DETERMINATION OF REPLACEMENT TIME FOR CARS

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ABSTRACT

Replacement times for cars were studied using their operating and maintenance records and their resale and depreciation values obtained from market surveys. In a popular brand of saloon cars, the replacement time is established as six years after purchase as brand new. If second-hand cars are also to be considered, two-year-old cars should be bought and used for four years before being replaced. These findings are based on prices of cars, spares and maintenance items up to 1992.

1.0 INTRODUCTION

Increasingly, management of different organisations are being confronted with problems of maintenance and replacement of existing equipment. Since many equipment deteriorate with age and use, their operating and maintenance costs become comparatively enormous as the benefits derived from them decline [1]. There is therefore need for corrective measures based on objective judgement that could be implemented to restore effectiveness. There is growing awareness that scientifically controlled maintenance can become a positive profit-contributing activity within an organisation [2,3].

This work refers only to replacement problems where performance deteriorates deterministically over time and this is measured by a decrease in the net benefits derived from operating them or by their increasing operating cost [4].

Models of deterministic problems may differ for the fact that the optimising criteria are not the same. It is futile to determine a maintenance policy which enables system availability to be maximised if the organisation would rather have profitability maximised[5].

The objective of this work is to demonstrate how the replacement time for a piece of equipment could be established using a popular brand of saloon car as example. For simplicity, the time value of money is not considered here. It is however possible to include factors of time value of money in this kind of analysis. Hyper-inflationary situations, equipment rather than depreciate in value, appreciate thus requiring a different analytical model.

2.0 REPLACEMENT DETERMINANTS

The factors that determine the replacement time are the components of the total cost of owning the equipment. These determinants are such that the total cost should be at a minimum. The following are the determinants of replacement:

(a) Purchase prices of new cars
(b) Time-based resale values of existing cars
(c) Time-based purchase price of second-hand cars
(d) Operating and maintenance costs of existing cars

The replacement problem seeks to determine when to replace an existing car with a new one or with a used car of a particular age. Resale values are expected to be less than purchase prices since a car normally depreciates in value with time.

2.1 PURCHASE/RESALE PRICES

Purchase price is the amount of money to acquire an asset or equipment. Resale price is the recovered sum for the disposal or transfer of ownership of an equipment. Resale price is not the same as
3.2 REPLACEMENT WITH A NEW OR USED EQUIPMENT

The need to ascertain, in addition, the age of the used car that would replace the existing one makes this model more complex [6]. The problem becomes that of replacing the existing car age \( i \) with a used car aged \( j \) where \( i = 1.2.3... \) and \( j = 0.1.2.3... \). Annual capital cost, \( C(i,j) \) is given by

\[
C(i,j) = C(i) - C(j)
\]

(3)

Where \( C(i) \) is purchase price of car aged \( i \) and \( C(j) \) is the resale value of existing car at age \( j \).

Cumulative operating cost, \( C_n(i,j) \) is expressed as

\[
C_n(i,j) = C_n(i,j-1) - C_n(j-1)
\]

(4)

The total annual cost, \( C(i,j) \) can then be expressed as

\[
C(i,j) = C(i,j) + C(i,j)
\]

(5)

From equation (5), the average total annual cost, \( C_n(i,j) \) becomes

\[
C_n(i,j) = \frac{C_n(i,j)}{i-j}
\]

(6)

4.0 ANALYSIS OF DATA

Tables 1 to 7 show that analysed data for each of the seven cars with complete operating and maintenance data. These cars were purchased between 1982 and 1994. All the data were obtained from records for the previous ten years up to 1992. These records are available from dealers, accounting firms, insurance brokers, and the Accounting and Maintenance Departments of the organisation that owns the vehicles studied. The record of the last vehicle (Table 7) was only for eight years (1994 - 1992). Values for the remaining two years completing the ten-year span were obtained by graphical extrapolation.

The purchase price, operating and maintenance costs and the year and resale values are given in the first part of each table from where the average annual cost are derived in the second middle part of the table. The minimum average annual cost shown with a single asterisk determines the optimum time of replacement with a new car. The last part of each table gives the average total cost per year for a car sold at age given in the row (top) to the replaced with another car purchased at age given in the column (left side). The optimum replacement time is at the minimum average cost per year indicated with double asterisks. The assumption here is that replacement occurs with the same brand of vehicle or equipment.

All the tables agree that replacement with a new car should occur at the end of the sixth year of use except for Table 2 that specifies end of fifth year. Table 3 to 7 recommend that, if used cars also come into consideration, the optimum replacement policy is to purchase a five-year-old car and replace it after four years i.e. when it is six years old. Tables 1 and 2 respectively recommend purchasing a year-old car to replace it after three years and purchasing a five-year-old car to replace it after four years. It is noteworthy that all the different ages at purchases have their minima at the same age at sale i.e. at the age five years for Table 2 and age six years for Tables 3 to 7.

Table 1 has no such pattern which indicates that the values are faulty and should be reviewed. It therefore becomes clear that five out of six correct sets of data kept for the cars recommend a replacement.
policy or purchasing a two-year-old car and replacing it after four years of further use. This method can then be applied to the determination of replacement policy for other types of equipment.

4.1 EFFECTS OF SAP ON REPLACEMENT

Since the introduction of structural adjustment programme (SAP) into the national economy, the rates of inflation and banking interests have climbed up [7]. Apart from considerations of time value of money, the values of equipment and other items keep appreciating instead of depreciating as in normal economies. A normal economy here refers to an economy where items and equipment except land depreciate in value over time.

Our economy therefore is one with high rates of increase in maintenance costs, operating costs and monetary value of the cars. In other words, the resale value of the car becomes higher (if not appreciably) than the purchase price. Fig. 1 shows that with increasing resale price, the replacement time increases for the same maintenance and operating costs.

On the other hand, the similar rate of increase in the costs of maintenance and operations tends to oppose the effect of increasing resale price i.e. it reduces the replacement time. For increasing resale price and other increasing costs, the total cost minimisation concept still applies to the determination of optimum time of replacement. This concept is applicable irrespective of the high prices of vehicles and other equipment as there are corresponding increases in the operating and maintenance costs. For high car prices, the rates of depreciation are likely to be quite high when resale prices decrease over time. This is because these increases in purchases prices do not reflect corresponding increases in value. Data are not yet completely available to properly examine replacement under the present high prices of cars.

5.0 CONCLUSION

From the foregoing, the determination of the optimum replacement time for most equipment is possible provided the depreciation, and operating and maintenance costs records are properly kept. For this popular brand of saloon car studied, the optimum replacement time is six years. In other words, if replacement is to be made with a new car, sell the old one after six years of service and buy a new one. If used cars are considered as well, the replacement purchase a two-year-old car and replace after four years of service i.e. when it is six years old. It is not likely that the present high prices of cars will significantly change this policy as there are corresponding increases in maintenance and operating costs.

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6.0 REFERENCE