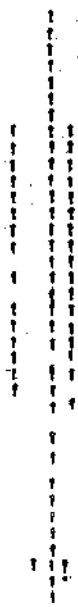
CHAPTER VI

Summary and Conclusions



It is proposed to present a summary of the present work and give a brief resume of the important findings in this chapter. At the end of this chapter some guidelines are suggested for the future studies* A discussion about utility of the present study for nationalised road transport undertakings is also taken up.

In chapter I it was noted that the problems dealt with in the theory of replacement can be classified into two categories, viz. i) deterministic or ii) stochastic. The theory of replacement can be made applicable to men as well as machinery though comparatively larger number of applications are for durable equipments.

The awareness of the systematic approach to the replacement problems and its importance is seen to be comparatively more in U.S. and U.K. than that in India. As far as the systematic study of the problem of replacement of vehicles belonging to a fleet qf vehicles is concerned, the C.I.R.T. has made a beginning by conducting a workshop on 'Bus Replacement' in July 1978, which was at the instance of the Association of State Road Transport Undertakings, Few Delhi. The problem of replacement of vehicles falls in the category 1, viz. replacement of items that deteriorate with time. As far as the second category, viz. 'replacement of items that fail suddenly' is concerned, the vehicle-replacement problem had no bearing with it.

A review of the historical background of the theory of replacement reveals that its origin can be traced in the papers by Taylor and Hotelling published in 1923. But it was in 1949 that Terborgh made a break-through in the theory of replacement and comparatively in last 30 years i.e. after 1949, significant work has been published in this field as compared to the earlier period of 26 years— i.e. preTerborghian period. A categorization of different replacement models was made and five broad categories were identified. Landmark replacement models were reviewed from different aspects such as, use of different mathematical/ statistical/operations research techniques, category, variables/parameters used, assumptions made, etc. A presentation of these models in a tabular form gives an overall view of these models* It was noted that various authors have used different names for certain common basic variables representing slightly different shades. But terms like inferiority gradient, challenger, defender, cost due to machine stoppages, cost of lost production time, etc. are peculiar for the theory of replacement alone. Use of dynamic programming, sensitivity analysis, computer programming, discounted cash flow technique, etc. in the theory of replacement shows that as and when new techniques in mathematics/statistics/operations research were developed they were advantageously employed in the theory of replacement. Host of the replacement models were meant for equipments in general and very few models were 'problem oriented'. Of course this statement does not necessarily

imply less utility on the part of theoretical models. Most of the replacement models are such that an exact estimation of various parameters involved in these models is an essential factor for the effective use of them in real life situations. Estimation of various parameters naturally requires adequate and reliable data. It is noted that as far as the problem of replacement of vehicles belonging to the large fleet possessed by the nationalised road transport undertakings in India is concerned, paucity of adequate and reliable data is the biggest hurdle. This being an individual's research project no controlled experiments generating the desired volume of data-set could be possibly conducted. Secondly all the existing replacement models are dominated by mostly the economic considerations. Maximisation of profits or minimisation of costs is mostly the objective of these models. Considering the problem on hand, it was, therefore, not advisible to apply the existing models for the vehicle replacement problem.

A separate review of the vehicle-replacement models was taken keeping in view the bearing it has with the problem on hand. The operational cost studies, incorporated in this review, revealed that the consumption of high-speed-diesel, lubrication oil and spare parts is a function of a large number of factors. The utility of such studies is limited upto the identification of these factors. Certain factors such as existing road condition and type of road surface,

lengths of different scheduled trips, quality of spare-parts etc. are beyond the control of any undertaking. Secondly all the vehicle replacement models reviewed earlier require estimates of different parameters used in the model. But because vehicle-wise accounting system is not followed in any of the nationalised road transport undertakings, there was no likelihood of getting adequate data which would enable estimation of different parameters involved in the models. Thirdly all the existing vehicle-replacement models were dominated by economic considerations and social obligations of operating a specified target of kms. per day to serve the travelling public in rural area could not be incorporated in these models. The review of these vehicle replacement studies reveals that comparatively more awareness is seen in this particular type of durable equipment, viz. vehicles than the other machinery such as locomotives, ships, textile machinery, etc. However nonavailability of vehicle-wise data continues to be a hurdle in the applications of replacement models in meaningful decisions of vehicle-replacements.

In chapter IV the activity of reconditioning is considered from different points of views. A review of the maintenance practices occuring in the M.S.R.T.C. reveals that it is quite decentralised and well organised. Different activities are entrusted at depot, division and central

workshop levels and all the levels are being strengthened during last several years. However vehicle-wise accounting is not done at any of these levels. As noted earlier, the activity of reconditioning can be viewed as a kind of replacement of different components whenever necessary. The need for reconditioning is quite obvious for the M.S.R.T.C. in particular, or for any nationalised road transport undertaking in India, in general. * Nonavailability of chassis has been a head-ache for all the nationalised undertakings since last 10 years or so. The existing fleet could not, therefore, be strengthened in an adequate measure by the M.S.R.T.C. in the last decade. Consequently the activity of reconditioning was required to be decentralised from the Central Workshop level to the divisional heavy repairs units situated at all divisional headquarters. ..

Inspite of the pressing need for the activity of reconditioning a time-lag was observed in the actual implementation of reconditioning compared to the prescribed kilometerages for the 1st to 4th reconditionings. The sample study based on Aurangabad division's data revealed that the delays or deviations of the actual implementation of the policy of reconditioning from the planned ones are not sizable as far as the first and second reconditionings are concerned while for the later two reconditionings they were quite sizable. This fact implies that the third and fourth reconditionings required more careful control

and planning eventhough the benefits in terms of improved K.P.T.L., K.P.L. and monthly utilisations are not substantial. But for an undertaking which is faced by an acute shortage of vehicles especially in peak seasons, availability of every additional kilometre in its potential was important from the point of extension of travelling services to rural areas. Different methods suggested for estimating the actual costs of reconditionings require vehicle-wise data on all the components which contribute to the total cost of reconditionings. Once such precise estimates are obtained the cost-benefit analysis can be done for the activity of reconditioning. As far as the improvement in K.P.T.L., K.P.L. and monthly utilisations obtainable from reconditioned vehicles is concerned, it is of varied intensity for the 1st to 4th reconditionings. Furthermore for any reconditioning, with every increase in utilisation by 50,000 kms. since reconditioning the improvements tend to decline. It was also noticed that the activity of reconditioning does not bring a vehicle on par with the new one. This indicates that excessive use of old but serviceable parts be avoided so that problems of misalignment and of not getting optimum performance can be eliminated. But that would increase the cost of reconditioning. But if spare-parts are available and the fuel economy is to be given more weightage, it is worthwhile increasing the cost of reconditioning and get fuel economy and further improvements in the monthly

utilisations. This suggestion is further substantiated by the fact that the incidence of breakdowns can also be further minimised with improved quality of reconditioning.

In chapter V it is stressed that while proposing a vehicle-replacement model for a nationalised road transport undertaking the replacement of a vehicle be seen in conjunction with the fleet-characteristics and the target set for that fleet. Consideration of a vehicle in isolation from the fleet, which has been the conventional approach is not worthwhile. Consequently utilisation pattern of different components of a fleet of vehicles was firstly estimated. The average monthly utilisation per vehicle obtainable from a new vehicle comes to be 10173.6360 kms. while that from a vehicle belonging to the 8.5 to 9.00 lacks pro.kms. group is estimated to be 3519.5590 kms. These estimates are the averages for the peak, normal and slack seasons. These estimates were tested in the light of 1976-77 data of the M.S.R.T.C. fleet and the estimates were found to be agreeing to the facts. An empirical relationship between age expressed in terms of years and the age expressed in progressive kms. was estimated on the basis of a sample of vehicles. This can be used for predicting one given the other form of information. Similarly if the estimated value and actual value of age expressed in pro. kms. of a certain vehicle are differing significantly, it is an indicator of either

excessive utilisation or under utilisation compared to the utilisation pattern prevailing for the fleet to which the vehicle is attached.

In the subsequent section movements of vehicles to the higher age-groups are studied. Over a span of one year how many vehicles go to the next higher age-group is indicated by the ratios 'r' which are computed for different age-groups on the basis of the M.S.R.T.C. data. In general, for the year under consideration, data of the preceeding two years should be analysed to get the values of r's and these r's can be used as the estimates for the year under consideration so that the probable composition of the fleet at the end of one year can be estimated beforehand.

An indicator for fleet-strength of any undertaking is developed which is a more representative measure of the fleet-strength. The indicator, Z, is the proportion of the actual vehicle-kilometres of service remaining in the fleet to the vehicle-kilometres, a fleet would represent if all the vehicles in it were new. For the computation of Z, an estimate of the expected life of a vehicle is required. In the case of the M.S.R.T.C. data, it is taken to be 9 lacks pro, kms. or equivalently 12,60 years. The utilisation pattern, estimated earlier, is used and thus the remaining life of the fleet is calculated for a given age-distribution of the fleet. For illustration purposes data of the

M.S.R.T.C. fleet for the year 1977-78 is taken and the value of Z is computed. A general pattern of the behaviour of Z, the fleet strength indicator, N, the number of new vehicles added to the fleet and S, the number of old vehicles scrapped from the fleet is studied. For given N and for retaining the current value of Z, the minimum value of S is obtained. Similarly for retaining the same Z, and for a given minimum S, what minimum value of N is required is also obtained. For different sets of values of N and S, tables indicating the changes in the original value of Z are prepared. But it is noted that only the criterion of retaining or improving the fleet-strength is not sufficient but one has to also take into consideration the set target fixed in terms of the total kms. to be performed in a given year. The study of fleet-para meters at depotlevel is taken up subsequently so that an idea as to how vehicles belonging to different age-groups contribute to the total operating cost of the fleet is obtained. The M.S.R.T.C. does not have vehicle-wise data of operational cost and earnings but depot is taken as a unit. Naturally the fleet-parameters were required to be studied at depot level only. For this purpose the depot-budgets or performance reports of the depots which are maintained by the M.S.R.T.C. were used. A case-study of Aurangabad depot was taken up and the coefficients associated with each age-group were estimated and analysed. The interpretation Of these coefficients for different variables such as

effective kms., K.P.T.L., K.P.L., expenditure on spare-parts, expenditure on labour charges, etc. gave an idea of the quantification of the contributions of vehicles belonging to the different age-groups in the total operational cost of the fleet.

In the last section of this chapter a need for a different approach to tackle the problem of replacement is stressed in view of the social obligations, any nationalised road transport undertaking has to meet. Multiple objectives are discussed and the prime goal of fulfilling the target of a specified number offerns, is highlighted. In view of this and the fact that vehicle-wise accounting is not maintained by the M.S.R.T.C., a vehicle-replacement model is proposed. The salient features of this model are as follows:

1) Individual vehicle is not considered in isolation for taking the decision about its replacement but what proportion of a given fleet be scrapped is decided first keeping in view the objective of the target for the total gross kilometres to be achieved by the undertaking in the coming years. Thus whether to retain a given vehicle or to scrap it does not depend solely on the characteristics of that vehicle but it depends upon the characteristics of the fleet to which the said vehicle belongs. In a hypothetical situation where the entire fleet of vehicles consisting of all 'newer' vehicles belonging to age-groups, say, 0-1 or 1-2 lacks

pro. kms., required to meet a target of say T lacks tans., it is likely that one may take a decision to scrap a vehicle which has completed, say, 1,90,000 kms. On the other hand, for a fleet consisting of predominantly, older vehicles required to meet a target of T' kms., it is likely that a vehicle which has completed say, 9,00,000 kms. may be picked up for scrapping. Thus the decision of replacing a vehicle has to be taken in conjunction with the fleet to which the vehicle belongs.

2.) It is seen that the target for the total gross kms. to be obtained in the coming year can be met by three major components as given below.

$$T = n + e + s$$

where T = target in lacks of kms. to be achieved.

n = contribution by the new vehicles added to the existing fleet from time to time.

e = contribution by the existing vehicles in the fleet at the starting of the year.

s = contribution by the old vehicles before they are scrapped.

As noted earlier, e forms the major part of T (say 70 to 80 percent), n and s are to be adjusted by selecting the values of N and S in such a way that the target is just achieved.

The sequence of actions suggested in our model is such that in the light of the information about the number of new vehicles actually available at the start of any month, the decision about scrapping of vehicles is taken subsequently so that the target is just achieved. The model is to be operated in stages, at each stage latest information about IT and S being made use of. it each stage the fleet is so maintained that the yearly target is just attainable.

As appendix-A, a discussion about the estimates of salvage value that a vehicle can fetch is presented. Appendix-B presents a proposed Management Information System (M.I.S.) which when implemented can generate a data-set which would make the decision-making process of replacement more realistic and easy to operate.

Upon consideration of the facts that i) vehicle-wise accounting is not maintained ii) profit-making is not the prime goal of any nationalised road transport undertaking but iii) achievement of a target in terms of given number of kilometres is to be given top priority, the present model is proposed. Whatever information that is presently available in the records of the M.S.R.T.C. has been made use of. As an individual it was not possible to generate data-set and propose a model, as such a model suitable for the existing data is proposed. A new approach to consider the fleet as a whole in preference to the consideration of a single vehicle in isolation for tackling the problem of replacement is suggested in this study.

As far as the utility of the present work to the nationalised road transport undertakings such as the M.S.R.T.C. is concerned, it can be briefly put in the following words.

The existing policies regarding reconditioning, maintenanc practices, utilisations, etc. of vehicles have been systematically studied and their rationality was examined. Suitable suggestions are made which when implemented can make replacement decisions more rational. Different estimates about the monthly vehicle utilisations, operational cost parameters, etc. which are obtained on the basis of a sample of vehicles in the present work, can prove useful and further refinements in them can be done by the Undertakings. The proposed M.I.S., which is a compromise between two extreme accounting methods, can prove useful for the Undertakings in order to take more meaningful decisions on replacement problems. Similarly for important spare-parts and major assemblies this technique can be progressively extended which would help improve the inventory control also. If necessary estimates at depot levels are obtained, the proposed model can help an Undertaking in achieving the desired target of a specified number of kilometres.

In the present study the problem of replacement of a vehicle is studied and consideration of spare-parts and

important assemblies constituting a vehicle could not be taken up. Controlled experiments using the principles of Design of Experiments and Factor Analysis be conducted by different undertakings so that exact quantification of different factors in operational costs can be done.

If the proposed Management Information System is implemented by any undertaking, it would generate quite useful data for arriving at rational replacement decisions. The present policy of the M.S.R.T.C. of procurring new vehicles at the Central Office level be continued but the decision about scrapping of a vehicle be taken at divisional level. Fixation of targets be done at depot level and the compilation of these figures be merely done at higher levels. If these policy implications are effected, the decision making process about the replacement of vehicles can become easier and rational.

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