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VEHICLE REPAIR AND MAINTENANCE COSTS IN NIGERIA DEVELOPMENT OF A STANDARD MODEL.

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ABSTRACT

A standard model was established for the prediction of repair and maintenance costs of vehicles in a non-profit making government parastatal. The model was derived based on data collected over a ter. year period from a non-profit making government parastatal, and it predicts repair and maintenance costs as a linear function of the age (in years) of the vehicles. The model showed that the vehicles' age (in years) was the major determinant of the vehicle repair and maintenance costs. It also revealed that a number of other factors, which were not quantified in this study due to lack of information, influenced repair and maintenance costs but to a lesser degree as compared to the age of the vehicles. These factors include maintenance management, driver skill and attitude, and the condition of the roads. Tests of significance for the model parameters show that most of the parameters are highly significant.

Keywords: Repair, Maintenance, Vehicle, Replacement, Model

INTRODUCTION

Transportation plays a great role in the economy of a nation. In Nigeria, transportation is generally characterized by predominantly individually-owned vehicles with varying degree of government intervention in their management. However, there are quite a number of vehicles invariably maintained and managed by the government. Transportation system in Nigeria is largely underdeveloped, even though the government conceives transportation as a major component of any governmental development strategy and life improvement process. Hence, the government of Nigeria gives vehicles to different government parastatals in the country. Most government establishments have a set of vehicles of different types and models, which they use for official assignments. Vehicles represent the central component of any improved transport system in Nigeria since it is the most frequently used mode of transportation. Repair and maintenance costs are a small but relatively important portion of the total costs of owning and operating vehicles. Estimates of repair costs are important tools that assist in vehicle replacement decisions and in developing an optimal policy in order to minimize those costs that accrue over the useful and economic life of the vehicles.

The objectives of this study among others include:

1. To develop a standard prediction model for repair and maintenance costs of vehicles in Nigeria.
2. To compare prediction models for repair and maintenance cost of government vehicles in Nigeria.
3. To investigate the major factors, which influence repair and maintenance cost.

LITERATURE REVIEW

Very little data concerning repair and maintenance costs of vehicles in government parastatals were available for developing countries. This was the case also with tractor maintenance as pointed out by Beppler and Hummeida (1985). Previous investigations and studies indicated that using American and European data in estimating repair and maintenance costs of used items in developing countries produced unrealistic and misleading estimates (Inns, 1978, Hanna and Younis, 1987, Adekoya and Oteno, 1990). Etuk (1986) also showed that maintenance functions adapted to a profit making organization in Nigeria cannot be used to estimate repair and maintenance costs functions in government parastatals, otherwise, the results could lead to erroneous conclusions. The results were expected to vary from one organization to another because of differences in usage, availability of funds and handling. (Rotz, 1987, Morris, 1988 and Ward 1990) have established that a best model structure, which is well suited for the prediction of repair and maintenance costs of machines, was a power function of the form $Y = ax^b$ where Y was the total cumulative repair and maintenance costs in percentage of the machine initial purchase price, while the independent variable X was the machine cumulative use (in hours). The constant

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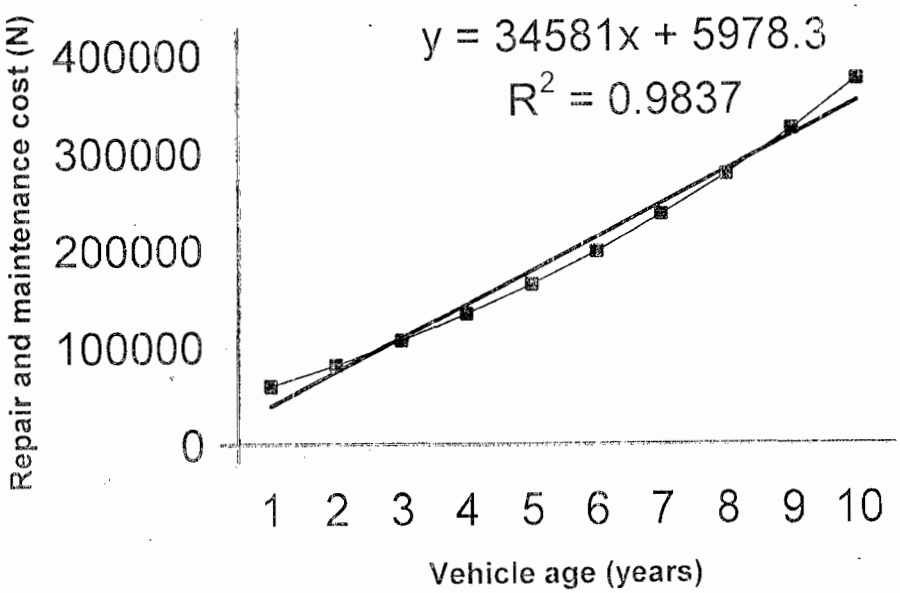

Fig. 1 Simple linear fit of vehicle repair and maintenance cost.

a is the average cumulative repair and maintenance cost of a new Machine, while b is the average increase in cost of repair and maintenance per unit increase in cumulative use (in hours) of the machine. The model assumed that a machine cumulative repair and maintenance cost was a function of its cumulative use in hours. The parameters of the model varied with a number of factors such as machine maintenance management, working conditions, skill and attitude of the machine operator, machine design features, size of samples surveyed, accuracy of data keeping systems and operational systems adopted.

In order to determine optimal age at which to replace an ageing vehicle, costs relating to purchase, operations and disposal value of the vehicle are required: see Lake and Muhlemann (1979), Schwartz et al (1983). This suggested that a cost function should be fitted to the repair and maintenance costs which constitute the major part of the operational cost. Christer and Goodbody (1980) and Mital and Kaul (1984) suggest that because of the prevailing high inflation rates, any model developed to predict repair and maintenance costs should include an inflation factor. Consequently, an average inflation rate of (26%) was used to adjust prices and costs.

METHODOLOGY

A field survey of a number of management parameters, including costs relating to purchase, operations and disposal value of vehicles in a non-profit making government parastatal was conducted. The parastatal was chosen to represent the main non-profit making government parastatal in Nigeria whose management has been maintaining relatively appropriate and reliable operation and management data system. The total number of vehicle population surveyed was forty 504-saloon vehicles. Part of the data was collected from the vehicle log book and it included vehicle make and model, date of purchase, purchase value, vehicle registration, chasis and engine numbers, detailed repair and maintenance expenditure (spare parts and labour).

Also data on the salvage value of the vehicle at a certain age t, was collected. In addition, the government drivers, maintenance management personnels were also interviewed. All the costs were discounted to the base year, which is the first year of the period of study.

All monitored costs in this study were accrued over a period of 10 years during which the rate of inflation was remarkably high, consequently, an average inflation rate of (26%) was used to adjust these prices and costs (Central Bank of Nigeria, Annual Report and statement of accounts (1996-2000)).

Vehicle cumulative age in use (in years) was linearly correlated with the average annual repair and maintenance costs per year. In this study, we shall be using three models to fit our data namely: simple linear regression given as $y= a+bx$, exponential function given as $y= \exp (a+bx)$ and power function given as $y= ax^b$ where, y is the average annual repair and maintenance cost of a vehicle, x is the vehicle cumulative age in use(in years), a is the average annual repair and maintenance cost of a new vehicle and b is the average increase in cost of repair and

TABLE 1: COMPARISON OF THE FITTED MODELS TO THE DATA

Model	Model equation	r^2	F
Simple linear Y a+bx	Y=5977.800+34581	0.984	483.243
Exponential Y= exp (a+bx)	$Y=56931e^{0.197x}$	0.985	530.688
Power function $Y=ax^b$	$Y=49892x^{0.8073}$	0.963	207.171

TABLE 2: TEST OF SIGNIFICANCE FOR MODEL PARAMETERS

Model	Coefficients	t-value
Simple Linear	βo = 5977.800	0.612
	β1 = 34581.509	21.983
Exponential	βo = 10.950	205.621
	β1 = 0.198	23.037
Power function	βo = 10.818	115.989
	β1 = 0.807	14.393

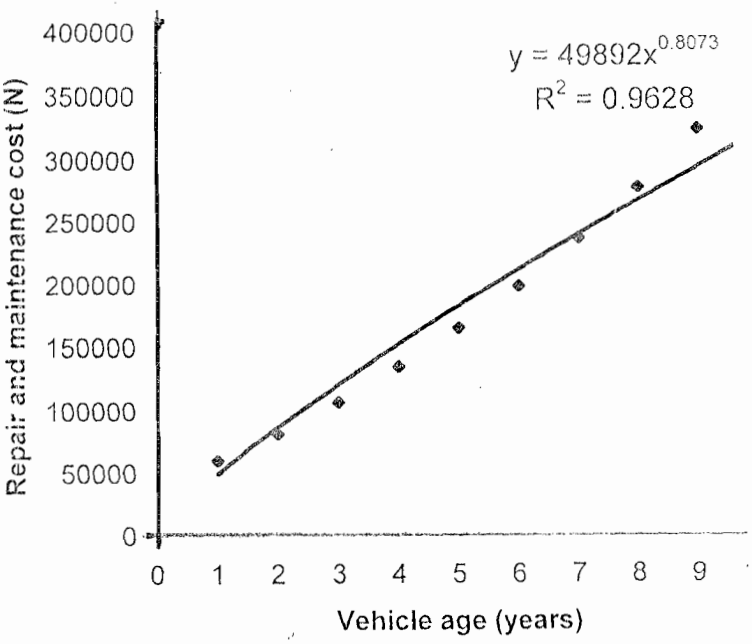

Fig. 2 Power curve of vehicle repairs and maintenance cost.

maintenance cost of a vehicle per unit increase in cumulative use (in years) of the vehicle. The choice of these models for our study was justified by the common models used for such studies in the literature. Simple linear regression models were established by log transformations.

The data was then set and analyzed using (MSTAT C) statistical computer Program, on IBM-586 personal computer which fitted the models to the case study data. The best-fit was selected based on the value of the coefficient of determination (r^2).

RESULTS AND DISCUSSIONS

The analysis of data showed that the three models fitted namely simple linear regression, exponential and power function models, all provided good fit for the data. Table 1 shows a comparison of the best fitted models to the data. It includes the transformed equation for the models and their F-ratio. The analysis of the data indicated that repair and maintenance costs increased proportionally with vehicle cumulative use in years. The relatively high coefficient of determination for simple linear, exponential and power function which are 0.984, 0.985 and 0.963 respectively, suggest that the vehicle cumulative age (in years) was the major determinant of vehicle repair and maintenance costs. Hence the age in use of a vehicle could adequately explain variation in repair and maintenance costs. Figure 1 shows the model prediction curve using a simple linear regression model. Figure 2 shows the model prediction curve using an exponential model while Figure 3 shows the model prediction curve using a power curve. All the three Figures indicated that the repair and maintenance costs were increasing as cumulative use (in years) of the vehicle increased.

Table 2 shows the model coefficients and their respective t values for the three models fitted to the data. The tests of significance for the model coefficients show that the parameters are highly significant at 5% level of significance except for the intercept coefficient in the simple linear regression model.

CONCLUSIONS

Based on the analysis of data utilized in this study, the following conclusions can be drawn. Correlation between repair and maintenance costs and vehicle cumulative use (in years) would best be described by an exponential function

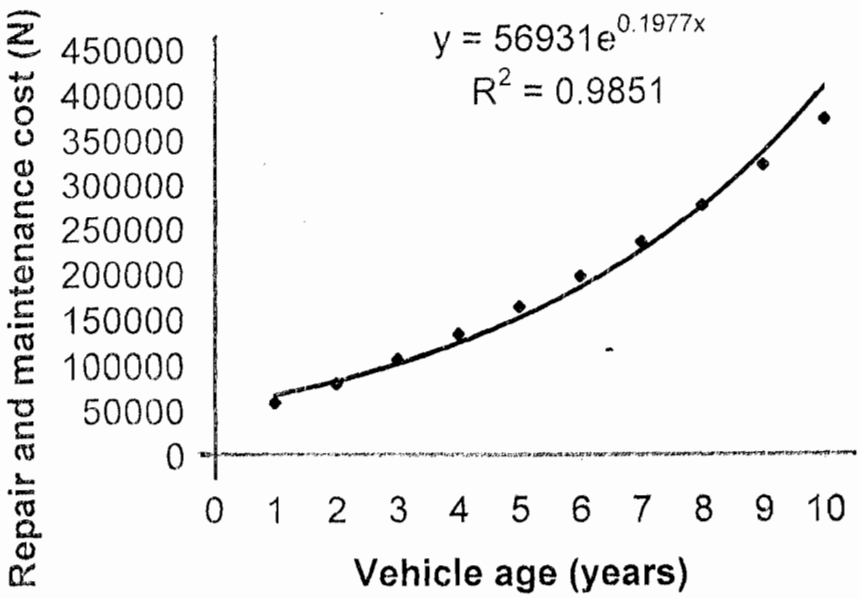

Fig. 3 Exponential curve of vehicle repair and maintenance cost

equation of the form Y = exp (a+bx), which gives the highest coefficient of determination when compared with other models fitted in this study. The established prediction model for repair and maintenance costs for a typical non-profit making government parastatal in Nigeria was Y= 5693 $1e^{0.1977x}$. Vehicle cumulative use (in years) was a major determinant of repair and maintenance costs.

Other factors, which were not qualified in this study, influence vehicle repair and maintenance costs very little compared to vehicle cumulative use because the unexplained coefficient of the fitted model is less than 2%.
Other prediction models such as simple linear regression models and power function could also be used to describe the repair and maintenance costs for vehicles in Nigeria, however, the exponential function gave a slightly higher coefficient of determination r^2.

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