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Analytical Study of Fleet Management and Vehicle Replacement Model: Evidence from the Nigerian National Petroleum Co-operation Headquarter Abuja

Victor Omoke, Obioma R. Nwaogbe, Abraham Pius, Stella M. Ayam and Husam A. Hemli

Department of Transport Management, Federal University of Technology, Minna, Nigeria
victor.omoke@futminna.edu.ng ; obioma.nwaogbe@futminna.edu.ng.

Faculty of Business Management, Arden University. UK
apius@arden. ac.uk

Faculty of Business Management, University of Wales (Trinity Saint David) UK
h.alharahsheh@uwtsd.ac.uk

ABSTRACT

This study focuses on improving the operational performance of transport services in Nigeria by examining the economic life cycle of the vehicles in Nigerian National Petroleum Cooperation (NNPC). Data were collected on vehicle numbers, make, price, year of purchase and maintenance costs. Using Vehicle Replacement and Maintenance Model (VRMM) for the analysis. The study found that Toyota Hilux (T/Hilux) has economic life span of six years, while both Corolla T/Coaster and Skoda Superb have economic life span of eight years. Lastly, T/Camry and Honda Pilot should be replaced after nine years. Also, it is discovered that the NNPC vehicles were used to the end of their life spans. In the asset management principle, this practice is an economic wastage i.e. waste of resources and this issue need to be addressed. In view of the findings in this research work, the following recommendations are explained; the land transport department of NNPC should derive a policy of using their vehicles to its economic life span thereby preventing economic wastage, and NNPC fleet managers should be able to set apart a certain amount every year to make replacement easy. For example, 15% of inflation rate can be set apart every year for each vehicle.

Keywords: vehicles, replacement, maintenance and management

Introduction

Transportation can be defined in commercial terms as a system of conveying or moving people or goods from one place to another using vehicle. Transportation is the movement of people, goods, and services from one place to another by means of different or various modes of transport, which include air, road, railway, pipeline, or maritime transport. Oladipupo (2002) in his presentation stated as follows: "transportation is not only limited to conveying human beings only as the definitions stated. It includes the use of different types of trucks designed for different purposes or operations. There are trucks, vehicles for fire-fighting; there are those to convey liquid cargoes, and those for the solid. Some are designed to keep the consignment cool or frozen always while some with heater to keep the consignment soft such as far cool tar. By all these, the importance of transportation in business of any size, worldwide, is obvious". According to Jones (2000) "transport occupations form a part of commerce since they are engaged in the movement of goods and passengers from one place to another and so increase their efficiency". Road transportation which has become such a major mode in Nigeria with patronage cutting across individual, private, corporate and government organizations serves as coordinate basis for all modes of transport system. Road Transport Safety Standardization Scheme created by law in the National Road Traffic Regulations (NRTR) (2004) Section 115 made pursuant to Sections 5 and 10 (10) of the FRSC (Establishment) Act 2007 provides for the establishment of safety units by all transport operators so as to bring professionalism into the industry, promote and develop rapid safe, efficient and convenient fleet transportation system in the country.

Fleet management is the optimization of existing fleet asset and infrastructure to achieve a very high level of efficiency, performance, safety, sustainability, and output. The pressure to deliver faster and cheaper has made vehicle utilization an important aspect of fleet management (Jonsson 2008 and Waters, 2009). Better vehicle utilization lowers operating cost through better planning. Odutola (1997) argued that "transport administration is concerned with the management of all factors with a view to obtaining optimum efficiency with minimum delays and cost". This idea is that a prerequisite for efficient transport administration is the administration of vehicles. The choice of the type and size of investment on transport vehicles, the maintenance and control of their use are therefore, dependent on the efficiency of their service, which by and large depends on the administrative machinery. Fleet Management is a function which allows companies which rely on transportation in business and commerce to remove or minimize the risks associated with vehicle investment, improving efficiency, productivity and reducing their overall transportation and staff costs, providing a great compliance with government legislation (duty of care) and many more. These functions can be dealt with by either an in-house fleet-management department or an outsourced fleet-management provider. Fleet management is central to the activities of the land transport department of NNPC. With increase in vehicle ownership, population growth, and a growing number of budget constraints, fleet managers in NNPC must devise methods of detecting and resolving cost sinks while improving the ability of the department to meet and exceed expected service levels. With increasing budgetary constraints and service requirements, it is required that fleet managers, optimize fleet utilization through the implementation of management practices that maximize fleet utilization, while effectively engaging in predictive maintenance practices. In addition, fleet managers must can determine optimum fleet life cycles points (vehicle economic life) at which the cost of maintenance exceed the benefits derived from vehicle operation through analysis of recent, reliable data. Equipping fleet managers with tools for efficiency, and productivity, is the optimal goal for continues improvement in fleet management within the land transport department of Nigerian National Petroleum Corporation.

1.1 Statement of the Problem

Ratcliffe (2007) stated that the most important thing in fleet management is cost management. The fleet manager must ensure that his/her activities are cost effective. Fleet managers oversee delegation of duties to large groups of personnel responsible for operating the vehicles within the fleet. Fleet management involves several activities, ranging from purchasing, maintenance, and leasing of vehicles, management of human resources, service delivery improvement and value addition to the entire process of logistics management and transport management system. Given the complex nature of fleet management and fleet replacement which refers to the systematic acquisition of new vehicles to take the place of aging ones, it is important for fleet management professionals to see new ways in which to visibly improve on service delivery to their various clients. The problem affecting the land transport services in NNPC, there are several operational vehicles for operational staff on 24 hours basis as provided and these vehicles are not being fully utilized because a lot of money is spent in purchasing these vehicles and after a few years of purchasing them, the vehicles are sold off/replaced with new ones. By doing so, however, resources which should have been used in satisfying other purposes or meeting the needs of other departments within the corporation is being wasted because of disposing vehicles which are not yet due for replacement and purchasing new ones. Some of the corporate vehicles are being subjected to carefree attitude by the staff user since they are not the ones maintaining the vehicles. The major problem is that the economic lives of these vehicles have not been determined i.e. the number of years the vehicles will be in operation before replacement. If this problem is solved, then these vehicles can be efficiently utilized to its economic life span before the corporation decides to replace them, thereby saving cost and preventing waste of resources. This study aims to assess NPPC fleet maintenance and vehicle replacement model used by the NPPC.

1.2 Study Objectives

- To determine the fleet size and their compositions.
- To analyze the fleet maintenance cost structure and method of maintenance.
- To examine the fleet acquisition and replacement policies.
- To identify the challenges associated with NNPC fleet maintenance system
- To determine the economic life of the vehicles.

Literature Review

Maintenance is a complex activity involving such variants as equipment, statistics, cost administration, productive activity, and business. These variants must be well administered in order to be efficient. In the past, maintenance decisions have been limited to what kind of action to use (corrective or preventive) and to the definition of such variables as best frequency, best predictive technique, and best information organization, Frederico (2000). Today, due to the changing role of fleet management and maintenance, decision-makers also must consider the coordination of the human, physical, logistical, and logical structures of maintenance, which in turn must be combined with previous variables to create an integrated administration. Maintenance may be a group of interrelated structures that share the common objective of supporting and/or executing actions to maintain or repair Frederico (2000). In the case of fleet vehicles, the variants are even more evident, Dolce (1998). Factors such as size, responsibility of the task carried out, fleet complexity, market characteristics, and competition level vary markedly from one activity branch to another, or even from among geographical areas. Traditionally, the information required to manage a fleet of vehicles has been derived from observations made at the maintenance facility, utilizing mileage, consumables, operator defect cards, and other data, Abrams, et al. (2000). Today, more advanced technology allows vehicles to generate and store observations about the vehicles themselves. In this report we discuss some cost-effective technological solutions available to help fleet managers better manage their facilities.

2.1 Theory of Replacement

Machine replacement problem has been studied by many researchers and is also an important topic in operation research and management science Nahmias 1997. Replacement theory is a useful tool in modeling many systems. The quantity-based replacement policy and time-based replacement policy for a single machine problem are reported. These two kinds of policies have been applied to inventory management problems. In a quantity-based replacement policy, a machine is replaced when an accumulated product of size q is produced. In this model, one has to determine the optimal production size q. In fleet management an organization should determine the expected optimal workload a fleet can handle depending on usage before it can be taken for repair and maintenance and later replaced. This should be done considering factors such as cost of running the fleet, repair and maintenance cost among others, it is important to note that these costs should not be higher than the cost of service provided by the fleet. While in a time-based replacement policy, a machine is replaced in every period of T. For this model, one must determine the optimal replacement period T in each production cycle. During the cycle however, the organization should also determine the appropriate intervals for repair and maintenance. In fleet management an organization must project the optimal lifetime that a fleet should serve the organization after which it is replaced. This is crucial to ensure at all time the organization has a reliable capacity to serve its needs. This should be evaluated by experts for accuracy purposes. The time-based policy is preferable than the quantity-based dispatch policy for satisfying timely customer service. Especially, time-based shipment consolidations have become a part of the transportation contract among the members of a supply chain. Two analytic models were compared according to their average long-run performance. Average long-run costs for both models have been developed by using replacement theory. The costs here include both the cost of a new machine and the machine maintenance cost Bagui, Chakraborti and Bhadra (2012).

Replacement theory is generally concerned with the problem of replacement of machines, bulbs and men due to deteriorating efficiency, failure or break down. Replacement is usually carried out under the situations as: When existing items have outlived their effective lives and it may not be economical to continue with them anymore and When the items might have been destroyed either by accidents or otherwise. In fleet management fleet may be replaced if: The fleet performance have deteriorated with time; Replacement of fleet which did not deteriorate but failed completely after certain use; Replacement of fleet that became out of date due to new development; Gradual diminishing of the existing working staff in an organization due to retirement, accidents among others Bagui, Chakraborti and Bhadra (2012).

2.2 Planning Maintenance Management Systems

Planning for fleet maintenance management systems begins with analyzing the requirements of the company (the operational requirements of the vehicles and the needs of the organization) about fleet maintenance, Frederico (2000). These requirements further translate into technical objectives to be met by the planned system. Several different characteristics are analyzed: the organization, the vehicles, and operation conditions. While assessing the needs of the company, the following parameters need to be considered: environmental demand, commitments to punctuality, supply chain, quantity demand, security requirement, and human resource management, Riis, Luxhoj, and Thorsteinsson (1997). After analyzing the requirements of the facility, the fleet manager establishes a general idea of the functions and functional flow necessary for fleet maintenance involving, for example, inventory and parts ordering, scheduling for preventive maintenance, etc. Furthermore, each function is analyzed based upon available solution alternatives: manual or computerized management system, basic category of maintenance (regular inspections, corrective maintenance or preventive maintenance) and the basic repair functions (from non-repair to complete repair of the vehicle), Frederico (2000) Finally, a fleet management solution is designed or chosen based on manual or computerized management options. Some aspects that need to be considered while choosing a computerized management solution are:

1. Functional requirements that need to be met
2. Cost effectiveness
3. System flexibility
4. Ease of use; and
5. Training requirements and flexibility.

2.3 Empirical Review

Ratcliffe (2007) emphasizes that the most important thing in fleet management is cost management. The fleet manager must ensure that his/her activities are cost effective. Fleet managers oversee delegation of duties to large groups of personnel responsible for operating the vehicles within the fleet. This may include coordinating the employee schedule, managing communication between the drivers and headquarters, planning driving routes or alternate routes, as well as referring or solving problems that may crop up during the day such as accidents, absenteeism and automobile malfunctions. Soltun (2007) carried out a study on Fleet Management Optimisation which was built around the concept of fleet management, focusing on designing and implementing a solution for such a purpose. The study was approached as a combination between a literature study (theory and business model creation) and a software design process (design and implementation). The study proposed that implementing the GIS functions was to be done after the proposed system was complete and implementing the remaining functionality in co-operation with a possible customer was a good approach to discover necessary functionality that had not been detected in the work process. The process of monitoring and increasing efficiency of transportation problems is called fleet management. The services included in a fleet management tool vary depending on the organization in context. According to Ratcliffe (2007), there are five main fleet management activities, these are pointed out as being; Routing and Scheduling, Fuel Management, Vehicle Acquisition, Vehicle Maintenance, Driver briefing and debriefing. These activities are supervised by the fleet managers and primarily, a policy is formulated to serve as a guide for these activities.

2.4 Benefits and Importance of Maintenance Systems

The maintenance system plays a very important role, as does many other systems within an organisation. The maintenance system must be considered carefully because this system can have great influence on the overall performance of the organisation. Maintenance expenditures in the UK 's manufacturing industry (as an example) range from 12 to 23% of the total operation costs (Cross 1988). Dekker (1996) reported that, in refineries, maintenance spending is about 30% of the total staffing costs. The mining industry spends between 40 to 50% of operating costs on maintenance (Campbell 1995). Alhouli et al. (2009) showed that, in a case study of data presented on a six-year-old, 75,000-ton bulk carrier, maintenance costs account for the largest proportion of operation costs (40%) based on the sample surveyed. Therefore, the issue of how to conduct maintenance optimally must be given careful consideration to reduce the great costs of such maintenance. The importance of maintenance has generated an increasing interest in the development and implementation of optimal maintenance strategies for improving system reliability, preventing the occurrence of system failures, and reducing maintenance costs of deteriorating systems. In addition to attempting to achieve those objectives, applying an optimum maintenance system in an organisation can produce many other benefits, which can be summarized as follows:

- The asset remains in its operational state and breakdown risks can be avoided.
- The instant availability of the asset when it is required to operate.
- The increase in safety levels for the employees who operate the machinery.
- Increased reliability, leading to less lost time while facilities are being repaired, less disruption to the normal activities of the operation, less variation in output rates, and more reliable service levels.
- Quality errors can be avoided, because well maintained equipment is more likely to perform to meet standards, thereby avoiding quality problems.
- The potential reduction of operating costs if maintenance is conducted at regular intervals.
- Longer life spans for the machinery; regular care can prolong the effective life of facilities by reducing the small problems in operation whose cumulative effect causes wear or deterioration.
- Higher end value of the machinery; well-maintained facilities are generally easier to dispose in the second-hand market. The benefits of maintenance demonstrate that a well-planned and implemented maintenance system is vitally important to the organization.

Theoretical framework

The researcher is adopting the model of replacement and maintenance analysis for this study. Replacement and maintenance analysis is a model for determining the economic life of an asset and identifying when the asset should be replaced with a new one or augmenting the existing one with an additional one. Using replacement and maintenance analysis, it explains how the average first cost goes on decreasing with the life of the asset and the average operating cost and maintenance cost increases with the life of the asset. From the beginning, the average total cost continues to decrease up to a particular life (year) and then it starts increasing. The point where the total cost is minimum is called the economic life of the asset. The secondary data collected consist of number of vehicles, vehicle make, amount, year of purchase and maintenance cost.

3.1 Data Collection

The information utilized as a part of this study was gathered from the accompanying source. This incorporates that information which the researcher gathered from officially archived or existing records. The wellsprings of information under this class incorporate; NNPC land transport department. The data specifically comprised of number of vehicles, vehicle make, amount, year of purchase and maintenance cost.

3.2 Method of Data Analysis

The data obtained was analyzed using replacement and maintenance analysis. The replacement and maintenance analysis are computed thus:

Column A - F
A = End of year (n)
B (Rs.) = Maintenance cost at end of year
C (Rs.) = Summation of maintenance cost
D (Rs.) = Average cost of maintenance through year given (C/A)
E (Rs.) = Average first cost if replaced at year end given (first cost/A)
F (Rs.) = Average total cost through year given (D + E)

The upkeep investigation of segment C condenses the summation of support expense for every substitution period. The quality comparing to any end of year in the segment speaks to the aggregate support expense of utilizing the hardware till the end of that specific year.

Model formulation;

$$\text{Average Total Cost} = \frac{\text{First Cost (FC)} + \text{Summation of maintenance cost}}{\text{Replacement period}}$$

$$ATC = \frac{FC}{n} + \frac{\text{Column C}}{n}$$

Average First Cost for the period + Average Maintenance Cost for the period.
<Column F = Column E + Column D>

The worth relating to any end of year (n) in segment F speaks to the normal aggregate expense of utilizing the vehicle till the end of that specific year.

Data Analysis and Discussion

This study analyzes the fleet size and their composition as follows (total number of vehicles, vehicle make, and cost price per vehicle and year of procurement), fleet maintenance cost structure and methods of maintenance, calculations to determine the economic life of 110 vehicles in the land transport department of NNPC. The calculations involve the maintenance cost at year end, summation of maintenance cost, average cost of maintenance through year given, average first cost if replaced at year end given and finally, average total cost through year given, using Microsoft excel.

4.1 Analyses of NNPC fleet size and their composition

Table 4.1 Total No of vehicles; vehicle make; amount (cost of purchase) and year of purchase.

S/N	VEHICLE MAKE	COST PRICE PER VEHICLE	D.O.P DEC 2011	D.O.P JAN-DEC 2012	VEHICLE TOTAL NO.
1	SKODA SUPERB	4,695,000.00	1	4	5
2	T/COROLLA	4,650,000.00	5	29	34
3	T/AVENSIS	5,990,000.00	3	12	15
4	T/HILUX	4,100,000.00	0	4	4
5	VW PASSAT	5,965,000.00	0	8	8
6	H/ACCORD	6,195,000.00	0	21	21
7	T/CAMRY	7,985,000.00	0	3	3
8	HONDA PILOT	8,595,000.00	0	1	1
9	T/COASTER	4,500,000.00	0	12	12
10	T/HIACE	6,100,000.00	0	7	7

	Total = 9	Total = 101	Total = 110

Source: NNPC Data (2015).

Table 4.1 analyze the total fleet size in the land transport department of NNPC, the vehicle composition (vehicle make), amount or cost of procurement and the year of procurement. A total of one hundred and ten (110) vehicles are being analyzed and grouped into the different vehicle makes corresponding to the cost of purchase, for example, there are 5 Skoda Superb in the fleet bought at different years but having the same procurement cost. Same goes for 34 T/Corolla in the fleet bought at different years and having the same cost of purchase, and so on. About 9 vehicles were purchased at the end of 2011 and 101 vehicles from Jan-Dec 2012.

4.2 Analysis of fleet maintenance cost structure

Table 4.2 Vehicle maintenance cost

S/N	VEHICLE MAKE	Year 1	Year 2	Year 3	Year 4
1	SKODA SUPERB	0	420,000	620,000	820,000
2	T/COROLLA	0	420,000	620,000	820,000
3	T/AVENSIS	0	470,000	670,000	870,000
4	T/HILUX	0	350,000	550,000	750,000
5	VW PASSAT	0	470,000	670,000	870,000
6	H/ACCORD	0	498,000	698,000	898,000
7	T/CAMRY	0	510,000	710,000	910,000
8	HONDA PILOT	0	520,000	720,000	920,000
9	T/COASTER	0	300,000	500,000	700,000
10	T/HIACE	0	498,000	698,000	898,000

Source: NNPC Data (2015).

The analysis in table 4.2 gives the maintenance cost of each vehicle for a period of four years. The method of maintenance adopted by the corporation is in-house maintenance in the Workshop Department which is under the Central Transport Service Section (CTSS). Preventive maintenance is carried out for maintaining the vehicles before breakdown.

4.3 The fleet acquisition and replacement policy

The fleet acquisition method used is direct purchase and the replacement policy states that; after every four to six years of using the vehicles, the vehicles are sold out and replaced with new ones. This replacement and fleet acquisition if carried out appropriately will give the vehicle economic life span and with this economic life span, the organization or company will be able to know when to replace their vehicles as in when to purchase new ones and send some for scrap. The operation makes any fleet or transport and logistics company to manage and plan their fleet management efficiently and effectively.

4.3 Analysis of Vehicle Economic Life

In determining the economic life of these vehicles, the maintenance cost was given for a period of four years, based on this data; the money allocated for the maintenance of these vehicles increased by 200,000 yearly, from this data therefore, the maintenance cost was gotten for 10years to calculate the vehicle economic life.

Table 4.3 Determination of Economic Life of T/Corolla (first cost = 4,650,000)

End of year (n)	Maintenance cost at end of year	Summation of maintenance costs	Average cost of maintenance through year end	Average first cost if replaced at yr end given	Average total cost through year given
A	B	C	C/A	4,650,000/A	D + E
1	0	0	0	4,650,000	4,650,000
2	420,000	420,000	210,000	2,325,000	2,535,000
3	620,000	1,040,000	346,667	1,550,000	1,896,667
4	820,000	1,860,000	465,000	1,162,500	1,627,500
5	1,020,000	2,880,000	576,000	930,000	1,506,000
6	1,220,000	4,100,000	683,333	775,000	1,458,333
7	1,420,000	5,520,000	788,571	664,286	1,452,857*****
8	1,620,000	7,140,000	892,500.00	581,250	1,473,750
9	1,820,000	8,960,000	995,556	516,667	1,512,222
10	2,020,000	10,980,000	1,098,000	465,000	1,563,000

*Economic life of T/Corolla = 7 years

Source: fieldwork (2015).

From table 4.3, the average total cost of T/Corolla decreases till the end of year 7 having the maintenance cost at 1,420,000 and then the average total cost increases. Therefore, the optimal replacement period is seven years, i.e. the economic life of T/Corolla is seven years. Where the policy of replacement applies to the replacement of vehicles bought after 4 years, if T/Corolla was bought in 2011, four years after would be 2014 and where the economic life of the vehicle is 7 years, this means that T/Corolla is not being used to its maximum potential because the vehicle can still be used for another 7 years but it is being disposed after four years and replaced with a new one. Same goes for where the vehicle is disposed and replaced after 6 years; it has not reached its economic life of 7 years and in asset management, this is regarded as an economic wastage.

Table 4.3.1 Determination of Economic Life of T/Avensis (first cost = 5,990,000)

End of year (n)	Maintenance cost at end of year	Summation of maintenance costs	Average cost of maintenance through year end	Average first cost if replaced at yr end given	Average total cost through year given
A	B	C	C/A	5,990,000/A	D + E
1	0	0	0	5,990,000	5,990,000
2	470,000	470,000	235,000	2,995,000	3,230,000
3	670,000	1,140,000	380,000	1,996,667	2,376,667
4	870,000	2,010,000	502,500	1,497,500	2,000,000
5	1,070,000	3,080,000	616,000	1,198,000	1,814,000
6	1,270,000	4,350,000	725,000.00	998,333	1,723,333
7	1,470,000	5,820,000	831,429	855,714	1,687,143
8	1,670,000	7,490,000	936,250	748,750	1,685,000*
9	1,870,000	9,360,000	1,040,000	665,556	1,705,556
10	2,070,000	11,430,000	1,143,000	599,000	1,742,000

*Economic life of T/Avensis = 8 years

Source: fieldwork (2015).

From table 4.3.1, the average total cost of T/Avensis decreases till the end of year 8 having maintenance cost at 1,670,000 and then the average total cost increases. Therefore, the optimal replacement period is eight years, i.e. the economic life of T/Avensis is eight years. Where the policy of replacement applies to the replacement of vehicles bought after 4 years, if 3 T/Avensis was bought in 2011, four years after would be 2014 and where the economic life of the vehicle is 8 years, this means that T/Avensis is not being used to its maximum potential because the vehicle can still be used for another 8 years but it is being disposed after four years and replaced with a new one. Same goes for where the vehicle is disposed and replaced after 6 years; it has not reached its economic life of 8 years and in asset management, this is regarded as an economic wastage.

Table 4.3.2 Determination of Economic Life of T/Hilux (first cost = 4,100,000)

End of year (n)	Maintenance cost at end of year	Summation of maintenance costs	Average cost of maintenance through year end	Average first cost if replaced at yr end given	Average total cost through year given
A	B	C	C/A	4,100,000/A	D + E

1	0	0	0	4,100,000	4,100,000
2	350,000	350,000	175,000	2,050,000	2,225,000
3	550,000	900,000	300,000	1,366,667	1,666,667
4	750,000	1,650,000	412,500	1,025,000	1,437,500
5	950,000	2,600,000	520,000	820,000	1,340,000
6	1,150,000	3,750,000	625,000	683,333	1,308,333*
7	1,350,000	5,100,000	728,571	585,714	1,314,285
8	1,550,000	6,650,000	831,250	512,500	1,343,750
9	1,750,000	8,400,000	933,333	455,556	1,388,889
10	1,950,000	10,350,000	1,035,000	410,000	1,445,000

*Economic life of T/Hilux = 6 years

Source: fieldwork (2015).

From table 4.3.2, the average total cost of T/Hilux decreases till the end of year 6 having maintenance cost at 1,115,000 and then the average total cost increases. Therefore, the optimal replacement period is six years, i.e. the economic life of T/Hilux is six years.

Only T/Hilux has an economic life of 6 years and if the vehicle is replaced after 6 years, then the vehicle is being used efficiently and should be replaced at the end of the 6th year.

Table 4.3.3 Determination of Economic Life of H/Accord (first cost = 6,195,000)

End of year (n)	Maintenance cost at end of year	Summation of maintenance costs	Average cost of maintenance through year end	Average first cost if replaced at yr end given	Average total cost through year given
A	B	C	C/A	6,195,000/A	D + E
1	0	0	0	6,195,000	6,195,000
2	498,000	498,000	249,000	3,097,500	3,346,500
3	698,000	1,196,000	398,667.00	2,065,000	2,463,667
4	898,000	2,094,000	523,500	1,548,750	2,072,250
5	1,098,000	3,192,000	638,400	1,239,000	1,877,400
6	1,298,000	4,490,000	748,333	1,032,500	1,780,833
7	1,498,000	5,988,000	855,428.57	885,000	1,740,429
8	1,698,000	7,686,000	960,750	774,375	1,735,125*
9	1,898,000	9,584,000	1,064,888.80	688,333	1,753,222
10	2,098,000	11,682,000	1,168,200	619,500	1,787,700

*Economic life of H/Accord = 8 years

Source: fieldwork (2015).

From table 4.3.3, the average total cost of H/Accord decreases till the end of year 8 having maintenance cost at 1,698,000 and then the average total cost increases. Therefore, the optimal replacement period is eight years, i.e. the economic life of H/Accord is eight years.

Table 4.3.4 Determination of Economic Life of T/Camry (first cost = 7,985,000)

End of year (n)	Maintenance cost at end of year	Summation of maintenance costs	Average cost of maintenance through year end	Average first cost if replaced at yr end given	Average total cost through year given
A	B	C	C/A	7,985,000/A	D + E
1	0	0	0	7,985,000	7,985,000
2	510,000	510,000	255,000	3,992,500	4,247,500
3	710,000	1,220,000	406,666.60	2661666.6	3,068,333
4	910,000	2,130,000	532,500	1,996,250	2,528,750
5	1,110,000	3,240,000	648,000	1,597,000	2,245,000
6	1,310,000	4,550,000	758,333	1,330,833	2,089,166
7	1,510,000	6,060,000	865,714	1,140,714	2,006,428
8	1,710,000	7,770,000	971,250	998,125	1,969,375
9	1,910,000	9,680,000	1,075,555.50	887,222	1,962,778*
10	2,110,000	11,790,000	1,179,000	798,500	1,977,500

*Economic life of T/Camry = 9 years

Source: fieldwork (2015).

From table 4.3.4, the average total cost of T/Camry decreases till the end of year 9 having maintenance cost at 1,910,000 and then the average total cost increases. Therefore, the optimal replacement period is nine years, i.e. the economic life of T/Camry is nine years.

Table 4.3.5 Determination of Economic Life of T/Coaster (first cost = 4,500,000)

End of year (n)	Maintenance cost at end of year	Summation of maintenance costs	Average cost of maintenance through year end	Average first cost if replaced at yr end given	Average total cost through year given
A	B	C	C/A	4,500,000/A	D + E
1	0	0	0	4,500,000	4,500,000
2	300,000	300,000	150,000	2,250,000	2,400,000

3	500,000	800,000	266,667	1,500,000	1,766,667
4	700,000	1,500,000	375,000	1,125,000	1,500,000
5	900,000	2,400,000	480,000	900,000	1,380,000
6	1,100,000	3,500,000	583,333	750,000	1,333,333
7	1,300,000	4,800,000	685,714	642,857	1,328,571*
8	1,500,000	6,300,000	787,500	562,500	1,350,000
9	1,700,000	8,000,000	888,889.00	500,000	1,388,889
10	1,900,000	9,900,000	990,000	450,000	1,440,000

*Economic life of T/Coaster = 7 years

Source: Source: fieldwork (2015)

From table 4.3.5, the average total cost of T/Coaster decreases till the end of year 7 having maintenance cost at 1,300,000 and then the average total cost increases. Therefore, the optimal replacement period is seven years, i.e. the economic life of T/Coaster is seven years.

Table 4.3.6 Determination of Economic Life of Honda Pilot (first cost = 8,595,000)

End of year (n)	Maintenance cost at end of year	Summation of maintenance costs	Average cost of maintenance through year end	Average first cost if replaced at yr end given	Average total cost through year given
A	B	C	C/A	8,595,000/A	D + E
1	0	0	0	8,595,000	8,595,000
2	520,000	520,000	260,000	4,297,500	4,557,500
3	720,000	1,240,000	413,333	2,865,000	3,278,333
4	920,000	2,160,000	540,000	2,148,750	2,688,750
5	1,120,000	3,280,000	656,000	1,719,000	2,375,000
6	1,320,000	4,600,000	766,667	1,432,500	2,199,167
7	1,520,000	6,120,000	874,286	1,227,857	2,102,143
8	1,720,000	7,840,000	980,000	1,074,375	2,054,375
9	1,920,000	9,760,000	1,084,444	955,000	2,039,444*
10	2,120,000	11,880,000	1,188,000	859,500	2,047,500

*Economic life of Honda Pilot = 9 years

Source: fieldwork (2015).

From table 4.3.6, the average total cost of Honda Pilot decreases till the end of year 9 having maintenance cost at 1,920,000 and then the average total cost increases. Therefore, the optimal replacement period is nine years, i.e. the economic life of Honda Pilot is nine years.

Table 4.3.7 Determination of the economic life of Skoda Superb (first cost = 4,695,000)

End of year (n)	Maintenance cost at end of year	Summation of maintenance costs	Average cost of maintenance through year end	Average first cost if replaced at yr end given	Average total cost through year given
A	B	C	C/A	4,650,000/A	D + E
1	0	0	0	4,650,000	4,650,000
2	420,000	420,000	210,000	2,325,000	2,535,000
3	620,000	1,040,000	346,667	1,550,000	1,896,667
4	820,000	1,860,000	465,000	1,162,500	1,627,500
5	1,020,000	2,880,000	576,000	930,000	1,506,000
6	1,220,000	4,100,000	683,333	775,000	1,458,333
7	1,420,000	5,520,000	788,571	664,286	1,452,857*
8	1,620,000	7,140,000	892,500.00	581,250	1,473,750
9	1,820,000	8,960,000	995,556	516,667	1,512,222
10	2,020,000	10,980,000	1,098,000	465,000	1,563,000

***Economic life of Skoda Superb = 7 years**

Source: Source: fieldwork (2015).

From table 4.3.7, the average total cost of Skoda Superb decreases till the end of year 7 having the maintenance cost at 1,420,000 and then the average total cost increases. Therefore, the optimal replacement period is seven years, i.e. the economic life of Skoda Superb is seven years.

Table 4.3.8 Determination of the economic life of VW Passat (first cost = 5,965,000)

End of year (n)	Maintenance cost at end of year	Summation of maintenance costs	Average cost of maintenance through year end	Average first cost if replaced at yr end given	Average total cost through year given
A	B	C	C/A	5,990,000/A	D + E

1	0	0	0	5,990,000	5,990,000
2	470,000	470,000	235,000	2,995,000	3,230,000
3	670,000	1,140,000	380,000	1,996,667	2,376,667
4	870,000	2,010,000	502,500	1,497,500	2,000,000
5	1,070,000	3,080,000	616,000	1,198,000	1,814,000
6	1,270,000	4,350,000	725,000.00	998,333	1,723,333
7	1,470,000	5,820,000	831,429	855,714	1,687,143
8	1,670,000	7,490,000	936,250	748,750	1,685,000*
9	1,870,000	9,360,000	1,040,000	665,556	1,705,556
10	2,070,000	11,430,000	1,143,000	599,000	1,742,000

*Economic life of VW Passat = 8 years

Source: Source: fieldwork (2015).

From table 4.3.8, the average total cost of VW Passat decreases till the end of year 8 having maintenance cost at 1,670,000 and then the average total cost increases. Therefore, the optimal replacement period is eight years, i.e. the economic life of VW Passat is eight years.

*Table 4.3.**9:** Determination of economic life of T/Hiace (first cost = 6,100,000)*

End of year (n)	Maintenance cost at end of year	Summation of maintenance costs	Average cost of maintenance through year end	Average first cost if replaced at yr end given	Average total cost through year given
A	B	C	C/A	6,195,000/A	D + E
1	0	0	0	6,195,000	6,195,000
2	498,000	498,000	249,000	3,097,500	3,346,500
3	698,000	1,196,000	398,667.00	2,065,000	2,463,667
4	898,000	2,094,000	523,500	1,548,750	2,072,250
5	1,098,000	3,192,000	638,400	1,239,000	1,877,400
6	1,298,000	4,490,000	748,333	1,032,500	1,780,833
7	1,498,000	5,988,000	855,428.57	885,000	1,740,429
8	1,698,000	7,686,000	960,750	774,375	1,735,125*
9	1,898,000	9,584,000	1,064,888.80	688,333	1,753,222
10	2,098,000	11,682,000	1,168,200	619,500	1,787,700

*Economic life of T/ Hiace is 8 years

Source: Source: fieldwork (2015).

From table 4.3.9, the average total cost of T/Hiace decreases till the end of year 8 having maintenance cost at 1,698,000 and then the average total cost increases. Therefore, the optimal replacement period is eight years, i.e. the economic life of T/Hiace is eight years

4.4 Summaries of Vehicles and their Economic Life

Table 4.4.1 vehicle make and economic life

S/N	VEHICLE TYPES	ECONOMIC LIFE
1	SKODA SUPERB	7 YEARS
2	T/COROLLA	7 YEARS
3	T/AVENSIS	8 YEARS
4	T/HILUX	6 YEARS
5	VW PASSAT	8 YEARS
6	H/ACCORD	8 YEARS
7	T/CAMRY	9 YEARS
8	HONDA PILOT	9 YEARS
9	T/COASTER	7 YEARS
10	T/HIACE	8 YEARS

Source: fieldwork (2015).

From table 4.4, only T/Hilux has an economic life of 6 years, T/Corolla, T/Coaster and Skoda Superb should be replaced after 7 years, T/Avensis, H/Accord, VW Passat, and T/Hiace should be replaced after 8 years, and finally, T/Camry and Honda Pilot should be replaced after 9 years.

Conclusion

After careful analysis of NPPC fleet management and vehicle replacement model the study concludes that the organisation uses Toyota products mostly, it constitutes about 85% of the vehicle fleet. The method of maintenance adopted by the corporation is in-house maintenance in the workshop which is under the Central Transport Service Section (CTSS). Preventive maintenance is carried out for maintaining the vehicles before breakdown. T/Hilux model with 6 years economic life, while T/Corolla; T/Coaster and Skoda Superb are replaced every 7 years, T/Avensis; H/Accord, VW Passat, and T/Hiace are replaced on or after 8 years, finally, T/Camry and Honda Pilot are replaced after 9 years. Based on the study findings, NNPC does not use their vehicles up to the vehicle economic life span as noted in all models sampled. In asset management principle, this is an economic wastage i.e. waste of scare resources which needs to be addressed by the logistic managers. In view of the study findings, it is recommended that the land transport department of NNPC should adopt a uniform policy of using vehicles to the end of economic life span, to reduce and preventing wastage, NNPC fleet managers should be able to set apart a certain amount every year to make replacement easy. For example, 15% of inflation rate can be set apart every year for each vehicle.

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