downstream petroleum framework. Data from the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) reveal

that over 85% of petroleum products are conveyed via tanker trucks. This mode of transport is highly inefficient, especially given the state of Nigeria's roads, which are often congested, poorly maintained, and vulnerable to frequent breakdowns. In Lagos State, which accounts for roughly 40% of national fuel consumption, major distribution corridors are routinely clogged by tanker traffic, resulting in prolonged delays, increased environmental degradation, and heightened safety concerns. The prevalence of tanker accidents further exacerbates these issues, causing substantial human and economic losses, while severely disrupting product flow and contributing to fuel scarcity.

However, existing studies including Badejo (2018); Umar, et al. (2021); Adewuyi, et al., (2021); Nwoloziri et al., (2021) and Ucheobi et al. (2024) on physical distribution challenges and petroleum logistics in Nigeria often fail to adopt spatial approaches or focus specifically on Lagos State, highlighting a significant gap in the literature. Furthermore, the role of truck drivers in the petroleum distribution network is also critical. Truck drivers face numerous operational challenges that affect delivery efficiency, such as long waiting times at depots, inadequate rest facilities, poor logistics planning, and exposure to security risks. These challenges impact not only the drivers' well-being but also the timely delivery of petroleum products. An investigation into these operational issues will help uncover critical bottlenecks and opportunities for improvement.

2. Conceptual Framework and Literature Review

2.1 Concept of Physical Distribution Management

Physical Distribution Management (PDM) refers to the activities involved in moving and storing goods, ensuring that products are delivered to the right place at the right time, in the right quantity, and in a cost-effective manner (Somuyiwa, 2010; Oyesiku, 2021). This concept is integral to logistics and supply chain management, particularly in industries like petroleum distribution, where timeliness and efficiency are critical. PDM includes several key activities such as transportation, warehousing, inventory management, order fulfilment, and handling (Rushton et al., 2006). Effective PDM aims to optimise the flow of goods from the point of production or storage (depots) to the end consumer (e.g., filling stations), ensuring that the logistical chain operates smoothly and cost-effectively. The concept of PDM was primarily formalised by scholars such as Herbert Simon and George Dantzig, who contributed to the theoretical foundation of operations research and logistics management in the 1950s and 1960s (Rushton et al., 2006; Rodrigue, 2013). These scholars helped define how goods could be transported in the most cost-effective and efficient way. In the context of petroleum, PDM involves the intricate coordination of tanker trucks, pipelines, storage facilities, and various stakeholders to ensure uninterrupted supply to filling stations and ultimately consumers.

One of the key issues in PDM practice is the infrastructure challenges that hinder the smooth transportation of goods. Heavy congestion on the road networks, inadequate infrastructure, and poor road conditions significantly impact the operational efficiency of petroleum distribution. Furthermore, inefficient storage facilities and delays in loading and unloading also contribute to logistical bottlenecks. Studies on global logistics, such as those conducted by Christopher and Adepoju (2012) and Hugos (2018), emphasise the importance of infrastructure investment and technological integration in enhancing PDM efficiency. For example, effective route planning using GPS and Geographic Information Systems (GIS) has been employed in regions like the United States and Europe to improve the efficiency of petroleum distribution by optimising travel routes and reducing fuel consumption (Hugos, 2018).

PDM has evolved with technological advancements, especially in transportation management systems (TMS), warehouse management systems (WMS), and advanced inventory tracking tools. In countries like the United States, sophisticated software platforms are utilised to monitor and manage every aspect of the supply chain. For example, ExxonMobil uses data analytics and real-time tracking systems to monitor the movement of petroleum products and optimise delivery routes (ExxonMobil, 2020). These innovations reduce fuel costs, increase delivery speed, and help in making better decisions regarding supply chain operations. Similarly, Royal Dutch Shell has implemented automated systems for real-time tracking of inventory at depots, enhancing the efficiency of their distribution systems globally (Shell, 2018).

In Lagos, however, the full potential of PDM has not been realised due to ongoing infrastructural deficiencies. While global best practices such as the use of GPS systems and route optimization are not new, their implementation in Lagos remains limited. The petroleum distribution system often faces delays due to traffic congestion, frequent roadblocks, and poor road conditions. The studies by Salisu et al. (2022); Etuk et al. (2024) highlighted that the logistics sector in Lagos is characterised by inefficiencies such

as high transportation costs, long lead times, and fuel shortages, all of which stem from inadequate PDM practices. Improving PDM in Lagos requires addressing these infrastructural gaps, investing in technology, and improving the coordination between different stakeholders in the supply chain, including depots, tanker drivers, and filling stations towards achieving better operational efficiency in the state.

2.2 Literature Review

Distribution consists of the series of logistic activities involved in planning, organising, and transporting goods and services from production locations to where they are needed (Ekakitie-Emonena & Ehimen, 2016). It involves various distribution channels composed of intermediaries such as agents, wholesalers, and retailers, who specialise in distinct roles within the conveyance process. This aligns with the conceptual position of scholars like Marbuah (2014), who view distribution as a network of independent units working collaboratively to ensure products and services are made available for use or consumption across multiple locations. Within this system, intermediaries perform core activities that enable producers to focus on production while leaving the complexities of distribution to the channel members (Ekakitie-Emonena & Ehimen 2016; Joshi et al., 2016)

Many marketing studies highlight the significant benefits of involving intermediaries in the distribution process. For instance, using a constrained model (e.g., 4 + 4 = 8), producers are only able to make direct deliveries to consumers a limited number of times. However, through a dynamic model (e.g., 4 x 4 = 16), intermediaries increase efficiency by multiplying the number of delivery contacts. This not only ensures wider product reach but also stimulates business activities, maximises resource utilization, and satisfies consumer demands along the value chain. Beyond basic logistics, intermediaries perform deeper and more integrated functions, including information gathering, promotion, negotiation, physical distribution, financing, and risk management. These roles apply across both industrial markets and consumer markets, where intermediaries serve as critical facilitators between producers and end-users.

In channel management, Adamolekun (1999) identify multiple dimensions of flows in distribution, which they term "multivariate flows and mixes." These flows involve various patterns, including physical flows, financial flows, risk flows, negotiation flows, promotional flows, and payment flows. Successful distribution strategies often combine pull and push strategies, where goods are pushed through intermediaries to consumers or demand is pulled from the market through targeted promotion. In the Nigerian petroleum industry, such multivariate flows are particularly evident as stakeholders, ranging from depot operators to marketers and tanker drivers, engage in a series of coordinated activities to ensure product availability.

Marketers in the petroleum sector often adopt push and pull strategies to improve supply chain efficiency. Ekakitie-Emonena and Ehimen (2016) explains that the push strategy involves producers actively promoting products to intermediaries and final buyers, ensuring downstream demand. On the other hand, the pull strategy focuses on stimulating demand directly at the consumer level, compelling intermediaries to respond by stocking and distributing products. For instance, NNPC Mega Stations primarily rely on the pull strategy, promoting their products to attract end-users, while major marketers such as Total, Oando, and Mobil favor push strategies by engaging intermediaries in their supply chains. Globally, push-pull distribution strategies have proven effective in ensuring logistical efficiency and reducing supply chain disruptions. In countries like the United States and Japan, petroleum companies adopt hybrid models, combining direct deliveries with intermediary networks to optimise distribution costs and enhance responsiveness. These approaches ensure timely product delivery, mitigate bottlenecks, and maintain customer satisfaction.

In the Nigerian context, particularly Lagos State, the distribution of petroleum products faces several challenges, including traffic congestion, poor infrastructure, and supply inconsistencies. Intermediaries, such as tanker drivers and filling station operators, play critical roles in managing multivariate flows to ensure products reach consumers efficiently. Physical flows, negotiation flows, and payment flows are observable as sector actors navigate logistical constraints to meet the state's high petroleum demand. While marketers adopt pull strategies to promote availability and customer satisfaction, push strategies are equally necessary to ensure the efficient movement of products through Lagos' complex supply chain. The integration of effective distribution management strategies is crucial to addressing these challenges. By leveraging channel flows and optimising intermediary roles, stakeholders in the petroleum sector can enhance the physical distribution process, reduce delays, and ensure products reach end-users efficiently despite infrastructural limitations.

3. Research Methodology

3.1 Study Area

Lagos State was created on May 27, 1967, by virtue of States (Creation and Transitional Provisions) Decree No. 14 of 1967 which restructured Nigeria's Federation into 12 States. Prior to this, Lagos Municipality was administered as a Federal Territory by the Federal Government through the Federal Ministry of Lagos Affairs as the regional authority, while the Lagos City Council governed the City of Lagos (Lagos State Government-LASG, 2024). The State is located on the South–Western part of Nigeria, on the narrow plain of the Bight of Benin. Lying approximately on longitude 20 42'E and 32 2'E respectively, and between latitude 60 22'N and 60 2'N (Figure 1.1). Lagos State is bounded in the North and East by Ogun State of Nigeria, in the West by Republic of Benin, and stretches over 180 kilometers along the Guinea Coast of the Bight of Benin on the Atlantic Ocean (LASG 2024). Its territorial extent and political jurisdiction encompass the city of Lagos and the four administrative divisions of Ikeja, Ikorodu, Epe and Badagry collectively referred to as IBILE and covering an area of 358,862 hectares or 3,577 sq. km. which represents 0.4% of Nigeria's territorial land mass of 923,773 sq. km (LASG 2024).

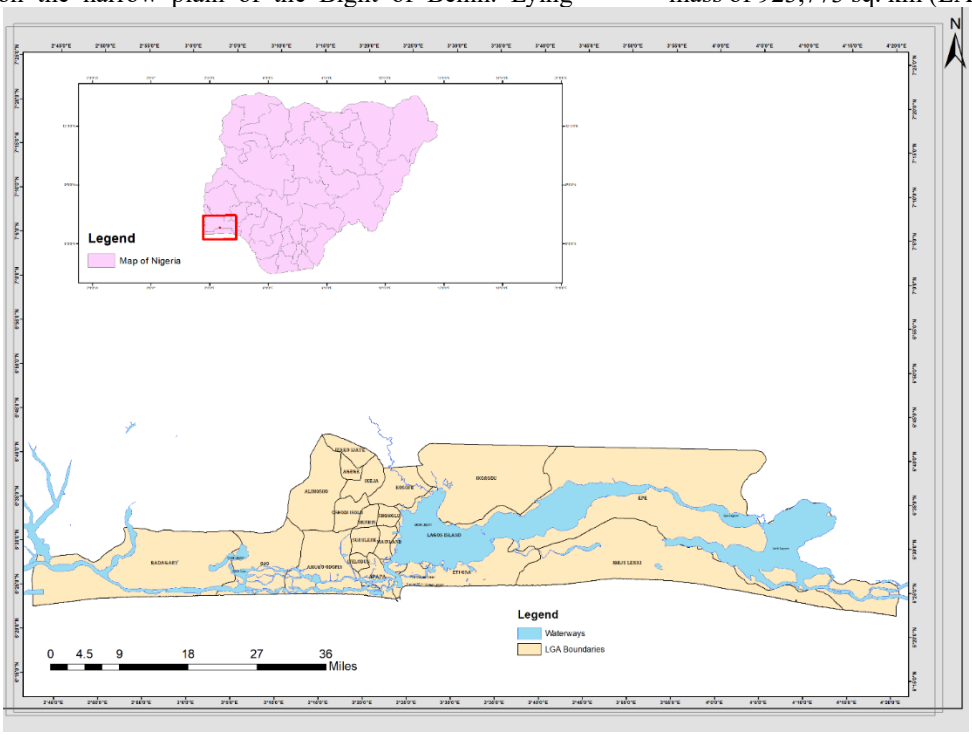

Figure 1: Lagos State Showing LGAs in the context of Nigeria
Source: *Author's GIS Analysis, (2024)*

3.2 Methods of Data Collection

The data for the study were obtained both using primary and secondary data source. This study adopts a quantitative research approach to systematically analyse the operational characteristics of petroleum products distribution in Lagos state. The quantitative approach ensures objectivity, reliability, and replicability by employing standardised instruments, such as structured questionnaire survey. The study population comprises key stakeholders directly involved in the distribution of petroleum products within Lagos State, Nigeria. Specifically, the study targets registered petroleum tanker drivers under the Petroleum Tanker Drivers (PTD), a specialised arm of the National Association of Road Transport Owners (NARTO). These tanker drivers play a critical role in the downstream sector, as they are responsible for the physical movement of petroleum products from depots to filling stations across the state. Structured questionnaires were administered to petroleum tanker drivers to gather information on the operational characteristics of petroleum distribution in Lagos State.

Systematic random sampling was used for the first sample unit, the petroleum tanker drivers. By employing this two-stage process to sample the truck drivers, it ensures unbiased selection and thus appropriate for this study. First, loading depot parks are randomly identified, and then the first truck in the queue is selected. Subsequently, every third truck in

the queue is systematically chosen. This process, repeated three times (Monday, Wednesday and Friday) a week in Apapa, Lagos State, ensures a representative sample of the drivers involved in the physical distribution of petroleum products. Systematic-random sampling is ideal here as it helps minimise selection bias while offering a methodical and efficient approach to data collection.

For the first sample unit, which consists of petroleum tanker drivers, the study systematically sampled 1,000 drivers from the cluster depot parks in the Apapa area of Lagos State. This sample represents approximately 23% of the total population of 4,393 registered truck drivers in Lagos State, according to the Lagos State Bureau of Statistics (2023). This sample size aligns with Bruton's (1985) recommendation, which suggests that a sample size of between 10% and 50% is appropriate when the population exceeds 1,000.

4. Findings

4.1 Socio-economic and Demographic Characteristics of Respondents (Truck Drivers)

The analyses of the demographic and socioeconomic characteristics of truck drivers involved in the distribution of petroleum products in Lagos State are presented in Table 4.2, focusing on key factors such as gender distribution, age group, marital status, ethnic group, and educational level, which collectively provide understanding into the demographic profile and workforce composition in the petroleum distribution sector in Lagos State, Nigeria.

The gender distribution of respondents reveals a significant disparity, with males accounting for 96.2% (962) and females only 3.8% (38) among the truck drivers' population in the study area.

The age distribution indicates that 44.6% (446) of respondents are aged 26–35 years, followed by 34.6% (346) in the 36–45 age group. Only 9.2% (92) are within 18–25 years, and an even smaller proportion (9.8%, 98) are aged 46–55 years, with just 1.8% (18) above 55 years.

Marital status data shows that 58.3% (583) of respondents are married, 37.3% (373) are single, 4.1% (41) are divorced, and only 0.3% (3) are widowed (Table 4.2). This prevalence of married individuals may reflect the stability and economic necessity associated with family responsibilities, which no doubt affects drivers' commitment to job. Single drivers, who constitute a significant proportion, might represent individuals at the beginning of their careers or those without immediate family obligations, enabling them to endure the rigors of the job. The petroleum distribution industry could leverage this dynamic by designing job roles and benefits that cater to both married and single individuals. For instance, providing family-friendly work schedules or incentives for singles who can handle extended trips may optimise workforce utility.

The ethnic composition shows a dominance of Hausa (41.4%, 414) and Yoruba (39.0%, 390), followed by Igbo (13.4%, 134) and Niger Delta respondents (6.2%, 62). In terms of educational attainment, the majority of drivers have secondary education (56.2%, 562), followed by primary education (17.2%, 172) and no formal education (16.6%, 166). A smaller fraction has technical/vocational training (5.6%, 56) or higher degrees (4.4%, 44). This highlights the adequacy of basic literacy levels in meeting the profession's requirements while pointing to a lack of specialised training as reflected in the lowest percentage of drivers with high degrees in the petroleum distribution in the study area. The findings emphasise the need for technical upskilling programs, which could improve operational efficiency by equipping drivers with advanced knowledge of vehicle technology and logistics management.

The analysis of income levels reveals that 33.5% (335) earn less than ₦50,000 monthly, closely followed by those earning ₦50,000–₦100,000 (32.9%, 329). Only 16.1% (161) earn ₦100,001–₦150,000, 16.9% (169) earn ₦150,001–₦200,000, and a meagre 0.6% (6) earn above ₦200,000.

In is worth knowing that the findings from Table 4.2 showed that the physical distribution of petroleum products in Lagos State relies heavily on a predominantly male, young to middle-aged, married, and moderately educated workforce. While this demographic configuration supports the operational demands of the industry, it also highlights critical areas for improvement, including gender diversification, equitable recruitment measures, and enhanced compensation. Enhancing these, could lead to more sustainable logistics practices and a more resilient workforce in the petroleum distribution sector in Lagos State and Nigeria at large.

Table 1: Socio-Economic characteristics of Tanker Drivers

Gender	**Frequency**	**Percentage %**
Male	962	96.2
Female	38	3.8
Total	1000	100.0
Age Group		
18-25 years	92	9.2
26-35 years	446	44.6
36-45 years	346	34.6
46-55 years	98	9.8
Above 55 years	18	1.8
Total	1000	100.0
Marital Status		
Single	373	37.3
Married	583	58.3
Divorced	41	4.1
Widowed	3	.3
Total	1000	100.0
Ethnic Group		
Yoruba	390	39.0
Hausa	414	41.4
Igbo	134	13.4
Niger Delta	62	6.2
Total	1000	100.0
Highest Educational Level		
No Formal Education	166	16.6
Primary Education	172	17.2
Secondary Education	562	56.2
Technical/Vocational Education	56	5.6
Higher Degree Education	44	4.4
Total	1000	100.0
Average Monthly Income		
Less than #50,000	335	33.5
#50,000 - #100,000	329	32.9
#100,001 - #150,000	161	16.1
#150,001 - #200,000	169	16.9
Above #200,000	6	.6
Total	**1000**	**100.0**

Source: *Author's Analysis (2024)*

4.2 Locational Distribution of Respondents

From the study, a total of 7 depot parks are represented, each with varying proportions of respondents. NIPCO Depot Park leads with the highest proportion of respondents, making up 42.0% (415) of the total sample. This large percentage indicates that NIPCO Depot Park is a central hub for petroleum distribution, likely serving more drivers with varied products due to its capacity, location, or other logistical importance. A significant concentration of drivers at this depot suggests that it plays a crucial role in meeting the demand of the drivers for petroleum products distribution in Lagos State. The centralization of operations at this depot could bring about both benefits, such as economies of scale and optimised resource use, and challenges, such as congestion and overburdened infrastructure.

Koko Trailer Park follows, with 30.0% (298) of respondents based there, suggesting that it plays a secondary role in the distribution network. While it represents a smaller share compared to NIPCO, it is still an essential point for drivers of petroleum product distribution, possibly serving specific routes or market segments. The Marine Bridge Park Depot, on the other hand, accounts for a small percentage, 0.3% (3) of respondents. This suggests that while it may play a smaller role in the overall distribution system, due to specialised nature handling specific drivers with limited capacity or reduced operational reach. Other parks represented in the figure include Oando Depot Park (9.0%, 94 respondents), AP Depot Park (8%, 81 respondents), Total Depot Park (6.0%, 55 respondents), and Conoil Depot Park (5.0%, 54 respondents). Each of these depot parks plays a role in the overall petroleum distribution system, but their lower representation compared to NIPCO Depot suggests that they may either serve niche market group or operate at a smaller scale and have less capacity to handle the volume of distribution that larger depot parks like NIPCO manage.

The findings revealed the need to improve the infrastructure and expanding capacity at depot parks

like Marine Bridge Park, Oando Depot Park, AP Depot Park, Total Depot Park, and Conoil Depot Park and these would help distribute the operational load more evenly, reducing pressure on drivers. Additionally, implementing strategic loading plan and optimising delivery schedules would alleviate traffic-related delays at the parks and improve overall operational efficiency of drivers of petroleum products distribution.

4.3 Analysis of Other Operational Characteristics of Petroleum Products Distribution

Table 2 present the findings on the tanker or truck vehicle capacity. As revealed in the table, findings indicates that the majority of drivers operate vehicles with a capacity of 45,000 litres (41.4%, 414), followed by 33,000 litres (26.9%, 269) and 40,000 litres (23.6%, 236). A smaller proportion use vehicles with 11,000 litres capacity (8.1%, 81). This distribution highlights a preference for larger-capacity tankers, which may stem from efforts to maximise efficiency in petroleum distribution by reducing the number of trips required. The average delivery hours per day reveal that 45.9% (459) of drivers spend more than 12 hours daily on deliveries, followed by 11–12 hours (22.0%, 220), 8–10 hours (17.7%, 177), and less than 8 hours (14.4%, 144). The prevalence of extended work hours suggests a highly demanding operational environment, potentially leading to fatigue and safety risks.

The average number of trips per week shows that 63.7% (637) of drivers complete 1–2 trips weekly, followed by 32.7% (327) completing 3–4 trips. Only 2.6% (26) and 1.0% (10) manage 5–6 trips and more than six trips, respectively. This low trip frequency could reflect the long distances covered and the delays experienced during deliveries. Operational coverage data shows that 59.2% (592) of drivers operate outside Lagos, while 40.8% (408) remain within the state. This suggests that petroleum distribution spans inter-state routes, requiring drivers to navigate diverse terrains and regulatory environments. The preference for operations outside Lagos could be linked to the presence of high-demand zones in neighbouring regions. However, inter-state operations often introduce complexities, such as extended delivery times and higher transportation costs. Policies aimed at decentralising petroleum storage and distribution hubs could reduce reliance on Lagos as the primary hub, thereby improving delivery efficiency across the country.

The nature of petroleum products carried is dominated by Premium Motor Spirit (PMS) at 69.6% (696), followed by Automotive Gas Oil (AGO) at 15.6% (156) and Liquefied Petroleum Gas (LPG) at 11.1% (111). Kerosene (DPK) and Aviation Turbine Kerosene (ATK) are carried by only 2.6% (26) and 0.6% (6) of drivers, respectively, while a negligible 0.5% (5) handle both PMS and AGO. This concentration on PMS reflects its status as the most widely consumed petroleum product in Nigeria. However, the limited transport of other fuels like DPK and LPG could indicate inefficiencies in meeting diverse energy demands. Expanding the distribution of alternative fuels could support energy diversification goals and reduce reliance on PMS, aligning with sustainable energy policies.

The findings from Table 2 however, emphasise several critical operational attributes and opportunities in petroleum product distribution in Lagos State. The dominance of high-capacity tankers suggests efficiency in bulk transport but raises concerns about urban sustainability and sustainable urban logistics. The extended work hours and limited trip frequencies highlight inefficiencies that could compromise driver safety and delivery schedules. Furthermore, the heavy focus on PMS transport emphasised the need for a more balanced distribution of petroleum products to align with broader energy needs transformation.

Table 2: Operational Characteristics of Petroleum Products Distribution

Tanker Vehicle Capacity	**Frequency**	**Percentage %**
11,000 Ltrs	81	8.1
33,000 Ltrs	269	26.9
40,000 Ltrs	236	23.6
45,000 Ltrs	414	41.4
Total	1000	100.0
Average Delivery Hours per Day		
Less than 8 hours	144	14.4
8-10 hours	177	17.7
11-12 hours	220	22.0
More than 12 hours	459	45.9
Total	1000	100.0
Average Number of Trips per Week		
1-2 Trips	637	63.7

3-4 Trips	327	32.7
5-6 Trips	26	2.6
More than 6 Trips	10	1.0
Total	1000	100.0
Operational Coverage		
Within Lagos	408	40.8
Outside Lagos	592	59.2
Total	1000	100.0
Nature of Petroleum Carried		
PMS	696	69.6
AGO	156	15.6
DPK	26	2.6
LPG	111	11.1
ATK	6	.6
PMS and AGO	5	.5
Total	1000	100.0

Source: *Author's Field Survey (2024)*

4.4 Association between Socioeconomic and Demographic Characteristics of Truck Drivers and Operational Capacity in Petroleum Product Distribution

This section evaluates the relationship between the socioeconomic and demographic characteristics of truck drivers and their operational capacity in the distribution of petroleum products in Lagos State using Pearson Chi-Square Analysis and Phi Cramer's V Test. In other words, these socioeconomic characteristics are linked to the type of driving training received to understand the extent to which the variables affect one another.

Findings presented in Table 3 on the age group and training type revealed that the majority of drivers aged 26–35 years (61.0%, 272) received specialised training for tanker driving, followed by those aged 36–45 years (57.5%, 199) and 18–25 years (55.4%, 51). Younger drivers, aged 18–25 years, exhibited a higher proportion of informal training (27.2%, 25), which reflects limited access to formal training facilities or reliance on informal learning sources, such as family and friends. Older drivers above 55 years also showed a preference for specialised training (61.1%, 11). The Pearson Chi-Square test ($\chi^2 = 38.571$, $p < 0.001$) confirms a significant relationship between age group and training type, with a weak but meaningful association indicated by the Phi value (0.196, $p < 0.001$).

Findings on gender and training type revealed that male drivers dominate the logistics workforce, with 58.5% (563) receiving specialised training, compared to 63.2% (24) of female drivers. However, female drivers are disproportionately represented in the "no training" category (15.8%, 6) compared to males (1.2%, 12). This disparity indicates potential barriers to formal training for women, likely influenced by gender biases or societal perceptions of their roles in physically demanding sectors. The Chi-Square test ($\chi^2 = 49.968$, $p < 0.001$) and Phi value (0.224, $p < 0.001$) confirm a moderate and significant association between gender and training type.

Findings on the marital status and training type revealed that married drivers predominantly received specialised training (56.6%, 330), reflecting the stability and economic motivation often associated with marital responsibilities. Single drivers also displayed significant engagement with specialised training (61.7%, 230), although they exhibited a slightly higher tendency toward informal training (19.8%, 74). Divorced drivers showed a mix, with some receiving specialised training (65.9%, 27) while others remained informally trained (19.5%, 8). The Chi-Square test ($\chi^2 = 32.279$, $p < 0.001$) and Phi value (0.180, $p < 0.001$) suggest a weak but significant relationship between marital status and training type. These results imply that marital stability influences access to or pursuit of formal training, potentially due to a focus on stable income streams to support family needs. Employers can enhance inclusivity by offering training packages that cater to drivers across different marital statuses, ensuring equal opportunities for professional development.

Analysis on ethnic group and training type showed that the Hausa ethnic group showed the highest proportion of informally trained drivers (29.2%, 121), whereas the Niger Delta group demonstrated the highest proportion of specialised training (77.4%, 48). Yoruba (60.8%, 237) and Igbo (47.8%, 64) drivers exhibited more balanced distributions between formal and informal training types. The Chi-Square test ($\chi^2 = 56.683$, $p < 0.001$) and Phi value (0.238, $p < 0.001$) confirm a moderate association between ethnicity and training type. Findings on the association between educational level and training type revealed that

drivers with higher degrees predominantly received specialised training (56.8%, 25), while those with no formal education were overrepresented in informal training (34.3%, 57). This trend highlights the correlation between education and access to advanced training. The Chi-Square test ($\chi^2 = 126.115$, $p < 0.001$) and Phi value (0.355, $p < 0.001$) indicate a moderate and significant relationship between education and training type. These results emphasise the need for specialised training programs that accommodate drivers with limited educational backgrounds, ensuring competency across the workforce. As suggested by Adewuyi et al. (2021), literacy-inclusive training initiatives can improve operational standards and inclusivity.

Findings on the influence of monthly Income on training received revealed that drivers earning less than ₦50,000 showed the highest rate of informal training (44.2%, 148), whereas those in higher income brackets, such as ₦150,001–₦200,000, predominantly received specialised training (85.8%, 145). This strong association is confirmed by the Chi-Square test ($\chi^2 = 208.032$, $p < 0.001$) and Phi value (0.456, $p < 0.001$). The findings suggest that income levels are both a determinant and a result of training type. Drivers with specialised training often earn higher incomes due to enhanced competencies and reduced risks. Subsidising training costs for low-income drivers can increase access and improve the operational capacity of this segment. Employers should also consider linking training completion to income progression, incentivising drivers to pursue professional development.

The findings from Table 3 however highlight that socioeconomic and demographic characteristics significantly influence the operational capacity of truck drivers in petroleum distribution, with implications for workforce development. Younger drivers, particularly those in low-income brackets, require accessible formal training to standardise competencies and improve operational safety. Gender equity initiatives are crucial to addressing training disparities for female drivers, diversifying the workforce, and enhancing efficiency. Establishing decentralised training facilities can mitigate regional and ethnic disparities, fostering a more uniform and skilled workforce. Specialised training programs for drivers with limited educational backgrounds can promote inclusivity and facilitate skill acquisition, while linking training completion to income progression can incentivise professional development and reduce reliance on informal training.

Table 3: Association between Socioeconomic and Demographic Characteristics of Truck Drivers and Operational Capacity in Petroleum Product Distribution using Pearson Chi-Square Analysis and Phi Cramer's V Test

Socio-economic and demographic characteristic		Driving Training Received					Pearson Chi-Square						
		None	Informal (Learned from Family and Friends)	Formal Driving School	Specialised Training for Tanker Driving	Total	Value	Df	Sig.	Phi value	Sig.	Cramer's V value	Sig.
Age Group													
18-25 years	F	8	25	8	51	92	38.571[a]	12	.000	.196	.000	.113	.000
	%	8.7%	27.2%	8.7%	55.4%	100.0%							
26-35 years	F	7	85	82	272	446							
	%	1.6%	19.1%	18.4%	61.0%	100.0%							
36-45 years	F	2	81	64	199	346							
	%	0.6%	23.4%	18.5%	57.5%	100.0%							
46-55 years	F	1	27	16	54	98							
	%	1.0%	27.6%	16.3%	55.1%	100.0%							
Above 55 years	F	0	5	2	11	18							
	%	0.0%	27.8%	11.1%	61.1%	100.0%							
Total	F	18	223	172	587	1000							
	%	1.8%	22.3%	17.2%	58.7%	100.0%							
Gender													
Male	F	12	222	165	563	962	49.968[a]	3	.000	.224	.000	.224	.000
	%	1.2%	23.1%	17.2%	58.5%	100.0%							
Female	F	6	1	7	24	38							
	%	15.8%	2.6%	18.4%	63.2%	100.0%							
Total	F	18	223	172	587	1000							
	%	1.8%	22.3%	17.2%	58.7%	100.0%							
Marital Status													
Single	F	11	74	58	230	373	32.279[a]	9	.000	.180	.000	.104	.000
	%	2.9%	19.8%	15.5%	61.7%	100.0%							
Married	F	5	139	109	330	583							
	%	0.9%	23.8%	18.7%	56.6%	100.0%							
Divorced	F	1	8	5	27	41							
	%	2.4%	19.5%	12.2%	65.9%	100.0%							
Widowed	F	1	2	0	0	3							
	%	33.3%	66.7%	0.0%	0.0%	100.0%							
Total	F	18	223	172	587	1000							
	%	1.8%	22.3%	17.2%	58.7%	100.0%							
Tribe													
Yoruba	F	6	73	74	237	390	56.683[a]	9	.000	.238	.000	.137	.000
	%	1.5%	18.7%	19.0%	60.8%	100.0%							
Hausa	F	5	121	50	238	414							
	%	1.2%	29.2%	12.1%	57.5%	100.0%							
Igbo	F	6	21	43	64	134							
	%	4.5%	15.7%	32.1%	47.8%	100.0%							
Niger Delta	F	1	8	5	48	62							
	%	1.6%	12.9%	8.1%	77.4%	100.0%							
Total	F	18	223	172	587	1000							
	%	1.8%	22.3%	17.2%	58.7%	100.0%							
Highest Educational Level													
No Formal Education	F	2	57	20	87	166		12	.000	.355	.000	.205	.000

Source: *Author's Field Survey (2024)*

5. Conclusions

Operational characteristics of petroleum product distribution showed that high-capacity tankers, long working hours, and low-trip frequencies dominate the petroleum logistics landscape in Lagos State. These factors contribute to inefficiencies and safety risks, requiring better scheduling, work-hour regulation, and investment in inter-modal means. Additionally, socioeconomic and demographic factors such as age, education, and income levels, significantly influenced truck drivers' operational capacity, revealing disparities in training and experience, which need to be addressed through targeted programmes. This finding highlights the need for standardised training programmes, gender-inclusive policies, and subsidies for low-income drivers or operators.

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