Optimization of Vehicle Fleet Replacement Decisions and Fuel Cost Dynamics in the Nigerian Transport Sector

Titilope Caroline OYINADE

Department of Business Administration, University of Benin, Benin City

DOI: https://doi.org/10.51584/IJRIAS.2025.10040093

Received: 25 December 2024; Accepted: 30 December 2024; Published: 23 May 2025

INTRODUCTION

Background to the Study

Any country's economic growth and social mobility are largely dependent on the transportation industry (Inegbedion & Aghedo, 2018). In Nigeria, a country with a vast and diverse population, efficient transportation is not only essential for connecting people and goods but also for fostering economic growth and prosperity. The Nigerian transport sector has historically been supported by fuel subsidies, which have alleviated the financial burden on both consumers and businesses (Ismail, Hezekiah & Bilikisu, 2014). However, recent policy changes, including the removal of fuel subsidies, have introduced new challenges and considerations for fleet managers and stakeholders in the transport industry.

The primary goal of replacement policy is to determine an item's economic life, as retaining an item longer than necessary may result in a decline in the profit generated by the item's use. Making the decision to replace the equipment at the appropriate stage of its useful life will maximize the profit from the equipment (Hossam, Ahmed, & Ahmed, 2023). The transition from subsidized fuel to market-based fuel prices has brought about significant shifts in operating costs for transportation companies, necessitating a re-evaluation of their fleet management strategies (Ismail et al. 2014). The decision to replace aging vehicles involves a complex interplay of economic, operational, and environmental factors, all of which must be balanced to ensure the sustainability and efficiency of transport operations. In light of this, it is in everyone's best interest from a practical standpoint to justify the best terms for equipment renewal. (Lapkina & Malaksiano, 2023).

As fuel costs rise due to subsidy removal, the timing of vehicle replacement becomes paramount. Replacing vehicles too early can lead to unnecessary capital expenditure, while delaying replacements can result in higher maintenance costs, reduced fuel efficiency, and environmental concerns (Amiens, Oisamoje & Inegbedion, 2015). Striking the right balance is crucial not only for the financial viability of transport businesses but also for the broader economy by ensuring the uninterrupted movement of goods and people. The aims of the organizations might frequently suffer as a result of poor vehicle replacement decisions (Edwards, 2009). Reducing failure frequency balances failure expense with maintenance advantages including downtime, dependability, and availability. This is the basic objective of equipment replacement. In the operations of commercial transportation enterprises, the investment in transport vehicles often represents the biggest deployment of resources (Rani & Sukumari, 2014).

This study will employ advanced analytics and optimization techniques to model the relationship between fleet replacement decisions and fuel cost dynamics.

The removal of fuel subsidies in the Nigerian transport sector has introduced a complex set of challenges that demand innovative solutions. This study will delve into the intricacies of determining the optimum replacement time for vehicle fleets while accounting for the constraints imposed by increased fuel costs and alternatives to fuel. By doing so, it seeks to contribute valuable insights to the ongoing discourse surrounding sustainable and efficient fleet management practices, ensuring the continued vitality of the Nigerian transport sector in a changing economic environment.

Statement of Research Problem

The transport sector in Nigeria plays a pivotal role in the country's economic development by facilitating the movement of goods and people. One critical aspect of managing this sector efficiently is determining the optimum replacement time for vehicle fleets, especially in light of constraints imposed by the removal of fuel subsidies. The removal of fuel subsidies has significant implications for the cost of fuel, which is a major operational expense for transport companies and individuals alike.

The majority of resources allocated to the operations of commercial transportation businesses are often spent on transport vehicles. Making the wrong choices while replacing vehicles can frequently go against the organizations' objectives. A methodical and trustworthy strategy for making judgments is therefore required in order to ensure that the likelihood of making a mistake is suitably reduced. The number of organizations that use equipment varies as much as how and when it is changed. It is unlikely that many Nigerian transportation firms have a written replacement plan for their fleet of vehicles.

However, how and when equipment is replaced can have an impact on yearly expenses that range from hundreds to millions of dollars (Edwards, 2009), as well as dependability and system efficiency, as optimal equipment replacement increases equipment reliability. Since commuters' locations are changed by using cars, which is a crucial transition in a transportation system, automobiles are perhaps the most crucial piece of equipment for transportation businesses. Since average costs are at their lowest when equipment should be changed, the goal of equipment replacement choices is to guarantee that equipment is replaced before it begins to incur greater costs. Therefore, the need for equipment replacement is driven by the need to reduce costs (Fallahnezhard & Niaki, 2011; Fan Machemehl & Gemar, 2012), since longer replacement time intervals have a tendency to lead to higher operational and overall expenses for equipment.

Large fleets of vehicles, often buses or taxis, are maintained by transportation businesses in Nigeria. The success of these businesses depends on these automobiles, which are an expensive investment. Choosing the appropriate time to replace each of the current cars is a glaringly major obstacle to the efficient management of such a big fleet of vehicles. Although there are evidence that these kinds of replacement decisions greatly impact the fleet's failure rate and, in turn, the dependability of such fleets, they do not appear to have any clearly demonstrated effects on profitability.

The best equipment replacement is regarded as a successful tactic for boosting a failing system's reliability. The cost of all the equipment that most producers purchase appears to be strongly influenced by investments in machinery and equipment. Given the constrained earnings and profits, many businesses replace their equipment at random, which might result in replacement at an age that is below ideal, which could limit earnings and hence profitability. The best age to start a business might limit profits and revenues. Because most assets have a lifespan that is ideal, determining the ideal age is crucial for planning and budgeting. The techniques used in finance theory to calculate an asset's optimum life make the assumption that either an asset's productivity declines with time or that its operational expenses rise annually.

However, the sector faces multifaceted challenges that impact its efficiency and sustainability. Two critical factors, overloading and fuel cost, have historically posed significant constraints on the operation of vehicle fleets within the sector (Ismail et al. 2014). While overloading has been a major constraint in many of the research conducted in the transport sector for instance (Inegbedion, 2014; Inegbedion & Ahgedo, 2018; Inegbedion & Osifo, 2014), due to safety concerns and road deterioration, the recent removal of fuel subsidies in Nigeria has introduced a new dimension, and making fuel costs a crucial consideration in fleet management decisions. Hence, this research work aims to arrive at an efficient fleet management strategy given the increment in fuel cost and possible alternatives to ensure transport company break-even.

Furthermore, previous research in this area of study has used data from God is Good Motor as a case study from 2009 to 2013 (Inegbedion, 2014). This study accessed the same data set from 2009 to 2022. This is to ensure a more comprehensive analysis and to take advantage of recent data availability, validation, robustness, and generalizability of previous research findings.

The study aims to offer practical recommendations for vehicle fleet management in Nigeria's transport sector in a changing economic and policy landscape marked by fuel subsidy removal, thereby enhancing economic efficiency and environmental sustainability.

Research Questions

To guide this study, the following research questions have been formulated:

1. to what extent does total operating cost of vehicle affect replacement time of vehicle fleet?
2. how much do cost variations affect replacement time of vehicle fleet?
3. what are the appropriate models for assessing the impact of cost of fuel on fleet replacement?
4. how do various fuel alternatives affect the longevity of fleet vehicles and their overall sustainability performance?

Research Objectives

The research objectives is to provide valuable insights and recommendations for optimizing the replacement of vehicle fleets in Nigeria as this would contribute to improving fleet efficiency, reducing operational costs, promoting environmental sustainability and guiding policymakers and fleet managers evidence-based decisions. Specifically, the study objectives are to:

1. ascertain the extent to which total vehicle costs influence replacement time of vehicle fleet.
2. determine the extent to which cost variations affect the replacement time of vehicle fleet.
3. to investigate the appropriate models for assessing the impact of cost of fuel on fleet replacement.
4. to examine the extent to which fuel alternatives affect the longevity of fleet vehicles and their overall sustainability performance.

Research Hypotheses

The following Null hypotheses were tested

$H0_1$: total vehicle costs do not influence replacement time of vehicle fleets.

$H0_2$: cost variations do not significantly affect replacement time of vehicle fleets.

$H0_3$: costs of fuel do not influence fleet replacement.

$H0_4$: fuel alternatives do not affect the longevity of fleet vehicles and their overall sustainability performance.

Scope of the Study

Basically, the study sought to investigate the optimum replacement time of vehicle fleets with cost of fuel constraints as a result of subsidy removal in Nigeria. The study will focus on transport companies in Benin City reason being that the city has a lot of reputable transport companies in Nigeria. The study will focus on the activities of God is Good (GIG) mobility because the firm is one of the best and technological-driven private commercial transport company in Nigeria. GIG mobility located in Benin- City. Edo State.

The study is consistent with the goal of the replacement theory for deteriorating items, which seeks to replace equipment or equipment parts in a manner that minimizes economic loss. It confines itself to the cost model of equipment replacement. The operation of GIG mobility for the period of 2009 – 2023 will be adopted for the study. This is because the era has experienced incessant increase in fuel price and also the total removal of fuel subsidy.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

Significance of the Study

By incorporating data on fuel prices, vehicle maintenance costs, operational efficiency, and environmental impact, the study aims to provide evidence-based insights to guide fleet managers, policymakers, and other stakeholders in making informed decisions about when to replace vehicles within the new economic landscape.

1. **Operational Efficiency**: Optimizing the replacement of vehicles in a fleet can significantly improve operational efficiency. Identifying the optimal replacement time based on the factors such as age, millage and maintenance costs help ensure that vehicles are replaced before they become unreliable or inefficient. This, in turn, reduces the risk of breakdowns, minimizes downtime, and enhances overall fleet performance.

2. **Cost Savings**: Vehicle management involves significant costs, including acquisition costs, maintenance expenses, and disposal costs. A well-planned equipment replacement strategy can lead to cost savings by minimizing maintenance and repair expenses associated with older vehicles, reducing fuel consumption through the adoption of more cost saving vehicles and avoiding costly breakdowns and downtime. Additionally, by considering the total cost of ownership, including depreciation, resale value and lifecycle costs, fleet managers can make financially informed decisions regarding vehicle replacement.

3. **Environmental Impact:** The transportation sector, including vehicle fleets, contributes to environmental degradation through emissions of greenhouse gases and air pollutants. By optimizing equipment replacement, fleet managers can transition to newer, cleaner and a smaller carbon footprint. This aligns with national and international commitment to address climate change, improve air quality and promote sustainable development.

4. **Cost of fuel:** Studying cost of fuel as a constraint to optimum replacement of vehicle fleet in Nigeria have a broader economic implication, higher fuel prices can impact transportation cost, inflation rates and the competitiveness of transportation companies. Studying the cost of fuel as a constraint to motor vehicle replacement helps assess the potential economic benefits by adopting fuel-efficient vehicles or alternative fuel technologies.

5. The study enables fleet managers, policy makers and stakeholders to make informed decisions considering the financial, environmental and economic aspects. It facilitates cost optimization, sustainable transportation planning and the development of strategies that align with energy and environmental goals.

Above all Research on optimum equipment replacement for vehicle fleets in Nigeria fills a knowledge gaps in the field of fleet management within the country. It provides local insights, data and recommendations specific to the Nigerian context, which guide fleet managers, policy makers and stakeholders in making informed decisions and developing effective strategies

LITERATURE REVIEW

Introduction

The chapter examines conceptual review, which includes concepts of equipment replacement time, models of equipment replacement time, determinants of equipment replacement time, vehicle operating cost, relationship between operating cost and equipment replacement time, empirical review of alternative to fuel, as well as replacement optimization framework.

Conceptual Review

Concept of Equipment Replacement

Physical life, financial life, and economic life are three different mathematical definitions of equipment life. When evaluating equipment life, all three components must be stated and quantified in order to move toward replacement analysis and eventually decide on equipment replacement. The concepts of downtime, obsolescence, maintenance and repairs, investment, inflation, and depreciation are also put into consideration.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

This chapter discusses all of these topics in depth and provides examples of how to apply the economic calculations, all of which are essential to replacement analysis. The equipment manager will be able to conduct replacement analysis correctly and make informed equipment replacement decisions by combining these concepts and procedures.

The goal of equipment replacement policy is to replace equipment at the best possible moment. Choosing whether to replace old cars in the fleet is a significant and tough task of managing vehicle fleets. Such choices have a definite established effect and also have an influence on the fleet's capacity to supply the necessary equipment (Kriett, 2009). This issue has long been recognized by fleet managers and experts, who have come up with a number of solutions. Ankoff (1961) asserts that the issue of equipment replacement entails two steps: (1) deciding on the ideal point in time or cumulative usage to replace, and (2) selecting the finest equipment that is available at the moment. The two issues—economic life and equipment selection issues—are precisely what equipment replacement policy addresses. The tendency of the equipment to decay, fail, or malfunction makes replacement necessary. A necessary service supplied by one or more assets over a limited time frame is the focus of the replacement problem. In order to maximize a certain measure of economy, the choice is often made about the replacement schedules for individual assets (Karabakal, Lohmann, & Bean, 1994). The present value of the asset is frequently this economic metric that has to be maximized.

According to Gillepie and Hyde (2005), keeping and using a piece of equipment as long as its estimated marginal cost (MC) is less than or equal to the anticipated average total cost (ATC) of a new piece during its lifetime is the best course of action. Expressed mathematically, this strategy is $MC_{old} \leq$ (ATC_{new}) is the average lifetime cost per unit of service expected from a new machine. Any alternate plan for replacing equipment would be more expensive. As a result, the lifetime average cost of a machine reaches its lowest point at the point in its service life when its marginal cost of operation equals the lifetime average cost of a new machine (Gillespie & Hyde, 2005). It is therefore recommended that the owner dispose off the equipment and buy a new one, which can serve as a decent or superior substitute for the old and which can be utilized up to the point of minimal average total cost.

The period at which the unit costs are at the lowest is known as the optimal replacement time (t) as defined by Sebo, Busa, Demec, and Svetlic (2013). Unit expenses will start to rise beyond that point. A replacement schedule outlines how long each asset in the sequence is to be kept in service, which determines when to replace the organization's equipment (Akpan & Ufot, 2013). It also specifies whether to keep an existing asset (the defender) or to replace it immediately with one of the new assets (current challengers) or a sequence of future challengers to be installed after the current decision. The decision of whether to preserve a piece of equipment or replace it with a more modern technology is another name for equipment replacement challenges (Nair & Hopp, 1992). This resolution must give proper consideration to the nature of the replacement technology already in use as well as the potential for future technological improvement.

The process of replacing used equipment entails determining the right time to do so based on the study of a criterion or combination of decision criteria (Christer & Goodbody, 1980).

When beginning a design and implementation project, equipment replacement in the process industry must take the commissioning, operating, and end-of-life phases of physical assets into account (Schuman & Brent, 2006). Guerts (1983) focuses on age-replacement, which asserts that a piece of equipment needs to be replaced with a new one if it fails or survives a specific age (preventive replacement or corrective replacement, depending on which occurs first). The term "Age" or "Time" should be understood as the variable that determines the equipment's risk of failing. Examples of this variable include calendar time, operating hours, the quantity of goods produced, the volume of activities carried out, and the distance traveled (in the case of vehicles).

The likelihood of failure must also increase as a function of the equipment's age for age replacement to be a rational norm, and corrective replacements must be more expensive than preventive replacements. The two replacement costs must be understood in order to apply it. Beichelt (2006) suggested a total maintenance cost limit replacement policy and shows how the reliability component may be incorporated into the total maintenance cost limit replacement model. Nevertheless, with the development of increasingly advanced and diverse condition monitoring technology, condition-based replacement is progressively emerging as a workable substitute for age replacement. The moment of failure is predicted from measurements on some "prognostic characteristics," which are the object of the monitoring process, according to Geurts (1983). Conditioned-based replacement requires equipment to be inspected periodically or monitored continuously and replaced just before it fails. The same regulation will once again apply to the new piece of equipment. The best equipment replacement strategy, in general, is to maintain using a piece of equipment as long as its projected marginal operating cost is less than or equal to the expected average total cost of a new piece during its lifespan, as stated by Gillespie and Hyde (2005).

Reasons to replace equipment

1. Age and usage: After being bought and put to use, a piece of equipment gradually starts to deteriorate and develop mechanical issues. It eventually approaches the end of its usable life and has to be replaced. The process of choosing when to replace equipment is thus a key component of effective equipment fleet management. In essence, this choice is deciding whether it is not more economically feasible to fix a malfunctioning piece of equipment (Gouglas, 2005). Equipment has an expiration date, and as it ages, the likelihood of breakdowns, problems, and inefficiencies increases. It could be time to replace your equipment with newer, more dependable ones if it is obsolete or exhibiting significant wear and tear.

2. Cost Reduction: The typical guideline for reducing the yearly total cost of owning and running a piece of equipment is to make a modification when that cost starts to rise. The cost of interest also starts to decline at this stage when repair expenses start to rise faster than depreciation. Total cost increases, however, frequently happen very gradually, as a result, while the rule of growing total cost might provide an overall idea of when to replace a specific unit, it cannot provide an exact response. Note that the estimated repair costs indicate a progressive upward trend over time. In practice, however, repair expenses might vary significantly from one year to the next, from simple upkeep to a total overhaul Edwards (2009).

3. Reliability: Most operators additionally factor in timeliness costs while making replacement selections in addition to the normal machinery expenses. Any occurrence that is timely, seasonable, or well-timed is referred to as being timely. Thus, the opportunity cost of not occurring at a proper moment is implied by the cost of timeliness. A machine that is trustworthy to work well is one that is reliable. Therefore, the term "equipment reliability" refers to the possibility or probability that the device will perform as expected. A machine is considered eighty percent (80%) dependable if it operates well or is anticipated to operate well eighty percent of the time. To put it another way, there is a 20% chance of becoming dissatisfied after using that equipment.

4. **Need to increase capacity:** It is essential for management to replace outdated equipment with models that have a larger capacity to compete with competitors in the industry or even superior ones, without endangering timeliness, when productivity needs to be increased greatly as a result of expansion. Similar to this, when production drops, it could be required to cut operational expenses by getting rid of some equipment.

Vehicle Operating Costs

Gupta, Sharma and Ahuja (2007) opined that vehicle operating costs are a crucial factor in decision-making for individual, business, and policymakers. The costs associated with running a firm, or with running a machine, part, piece of equipment, or facility, are known as operating costs. These costs encompass a wide range of expenses associated with owning and using a vehicle. Pfueger (2005) states that running costs often comprise expenses that are spent as a direct result of using the unit. The variation in machine utilization affects these expenses. They are:

Fuel Costs: Fuel costs are a significant portion of operating expenses. The price of fuel and the vehicle’s fuel efficiency determine how much you spend on fueling. The type of fuel (gasoline, Compressed Natural Gas (CNG), electricity) also impacts costs.

Maintenance and Repairs: Regular maintenance includes services like oil changes, filters replacement, tire rotations, and brake checks. Unplanned repairs for mechanical issues, wear and tear, and accidents are

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

additional expenses.

Depreciation: Depreciation is the decline in a vehicle's value over time. It's a major cost for vehicle owners, particularly those who plan to sell or trade in their vehicles in the future.

Insurance Premiums: Insurance costs vary based on factors like the type of coverage, the vehicle's make and model, the driver's history, and the location. Premiums include liability, collision, and comprehensive coverage.

Registrations and Taxes: Annual vehicle registration fees and taxes contribute to operating costs. These fees are typically based on the vehicle's value, weight, or other factors determined by local regulations Pfueger (2005).

Financing Costs: For those who finance a vehicle purchase, monthly loan payments or lease payments add to operating expenses.

Tires and Tire Maintenance: Tire replacement and maintenance expenses include purchasing new tires and periodic balancing, alignment and rotation.

License and Permits: Some commercial vehicles require special licenses or permits for operation, which come with associated costs.

Toll fees and Parking: Tolls and parking fees can be ongoing expenses, particularly for urban drivers who navigate through toll roads and city parking areas.

Cleaning and Detailing: Regular cleaning and detailing help maintain the vehicle's appearance and value. Costs vary based on the cleaning frequency and the type of service Pfueger (2005).

Vehicle upgrades and modifications: Optional upgrades, modifications and accessories contribute to the overall operating cost. These may include features like Global Positioning Systems (GPS) entertainment systems, and aftermarket parts.

Environmental and regulatory fees: Some regions impose environmental fees or emissions testing requirements, which add to vehicle operating costs.

Calculating and managing vehicle operating costs is essential for budgeting purposes, evaluating the economic feasibility of vehicle ownership, and making informed decisions when purchasing or using a vehicle. Different vehicles, usage patterns, and geographic locations can lead to varying operating cost profiles. As technology evolves, particularly in the area of alternative fuels and electric vehicles, operating costs may shift as well Ahuja (2007).

Measurement of Vehicle Operating Costs

Measuring vehicle operating costs involves quantifying the various expenses associated with owning and using a vehicle. Vehicle expenses may be divided into fixed and variable costs, sometimes referred to as operational, marginal, or incremental costs, which rise with mileage, in accordance to the Vitoria Transport Policy Institute (2022). There are other expenses that are usually labeled as fixed expenditures, such as taxes on vehicles, insurance, and registration. Depreciation does not grow with miles on a car, although insurance does.

Here's how the costs can be measured according to the institute:

Fuel cost: Measuring fuel consumption has to do with keeping track record of fuel consumption per miles driven and fuel filled. Calculate miles per gallon (MPG) or liters per kilometer(L/100km) to measure fuel efficiency. Besides, record the amount spent on fuel during a specific period.

Maintenance and Repairs: Maintain a maintenance log by recording all maintenance activities, including oil changes, filter replacements, and repairs. Also, track maintenance expenses are to sum up all cost related to scheduled maintenance and unexpected repairs.

Depreciation: Determine initial and current value by calculating the difference between the initial purchase price and the current market value of the vehicle, Furthermore, calculation of depreciation involves dividing the difference in value by the number of years the vehicle has been owned.

Insurance Premiums: Record insurance payments by documenting insurance payments made over a specific period.

Financing Costs: Calculate interest payments by determining the total interest paid over the loan or lease agreement.

Tire Costs: Note tire replacements by recording the number of times you replace the vehicle's tire and associated costs.

Registration and Taxes: Record the amount paid for vehicle registration and associated costs.

Total Cost of Ownership (TCO): sum all expenses by adding all the costs mentioned above to calculate the total cost of ownership over a specific period (e.g., monthly, annually) Lisa (1995).

Cost per Mile (Kilometer): Divide total cost, this is done by dividing the total operating cost by the number of miles (or kilometers) driven during the same period to calculate the cost per unit of distance.

Comparative Analysis: Compare Vehicles, if you own multiple vehicles, compare the operating costs by the number of miles (or kilometers) driven during the same period to calculate the cost per unit of distance.

Relationship between Operating Cost and Equipment Replacement Time

There are many iterations of choices that must be made in relation to equipment ownership. The owner of the main piece of equipment must select how much and how frequently routine preventative maintenance should be performed. Preventive maintenance consists of routine, periodic operations designed to reduce repair costs or increase the lifespan of equipment. Lubricant replacements on a regular basis are an excellent illustration of preventative maintenance. Corrective maintenance or repair choices are the next step of decision-making following preventative maintenance. When a machine or one of its parts malfunctions in the course of business, it is crucial to fix it in order to recover operational status and, in the case of commercial transport vehicles, win back the trust of clients. Corrective maintenance decisions, rebuild decisions, or repair decisions include significant mechanical upgrades that help the equipment last longer. The equipment manager must consider an equipment replacement option when a machine nears the end of its useful life, and the majority of these decisions are complex (Mitchel, 1998).

Economic considerations have a role in equipment selections linked to upkeep and repair. They fall under the umbrella of increasing the investment's profitability. Two more categories of decisions, in addition to those involving maintenance and repair, are presented to policymakers when it comes to heavy machinery. The first category of choice is of an operational character and deals with how to maximize the output of the machinery. The second is mechanical and deals with methods to guarantee the dependability of the apparatus.

An Earthmoving Machine goes through three stages in its life cycle: purchase, use, and sale. The equipment manager should aim to buy as frequently as possible owing to the significant capital expenditure involved since the decision to buy only occurs once over the life of each machine. After the machine is purchased, "operate" choices are commonly made; the objective is to run the machinery as inexpensively as feasible to achieve the desired productivity. In the course of a machine's life, the "sell" choice may be considered more than once, but it is only ever made once. According to Mitchell (1998), the equipment should be sold for the highest price feasible. The three distinct economic choices might not be too challenging to understand and analyze when looked at separately. But the three of them have a complicated dynamic. Each one can have a significant influence on the others. Despite the high cost of purchasing new equipment, running costs are relatively low at the beginning of a machine's life. The choice to "sell" should be taken into consideration when operational costs rise.

The costs associated with owning a machine are those that would otherwise have to be paid in order to use it. Inputs other than purchase and sell include expenses like taxes or insurance. The easiest way to describe ownership expenses is on a calendar basis; they are incurred whether or not the machine is in use. The average owing cost each period decreases with increased equipment retention. On the other hand, the average cost of ownership per period might be rather high if the equipment is only held for a little time due to the fact that new machines depreciate quite fast in the beginning.

According to Mitchel (1998), using a piece of equipment results in a continuous flow of running expenses. These are expenses that arise regularly as a result of operating a machine. Operating expenses may be essentially nonexistent if the machine is not in use. The machine's running expenses may increase significantly if it is utilized frequently. Other expenses, such as tires, repairs, and rebuilds, come up more frequently and can be rather expensive. When a machine is young, the average running costs are low, but as it becomes older, the average expenses tend to rise.

Concept of Alternative to fuel

Following the termination of fuel subsidies by the Federal Government, there are signs that more Nigerians are requesting the usage of compressed natural gas. When President Bola Tinubu said that the government would no longer provide gasoline subsidies, Nigerian service stations increased the price of petrol at the pump. Petrol, diesel, and propane/LPG can all be substituted with compressed natural gas as a fossil fuel. It does release greenhouse gases upon burning. In the case of a spill, it is significantly safer than other fuels and a more ecologically friendly substitute for gasoline and diesel. (Independent Newspaper in Nigeria, June, 2023.)

Stakeholders believe that for every million converted automobiles, compressed natural gas can bring in over N200 billion for the federal government. These CNG stations cater to Auto Gas requirement of vehicles, providing a cleaner, safer, economical, proven, and indigenous fuel. NIPCO Gas presently fuels 7000 vehicles with AutoCNG. Nipco Gas has 4 AutoCNG conversion workshops in Ogun state and Abuja FCT to convert PMS vehicles on AutoCNG. More and more fleets operate converting their fleet on AutoCNG due to safety, availability, and economic reasons.

Autogas, a blend of liquefied petroleum gas and compressed natural gas used as a transportation fuel, is the second most popular and well-liked alternative vehicle fuel in use today, behind ethanol. The use of auto-gas has dramatically increased during the previous few years on a global scale. 26.7 million tons were used in 2016, an increase of 3.7 Mt (16% from 2000) and 283 000 tons (1.1% from 2015). Almost 26.8 million auto-gas cars are already on the road worldwide (Morgan, 2017). The need for more eco-friendly, better, and cleaner fuels has been driven by the problems posed by global warming. The most popular types of petroleum fuels are PMS and AGO.

Possible Alternatives to Fuel

There are several alternatives to traditional fossil fuels that can be used to power vehicle fleets. These alternatives aim to reduce greenhouse emissions, dependence on oil, and overall environmental impact. Numerous studies have been conducted recently on the use of alternative fuel vehicles in the light vehicle category Singh, Singh, and Vaibhav (2020). A group of factors that are essential for the effective adoption of alternative fuel cars have been discovered by these investigations. Here are some notable alternatives:

Electricity: Electric vehicles (EVs) are becoming increasingly popular due to their zero tailpipe emissions and improving battery technology. They can be charged from the electric grid and offer varying ranges, form short-range city cars to long-range options for highways.

Hydrogen Fuel Cells: Hydrogen fuel cell vehicles use hydrogen gas to generate electricity, with the only byproduct being water vapor. These vehicles have the advantage of quick refueling times compared to EVs, but hydrogen production and distribution can be challenging Zhou, Kong, Zhao, Huang, Wang and Campy (2019).

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

Biofuels: Biofuels are derived from organic matter like crops, algae, or waste materials. They can be blended with or replace conventional gasoline and diesel fuels. Ethanol (derived from corn, sugarcane, etc), and biodiesel (from vegetable oils or animal fats) are common examples.

Natural Gas: Compressed gas (CNG) and liquefied natural gas (LNG) can be used as alternative to gasoline and diesel. Natural gas is cleaner burning than traditional fuels and can be sourced domestically.

Propane Liquefied Petrol Gas (LPG): Propane is a byproduct of natural gas processing and oil refining. Vehicles can be converted to run on propane, which burns more cleanly than gasoline or diesel.

Synthetic Fuels: Also known as e-fuels or electro fuels, these are produced by using renewable energy sources to generate hydrogen, which is then combined with carbon dioxide captured from the air. The resulting synthetic fuels can be used in conventional internal combustion engines Lai, Liu, Sun, Zhang and Xu (2015).

Solar-Powered Vehicles: Solar energy can be harnessed to power electric vehicles. While fully solar-powered cars might be limited by available space for solar panels, solar-assist systems can extend the range of electric vehicles.

Kinetic Energy Recovery Systems (KERS): These systems capture and store energy braking or deceleration, then use it to assist the vehicle during acceleration. KERS can be employed in combination with other power sources.

Hybrid Vehicles: Hybrid Vehicles combine an internal combustion engine with an electric motor and battery. They can run gasoline or a combination of gasoline and electricity.

Plug-in Hybrid Vehicles (PHEVs): PHEVs are hybrids with larger batteries that can be charged from an external power source. They can run on electric power for shorter distances and rely on gasoline or alternative fuels for longer trips.

Range, availability to recharging infrastructure, affordability, and vehicle performance are among the factors that have been recognized as essential for the effective adoption of alternative fuel technologies (Lai et al, 2015; Sierzchula, Bakker, Maat, & Van, 2014; Singh et al., 2020; Statharas, Moysoglou, Siskos, Zazias, & Capros, 2019; Zhou et al, 2019). Range is seen as a crucial aspect, particularly for Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV), since buyers are worried about the car's capacity to go long distances before needing to recharge. Access to recharging infrastructure is crucial, since customers must have faith that they can find charging stations when they need to refuel their cars. The price of alternative fuel cars is viewed as one of the biggest obstacles to their acceptance. Different fuel substitutes must be taken into consideration for transportation businesses to break even, weighing the benefits and drawbacks associated with each solution. Additionally, it may boost the cars' economy and enhance transportation sustainability (Alp, Tan, & Udenio, 2022; Backhaus, 2022).

Financial Incentives Policy for Gas Fuels Adoption

There may be financial incentives for the fuels themselves or the vehicles that can use them. The primary tool used by the nations evaluated for this research to encourage vehicle gas can be a reduction in excise duty, a total exemption from sales tax, or both. On occasion, a tax credit for fuel may be given to commercial vehicles. By adopting these actions, the cost of running an Alternative Fuel Vehicle (AFV) is directly cheaper than that of a gasoline or diesel vehicle, which reduces the payback period for converting or acquiring an AFV. Differences in excise duty are particularly evident since they affect pricing at the pump, making people aware of the possible financial benefits from utilizing alternative fuels Morgan (2017).

Morgan (2017), suggest the following key reasons why a transportation company should consider using CNG:

Cost savings: CNG generally costs less than traditional fuels like gasoline or diesel. By switching to CNG, transportation companies can significantly reduce their fuel expenses, which can have a positive impact on their overall operating costs. This cost advantage can make the company more competitive by offering more

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

competitive pricing to customers.

Environmental Sustainability: CNG is considered a cleaner-burning fuel compared to gasoline or diesel. It produces fewer greenhouse emissions, reduces air pollution, and improves local air quality. As sustainability becomes increasingly important to consumers and regulators, transportation companies that prioritize environmentally friendly practices can gain a competitive edge by attracting environmentally conscious customers and complying with stricter emission regulations.

Government Incentives: Many governments and regulatory bodies provide incentives and tax breaks for companies that adopt cleaner fuel technologies such as CNG. By taking advantage of these incentives, transportation companies can reduce their operational costs further and gain a competitive advantage over companies that have not embraced cleaner fuel options.

Access to restricted areas: In certain urban areas, there may be restrictions on vehicles that run on conventional fuels due to pollution concerns. By using CNG-powered vehicles. Transportation companies can access these restricted zones, providing them with more business opportunities and expanding their reach.

Long-term fuel price stability: CNG prices are generally more stable compared to gasoline or diesel prices, which are subject fluctuations in global oil markets. This stability allows transportation companies to have better predictability in their fuel costs, making it easier to plan and budget for the future.

Technological Advancements: The technology for CNG-powered vehicles has advanced significantly, providing greater efficiency and performance. Modern CNG engines can offer similar power and torque to their conventional counterparts, ensuring that transportation companies do not compromise on performance while enjoying the benefits of CNG.

By embracing CNG as a fuel source, a transportation company can demonstrate its commitment to cost efficiency, environmental sustainability, and staying ahead of market trends. These factors can contribute to improved competitiveness in the industry, by attracting customers, reducing operating cost, and complying with regulatory requirements World Liquefied Petroleum and Gas Association (WLPGA, 2014).

Benefits of Gas Fuels on the Vehicle and Environment

When LPG is the only fuel utilized, there are some durable benefits over gasoline, according to experience. Engine life is said to be generally 50% longer as a result of reduced cylinder bore wear at cold starting since LPG does not wash oil from the cylinder walls and the lubricating oil has a longer effective life owing to nearly absolute lack of dilution. While deposits in the combustion chamber and on the spark plugs are reduced, the lifespan of the spark plugs is not always increased. The durability of the exhaust system is improved while running only on LPG fuel. Additionally, because to its basic chemical make-up, LPG burns more thoroughly, resulting in fewer environmental emissions of CO and HC (WLPGA, 2014).

Benefits of Gas Fuels to Nigeria as Country with Natural Gas Endowment

Nigeria may use its own natural gas supplies instead of foreign oil to reduce import prices and strengthen the nation's balance of payments. This is because using local natural gas as a form of transportation might help Nigeria's current account balance. The total FOREX committed to imports in the country from 2013 to 2017 was $119.409 billion, according to data from Central Business Nigeria (CBN), and the total FOREX committed to imports in the oil sector was $36.371 billion, or about 13.5% of all imports made by the nation.

Conditions for CNG fleet Conversion

Converting vehicles to run on compressed natural gas (CNG) involves modifying the vehicle’s fuel system to accommodate CNG as a fuel source. CNG is a cleaner-burning alternative to gasoline or diesel, and it can offer cost savings and reduced emissions (WLPGA, 2015). However, there are certain conditions and considerations that need to be met for a successful CNG conversion:

Vehicle Compatibility: Not all vehicles can be easily converted to run on CNG. Typically, vehicles with gasoline engines are more suitable for CNG conversion compared to diesel engines. Modern fuel-injected vehicles are usually better candidates for conversion than older carbureted vehicles.

Certification and Regulation: Ensure that CNG conversions are complaint with local and national regulations. Some regions have specific requirements and standards for CNG conversions to ensure safety and environmental standards are met.

Qualified Conversion Kits: Use certified and approved CNG conversion kits. These kits include components like CNG storage cylinders, regulators, injectors, and control systems Efforts are to ensure that conversion kit is designed for your specific vehicle make and model.

Professional Installation: CNG conversions should only be performed by trained and certified professionals. A professional mechanic or conversion shop with experience in CNG conversions should carry out the installation to ensure safety and proper functioning (WLPGA, 2015).

Fuel System Modification: The vehicle's fuel system needs to be modified to accommodate CNG. This includes adding CNG storage cylinders (typically mounted in the trunk or bed of the vehicle), a high-pressure regulator, and injectors that can deliver CNG to the engine.

Emission Control: CNG conversions should maintain or improve emissions performance compared to the original gasoline system. Properly calibrated and functioning emissions control systems are essential to meet environmental standards.

Performance and Power Considerations: CNG has a lower energy content compared to gasoline, which can result in a decrease in power and range. Vehicle performance might be slightly affected, so its important to manage expectations.

Maintenance: CNG systems require regular maintenance to ensure safety and optimal performance. This includes periodic inspections of the CNG components, such as cylinders, regulators, and injectors.

Safety Precautions: CNG is stored under high pressure, so safety precautions are paramount. Proper installation, regular maintenance, and adherence to safety guidelines are critical to prevent accidents.

Fuel Availability: Consider the availability of CNG refueling stations in your area. CNG refueling infrastructure might be limited, so its important to ensure you have access to fuel before converting your vehicle.

Cost Analysis: Evaluate the costs of CNG conversion, including the price of the conversion kit, installation, potential decrease in performance, and fuel savings over time. Determine whether the investment aligns with your needs and budget.

Before proceeding with a CNG conversion, its recommended to consult with experts in the field, gather information from reliable sources, and thoroughly assess the feasibility and benefits of the conversion for your specific vehicle and circumstances.

History of CNG fleet conversion and adoption in Nigeria Transport Sector

Compressed natural gas (CNG) is being employed in automotive transportation in countries like Italy, France, New Zealand, Canada, the United States of America, Russia, etc., according to Oghenejohoh and Akpabio (2023). The 1950s saw the beginning of early CNG transportation tests in Russia. With the implementation of intricate programs to guarantee the establishment of a network for the delivery of CNG to vehicles, interest was renewed in the 1980s. As part of its efforts to exploit natural gas (NG) resources, the Nigerian government proposed using compressed natural gas (CNG) as a vehicle fuel in 1997. However, development has been slow Olufemi (2015).

Over liquid fuels, compressed natural gas (CNG) offers operational benefits. It combines well with air in an engine even when the temperature is low and does not require heat to vapourize. CNG also lessens issues with engine wear and exhaust pollutants.

The Nigerian Gas Company (NGC), a subsidiary of the Nigerian National Petroleum Corporation (NNPC), launched the Compressed Natural Gas (CNG) pilot scheme in 1989 to promote CNG as an automotive fuel as part of the company's efforts to promote natural gas utilization in the nation and increase the revenue base of the company Oghenejohoh and Akpabio (2023).

Presently, in the Nigerian transport sector, commercial transport company recently have started to adopt CNG as an alternative to fuel. God is Good mobility has been discovered the most technologically sophisticated road transport company in Nigeria. Although GIGM may not have the most cutting-edge technological systems, its utilization of technology across its activities much outpaces those of its rivals. GIG Mobility, the transport management system uses GIGM to handle many elements of its operations. However, frequent passengers know that GIGM keeps to schedule at least 80% of the time. The fleet can be tracked by GIG Mobility, which enables them to look into unexpected delays and take appropriate action. This reduces trip times and boosts the fleet's overall efficiency Oyeniyi (2016).

However, adoption of CNG in Nigeria has been discovered with the following drawbacks: A high rate of engine knocking in vehicles, lack of luggage room, expensive conversion, explosion propensity, a dearth of CNG stations Oyeniyi (2016).

History of GIG mobility in Nigeria

God is good motor now known as GIG mobility is a transportation company in Nigeria. It’s a popular intercity cum country transport service that provides bus services to various destinations across Nigeria and beyond. It was founded by Edwin Ajaere in 1998. The company started its operations with a focus on providing safe and reliable bus transportation services in Nigeria.

Over the years, GIG Mobility has grown to become of the leading intercity transportation companies in Nigeria. The company’s commitment to safety, comfort, and professionalism has contributed to its popularity among travelers. GIG mobility has expanded its network to cover numerous routes connecting major cities and towns across Nigeria Rafiu (2022).

One of the distinguishing features of GIG mobility is its adoption of technology to enhance customer experience. The company has implemented online booking platforms and mobile apps, allowing customers to book tickets, choose their seats, and track buses in real-time. This has made the booking process more convenient for travelers. GIG mobility boasts a modern fleet of buses that range from standard to luxury options, catering for different customer preferences. They offer various services such as express routes, shuttle services, and charter services. This diverse range of offerings has contributed to the company’s popularity.

Rafiu (2022) stated that GIG mobility has gained a strong reputation for its focus on safety, comfort and professionalism. The company’s name, which incorporates a positive message has also likely contributed to its brand recognition and popularity. It was found that by Rafiu (2022), that GIG mobility is the best private transport company in Nigeria and also highly technological driven in relation to other transport companies in Nigeria.

Theoretical Review

There are several theories and models that have been developed to address the question of when to replace equipment. These theories provide different perspectives and methodologies for determining the optimal timing for equipment replacement. Below are some of the prominent theories of equipment replacement:

Economic Life Cycle Theory

This theory suggests that equipment should be replaced when the sum of its operating and maintenance costs becomes greater than the costs of replacement. It aims to find the point where the total cost, including acquisition, operation, maintenance, and disposal, is minimized over the equipment's life cycle. Hartman and Tan (2014) opines that the total of all possible expenditures that may be incurred with the equipment over the course of its lifespan (including the cost of purchase and the total cost of ownership) is used to calculate the life cycle cost of a piece of equipment. Because of the notion of declining money value in the "time value of money," it is well known that the cost of a spending today is higher than the cost of an expenditure next year. In order to take into consideration the time worth of money in this study, a discount rate was applied. We must move these expenditures to a point in time that serves as a baseline in order to compare costs incurred at various dates. In order to assess the present value of the expenses for the case study, the discount rate factor was taken into account. Through the lens of their repair limit theory, Drinkwater and Hastings (1967) offer an alternative perspective on the economic replacement decision dilemma. The life-cycle costing (LCC) study takes into account every expense related to the use of an item. In light of this, equation (2.1) is suggested in this article to determine the life cycle cost of earthmoving equipment Pedram, Mehdi, and Saheed (2016). The goal of this model is to calculate the cost of construction equipment during its lifetime. As a result, the life cycle cost of earthmoving equipment is represented as follows:

$$\boldsymbol{LCCe = VAC + TC + IOC + IC + FC + MCC + RC + GOC + TC + DTC + SCC} \quad (2.1)$$

Where: LCCe is the earth moving equipment life cycle cost.

VAC is the equipment acquisition cost.

TC is the tire cost.

IOC is the cost of intermediate overhauls.

LC is the lubricant cost.

FC is the fuel cost.

MCC is the cost of maintenance and checkup.

RC is the repair cost.

GOC is the cost of general overhauls.

TC is the tax DTC is the downtime cost.

SCC is the cost of sleep capital.

When determining the economic life of capital equipment, there are two main conflicts to consider according to Pedram et al (2016): (1) The aged asset's rising operational and maintenance expenses.

(2) The decreasing ownership cost of maintaining the equipment in use as the initial capital cost is deducted over a longer period of time. The economic life model calculates the dollar cost as a result of an endless series of replacements or modifications during the first N cycles. It is helpful to convert the entire discounted expenses related to the economic life to an Equivalent Annual Cost (EAC), which is represented in the equation (2.1) in order to make the comprehension of this total discounted cost easier (Campbell and Jardine 2001).

$$EAC(n) = \frac{A + \sum_{i=0}^{n} C_i r^i - S_n r^n}{1 - r^n} \times i \quad (2.2)$$

where A=Acquisition cost

C_i=O & M costs of equipment in its ith year of life, assuming payable at the start of year

i=1, 2, . . ., n

r=Discount factor

S_n=Resale value of equipment of age n years

n=Replacement age

C(n)=Total discounted cost for a chain of replacements every n years

Age-based Replacement Model

In this approach, equipment is replaced based on its age, often using a predetermined replacement age. This theory assumes that equipment becomes less reliable and more costly to maintain as its ages. Replacement decisions are made to avoid increased maintenance costs and potential failures. Comparing multi-component systems to single-unit systems, the research of age replacement plans is more difficult. This is because, at the moment of replacement, a number of still-functioning components might exist. To calculate the replacement costs, it is important to know the expected value of the random variable known as the number of non-failed components. In other words, the age replacement issue for a system with several components requires additional derivations and analysis. When the components' lives are continually distributed, age replacement strategies for multi-component systems have lately been studied. For parallel and series systems with dependent components, Safaei (2020) investigated age replacement policies for equipment and found it reliable.

Condition-based Maintenance (CBM) Theory

This revolves around monitoring the condition of equipment using various sensors and techniques. Replacement decisions are based on the equipment's actual condition rather than a predetermined schedule. When the monitored condition indicates a significant decline in performance or potential failure, replacement is initiated. The key to CBM is carrying out preventive maintenance tasks before faults happen while continuing to utilize the product. But creating monitoring and maintenance solutions based on real-time sensor data is quite difficult. Failures that are detectable by one or more indications are dealt with by CBM. Cadick, Gabrielle, Traugott and John (2009). In a CBM environment, maintenance efforts (people, processes, and tools) are applied based on the actual condition of the equipment rather than its age, so equipment in good condition does not require as frequent maintenance as equipment that has reached the predicted age of deterioration. Utilizing test tools or statistical modeling of data to foretell equipment status is the foundation of CBM Cadick et al (2009).

Technology Obsolescence Theory

This theory focuses on replacing equipment when newer technologies offer significant improvements in efficiency, performance, or cost-effectiveness. The decision is based on the idea that holding onto outdated equipment may lead to competitive disadvantage or increased operational costs.

Optimization Models

Optimization techniques, such as linear programming, dynamic programming, and simulation, can be employed to find the optimal replacement strategy considering multiple variables, constraints, and objectives. Even though the problem is categorized as a complicated system, using the optimization model is a straightforward and simple process for solving many problems. Additionally, dynamic programming's division of the system into successive stages makes the issue much simpler, clearer, understandable, and controllable. This technique was solved using Microsoft Excel, a well utilized piece of classic PC software. This makes it possible for many non-technical people interested in environmental policies to handle such issues with ease (Alaa, 2009).

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

Achieving the global optimum for each stage of the model is ensured by using linear programming to find the best solution at each level. When the alternatives of the streamlined method are established, a sensitivity analysis is immediately created. Each option provides the best values for the many factors linked to the lowest prices.

Repair Limit Theory

The 1960s saw the debut of repair limit theory. The concepts of "defender" and "challenger" are used to describe repair limit theory. According to Terborgh (1949), the defender is the equipment that the corporation is now using, and the challenger is new equipment that might perform the same function as the defender. A capital good reaches the end of its maximal physical life when repair becomes physically impossible, according to Ahmed (1973). Furthermore, "the maximum economic life of any equipment may be defined as ending when its repair cost exceeds its replacement cost"; as a result, the equipment replacement problem aims to achieve the equipment's optimal economic life. Mitchell (1998) described the repair limit as a cap on the quantity of repairs that may be made to the repair limit is a cap on the quantity.

Replacement Models

In most of the models found in the literature and proposed to companies, the criteria for reform/replacement are mainly of an economic nature; very few use environmental or technological criteria. Obviously, construction equipment (subject of this research project) cannot be isolated from this generality even if the environment and technological progress must be better taken into account in the choices (decisions) of reform and/or renewal Ricardo (2017). It is useful to remember that in any construction company, the department in charge of equipment is responsible for the "health" of each piece of equipment throughout its useful life cycle, from acceptance through to its aging period and downgrading. He is also responsible for controlling the expenses relating to the possession of each piece of equipment. This is how a certain number of questions will successively arise and may influence the reform policy:

What is the expected durability of the equipment? When does this hardware provide maximum operating gain? When maintenance actions should be stopped by stopping "therapeutic relentlessness" on this equipment? When should it be reformed (downgraded)? What is the resale value of the equipment? Alternatively, conversely, what is the cost of scrapping or dismantling? Should it be replaced identically or with new generation equipment? Should it be renovated?

These questions are essential for the equipment manager when it comes to addressing the technical and economic dimension of the reform models to be proposed. We have already seen that, of all the criteria discussed, the optimal lifespan is the most used in the literature. Which is completely understandable since the vocation of a company is above all to obtain profit. This is (of): The minimization of the life cycle cost (LCC) taking into account the evolution of the silver rate for classic¬ construction equipment (> 10 years). In this case, Ricardo (2017) opines that, it is a question of summoning the equations respectively:

$^{\theta}t = {}^{y}/_{t}$ where y = cumulative cost of equipment of age t

$$\frac{Cr + Cr\ f(t)}{Vra(t)} < {}^{\theta} \qquad \text{decision in favour of compensation}$$

$$\frac{Cr0 + Crf\ (t)}{Vra\ (t)} = {}^{\theta}$$

decision favourable to the reform and Cro (t) representing the equipment repair limit at time t

Technological evolution weighs less in decommissioning/replacement decisions. It is a criterion which, if taken into account, is because it influences the performance of the equipment. In this case, it is difficult not to link the replacement to the economic aspect of the decision-making. This reflection is also valid for the environmental criterion of the reform decision. Indeed, the company is pushed to the decision of replacement

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

for "environmental" reasons when its profit is threatened by possible surcharges, as is the case in certain current projects. Minimization of the average annual maintenance cost (Cma) by using equations Galvis (2014) and Blank (2005). The annual value method developed with the equivalent uniform annual cost (CAUE) minimization.

The equation Ricardo (2017) known as the Blank and Tarquin formula makes it possible to obtain the economic service life (ESL) which, minimized, leads to the optimal replacement time. From the replacement model of Ricardo where the month is used as the period in the studies unlike the others which use the year. The advantage of the work of Ricardo (2017) is its easy adaptation to equipment with relatively short lifetimes such as small equipment. Equation Fraser (2000) is invoked to illustrate this method. The repair cost limit is also an interesting criterion used by Drinkwater (1967). to propose a fairly practical method. The latter succeeded in proving the advantages of their method with respect to the criterion of the limit of life. Indeed, the equipment is downgraded because of the repair costs, which increase considerably with age relations Lussier (1961), Tufts (1982) and Drinkwater (1967).

Equipment replacement methods

The replacement method of Ricardo (2017). Contrary to many works encountered in the literature Fraser (2000) and Jardine (2017) where studies of replacement and reform of equipment use the year as a period, Ricardo (2017) and his collaborators find that the month is the most appropriate Lussier (1961) and Tufts (1982). Indeed, using the year as a period could be too broad for some, such as the category "small construction equipment" for example. The mathematical model was built on the work of Tufts (1982) who proposed an approach based on a solid theory of investment. This model supports decision making on replacement age, but can also be used to make a decision where the options are either to replace, repair, or choose from different machine options. Working capital and risk premiums are included in the model proposed by Ricardo (2017); this model will help determine the optimal replacement period, as the following equation describes:

$$n = max\left(MCRF_n\left[H_0 - \sum_{i=1}^{k} PP_i\,(i) + (MV_n - TX_n - LB_k) + \sum_{i=1}^{n} \quad NOPAT1.P(i)\right]\right)$$

Fraser (2000)

With

n = Optimal replacement period (months); 1≤ n ≤ N

MCRFn = Monthly Capital Recovery Factor

H0 = Initial investment during period zero

K = Number of loan installments

PP_i = Principal repayment in period i

P(i) = Monthly discount factor

MVn = Expected market value of the asset in period n

LBk = Loan balance at the end of period k

NOPATi = Net operating income after tax for period i

In this model, the company buys the equipment using a mix of debt and equity. Debt will be assumed to have an annual percentage interest rate, while equity will be hedged using an expected minimum acceptable rate of return. Thus, the model is designed to determine a period during which the replacement maximizes the benefits generated by the equipment.

The Annual Value Method

The annual value method With this method developed by Blank (2005), the economic lifetime of an item of equipment is the number of years n, during which the equivalent annual uniform cost Blank (2005). Engineering is a minimum, taking into account the most recent cost estimates over all possible years of asset lives. One methodology to approach this analysis is to acquire data from as many pieces of equipment (of the same type) as possible and obtain the averages for these expenses. To do this, a linear regression model can be used to determine for each component the costs expected over the number of years of life of the equipment. This way of approaching the problem considers the age of the hardware as the independent variable. Another linear regression can be used to determine the expected number of failures per period of year n. Again, the age of the equipment is taken as the independent variable. For the specific case of opportunity cost due to catastrophic failure, it can be calculated based on the probability of catastrophic failure. If we consider that the age of equipment follows a normal distribution with a given mean and standard deviation, the cumulative probability of catastrophic failure will increase with age. To find the minimum useful life cost, one increases the useful life value, called k, from 1 to the maximum expected value for the asset N, i.e., k = 1,2, 3, …N For each value of k,

The CAUEk value is calculated using the following formula from

$$CAUE_k = P(A/P\,, i\%. k - VS_k(A/F), i\%, k) + \left[\sum_{i=1}^{k} \quad CAOj(P/F, i\%, j)\right](A/P\,, i\%k) \qquad \text{(Blank, 2005)}$$

Where VS_k

CAOj : annual operating cost during year j (j = 1, 2, ...,k)

The following must be transformed into annual values for each number of years, the equipment is studied, for an interest rate i:

The cost of acquiring the equipment Operation and maintenance costs (major maintenance cost, opportunity cost, opportunity cost for catastrophic failure)

The salvage value at year n

The salvage value at the end

These expenditures in annual value will then be added together to obtain a value of the CAO annual operating cost for each year.

The annual capital recovery value must then be added to the CAO to obtain the Economic Service Life (ESL). The optimal replacement time would be when the ESL is at a minimum.

NB: Any cost that does not change with the age of the equipment (such as the cost of labor in certain special cases) should not be included in the calculation.

Grant’s Model (1950)

The Terborgh cost reduction model was streamlined by Grant (1950). He talks statistically about the issues of when to replace outdated equipment due to inadequacy, unnecessary maintenance, obsolescence, and deteriorating efficiency. He provides methodologies for studying and addressing the economic replacement problem when management is confronted with any one of the following three constraints:

(i) When a piece of equipment that is more efficient is introduced before the old one is replaced.

(ii) When the cost of goods remains constant across their useful lives

(iii) When the equipment's yearly running expenses aren't declining.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

Dean's Model (1951)

Dean (1951) put up a replacement strategy for equipment that is ideal. For the first time, one author specifically called for the corporation to make a capital investment in equipment replacement in order to compete with other investment options. In order to do this, he made the case that alternative capital investment options, whether they include the replacement of equipment or any other type of expenditure, should be evaluated using the return on investment. As a function of equipment age, the total cost of current equipment is calculated as the sum of applicable operating expenses and capital waste costs. When the total cost is equal to the average yearly cost of the new equipment plus the annual return on the capital investment for the new equipment minus one, replacement takes place.

Empirical Review

Hossam et al. (2023) looked at the relative weight of the many variables affecting the resale value of construction machinery. On average project expenses and the profit made from the usage of construction equipment were shown to be significantly impacted by equipment replacement laws. Equipment managers must properly predict the equipment's resale value in order to make the best decisions on equipment replacement. The aim of this study is to pinpoint the factors that influence construction equipment's resale value. These factors were ranked in order of how much of an impact they had on the equipment's resale value using statistical analysis and the analytical hierarchy process (AHP).

A research on the creation of equipment replacement periods that took wear and tear and obsolescence into consideration was conducted by Lapkina and Malaksiano (2023). The study's goal is to create techniques for scheduling the best times to replace worn-out equipment with newer, more sophisticated equipment while taking into consideration the degree of variability in the potential values for equipment performance indicators. The following goals were met in order to complete the goal: to conduct a quantitative estimation of the level of uncertainty of performance indicators depending on the choice of the service life of old and new equipment, to justify the selection of equipment performance assessment criteria when switching to a new type of equipment, to determine a multi-criteria estimate of average values and degree.

Optimum replacement time for a deteriorating system was studied by Rani and Sukumari (2014). In the study, the preventive replacement technique for figuring out the best time to replace a component of an automobile system that degrades with time is presented and explored, while the component is nearing the end of its useful life. The optimal replacement time may be calculated since the failure time follows the Weibull distribution. This period reduces overall downtime and increases the percentage of time that each component of the system is operational. The study did not look into the factors that influence equipment degradation and replacement.

Wei, Randy, and Mason (2012) investigated "Equipment replacement optimization: dynamic programming used approach." The primary goals of this study were to give a deterministic dynamic programming (DPP) based optimization model formulation and to suggest the Bellman and Wagner methods to the equipment optimization (ERO) problem. With or without taking yearly budget concerns into account, the established solution approach may be utilized to determine the best keep/replacement choices for both new and used automobiles. To explain and walk through the Bellman DDP solution procedure, a straightforward numerical example was provided. This example showed how the DDP may be used to manually solve the cost reduction ERO problem via backward recursion. Using the most recent Texas Department of Transportation data, the created DDP-based ERO program was evaluated and verified.

According to Srinivasan, Francis, and Purushothaman (2014), gasoline will run out within a few years and will cost more money every day. The exhaust is a further issue with current fuel usage. The exhaust contains NO, CO, CO, SO, lead, and other particles that have a negative impact on human health and cause air pollution on a two-fold scale. In order to save money and protect the environment, it is crucial to use alternative fuels.

Natural gas, according to Ubani and Ikpaisong (2018), is a safe, clean-burning fuel that may minimize your gas station expenditures while simultaneously promoting environmental protection and reducing Nigeria's dependency on foreign oil. It is a naturally occurring mixture of gaseous hydrocarbon, non-gaseous non-hydrocarbons, and gaseous non-hydrocarbons that is present in subsurface reservoir rocks and may be found

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

either on its own (non-associated gas) or in association with crude oil (associated gas). Natural gas is currently regarded as one of the best energy sources for the world and the future since it is more environmentally friendly than other kinds of fossil fuels. Nigeria enjoys her top position as the most populous nation in Africa and the country with the seventh-highest natural gas reserves in the world.

In Nigeria, the following gas uses are now possible:

1. Gas to electricity and gas to reinjection systems
2. Petrochemicals using gas as a feedstock
3. Liquefied Natural Gas, or LNG
4. Liquid petroleum gas, or LPG
5. Compressed natural gas, or CNG.

The usage of Compressed Natural Gas (CNG) as vehicular fuel in Nigeria, according to Ubani and Ikpaisong (2018), offers a variety of advantages, with the economic benefit receiving special attention. CNG is made by compressing natural gas to a tenth of the volume that it takes up at regular atmospheric pressure. In order to calculate the cost savings from using CNG instead of PMS, a thorough economic study was conducted using the example of a driver who travels 100 km per day on average during the roughly 30 days that make up a month. The results showed that switching a car from PMS to CNG may save N1,143 per day and N34,290 per month. The expense of doing so is recouped before the end of the sixth month.

For instance, the International Energy Agency (IEA) proposed in May 2012 that global demand for natural gas could rise more than 50% by 2035, from 2010 levels. The Intergovernmental Panel on Climate Change (IPCC) states that in order to prevent drastic effects of global warming, global greenhouse gas (GHG) emissions must be cut by 50 to 80 percent by 2050. We need to develop every economically feasible energy source in order to fulfill the rising energy demand and reduce GHG emissions. We all know that no one energy source is sufficient to address the world's rising energy demands.

In the words of Ogunlowo (2016), a more varied energy mix is also necessary to provide energy security and combat climate change. We must create all feasible and ecologically responsible energy sources in order to meet this social need that is only going to increase over time. There is natural gas accessible to provide the world with a practical substitute because it is the cleanest fossil fuel. Its availability, dependability, adaptability, and quantity will all be important. The study comes to the conclusion that a number of obstacles have made it difficult for CNG to be used as a fuel for road transportation in Nigeria. This is supported by the case study's insights, the semi-structured interviews' participants' consistent responses, and the results of the Delphi survey. These factors are: Insufficient focus, unconducive energy market structure, limited access to funding, weak transportation market structure, weak institutions for vehicle standards enforcement and low level of public awareness.

In his 2005 study, Redner looked at freight transportation firms' vehicle replacement planning. The strategy for establishing the best replacement policy for the vehicles used by a freight transportation business is presented in this article. The equipment replacement cost minimization model is used in the investigation.

The study took into account the utilization intensity (annual mileage) of vehicles in consecutive years of their operational lives, the technical durability of vehicles (such as maximum mileage), as well as various methods of financing the fleet investments (buying with cash, renting, or leasing), in order to apply the minimal average cost replacement policy to the vehicles whose utilization intensity decreases over time. The issue was stated in terms of one criterion, which was linear, deterministic, and

Statistical quality control (SQC) and partly observable Markov decision processes (POMDP) were combined by Ivy and Nembhard (2005) for use in determining maintenance decisions for failing systems. They defined the observed distribution for the POMDP modeling in their study by using SQC to a sample of a real-world system. In their study, simulation approach was used to combine SQC and POMDP to generate and evaluate maintenance policies in relation to process features, system operating costs, and maintenance expenses.

In their study on "Development of vehicle replacement programme for a road transport company," Offiong, Akpan, and Ufot (2013) covered a workable replacement strategy for a transport company. To identify an

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

appropriate replacement interval for different groups of vehicles, an annual maintenance schedule and depreciation costs were developed, and a replacement model that takes the value of money into account was implemented. For the purpose of establishing fair prices that allow for a profit margin and a successful vehicle replacement program, a fare model was developed. According to the data, the planning horizon is indefinite and the replacement model implies that the firm under study replaces cars with similar vehicles. With an identical vehicle and an indefinite planning horizon, a vehicle may be replaced at any age.

In their 2014 study, Ajibade, Odusina, Rafiu, Ayanrinde, Adeleke, and Babarinde looked at the application of the replacement model to decide when to replace aging industrial equipment. They tried to pinpoint the precise moment that instrument replacement is most cost-effective. The information utilized in the article is all about the price of repairing a 250 KVA Mikano generating plant, which was created by the works and services department of the Polytechnic of Ibadan's Adeseun Ogundoyin campus in Eruwa. The replacement model accounts for objects whose maintenance costs rise with time while ignoring variations in the value of money over the research period. The decision variable, or average equipment cost, was manually calculated. According to the analysis's findings, by the fifth year.

The impact of degradation on resale value was examined by Ekeocha, Odukwe, and Aguwamba in 2011. Front-end loaders, CAT 140H motor graders, capsule fillers, injection mover machines, Mercedes Benz express buses, and Hiace minibuses all had maintenance expenses and salvage values that were recorded. Using the Monte Carlo simulation with the uniform probability distribution, values of degradation were produced as random numbers. The procedure of dynamic programming enumeration was used as a solution strategy. Field data from several industries were used to validate the model's outputs once it had been calibrated. Finally, the model's output was contrasted with output from other models. Basically, the findings indicate that, for construction machinery, the ideal replacement days are between 4 and 6 years, and 16 and 20 years, when corrective maintenance is performed regularly and on schedule.

The ideal lifestyle limit for a fleet of freight vehicles is derived by Redmer (2005) and exhibits declining use as equipment ages and stable utilization levels within age classes. His methodology is founded on Eil's LCCA strategy.

Buddhakulsomsiri and Parthandee (2006) published a second research that emphasizes the value of lowering equipment use over equipment age. Their approach is based on Hartman (1999). Utilization in Hartman's model is defined as a decision variable, however it is not in the research of Buddhakulsomsiri and Parthandee (2006). Utilization is a model parameter since it is expected that utilization for each age class is constant. The usage level assumptions stated by Redmer (2005) and Buddhakulsomsiri and Parthandee (2006) are the same. Furthermore, decreased consumption may result from a dependent use pattern, according to Buddhakulsomsiri and Parthandee (2006). "Since there are numerous vehicles that can provide the same service or fulfill the same purpose, it is the newer ones that are more effective." Given the rapid development, many studies have attempted to understand reasons why alternative to fuel energy should be considered. Alternative to fuel adoption include CNG, BEV etc. Fleet managers should consider these options for social, economic and environmental impact the decisions hold Zhenhus, Andre, Christiana, & Wei, (2022).

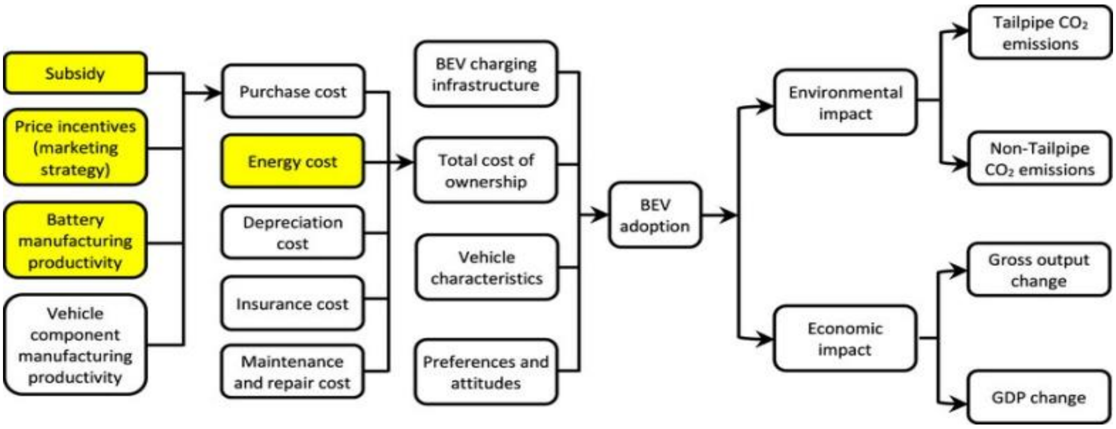

Figure 1: Adoption of BEV as an alternative to fuel.
Zhenhus, et. al. (2022).

Research Gap

While there has been significant research conducted on vehicle fleet management and equipment replacement strategies, there are still several research gaps that exist when it comes to identifying the optimum equipment replacement of vehicle fleet. For instance Inegbedion & Osifo (2014) conducted a research on overloading and replacement of vehicle fleets of commercial transport companies in Nigeria. Another research on this area of study include Aghedo & Inegbedion (2015), who emphasized overloading as a major constraints for vehicle replacement time. However, overloading is not sufficient to be a major constraints any longer as a result of fuel subsidy removal, and with fuel now accounting for a major percentage of vehicle operating expenses in Nigeria.

This study, seek to find an optimum replacement for vehicle fleet taking into consideration cost of fuel and possible alternatives transport companies can adopt other than vehicle using fuel for energy. The transport sector in Nigeria plays a pivotal role in the country's economic development by facilitating the movement of goods and people. However, the sector faces multifaceted challenges that impact its efficiency and sustainability. Two critical factors, overloading and fuel cost, have historically posed significant constraints on the operation of vehicle fleets within the sector. While overloading has been a formal constraint in many of the research conducted in the transport sector, due to safety concerns and road deterioration Inegbedion & Osifo (2014), the recent removal of fuel subsidies in Nigeria has introduced a new dimension, making fuel costs a crucial consideration in fleet management decisions. Hence, this research work aims to arrive at an efficient fleet management strategy given the increment in fuel cost and possible alternatives to ensure transport company break-even.

Also, the study extends the scope of other research beyond the traditional routes, Benin-Lagos, Benin-Port Harcourt, and Benin-Abuja. This research has the potential to contribute to a more comprehensive understanding of trade and transportation dynamics in West Africa. By examining routes that have received less attention, Ghana, specifically focuses on the less explored routes connecting these two nations.

Furthermore, previous research in this area of study has used data from God is good motor as a case study from 2009 to 2013. This study accessed the same data set from 2009 to 2022. This is to ensure a more comprehensive analysis and to take advantage of data availability, validation, robustness, and generalizability of previous research findings.

METHODOLOGICAL REVIEW

The type of model was based on the criteria established in advance, the best known of which are based on the lifespan of the equipment and the repair costs Kriett (2009). Most of these models consider economic or financial criteria Dietz (2001). They are effective for any business that is aiming for a particular criterion. They are very precise and give equipment managers specific leads on specific problems related to renewal. Although they lead to very relevant results in terms of contributions to lowering costs or increasing profits, they do not take into account other variables involved, such as the environment and technology. The models of Sarache, Castrillon, Gonzales and Viveros (2009) had better take into account the realities of the company.

Modelling equipment replacement is necessitude by the deteriorating nature of most equipment. This deteriorating nature precipitates downtime and failure rates of equipment with age. This explains why some of the equipment replacement models are consistent with modeling of equipment's time to failure. Rani and Sukumari (2014) used Weibull distribution to show the failure rate of a deteriorating system which is the basic characteristics of most equipment. The Weibull distribution gives the distribution of lifetimes of objects. Such a distribution helps to explain or give some hint on the reliability of equipment with time.

Most of the previous studies on equipment replacement either modeled equipment replacement as a stochastic process or as a Markovian deterioration or using Bayesian Inference. Others utilized forecast horizons or network simulation models; while majority of the studies used dynamic programming techniques. The preference for dynamic programming is underscored by its ability to generate greater alternatives at the point of decision making than any other method (Arvore, 2005).

Bellman (1955) first considers that there are two potential courses of action at each time t before constructing a dynamic programming model for replacing equipment. Either a machine is preserved for a longer amount of time or it is replaced with a machine that was purchased. In the case that the machine is retained, f(t) = f_k (t), where: He defines f(t) as the total returns from a machine of age t, using an optimum replacement policy.

$$f_k(t) = r(t) - u(t) + af(t+1) \qquad (2.1)$$

For an output-return function r (t), maintenance cost function u (t), and discount factor a.

In the second case, $f(t) = f_k(t)$, where:

$$f_p(t) = s(t) - P + r(0) - u(0) + af(1) \qquad (2.2)$$

With salvage value function s(t) and acquisition cost p, hence the expression for f is:

$$F(t) = max[r(t) - u(t) + af(t+1), s(t) - P + r(0) - u(0) + af(1)] \qquad (2.3)$$

$0 \leq t$

The value, t_0, that maximizes f is found by means of a successful substitution in an expression involving r(t), u(t), p, and a. Bellman also presented extensions of dynamic programming technique to the problems of replacement of average machines and technological improvement. For the over-aged machine whose age (T) is greater than t_0, is modified to obtain maximization for $T \leq t$.

Equation (3) is for maximization problem. A variant of this equation is the cost minimization equivalent given by:

$$f_n(t) = min\{C_n(x) + f_{n-1}(t - x_n) : xin\{1,2,3,...,\}, t = 0,1,2,3,...,T : t - x_n \geq 0\} \qquad (2.4)$$

Where:

C (x) = cost of equipment from year 1 to year x (Sniedovich, 2002).

The Net Costs of owing equipment over x years are given as follows:

$$C_n(x) = C_p + \sum_1^x \quad M_i + \sum_0^x \quad R_i - S_i \qquad (2.5)$$

Because determining the unknown function V—the value function—is required to solve the Bellman equation, it is categorized as a functional equation. Remember that the value function, as a function of the state x, describes the greatest feasible value of the aim. The function a(x) that characterizes the ideal course of action as a function of the state is known as the policy function, and it may be discovered by computing the value function. The value function and policy function, respectively, are the functions that explain the optimal value as a function of the state and the ideal action as a function of the state. The notion of optimality, according to which subsequent decisions always form an optimal strategy for the states emerging from the original decision, regardless of the beginning state and the initial decision, is the core strength of Bellman's model. As a result, a complicated problem may be divided into simpler problems and solved one at a time. As a result, we gain the value function—also known as the policy function—that specifies the greatest potential value of the aim as a function of the state. Because it provides a considerably wider variety of options than the conventional approaches at the time of decision-making, the Bellman's model has an advantage over other models (Arvore, 2005). To examine the short run and the long run relationship between gasoline subsidized price and transport sector, this research employed the co-integration and Error Correction Methodology (ECM). The Co-integration approach provides information about the long run relationship between the variables while the Error Correction Method (ECM) provides information about the short-run relationship between the variables. The error correction term provides information on the speed of adjustment from the short run disequilibrium to the long run equilibrium in the event of any deviations from the long run equilibrium (Arvore, 2005).

Value Iteration Method

In simple form, the value iteration Function in Dynamic Programming Model is given by the Bellman equation:

$$F_n(Q) = Max[f_n x_n + f_{n-1}(Q - X_n)] \quad (2.6)$$

This equation (6) is for a maximization problem. For minimization problem, the value iteration function is given by:

$$F(t) = min[C(x) + f(t - x)] : x\{1,2,3,...,k\} fort = 1,2,3,...,T. k \leq T \quad (2.7)$$

Equation (6) and (7) are variants of equation (3) and (4).

METHODOLOGY

Introduction

Basically, the study sought to investigate the optimum replacement time of vehicle fleets with cost of fuel constraints of the best private commercial transport company in Nigeria. GIG mobility located in Benin- City. Edo State.

The study is consistent with the goal of the replacement theory for deteriorating items, which seeks to replace equipment or equipment parts in a manner that minimizes economic loss. It confines itself to the cost model of equipment replacement. The operation of the best private transport company in Nigeria GIG mobility for the period of 2009 – 2022 was chosen for the study. The focus was on some vehicles plying three main routes (Benin-Lagos, Benin- Abuja, and Benin - Port –Harcourt

Research Design

The research design is mixed, being a combination of a field survey of interstate transport companies in Benin City and a longitudinal study of vehicle fleets of a randomly selected transport company in Benin-City, Nigeria. The vehicles consisted of Toyota Hummer buses with a carrying capacity of fourteen passengers each, plying three major routes in Nigeria: Benin-Lagos, Benin-Port Harcourt and Benin-Abuja.

Population of the Study

The population of the study include all inter - state transport companies in Nigeria. The vehicles consisted of Toyota Hummer buses with a carrying capacity of fourteen passengers each, plying three major routes in Nigeria namely Benin- Lagos, Benin- Port-Harcourt, and Benin to Abuja.

Sample and Sampling Technique of the Study

To capture the nitty-gritty of the objective of the study, Multi-stage sampling technique was adopted. Firstly, Benin City was randomly chosen out of the thirty six (36) state capitals and the Federal Territory, next the sampling frame of the interstate transport companies in Benin City was obtained from a field survey (see table 3.1). Thereafter, simple random sampling (lottery method) was used to select God is Good Motors Company (GIG mobility). GIG is renowned for providing quick and safe services. The organization is recognized to operate a transport business, which considerably complements its logistics activities. They also have extremely effective transportation facilities (Rafiu, 2022). The GIG mobility which was formerly referred to as God is good motors ply Benin-Lagos, Benin-Port Harcourt, Benin-Abuja, Benin –Bayelsa, Benin – Ekpoma, Benin - Umuahia. However, three routes were studied. Simple random sampling (lottery method) was used to select these three routes – Benin – Lagos, Benin-Port Harcourt, Benin-Abuja.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

Table 3.1 List of Major Interstate Transport Companies in Benin City

S/N	TRANSPORT COMPANY	S/N	TRANSPORT COMPANY
1	Ameosa Line	2.	Assoicated Bus Company Limited
3.	Chase Travels & Tour	4.	Greener Line Transport
5.	Big Joe Ventures Ltd	6.	Julglad Travels & Tours
7.	Muyi Line Transport	8.	Sefgetin
9.	Zumalex Nig. Enterprises	10.	Eco Bus
11.	Edegbe Line	12.	EFEX Executive
13.	Efosa Express	14.	Eke Line
15.	Kings Motor	16.	Faith Motors
17.	God's Time Motors	18.	God's speed Motors
19.	Iyare Motors	20.	Magorowa Motors
21.	Ohonba Line	22.	Osayame Line
23.	Ulo Motors	24.	Bob Izua Motors
25.	Faith Motors	26.	Continental Corporate Logistics
27.	Iyayi Brothers Nigeria Limited	28.	Amma Transport Sers. Ltd
29.	Edo Municipal Transport Service	30.	J.B.S Transport & Supply Company
31.	Takwas Inter Transport Company	32.	De Modern Motors
33.	Discoop Motors	34.	Edobor Line

Source: field survey, 2023

Sources of data

The data used in the study were primary and secondary sources. Primary data were obtained on the major interstate transport companies in Nigeria, GIG mobility from a field survey while the secondary data were obtained on the life cycle cost(purchase, running and operating cost) of buses from the private Transport Company under investigation.

Besides, This study investigates the connection between the Nigerian economy's transportation sector and gasoline price subsidies. The Nigeria National Petroleum Corporation (NNPC) statistics bulletin and Ismail et al. (2014) works provide information on gasoline subsidy prices. Additionally, information regarding the growth of the transportation industry was gleaned from Okezie et al. (2014).

Model Specification

The replacement models developed in several empirical studies (Ahmed, 1973; Arvore, 2005 ; Edward, 2008) hypothesize that vehicle replacement time is a function of total cost in the system.

The mathematical formulation of the vehicle replacement problem adapted from (Inegbedion, 2014) is given as:

Minimize $\sum_{j=1}^{L} C(X_j)$ (3.1)

Subject to $\sum_{j=1}^{L} X_j = T$ (3.2)

Where:

$C(X_j)$ =ne cost of owning equipment over T years; and

X_j = components of time periods.

According to the study's goal, the research's starting point was the value iteration function, which was followed by a sensitivity analysis of cost fluctuations brought on by environmental elements in the transportation system. The replacement models created in various empirical investigations (Ajibade, Odusina, Rafiu, Ayanrinde, Adeleke & Babarinde, 2014; Arvore, 2005; Edward, 2009; as well as Offiong, Akpan, & Ufot, 2013).

The model specifically hypothesizes that the total system vehicle costs are a function of vehicle replacement time. The Bellman equation (Bellman, 1955) describes the recursive value connection of the value iteration function of the dynamic programming model for a maximizing issue.

$$F_n(t) = Max\left(f_n x_n + f_{n-1}(t - x_n)\right) \quad (3.3)$$

The cost minimization equivalent of the equation

$$F_n(t) = min\{C(x_n) + f(t - x_i): xin\{1,2,3,\ldots,\} fort = 1,2,3,\ldots,T: t - x_i \geq 0\} \quad (3.4)$$

Where:

1. $F_n(t)$= minimum net cost over period of t years, given that we start with a new machine (t = 1, 2, 3…, T);
2. $C(X_n)$ = cost of keeping a vehicle for x years;
3. $F(t\text{-}x_n)$ = optimal cost of dealing with the remaining (t –x) years. That is, the cost of keeping a machine for (t – x) years after keeping for x years at a cost of C(x);
4. $F_{(0)} = 0$ and $f_{(1)} = C_{(1)}$

Net cost t(1) of keeping a vehicle at first period is equal to cost of keeping a vehicle C(1) F_n the first period f(1) = C(1)

Therefore, the net cost of owning equipment over T years is given as follows:

$$C_{(x_i)} = C_p + \sum_{i=1}^{n} M_i + \sum_{i=0}^{n} R_i - S \quad (3.5)$$

Equation (5) = $C^{n_1} M_i + \sum_0^n R_i + Cd$ since $C_p - S_i = C_d$ (3.6)

$C_{(x_i)} = \sum_{i=1}^{n} M_i + \sum_{i=0}^{n} R_i$- Cd as the new equation. (3.7)

Where:

$C_{(x)}$ = total cost (operating cost + depreciation cost);

C_p= cost of purchase of new equipment;

M_i = maintenance cost for a period of time;

R_i= running cost for a period of time;

Cd = Depreciation Cost;

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

S = Salvage Cost;

Dynamic programming model used to formulate the problem is with Typescript and JavaScript as the modeling language implementation platforms.

To examine the relationship between subsidized gasoline price and transport sector, this study adopted the multifactor neoclassical production function framework, the model is expressed as:

Tr = f (SPP, UPP, PQ) (3.9)

Where Tr = Transport sector's output

SP = subsidized petroleum price

UPP = unsubsidized petroleum price

PQ = PMS sales per litre

Specifying equation (3.9) in an exponential form, we have:

$$\mathbf{Tr = \lambda_o SPP^{\beta 1} UPP^{\beta 2} PQ^{\beta 3} e^{\varepsilon t}} \quad (3.10)$$

Linearizing equation (3.10),

$\ln Tr = \ln\lambda_o + \beta_1 \ln SPP + \beta_2 \ln SPP + \beta_3 \ln PQ + e_t$

Apriori expectation: $\beta_1, \beta_2, \beta_3 < 0$

In the road transportation sector, traffic flow and the resulting congestion are important sector output. It is significant because it has repercussions for the local and global economies upstream. Many of these effects, including easier access, increased goods movement, increased trade, and increased investment, are positive when traffic flow increases smoothly. There is a threshold, though, beyond which increased traffic flows start to exacerbate congestion. This has a different set of effects, including increased wear and tear on the vehicle that necessitates equipment replacement sooner (Mogarita, 2004), increased fuel consumption, increased travel time, and generated pollution. λo, is intercept, β_1 to β_3 are the slope of the coefficients of the independent variables to be determined where ε_t is the error term at time t. Equation (3.10) is the long run regression equation to obtain the long run relationship between the variables. In order to estimate the short-run relationship among variables in equation 3.10, the corresponding error correction equation is estimated as follows:

$$\Delta \ln Tr_t = \lambda_o + \sum_{i-1}^{m} \beta_1 \Delta \ln SPP_{t-i} + \sum_{i-1}^{n} \beta_2 \Delta \ln UPP_{t-i} + \sum_{i-1}^{p} \beta_3 \Delta \ln PQ_{t-i} + \alpha ECM_{t-1} + e_t \quad (3.11)$$

The ECMt-1 is the error correction term of the short run equation (3.12)

The ECM in equation 3.10 is the error correction mechanism which indicates the speed of adjustment to equilibrium whenever disequilibrium occurs in the transportation system in Nigeria (Ochei & Mamudu, 2020).

Operationalization of Variables

The study investigates the vehicle replacement time of GIG mobility in Nigeria. The variables of the study are operationalized below:

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

Operational Measurement of Replacement Time

The replacement time is placed on ratio scale. This is consistent with the measurement procedure used by Chang (2005) and Terborgh (1958).

Operational Measurement of Total Cost

The study utilized actual data on purchase price of vehicles, depreciation, maintenance cost and running costs of randomly selected vehicle which is Toyota Hummer Bus. This is necessary because of the excessive data involved in trying to establish the detailed maintenance and running cost record of all vehicles used by the Company. This approach will be applied uniformly to the three vehicle groups since all the vehicles in the same group are of the same make and ply the same route and can be said to operate under the same condition.

Operational Measurement of Cost of fuel as a constraint

Data on fuel-subsidized price is from the Nigeria National Petroleum Corporation (NNPC) statistical bulletin. Also, data used for transport sector development are obtained from GIG mobility. To examine the short run and the long run relationship between fuel subsidized price and transport sector, this research will employ the co-integration and Error Correction Methodology (ECM). The Co-integration approach provides information about the long run relationship between the variables while the Error Correction Method (ECM) provides information about the short-run relationship between the variables. The error correction term provides information on the speed of adjustment from the short run disequilibrium to the long run equilibrium in the event of any deviations from the long run equilibrium.

Assumptions

1. Only new vehicles are used for replacement.
2. The depreciation method for all the vehicles is reducing, 25% for Benin – Lagos route and 40% for Benin-Abuja and Benin – Port-Harcourt route.
3. Vehicle deterioration increases maintenance cost.
4. Vehicle plying the same route are homogenous and thus have the same characteristics (life cycle costs and depreciation)
5. Vehicle operates 300 days per year.
6. Salvage Value is calculated once in asset life cycle.
7. Cost of fuel is differentiated in terms of subsidized price and unsubsidized price.

Estimation Technique

Dynamic programming was utilized to estimate the ideal time to replace cars based on life cycle costs and the study's objectives. In the model, replacement time is the dependent variable, while the running, maintenance, and depreciation costs of the vehicle are the independent variables. Since all cost components are quantified in terms of money, they all come under the ratio scale. The equipment replacement optimization (ERO) issue is formulated using dynamic programming, and the data structure is created before being implemented using Java script and Pascal programming. The operating cost and maintenance cost for equipment based on model year were calculated, and the purchase price was utilized to calculate the depreciation cost. the total cost of operation and depreciation combined. The entire cost was then calculated by adding the cumulative operating cost and the cumulative depreciation. The Pascal Program read and processed the complete cost information that was gathered for the research. Thus, the annual total cost of automobiles served as the primary input. To store and solve the data, many dynamically allocated arrays were created. The Bellman's technique was gradually solved, and the recursive function was successfully invoked. The predicted total vehicle cost, which

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

is a function of the purchase price, yearly operating cost, maintenance cost, and salvage value, is what the DPP solution software uses to optimize the ERO decisions over a specified time horizon. In other words, the DDP technique assumes that these costs/values are fixed or predefined over the study time.

Justification of the Estimation Technique

Dynamic programming was the study's model of choice. The equipment replacement time was specifically determined as a function of the life-cycle expenses (buy cost, maintenance and repair cost, and operation cost) using the discrete dynamic programming model (Value iteration). The dynamic programming approach was chosen because, compared to other conventional ways of equipment replacement, it provides a significantly wider variety of possibilities at the time of decision-making (Arvore, 2005). Because the study's pertinent inputs (buy cost, depreciation, maintenance cost, and running cost) are assessed at discrete points in time, the discrete dynamic programming model was used.

Being A Thesis Proposal Presented To The Department Of Business Administration, In Partial Fulfilment Of The Requirements For Award Of Doctor Of Philosophy (Ph. D) In Business Administration Of The University Of Benin, Benin City, Edo State.

REFERENCES

1. Alaa, N. E. (2009). Simplified approach for optimization by dynamic programming. International Journal on Environmental Hydrology, 6, 1-14.
2. Adkins, R., & Paxson, D. (2017). Replacement decisions with multiple stochastic values and depreciation. European Journal of Operational Research, 257 (1), 174–184.
3. Adkins, R., & Paxson, D. (2013). Deterministic models for premature and postponed replacement. Omega, 41 (6), 1008 – 1019.
4. Ahmed, B. S. (1973). Optimal equipment replacement policy. Journal of Transport Economics and Policy, 1 (3), 12- 28.
5. Ajibade, A. D., Odusina, M.T., Rafiu, A. A., Ayarinde, A.W., Adeleke, B. S., & Babarinde, J. B. (2014). The use of replacement model to determine the appropriate time to replace a deteriorating industrial equipment. IOSR Journal of Mathematics, 10 (2), 9 - 13.
6. Alp, O., Tan, T., & Udenio, M. (2022). Transitioning to sustainable freight transportation by integrating fleet replacement and charging infrastructure decisions. Omega, 109, 102595– 102595.
7. Amiens, E. O., Oisamoje, M. D., & Inegbenebor, A. U. (2015). A dynamic programming approach to replacement of transport vehicles in Benin City, Nigeria; British Journal of Mathematics & Computer Science, 6 (3), 204-214.
8. Arvore, R. (2005). Application of dynamic programming in equipment substitution, Online Journal, 29 (5), 749- 756.
9. Australian Government department of Resources, Energy and Tourism [AGDRET] (2011). Strategic framework for alternative transport fuels, December, Canberra.
10. Backhaus, R. (2022). Possibilities for the electrification of heavy commercial vehicles. ATZ Worldwide Journal, 124 (4), 8–13.
11. Beichelt (2006). Stochastic processes in science, engineering and finance. New York: Taylor and Francis Group.
12. Bellman, R. E. (1955). Equipment replacement policy. Journal of the society for industrial and Applied Mathematics, 3 (2), 133 – 136.
13. Bhurisith, A., & Touran, A. (2002). Case study of obsolescence and equipment productivity. ATZ Worldwide Journal, 124 (4), 65 – 71,
14. Biscoff, R., Akple, M., Turkson, R., & Klomegah, W. (2012). Scenario of the emerging shift from gasoline to LPG fueled cars in Ghana: A case study in Ho Municipality. Available at: https://www.nigerialpgas.com/downloads/780368.pdf, accessed: 23 May 2019.
15. Blank, E., & Tarquin, O. (2005). Engineering economy. New York: Mc Graw Hill, 144 – 230.
16. Buddhakulsomsiri, J., & Parthanadee, P. (2006). Parallel replacement problem for a fleet. NewYork: Mc Graw Hill, 235 – 240.
17. Campbell, J. D., & Jardine, A. K. S. (2001). Maintenance excellence optimizing equipment life cycle

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

cost decisions, Marcel Dekker Press, Basel, Switzerland.
18. Cantù, R. (2017). A context specific machine replacement model: case of forest harvesting equipment. Journal of the society for industrial and Applied Mathematics, 1 (2), 136 – 139.
19. Cerquitelli, A., Regalia, E., Manfredi, F., Conicella, P., Bethaz, E., & Liore, T. (2020). Data-driven estimation of heavy-truck residual value at the buy-back, 102409-102418.
20. Chang, P. (2005). Fuzzy strategic replacement analysis. European Journal of Operational Research, 160 (2), 532 – 559.
21. Chronopoulos, M., & Siddiqui, A. (2014). When is it Better to Wait for a New Version? Optimal Replacement of an Emerging Technology under Uncertainty.
22. Dean, J. (1951). Replacement Investment in capital budgeting, N Y: Columbia University Press.
23. Dietz, E., & Katz, A. (2001). US invent implements on cogent analytical Model for optimal vehicle Replacement. Interfaces, 65-73.
24. Douglas, D., & Gransberg, I. E. (2005). Equipment replacement**.** Journal of construction engineering and management, 100 (4), 157-198.
25. Drinkwater, E., & Hastings, O. (1967). An Economic Replacement Model. Operational Research Society, 2 (1), 121-138.
26. Ediri, E. (2018). NIPCO converts 5,600 vehicles engines from petrol to gas, viewed 3 June 2019, < https://www.vanguardngr.com/ 2018/10/nipco-converts-5,600-vehicles-engines-from-petrol-to-gas/ > accessed 5th July, 2019
27. Ediri, E. (2018). NIPCO converts 5,600 vehicles engines from petrol to gas, viewed 3 June 2019, < https://www.vanguardngr.com/ 2018/10/nipco-converts-5,600-vehicles-engines-from-petrol-to-gas/ > accessed 5th July, 2019
28. Edward, W. (2009). Replacement strategies for farm machinery. Journal of Construction Engineering and Management, 20 (3), 15-19.
29. Eilon, S., King, D. E., & Hutchinson, M. (1996). A study in equipment replacement. Operational Research Quarterly, 17 (1), 59 - 71
30. Ekeocha, E. O., Odukwe I. O., & Aguwambam, S.O. (2011). Dynamic modeling of machinery replacement problems, a thesis for the award of doctorate degree in the mechanical engineering department, University of Nigeria, Nsukka.
31. Elazouni, A. M., & Basha, M. O. (1996). Evaluating the performance of construction equipment operators in Egypt. Journal of Construction Engineering and Management, 122 (2), 109-114.
32. Fan, H., AbouRizk, H., Kim, O., & Zaïane, A. (2008). Assessing residual value of heavy construction equipment using predictive datamining model. Journal of Computer Civil Engineering, 22 (3), 181-191.
33. Fikayo, O. (2018). Central Bank of Nigeria (CBN) reveals how much Nigeria spends on fuel importation, viewed 5 June 2019, < https://nairametrics.com/2018/05/08/bn-reveals-how-much-nigeria-spends-on -fuel importation/> accessed 5th June, 2019
34. Fraser, A. N. (2000). Engineering Economics in Canada-Scarborough (ON): Canada Prentice-Hall Canada.
35. Gillespie, J. S., & Hyde, A. S. (2005). The replace/repair decision for heavy equipment. Virginia Transportation Research Council. Department of Transportation Federal Highway Administration Charlottesville, Virginia November, 2004.
36. Geurts, J. H. (1983). Optimum age replacement versus condition based replacement: some theoretical and practical considerations. Journal of Quality and Technology, 15, 171-179.
37. Grant, E. I. (1950). Principles of engineering economy, NY: Ronald Press.
38. Gupta, S. P., Sharma, A., & Ahuja, S. (2007). Cost accounting. New Delhi: VK (India) Enterprises.
39. Hagspiel, V., Huisman, K. J. M., & Nunes, C. (2015). Optimal technology adoption when the arrival rate of new technologies changes. European Journal of Operational Research. 243 (3), 897–911.
40. Hartman, J. C., & Tan, C. H. (2014). Equipment replacement analysis: a literature review and directions for future research. Engineering Economics, 59 (2), 136–153.
41. Hossam, M. T., Ahmed, A. H., & Ahmed, I. H. (2023). Factors affecting the resale value of construction equipment and their relative impact. Alexandria Engineering Journal. 66, 731-738.
42. Independence News Paper (2023, June). Subsidy removal in Nigeria. Premium Times, 1.
43. Inegbedion, H., & Aghedo, M. (2018). A model of vehicle replacement time with overloading Optimum Replacement Time of Vehicle Fleets with Overloading Constraints. Journal of Construction

Engineering and Management, 128 (4), 357-369.

44. Inegbedion, H. E. (2015). Optimum Replacement Time of Vehicle Fleets with Overloading cost constraint, Journal of Management Analytics, DOI: Postgraduate Studies, University of Benin, Nigeria, in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business Administration.
45. Ismail, O. S., Hezekiah, T., & Biliksu, M. Y. (2014). Impact of gasoline subsidy removal on the transportation sector in Nigeria. American Journal of Energy Research, 2 (3),60 – 66.
46. Ivy, J. S., & Nembhard, H. B. (2005). A modeling approach to maintenance decisions using statistical quality control and optimization. Quality and Reliability Engineering International, 21, 355-366.
47. Jaafari, V. K., & Mateffy, A. R. (1990). Realistic model for equipment replacement. Journal of Construction Engineering and Management, 116 (3), 514 - 532,
48. Jardine, E., & Tsang, O. (2017). Maintenance, replacement and reliability: Theory and application. 2nd Ed. New York Press
49. Kriett, P. (2009). Equipment Replacement Priorization Measures: Simulation and Testing for a vehicle Fleet. Oregon State University Libraries.
50. Lapkina, I., & Malaksiano, M. (2023). Elaboration of the equipment replacement terms taking into account wear and tear and obsolescence. Eastern – European Journal of Enterprise Technologies. 1 (1), 4 - 8.
51. Lapkina, I., & Malaksiano, M. (2018). Estimation of fluctuations in the performance indicators of equipment that operates under conditions of unstable loading. Eastern-European Journal of Enterprise Technologies, 1 (91), 22–29.
52. Lapkina, I. O., & Malaksiano, M. O. (2015). Modelling and optimization of perishable cargo delivery system through Odesa port . Actual Problems of Economics. 3, 53–365.
53. Lapkina, I. O., Malaksiano, M. O., & Malaksiano, M. O. (2016). Optimization of the structure of sea port equipment fleet under unbalanced load. Actual Problems of Economics, 9, 364–371.
54. Lisa, M. E. (1995). Total cost of ownership: An analysis approach for purchasing. International Journal of Physical Distribution and Logistics Management, 1(3), 3-5.
55. Liu, B., Wu J., & Xie, M. (2015). Cost analysis for multi-component system with failure interaction under renewing free-replacement warranty. European Journal of Operational Research, 243 (3), 874–882.
56. Lucko, G. (2011). Modeling the residual market value of construction equipment under changed economic conditions. Journal of Construction Engineering Management, 137 (10), 806-816.
57. Lussier, I. O. (1961). Planning and control of logging operations. Université Laval-Quebec.
58. Malaksiano, N. A. (2012). On the stability of economic indicators of complex port equipment usage. Actual Problems of Economics. 8, 226–233.
59. Mamadou, S., Mouhamed, F. N., & Elhadj, A. D. (2022). Policies and Strategies for the reform and renewal of construction equipment. International Journal of Management and Social Science Research, 8 (3), 9-21.
60. Mitchel, Z. W. (1998). A statistical analysis of construction equipment repair costs using field data and the cumulative cost model, a Dissertation submitted to the Faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Civil Engineering.
61. Morgan, T. (2017). Autogas Incentive Policies: A Country-By-Country Analysis of Why and How Governments Encourage Autogas and What Works. Journal of Construction Engineering Management, 17 (11), 106-116.
62. Nguyen, T. P., Yeung T. G., & Castanier, B. (2013). Optimal maintenance and replacement decisions under technological change with consideration of spare parts inventories. International Journal of Production Economics, 143 (2), 11- 14.
63. Nuhu, Y. (2015). Autogas, is Nigeria Ready? Journal of Construction Engineering and Management, 1 (2), 17-18.
64. Ochei, M. C., & Mamudu, Z, U. (2020). Analysis of the contribution of transport sector to economic growth in Nigeria. Journal of Economics and Finance, 11 (6), 18 – 35.
65. Offiong, A., Akpan, W. A., & Ufot, E. (2013). Development of vehicle replacement programme for a road transport Company. International Journal of Applied Science and Technology, 3 (2), 31 – 35.

66. Oghenejohoh, K. M., & Akpabio, E. J. (2023). Adaptation of natural gas for motor fuels in Nigerian transport system. Global Journal of Engineering Research, 1(2), 81-98.
67. Ogunlowo, O. O. (2016). Exploration of compressed natural gas as an automotive fuel in Nigeria. Journal of Construction Engineering and Management, 150-198.
68. Okon, T. (2018). Organization for Economic Corporation & Development [OECD]. Energy use: A graphical analysis, OECD, Paris.
69. Olufemi, O. O. (2015). Developing compressed natural gas as an automotive fuel in Nigeria: lessons for international markets. Energy Policy, 76, 7- 17.
70. Organization Economic Corporation and Development [OECD] (2013). Annual Report on the OECD Guidelines for Multinational Enterprises.
71. Oyeniyi, M. J. (2016). Possibilities of Compressed Natural Gas Vehicle Development in Lagos State Road Transport System: A Viable Concept for Nigeria Road Transport System.
72. Pedram, K. S. G., Mehdi, R., & Saheed, R. (2016). Determining economic life of earth moving equipment using life cycle cost analysis. Academia, 1(6), 1-6.
73. Pflueger, B. (2005). How to calculate machinery ownership and operating costs, San Diego State University (SDSU) College presented at the 91st annual meeting of the transportation research board, Washington.
74. Rafiu, B. A. (2022). Assessing the challenges of logistics services in Nigeria: an analysis of GIG logistics company in Nigeria. International Journal of Transportation and Logistics, 19 (42), 2335 – 2342.
75. Rani, T. C., & Sukumari, C. (2014). Optimum replacement time for a deteriorating system. International Journal of Scientific Engineering and Research, 2 (1), 32 - 33.
76. Redmer, A. (2005). Vehicle replacement planning in freight transportation companies.
77. Robert, M. (2016). Nigeria introduces auto-gas-powered cars, viewed 3 June 2019, < https://gazeo.com/up-todate/news/2016/Nigeria-introduces-autogas -powered- cars, news, 9950.html >accessed 5th June, 2019
78. Safaei, F. (2020). Optimal age replacement policy for parallel and series systems with dependent components. Journal of Reliable Engineering System Safety. 2 (3), 12-15.
79. Sarache, C., & Gonzales et Viveros (2009). A multi-criteria Application for an Equipment Replacement Decision. 80-98.
80. Sierzchula, W., Bakker, S., Maat, K., & Van - Wee, B. (2014). The influence of financial incentives and other socio-economic factors on electric vehicle adoption. Energy Policy, 68, 183-194.
81. Singh, V., Singh, V., & Vaibhav, S. (2020). A review and simple meta-analysis of factors influencing adoption of electric vehicles. Transportation Research Part D: Transport and Environment, 86, 102436–102436.
82. Srinivasan, V., Francis Luther King, M., & Purushothaman, T. (2014); Alternate Fuel. Journal of Construction Engineering and Management, 2 (4), 16-18.
83. Statharas, S., Moysoglou, Y., Siskos, P., Zazias, G., & Capros, P. (2019). Factors Influencing Electric Vehicle Penetration in the EU by 2030: A Model-Based Policy Assessment. Energies, 12 (14), 2739–2739.
84. Stutzman S., Weiland, B., Preckel, P., & Wetzstein, M. (2017). Optimal replacement policies for an uncertain rejuvenated asset International Journal of Production Economics, 185, 21–23.
85. Tasic, T., Pogorevc, P., & Brajlih, T. (2011). Gasoline and LPG Exhaust Emissions Comparison, APEM Journal, 2 (4), 223-268.
86. Terborgh, G. (1949). Dynamic equipment policy. NY: McGraw-Hill Book Co.
87. Tufts, M. (1982). Financial Analysis of Equipment selection. Journal of Construction Engineering and Management, 118 (1), 21- 36.
88. Ubani, E. C., & Ikpaisong, S. U. (2018). Use of CNG as Auto fuel in Nigeria, European Journal of Engineering Research and Science, 1 (1), 3 – 5.
89. Ubani, E. C., & Ikpaisong, S. U. (2018). Use of CNG as Auto fuel in Nigeria, European Journal of Engineering Research and Science.
90. Victoria Transport Policy Institute (2022). Transportation cost and benefit analysis II- vehicle costs. Available at www.vtpi.org.
91. Wei, F., Randy, B. M., & Mason, D. G. (2012). Equipment replacement optimization. A paper with

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue IV April 2025

dependent use. Industrial Engineering Research Conference (IERC), Orlando, FL.

92. World Liquefied Petroleum Gas Association (2014). A liquefied petroleum gas exceptional energy, Autogas Incentive Policies; A country-by-country analysis of why and how governments encourage Autogas and what works.
93. World LP Gas Association [WLPGA] (2001). Developing a sustainable autogas market: Guidelines for policemakers, WLPGA, Paris.
94. Zambujal-Oliveira J., & Duque, J. (2011). Operational asset replacement strategy: A real options approach. European Journal of Operational Research, 1 (2), 318–325.
95. Zhou, M., Kong, N., Zhao, L., Huang, F., Wang, S., & Campy, K. S. (2019). Understanding urban delivery drivers' intention to adopt electric trucks in China. Transportation Research Part D: Transport and Environment, 74, 65 – 81.

APPENDIX 1

List of the major Interstate Transport Company in Nigeria.

S/N	TRANSPORT COMPANY	S/N	TRANSPORT COMPANY
1.	ABC MOTORS	19.	EKILI HAULAGE
2.	ALIBE & SONS TRASNPORT COMPANY	20.	FAITH MOTORS
3.	AMMIRE HAULAGE	21.	GIG MOBILITY
4.	AMOS TRAVELS	22.	GUO TRANSPORT
5.	ASTAC NIGERIA LIMITED	23.	LIBRA MOTORS
6.	AUTOSTAR TRAVELS	24.	MARVEL SERVICES
7.	BENUE LINKS NIG LTD	25.	MEDITERRANEAN SHIPPING COMPANY NIGERIA LIMITED
8.	BIG JOE MOTORS	26	METRO FERRY
9.	BLUE CHEETAH SERVICES	27.	MUSHILAB NIGERIA LIMITED
10.	BONNY WAY MOTORS NIG. LTD.	28.	MUYI LINE
11.	CHISCO TRANSPORT LIMITED	29.	NOBLEPAT GROUP
12.	CROSS COUNTRY	30.	OSTAR-KEN INTERNATIONAL COMPANY
13.	CRYSTAL LINE	31.	PEACE AND JOY TRANSPORT
14.	DE MODERN MOTORS	32.	SAFE MOTOR WAY
15.	EAGLE LINE	33.	SAIMA NIGERIA
16.	ECO LINE	34.	TORON NIGERIA LIMITED
17.	EDEGBE MOTORS	35.	TOTAL LOGISTICS EXECUTIVE RYDE LTD
18.	EFEX EXECUTIVE	36.	TRIBEL GLOBAL MOTORS

Source: field survey, 2023