Replacement models in the heavy goods road transport industry: an exploratory study

PUBLISHER

Loughborough University of Technology

Replacement Models In The Heavy Goods Road Transport Industry : An Exploratory Study

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A Thesis submitted in part fulfilment of the requirements for a Master of Science Degree

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1966/67

Acknowledgments

This thesis represents the coagulation of information and opinion gathered from a number of sources. Primarily I would like to acknowledge the constant encouragement, constructive criticism and help from Mr. R. A. Fawthrop who was tutor for this study.

I would like also to thank the following people and their companies, for their invaluable help.

1. Mr. T. G. Slator and Mr. Jarvis of Ford and Slator Ltd.
2. Mr. R. C. Morton and Mr. A. Brook of Calor Gas Operations Division, Calor Gas Holding Co. Limited.
3. Mr. D. C. Brown of British Road Services Federation Limited
4. Mr. A. Mansfield and Mr. Baines of Hargeaves Transport Ltd.
5. Mr. H. Glassbrook of Leyland Motors Limited.

Contents

1. Introduction

The object of this study is to explore the patterns and policies which form the bases of replacement decisions in the field of heavy goods vehicles. A second objective is to formulate models and methods upon which future decisions may be arrived at more rationally.

This exploratory study is also intended to form the basis of further work in this field. This work is primarily to be an attempt to accurately quantify some of the hypothesis presented in this study and therefore to form eventually a firm set of criteria upon which replacement decisions in this field may be based.

2 Synopsis

2.1 The procedure adopted : an outline

A brief study of the basic principles underlying economic studies, for either replacement analysis or investment appraisal purposes, is presented together with a model put forward by Taylor[1] which finds specific application in the machine tool field. This model takes into consideration both periodic deterioration and obsolescence. The objective here ~~being~~ is to see whether perhaps this model might have application in the heavy goods vehicle field.

An analysis of the structure of capital allowances as applicable to the transport industry is presented and also a brief reference to the recent changes in the tax allowances and their effects. This latter, though now of purely historical interest, is relevant from the point of view of understanding the background of the industry.

At this point information about the relevant constraints is presented. This being followed by a series of models constructed mainly from information obtained from a number of firms in the haulage industry[2]. These models do not by any means present the actual practices in industry. They do present the various important influencing factors and the methods of dealing with them. It is suggested that models such as these should form the basis of replacement analysis or at least form the basis of further research into this field.

2.2. Summary of Conclusions

2.2.1 No overall policy of replacement is feasible. The industry has of necessity to be categorised and so studied.

2.2.2 The study rejects the suitability of Taylor's model vis-a-vis the heavy vehicle field upon the grounds that the basic premises are not comparable.

2.2.3 It was found that no very rigorous approach is being applied in this field in practice, especially relating to depreciation and cost of capital. The time value of money is not actually used in analysis, even though the concept might be accepted in principle. Further, no account is taken of the tax benefits accrueing to the vehicle.

2.2.4 The study clearly identifies the appearance of the progressively increasing costs of deterioration as being the primary factor governing the situation. Obsolescence plays a very indirect and unpredictable role.

The models show the presence of two minima in the total cost curve, providing that a major overhaul is envisaged.

2.2.5 It has not been possible to establish conclusively which of the two probable points in the life of the vehicle,at which replacement ought to occur, is the more advantageous.

2.2.6 The general level of economic activity in the country affects strongly the replacement situation.

2.2.7 The recent changes in the taxation regulations and the withdrawal of the Investment allowances represent a draconian increase in the effective cost of a vehicle to the operator.

2.2.8 It is hoped that this study will usefully provide paths along which further research may be directed.

1) See Section 4.4.

2) See acknowledgements

3. The concept of the Time Value of Money

3.1 Basic Principles The fundamental principle of the time value concept of money is that a particular sum of money is worth more at the present moment than at some time in the future. That is, there is a cost involved in the usage of capital. Alternatively a future sum is worth less than its nominal value. In order to assess its true value then the future sum is discounted appropriately. This requires two types of information as a prerequisite.

3.2 The cost of Capital The first data required is the cost of capital. This is the figure at which all discounting is to be carried out. The determination of this percentage figure is extremely difficult to arrive at and such a determination is beyond the scope of this report. However, certain criteria may be used to arrive at a reasonable figure for the cos of capital.

These are:-

3.2.1 Average for the relevant industry

3.2.2 The national average

3.2.3 The inverse of the Price/Earnings ratio

3.2.4 Some assessment of the opportunity cost

3.2.5 An arbitrary figure.

3.3 The Time interval It is clear that the time involved will be relevant to the time value of money. However, a further distinction is necessary. When interest rates are compounded, this then reqyires that the unit of time is not for example in years, but is the interest period itself.

3.3.1 The Time Scale On a time scale the point 0 represents the moment an investment or expenditure is paid for and 1 is the end of the first period - or rather the time when the first interest payment is due. This scale is illustrated in Figure 3.1

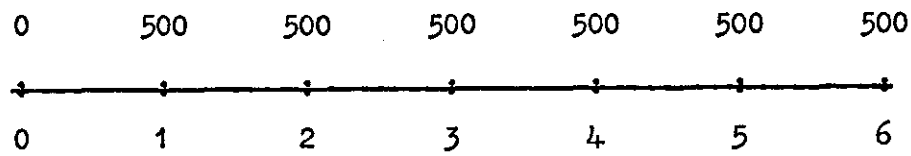


Figure 3.1

The figures above the line represent the flow of money at those particular points in time. For the sake of this model it is assumed that all such money flows occur at the end of each discrete period, though in practice this is not likely to be the case.

3.4 Rate of Return Formulae and Derivations In translating the time value of money into mathematical expressions a number of very useful relations are obtained.

3.4.1 Symbols and terminology

3.4.1.1 P designates a present sum of money. That is on the time scale it appears at the beginning of the initial period.

3.4.1.2 S designates a sum of money at a specified time in the future.

3.4.1.3 R designates a uniform series of end of period payments.

3.4.1.4 i designates the interest rate applicable. In this specific context interest may for other specific cases read rate of return or yield or cost of capital.

3.4.1.5 n designates the number of interest periods

3.4.2 Single payment compound-amount factor (s.p.c.a.f.). Consider the following time series

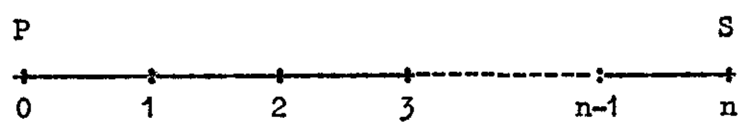


Figure 3.2

The value of S will then be given by the relationship

$$S = P(1+i)^n \qquad (3.1)$$

3.4.3 Single payment present worth factor (s.p.p.w.f.). This means that is is required to find the present value P of a future sum S. This is the inverse of the process in Section 3.4.2. Therefore rearranging equation (3.1)

$$P = S/(1+i)^n \qquad (3.2)$$

3.4.4 Uniform series compound amount factor (u.s.c.a.f.). Consider the following time scale.

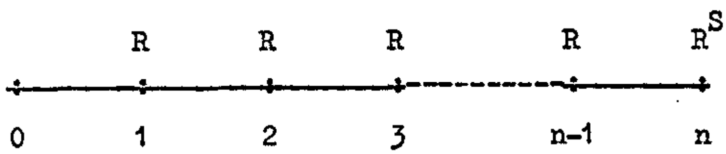


Figure (3.3.)

In this situation the value of S is given by the relationship

$$S = R\left[(1+i)^n - 1\right]/i \quad \text{-------} \; (3.3)$$

3.4.5. Sinking-fund deposit factor (s.f.d.f.). This enable the determination of a uniform series of end of period payments in order to provide a future sum S.

This is obtained by rearranging equation (3.3) thus,

$$R = Si/\left[(1+i)^n - 1\right] \quad \text{-------------} \; (3.4)$$

3.4.6 Capital Recovery factor (c.r.f.). Consider the following time series

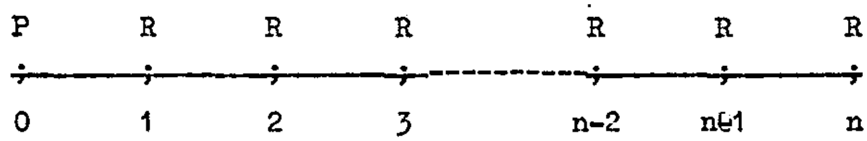


Figure (3.4)

It is required to determine the future series of end of period payments that will recover the sum P. Then substituting for S from equation (3.1) into equation (3.3) and transposing for R we get

$$R = P\left[i(1+i)^n\right] / \left[(1+i)^n - 1\right] \qquad (3.5)$$

3.4.7 Uniform series present-worth factor (u.s.p.w.f.). This enables the determination of the present worth of a uniform series of end of period payments. Transposing equation (3.5) we get

$$P = R\left[(1+i)^n - 1\right] / \left[i(1+i)^n\right] \qquad (3.6)$$

3.4.8 Cost and Income Gradients. Consider the situation in which annual disbursements increase progressively. Further that this increase is assumed to be uniform and arithmetic. This is illustrated in Figure (3.5).

3.5 **Assessment of Formulae** The above relationships and derivations provide the means of manipulating data in order to provide a consistent means of comparison and assessment. The usage of a time scale in visualizing the situation under examination is very useful indeed. It is not too difficult for these means to be incorrectly used and care ought to be exercised.

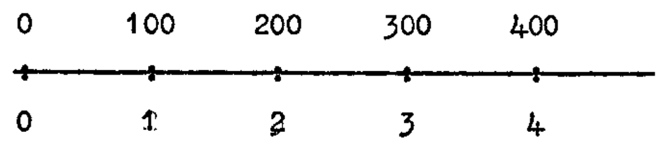
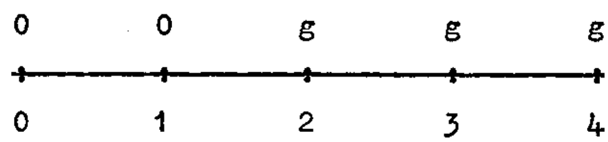


Figure 3.5(a)

Alternatively



where g = 100/period

Figure 3.5(b)

Figure 3.5

It can be shown that[1]

$$R = g\left[1/i - n/i \left[i/ \left[(1+i)^n - 1\right]\right]\right] \text{------------} (3.7)$$

That is the situation shown in Figure 3.5 can be represented as a uniform series of end of period payments.

3.6 Continuous Compounding

The inherent assumption in all preceding formulae has been that all payments occurred at discrete intervals of time, as did the interest payments. Clearly this is not a completely valid assumption as this does not always describe actual events. In practice there are some payments which are continuous while others are discrete. Simulation of this situation obviously presents great difficulty.

The concept of continuous compounding arises from the contention that earnings are generated continuously. It is seen then that continuous compounding may be applied to either discrete or continuous payments. In considering this approach some of the terminology of Section (3.4.1) requires modification.

3.6.1 Symbols and terminology

3.6.1.1 n now designates years

3.6.1.2 i designates the effective annual rate of continuous interest, that is discrete.

3.6.1.3 r designates the nominal annual rate of the continuous interest.

3.6.1.4 m designates the number of periods per year.

3.6.2 Continuous interest rates. For continuous compounding clearly m approaches infinity as the limiting value. That is, for example, the compounded sum will be given by the relationship

$$S = P \left[1 + r/m\right]^{m.n} \quad \text{------------------} \quad (3.8)$$

$$= P \; 1 + r/m \; ^{(m/r)(n/r)}$$

Then

$$\underset{m \quad a}{\text{Limit}} \quad 1 + r/m \; ^{m/r} = e$$

$$\therefore S = P.e^{r.n} \quad \text{----------------------------} \quad (3.9)$$

The following Table (3.1) illustrates the effect of the number of compounding periods in one year for two values of r. P is £1.

	20% Nominal Interest		100% Nominal Interest	
m	S	Effective Interest i	S	i
1	1.2000	20.00	2.0000	100.0
10	1.2190	21.90	2.5937	159.4
12	1.2194	21.94	2.6130	161.3
52	1.2209	22.09	2.6926	169.3
100	1.2211	22.11	2.7048	170.5
365	1.2213	22.13	2.7145	171.5
a	1.2214	22.14	2.7183	171.8

TABLE 3.1 Comparison of Nominal and Effective Continuous Interest.

3.6.3 Assessment of Continuous Compounding. Table (3.1) shows quite clearly that there is not much significance between compounding continuously and compounding in daily discrete intervals. The concept of continuous compounding though very interesting is not in use in industry, and consequently all subsequent discounting is based upon discrete time intervals. The above concept is presented for what is, an alternative and possibly more sophisticated, though computationally relatively more complex procedure.

1 Reference: Managerical and Engineering Economy
George A. Taylor

Publishers: D. Van Nostrand Company Inc. N. York.

4 The Determination of the Economic Life of an Asset

4.1 Economic Life The understnading of what is meant by economic life is of vital importance, however, the term is not amenable to a simple definition. The total annual cost of operating a machine is composed of two compnnents.

4.1.1 The Capital Cost. This can be represented as a uniform annual cost quite simply by applying the captial recovery factor, section (3.4.6). Therefore depending upon the length of life (n) the annual capital cost will vary accordingly, that is as n increases so the annual capital cost decreases.

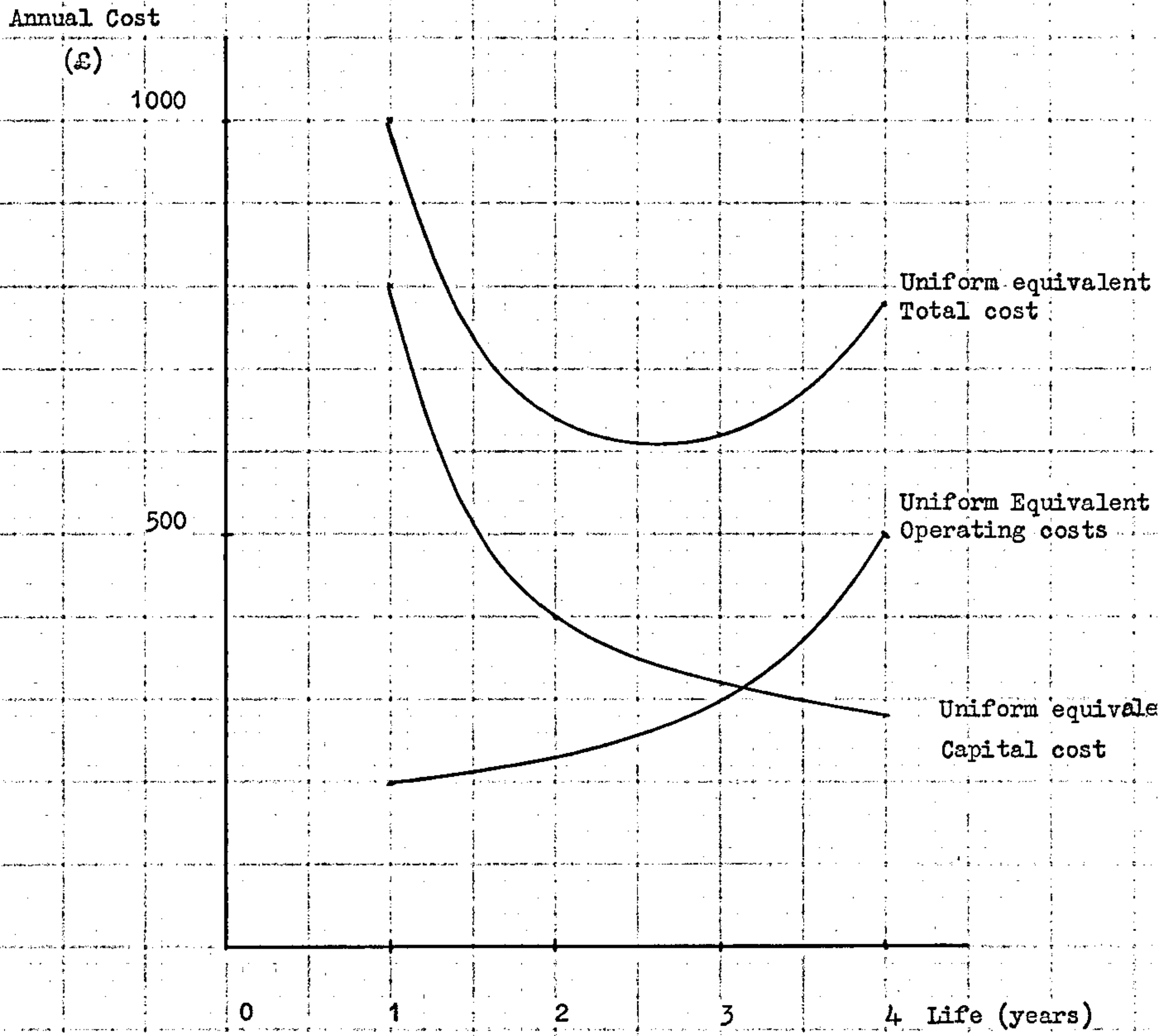


Figure 4.1 Variation of Annual Costs with Life Periods

4.1.2. The annual operating disbursements. These costs include all normal operating and repair and maintenance costs. By their very nature such costs tend to increase as the life of the machine is prolonged.

It is seen therefore that the total cost, that is the sum of sections 4.1.1 and 4.1.2 will display a minimum point at a particular point in the life of the asset. This is then known as the economic life of the machine. This concept is graphically illustrated in Figure 4.1

4.2 <u>Prediction of a pattern of Deterioration</u>. For purposes of illustration a particular pattern of operating costs has been assumed. In actual practice, however, it is the assessment of these operating costs and the effect of progressive deterioration upon them that gives rise to the greatest difficulty. If detailed historical statistics have been kept this difficulty can be relatively easily overcome. In the absence of such data reasonable approximations have to be made.

Footnote

The terms uniform equivalent on Fig 4.1 refer to the expression of these costs in terms of constant annual sums over periods, the annual sum varying as the period varies.

For example, we can assume that the operating costs will rise by a constant sum each year, that is an arithmetic series as illustrated in Figure 4.2

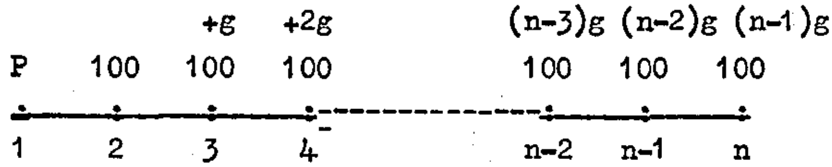


Fig. 4.2

In Figure 4.2 the sum g represents the annual increment in the operating costs. The total annual cost can then be easily determined thus:

Annual Cost (A.C.) = P(Capital recovery factor)

+ 100 + g (arithmetic series factor)[1]

Then according to Section 4.1 the economic life can be determined once the pattern of capital and operating costs is established. The point in time at which a machine should be replaced is clearly indicated by the economic life and not arbitrary management decisions.

Footnote

It is to be noted that g_1, g_2 ---- g_n (being annual increases in cost) could at a pinch be derived from comparison of operating costs between a new m/c presently owned and an older m/c of a closely similar nautre also presently owned. The assumption would tend to be linear, which as ia seen in this text is somewhat fallacious.

4.3 The Effects of Obsolescence upon the Economic Life

The analysis presented in the preceding sections takes no account of the effects of obsolescence. Obsolescence in this context may be considered as the increase in the engineering efficiency of new equipment in comparison with the best new engineering efficiency available at the moment. It follows therefore that obsolescence is a relevant consideration when comparative assessments are being made in replacement situations and plays no part in either initial investment appraisal or when replacement by like for like equipment is being made. However, since in practice it is often the case that like for like replacement does not occur, the consideration of both deterioration and obsolescence becomes vitally important in the determination of economic life.

4.4 Obsolescence and Deterioration as an Annual Cost. A model suggested by Taylor[2]

A specific model situation is considered in order to illustrate the suggested method of solution. The following exposition is in rather greater detail than presented by Taylor as it is felt that such detail will aid a proper understanding of the model.

4.4.1 Basic Assumptions

4.4.1.1 The annual operating cost rises by £20 annually as a result of deterioration.

4.4.1.2 That a new machine is brought out every year which has operating costs £30 less than those of the previous year's machine.

4.4.1.3 All new machines have the same first cost P.

4.4.1.4 That salvage value is at all time equal to zero.

4.4.1.5 That the economic life is some figure say 4 years.

4.4.1.6 That interest rate is 10%

4.4.1.7 That there is a machine presently owned whose operating costs are as shown in Figure 4.3. Further Z is the present salvage value of this machine. Alternatively Z is the capital cost if the presently owned machine continues to be used.

		+20	+40	+60	
Z	5000	5000	5000	5000	
0	1	2	3	4	

Figure 4.3

4.4.2 The Model is shown on a time scale in Figure 4.3 which indicates the costs of the proposed machine and its successors.

It should be noted that this pattern continues to infinity under the defined conditions. Further the reduced operating costs in period 5 are due to the improvements in the subsequent periods, that is due to relative obsolescence. Obsolescence really only appears as a comparative cost, and therefore the model in Figure 4.3 has really to be compared with an alternative situation.

Consider that there is an existing machine with costs as shown in Figure 4.4

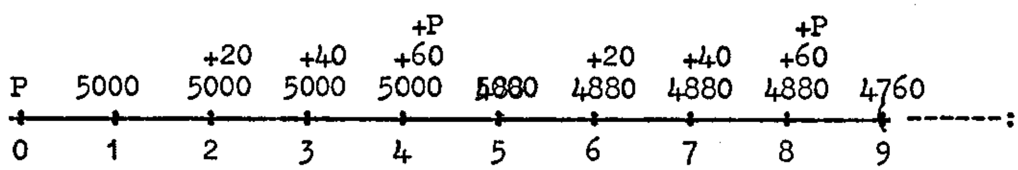


FIG. 4.4

The question that arises is whether the proposed machine should or should not be installed now, i.e. at t=0 or should the installation be deferred for one year. The deferred situation is shown in Fig 4.5

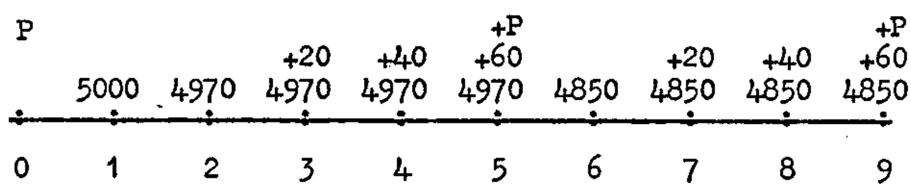


FIG. 4.5

In order to assess the relative merits of the courses illustrated in Figures 4.4. and 4.5. the two time scales diagrams are subtracted and this is illustrated in Figure 4.6. The first year's costs being neglected for the moment.

P	-P			P	- P			P	- P		
		50	50	50	-150	50	50	50	-150	50	
0	1	2	3	4	5	6	7	8	9	10	a

Figure 4.6

Figure 4.6. can be rearranged as shown in Figure 4.7

				P	- P						
P	-P				-200			P			
		50	50	50	50	50	50	50	50	50	
0	1	2	3	4	5	6	7	8	9	10	a

Figure 4.7

Still neglecting the operating costs in year 1, the present worth
at that time
at year 1 of the series in Figure 4.7 will ~~then~~ indicate/the cost
installing now (P):
of/todays machine/plus the disadvantage of installing now rather than deferring the installation for a year.

4.4.2.1. Determination of the Present Worth at year 1. There are two difficulties involved in the determination of this present worth. Firstly the series in Figure 4.7 proceeds to infinity and so limiting values of the formulae necessary have to be determined. Secondly the serie in Figure 4.7 is really in three distinct parts and each has to be taken in separately and in turn. These three components are separated and shown in Figure 4.8

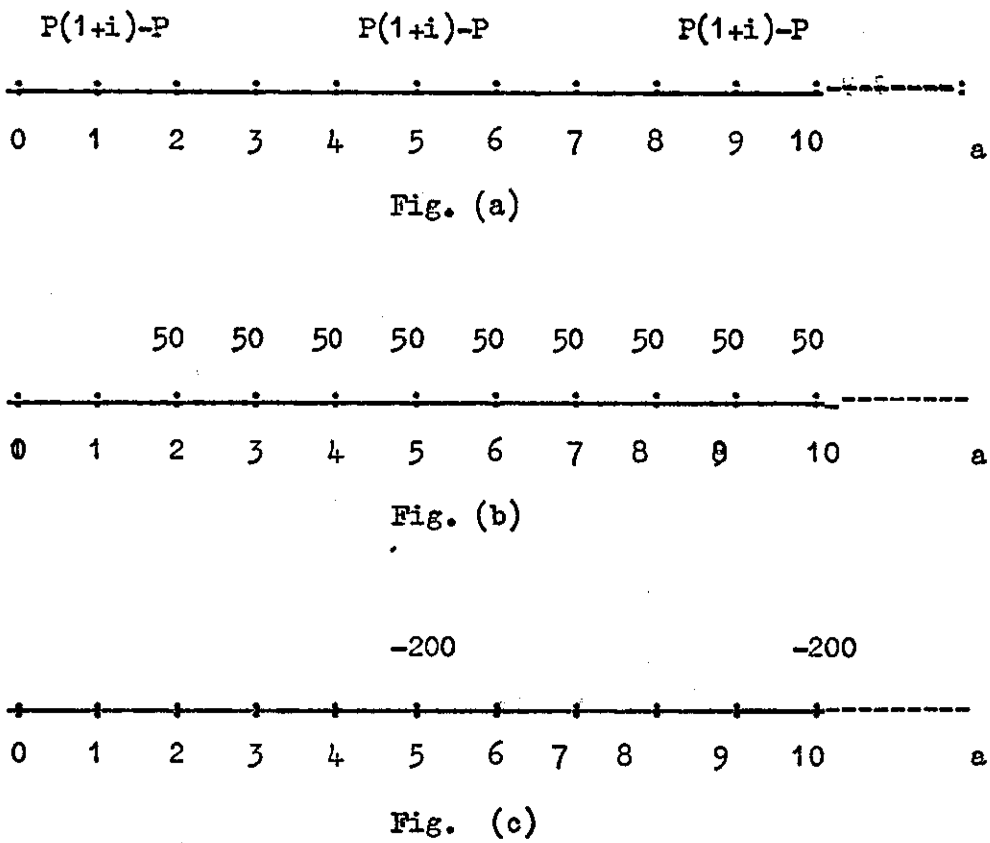


FIG 4.8

In the case of both Fig. 4.8(a) and 4.8(b) the series can easily be transformed using equation 3.4 to a uniform series. Since the series runs to infinity the equation 3.5 is not applicable. In this context.the uniform series present worth factor is given by the relationship:-

$$(\text{u.s.p.w.f.})_a^3 = (1/i) \text{ ------------- } (4.1)$$

The present worth at year 1 then will become

$$\text{P.W.1}(4.7) = P(1+i)-P + P(1+i)-p \ (\text{s.f.d.f.})/i + 50/i - 200.(\text{s.f.d.f.})/i$$

$$= P(i+\text{s.f.d.f.}) + ^{*} 50/i - 200.(\text{s.f.d.f.})/i$$

$$= P(\text{c.r.f.} + 50/i - 200.(\text{s.f.d.f.})/i \text{ ----}(4.2$$

4.4.2.2 Assessments. From the above analysis it is seen that there is a combined deterioration and obsolescence gradient (g), which in this case is £50.

Further the figure £200 is equal to ng where n is the assumed economic life.

Footnote * In effect the use of the sinking fund deposit factor transforms these two series by asking the following question what is the annual sum to be set aside at the given rate of interest which would be equivalent to the values of these two series? Such annual sums would constitute a uniform series.

Therefore putting equation (4.2) in general terms we get

P.W.1 (4.7) = P c.r.f. + g/i - ng/i.s.f.d.f.-------(4.3)

Equation (4.3) is clearly a mathematical function of the form P.W.1 = f(n) and will therefore have a minimum value for a particular value of n. This value of n would then be the economic life.

4.4.3. Conclusions

4.4.3.1 In order to establish the validity or otherwise of either installing or deferring for one year the proposed machine, or continuing with the presently owned machine, the operating costs for the first year have also to be taken into account. The final present worth at year 1 would therefore be -

P.W.1 = P.c.r.f. + g/i - ng/i s.f.d.i. + 5000
- 5000 + Z.c.r.f. -------(4.4)

The value of P.W.1. would then govern the decision. The last twp terms the represent the P.W.1 of the presently owned machine

4.4.3.2 The validity of the model presented is limited quite severely by the assumptions made. While it is clearly possible to quantify a deterioration gradient it is extremely difficult to do the same for an obsolescence gradient. Secondly no account is taken of any salvage value. This could introduce quite an error. Thirdly no account has been taken of the tax allowances. These will appreciably affect the situation.

1. Reference Section (3.4.8)

2. Managerial and Engineering Economy by George A. Taylor (op.cit)

3. Reference Managerial and Engineering Economy by Taylor (op.cit)

5. Capital Allowances Structure as applicable to the Transport Industry.

Subsequent models discussed in this thesis will be adjusted for various tax criteria currently in use in the U.K. In particular, use will be made of capital allowances which can conveniently be decribed at this point.

General Principles. Unde the present rules for company taxation, in computing the taxable profit no account is taken of the figure for depreciation which is provided by the company. The taxation authorities have their own system of capital allowances which are allowable against tax. These are in many cases very different from the depreciation pattern provided by firms. Since in fact capital allowances represent true depreciation and not retentions by way of depreciation, their understanding is vital to any study of replacement of any asset. This is so because the level of capital allowances governs the level of the sum to be redovered and further the pattern of allowances will effect the sum to be recovered on a discounted basis.

5.2 <u>Capital Allowances Structure pre January 1965</u>. The structure of capital allowances is best illustrated and explained by considering specific models. Figure (5.1) shown below does so using an arbitrary figure for the capital cost. This illustration is now only or historical interest but its comparison with the present structure indicated in Section 5.3 gives an insight into the background of the transport industry and is therefore of value.

5.3 <u>Capital Allowances Structure post January 1965</u>.[1] In this system Investment Allowances were replaced by Investment grants. However, these grants are not applicable to the Transport industry for the purchase of vehicles. In this case larger Initial ~~grants~~ allowances are allowable. The structure is illustrated in Figure 5.2 The same situation as for Figure 5.1 is considered in order to gain some idea of the effect the change in the capital allowances structure has made upon the situation.

	%	£	Value at 55% tax	Value at 40%Corp.Tax.
Gross vost of vehicle (truck)	100	4000		
Investment Allowance at 30%	30	1200	660	480
Initial Allowance at 10%	10	400	220	160
Annual Allowance : Year 1	25	1000	550	400
Written down value (W.D.V.) Year 1 end	65	2600		
Annual Allowance : Year 2 at 25% of W.D.V.	16.25	650	358	260
W.D.V. Year 2 end	48.75	1950		
Annual Allowance: Year 3 at 25% of W.D.V.	12.2	489	268	195
W.D.V. Year 3 end	36.55	1461		
Sales of vehicle : proceeds	25	1000	1000	1000
Balancing Allowance	11.55	461	254	185
Totals	130.00	5200	4310	2680

Figure 5.1 Model of Capital allowances Structure pre January 1965

	%	£	Value at 40% Corp.tax
Gross cost of vehicle	100	4000	
Initial allowance @ 30%	30	1200	480
Annual allowance: Year 1 at 25%	25	1000	400
W.D.V. at Year 1 end	45	1800	
Annual allowance : Year 2 at 25%	11.25	450	180
W.D.V. at Year 2 end	33.75	1350	
Annual allowance: Year 3 at 25%	8.45	338	135
W.D.V. at Year 3 end	25.3	1012	
Sale of vehicle : Proceeds	25	1000	1000
Balancing allowance	0.3	12	5
Totals	100	4000	2200

Figure 5.2 Model of Capital Allowances Structure, post January 1965

5.4 Assessment of the change in structure of capital allowances

5.4.1 The change has had the effect of reducing the value of th allowances to the company quite considerably. This naturally has the effect of increasing the amount of the capital cost which has in effect to be borne by the investment. This also has its consequent effect of tending to increase the length of the economic life.

5.4.2 Though at first sight it appears that the present structure permits a more rapid writing down of the vehicle, which is true, the fact that the investment allowance is not available reduces the total allowances in the early part of the vehicle's life. On a discounted cash flow (D.C.F.) basis, that is on a present worth analysis the present structure is relatively not so favourable.

6. General View of Heavy Vehicle Transport

6.1 Basic Constraints The picture being presented in this study is, of necessity, the end product of information gathered from only a handful of haulage organisations. However, the fact that except for one exception, there was a fair amount of cross verification and also that the firms in question are quite representative, provides a sufficiently stable basis for an overall assessment.

The road transport field is very varied in nature, and consequently economic viability studies with a view to replacement policy decisions are very complex. It is therefore not worthwhile considering the road transport situation as an overall entity. It becomes essential to break down the structure into its constituent parts and to confine analysis to specialised areas.

6.1.1 Types of Vehicles. There are various types of heavy commercial vehicles in operation. A complete list is not relevant here but there are three main categories of vehicles.

6.1.1.1 "Mass production" type vehicles. This category embraces vehicles of the B.M.H. Limited commercial series whose basic life is about 70 to 100 thousand miles. Basic life in this context implies the period after which a fairly extensive engine and other overhaul would become necessary.

6.1.1.2 Medium commercial vehicles with engine capacities around 400 cu.ins. whose basic life is around 150 to 180 thousand miles.

6.1.1.3 Heavy commercial vehicles with engine capacities over about 600 cu.ins. whose basic life is around 200 to 300 thousand miles.

It is easy to see that for each of the above categories the operating and capital costs will be appreciably different. Further that these limits are not to be considered very rigidly. Local topographical and terrain factors could appreciably alter the above ranges.

6.1.2 Types of Ultilization. As is natural, vehicles are put to various uses and dependent upon the prevailing conditions the life of a particular type of vehicle will fluctuate around a mean. That is, the type of utilization will affect the economic life of the vehicle. A sample of the various types of usage is given below.

6.1.2.1 Heavy haulage on trunk roads

6.1.2.2 Heavy haulage off trunk roads

6.1.2.3 Tipper vehicles both on and off roads

6.1.2.4 Tractor/trailer units

6.1.2.5 Specialised tanker applications

6.1.3 Operating Life. The life of a particular type of commercial vehicle in years is dependent not upon age but upon usage. Therefore life of the three categories indicated in Sections 6.1.1 - 61.2 and 6.1.3 will be respectively, the following, Being based upon an average utilisation of about 50,000 miles per year.

6.1.3.1 Approximately 2 years

6.1.3.2 Between 3 and 3.5 years

6.1.3.3 Between 4 and 4.5 years

Since therefore the relevant reference parameter is usage, this should be considered as the basis of analysis. The life in years being only a derivative reference. However, in practice since all accounts are usually kept on a time basis it is common practice to determine costs per mile on a particular time period.

6.2 <u>The Pattern of Vehicle Costs in the Commercial Vehicle Field</u>

6.2.1 Fixed Costs. Certain costx items are, with very slight variations, constant per unit of time. Upon the assumption of a constant average utilisation per unit of time, these costs become a constant cost per unit of utilisation (a mile). Such costs are:

6.2.1.1 Road Fund Licence

6.2.1.2 Insurance premiums

6.2.1.3 Drivers' wages. It tends to be a fact of labour costs in this industry that the driver will use his freedom from continuous supervision to even out his hours of work to a fairly constant rate of earnings, gross of overtime etc The growing incidence of invariable pay-roll/(SET. etc), costs tends to increase this fixed nature of total labour costs.

6.2.2 Running Costs

6.2.2.1 Fuel and tyre costs - Although these are to some extent a function of maintenance and deterioration, the effect of these factors is negligible. Unit costs per mile tend to be pretty constant over the life of the vehicle.

6.2.3 The cost of capital. This cost is normally recovered by means of a depreciation charge. It is important at this stage to consider the difference between this depreciation charge and the actual recovery of capital plus the cost of capital. Common practice.

is to charge depreciation on a straight line basis over the projected life of the vehicle, the sum to be depreciated being the gross cost of the vehicle. This clearly has little relation to either the actual net capital employed or the cost of such capital. This is indicated by Figure 5.2. This argument is taken up more fully later on in this report.

6.2.4 The costs of deterioration. These costs of deterioration appear in the form of a progressive increase in repair and maintenance costs of the vehicle. These show an increasing pattern until the end of the basic life of the vehicle. At this point if an overhaul is carried out the costs of such an overhaul would tend to inflate the repair and maintenance costs for the relevant period - that is,if overhaul cost is considered as a repair and maintenance cost.

Overhaul costs are not easily quantifiable. They comprise the following:

6.2.4.1 The cost of the overhaul

6.2.4.2 Implicit costs such as loss of profits, idle vehicle costs, idle capital costs and waiting time.

Though quite clearly item (6.2.4.1), (which being of the order of £1200 to £1500) is the primary cost, the implicit costs if neglected could introduce an error of about 10%. *

The pattern of repair and maintenance costs, that is the pattern of deterioration is graphically illustrated in Figure 6.1[1], which is based on the figures in Table 6.1, which is based on the average of 11 vehicles.

Operating year	Average Mileage/ Vehicle	Repair and Maintenance d/mile
0 - 1	28,586	1.12
1 - 2	25,370	2.35
2 - 3	27,720	2.36
3 - 4	26,990	4.7

Table 6.1 Repair and Maintenance Costs
Type of Vehicle : Albion Clydesdale

Footnote *

This figure of 10% is an assessment based upon the fact that during such a major overhaul the vehicle will be out of service for about 4 to 5 weeks. The implicit costs of this are assessed at between £120 to £150 i.e. around 10% of the cost of overhaul

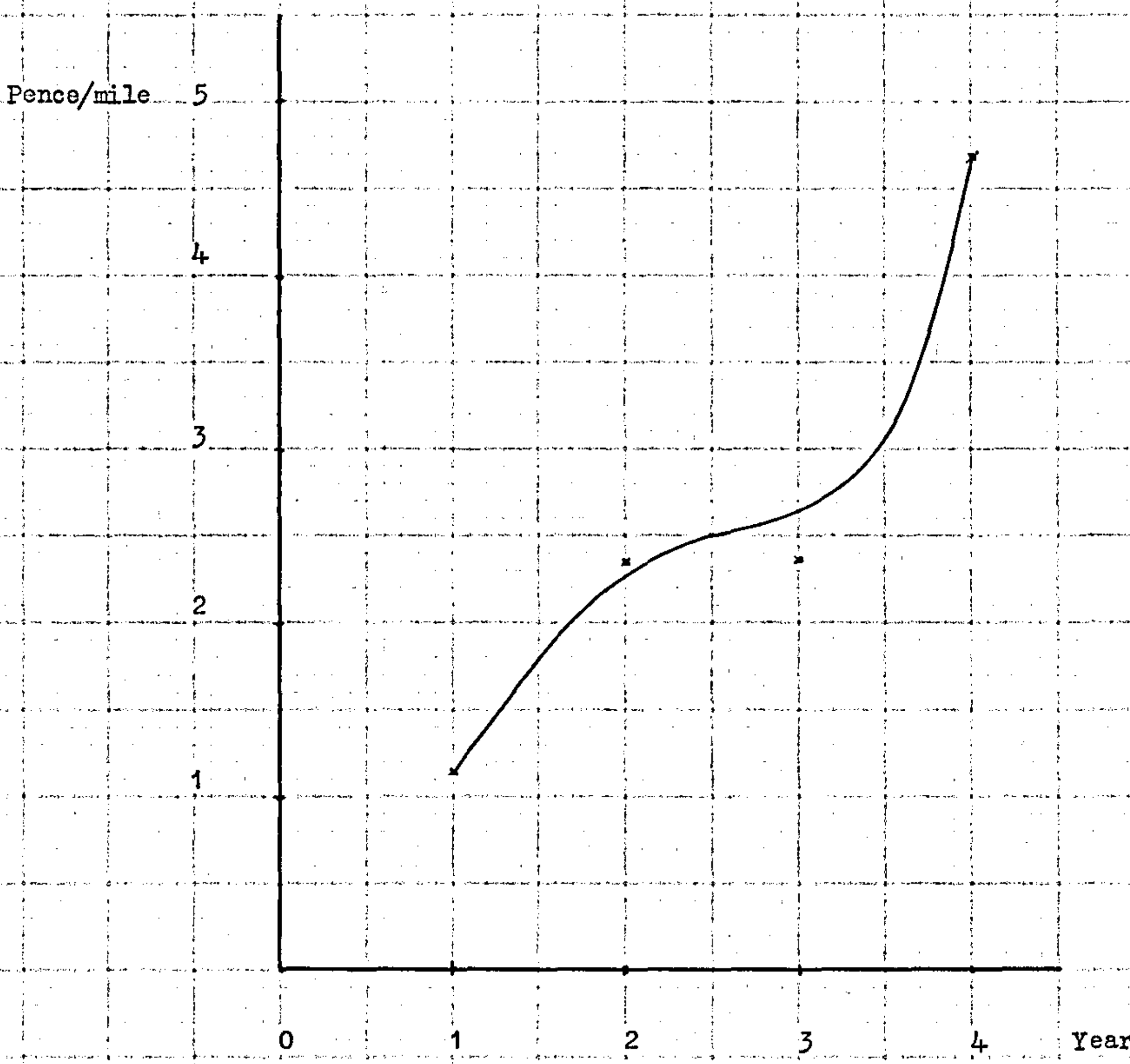


Figure 6.1 Repair and Maintenace costs

Figure 6.1 shows that there is a tendency for a quick rise in costs initially, these are attributed to minor faults at the manufactuer's end. This seems to be the general experience of operators. There is then a second stage when there is a plateau which runs through until the end of the basic life of the unit, when there is a sharp surge in the repair and maintenance costs indicating the imminent necessity for an overhaul.

6.3 Obsolescence in the Commercial Vehicle Field

Except for a period immediately after the 1939/45 War when the advent of the diesel engine, with its relatively much improved running costs, made the petrol engine technically obsolete, obsolenscence had not had a great influence in this field. Even in this instance it was only the motive unit which was made obsolete not the entire vehicle. The reasons for this situation are best understood by examining the two factors which could possibly introduce obsolescence effects.

6.3.1 The periodic advent of new vehicles which provide progressively lower operating costs would make obsolescence a vital factor in any replacement analysis. However, such is not the case. The heavy vehicle industry has had a pattern which has provided for only very marginal improvements in operating costs. These could cumulatively become appreciable only when a time span of about 7 or 8 years is considered, that is greater than the life of a vehicle.

6.3.2 Another factor which could create a certain amount of obsolescence is the progressive modification of the Motor Vehicles (Construction and Use) Regulations. These are, however, usually very minor changes. Drastic changes are few and far between. The most recent were the changes in 1963 vis-a-vis loading of vehicles[2]. While these do introduce obsolescence effects, the fact that the Ministry changes are not predictable makes it impossible to cater for them in

Footnote to para. 6.3.1.

It is interesting to speculate, given an 8 year obsolescence cycle as to whether an analysis based upon two four-year cycles would not be relevant. This would seem preferable to artificially dividing any obsolescence cost gradient into two arbitrary parts: See also footnote to para. 7.8.6.. page 71.

any policy on replacement. Further such changes always allow a change over period (for example, in the present changeover 1972 is the final date) which permits modification to overall policy. The pattern of increased costs due to ~~deterioration~~ obsolescence is not as regular and progressive as is catered for in Taylor's model.

6.4 Assessment of Situation

6.4.1 Technical obsolescence is not important as technological advances have not, and are not likely to be very radical . This is in no little part because the primary requirements of operators is utter reliability rather than radical advance.

Governmental changes in regulations governing road transport are not predictable and tend not to be radical. If they are drastic the change over period tends to soften any obsolescence effects.

6.4.2 The factor which really governs replacement decisions is the progressively increasing repair and maintenance costs due to deterioration and the necessity for an overhaul at the end of the vehicle's basic life.

6.4.3 Since the factors governing both deterioration and especially obsolescence do not correspond at all to the basic assumptions stated in Section 4.4.1 it follows that the Model suggested by Taylor Section 4.4 is not applicable to the Commercial Vehicle field.

1. See Acknowledgements

2. Reference : The Motor Vehicles (Construction and Use) Regulations 1963. No. 1646 Part III

7. Model Representations of Cost Patterns in the Heavy Goods Vehicle Field.

7.1 Introduction When the basic life of the vehicle expires two courses of action are available to the operator.

7.1.1 Operator can replace vehicle

7.1.2 Operator can carry out a major overhaul
Depending upon which course of action is adopted the pattern of costs will vary accordingly. These various patterns are illustrated by model representations

7.2 Basic premises used in the construction of the Models

7.2.1 All costs are merely informed estimates and are not true historical costs.

7.2.2 It is assumed that there is no salvage value.

7.2.3 The fact that discounted cash flow techniques have been used does not imply that such was found to be the case in practice.

7.2.4 The annual capital cost is arrived at using equation 3.5

7.2.5 All the repair and maintenance costs are discounted to present worth.

7.2.6. The cost of capital is based upon a rate of 10%

7.2.7. The gross vehicle cost in each model is £4000.

7.3 <u>Model I. No major overhaul envisaged.</u>

Table 7.1 and Figure 7.1 show the pattern of costs.

Life in years (n)	Capital Recovery Factor	Capital Recovery (£)	Present Worth Factors	Repair and Maintenance costs(R+M) (£)	Discounted R + M costs (£)	ΣR+M costs (£)	Uniform Series R+Mcosts (£)	Total Annual cost T.C(£)
1	1.1	4400	.909	1000	909	909	1000	5400
2	.576	2300	.826	1200	990	1899	1095	3395
3	.402	1600	.751	1200	900	2799	1125	2725
4	.315	1260	.683	1600	1090	3889	1228	2488
5	.264	1056	.621	2500	1550	5439	1432	2488

Table 7.1 Model of Cost Pattern

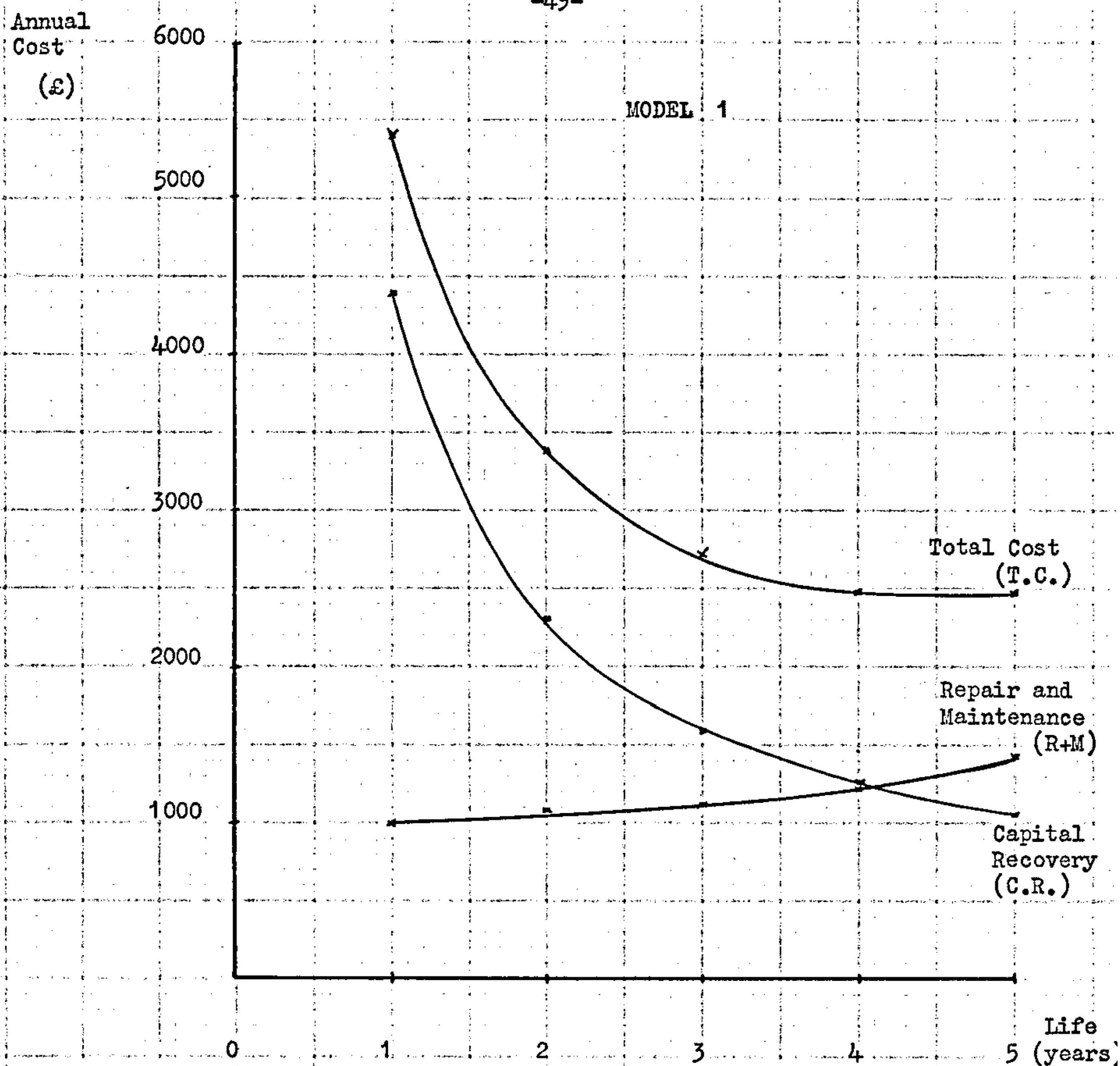


Figure 7.1 Model of Cost Pattern

At the end of year 5 the engine would require to be changed and therefore this would represent a sharp increase in the already rising repair and maintenance cost curve. Therefore the optimum economic life is in practical terms anywhere between the 4th and 5th years. It should be noticed that by discounting techniques the sharp rise in repair and maintenance costs in nominal terms appears somewhat mitigated

7.4 Model 2 A major overhaul is carried out, the cost of this being considered a repair and maintenance cost. The cost of this overhaul is assessed at £1500 and is considered to be paid at the end of year 4. In actual practice this cost will be spread out over a period. The model is illustrated in Table 7.2 and Figure 7.2.

Figure 7.2 Model of Cost Pattern

Life (n)	Capital Recovery Factor	Capital Recovery (£)	Present Worth Factors	Repair and Maintenance Costs (R+M) (£)	Discounted R and M Costs (£)	≤R + M Costs (£)	Uniform Series R+M costs (£)	Total Annual Cost T.C. (£)
1	1.1	4400	.909	1000	909	909	1000	5400
2	.576	2300	.826	1200	990	1899	1095	3395
3	.402	1600	.751	1200	900	2799	1125	2725
4	.315	1260	.683	3100	2117	4916	1549	2809
5	.264	1056	.621	1200	745	5661	1494	2550
6	.229	920	.564	1200	678	6339	1450	2370
7	.205	820	.513	1600	820	7159	1469	2289
8	.187	752	.466	2500	1170	8329	1558	2310

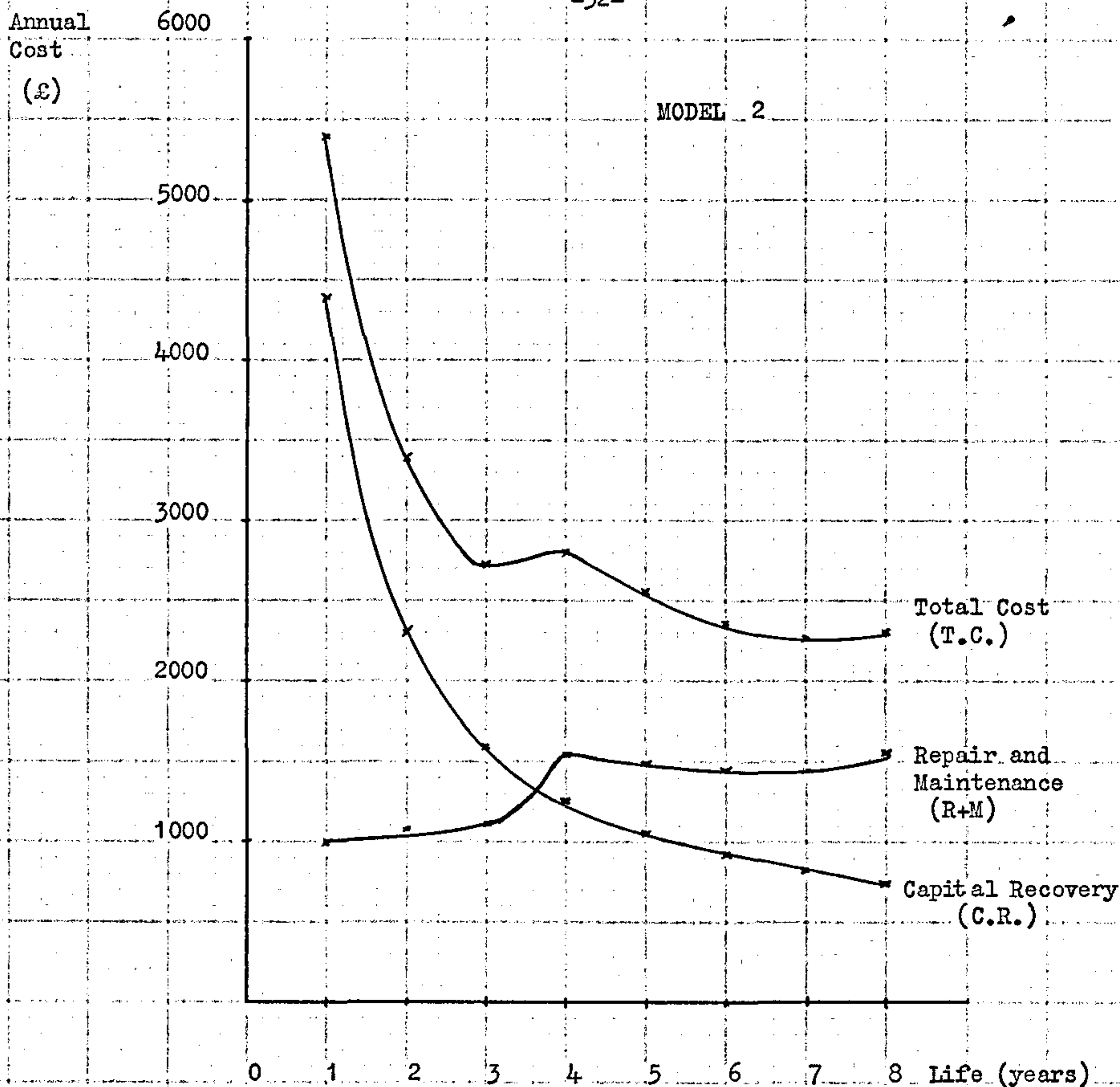


Table 7.2 Model of Cost Pattern

7.4.1 For an alternative viewpoint to the models presented above in which all money spent on both capital and operating expenses is expressed as a terminal value which is then reduced to a uniform series of costs using the sinking fund deposit factor please see Appendix No 1 . This corresponding alternative is shown only for the model relevant to Section 7.3 for illustrative purposes.

7.5 Model 3(a)Capital recovery takes account of capital allowances available. Figure 5.2 shows that the effective capital spent upon the vehicle is not represented faithfully by basing the capital recovery upon the gross cost of the vehicle. This model represents a method of extending models 1 and 2 to take account of the capital allowances available. There is zero salvage value as for Model 1 and also the gross cost is still £4000.

7.5.1 The extension of model 1. For reference to the value of capital allowances refer to Chapter 5. The value of the capital allowances is a function of the age of the vehicle and therefore the effective capital expenditure varies with the projected life of the vehicle. Effectively the annual cost in any year will be given by the relationship:-

$$A.C_n = (\text{Gross cost less present worth of all capital allowances})\ \text{c.r.f.} + (\Sigma\ \text{discounted R and M costs})\ \text{c.r.f.} \qquad (7.1)$$

The following Table 7.3 shows the determination of the effective capital expenditure. For reference to the value of capital allowances refer to Chapter 5.

Model 1 can now be modified using the above equivalent capital expenditure. As the computation of the repair and maintenance costs is identical to that shown in Table 7.1 the uniform series only is again shown in this model. Table 7.4 and Figure 7.3

Time (years)	SPPWF	Value of Capital Allowances V	Present Worth of V	Σ P.W of V	Value of bal. allowance	Present Worth of bal. allow.	P.W. of Cap.& bal allowances	Effective Capital expenditure
1	.909	880	800	800	720	655	1455	2545
2	.826	180	149	949	540	446	1395	2605
3	.751	135	101	1050	405	304	1354	2646
4	.683	101	69	1119	304	208	1327	2673
5	.620	76	47	1166	228	141	1307	2693

Table 7.3

Life (years)	Effective Capital expenditure (£)	Capital Recovery Factor	Capital Recovery	Uniform Series R and M costs (£)	Total annual costs (£)
1	2545	1.1	2800	1000	3800
2	2605	.576	1501	1095	2596
3	2646	.402	1062	1125	2187
4	2673	.315	841	1228	2069
5	2693	.264	710	1432	2142

Table 7.4

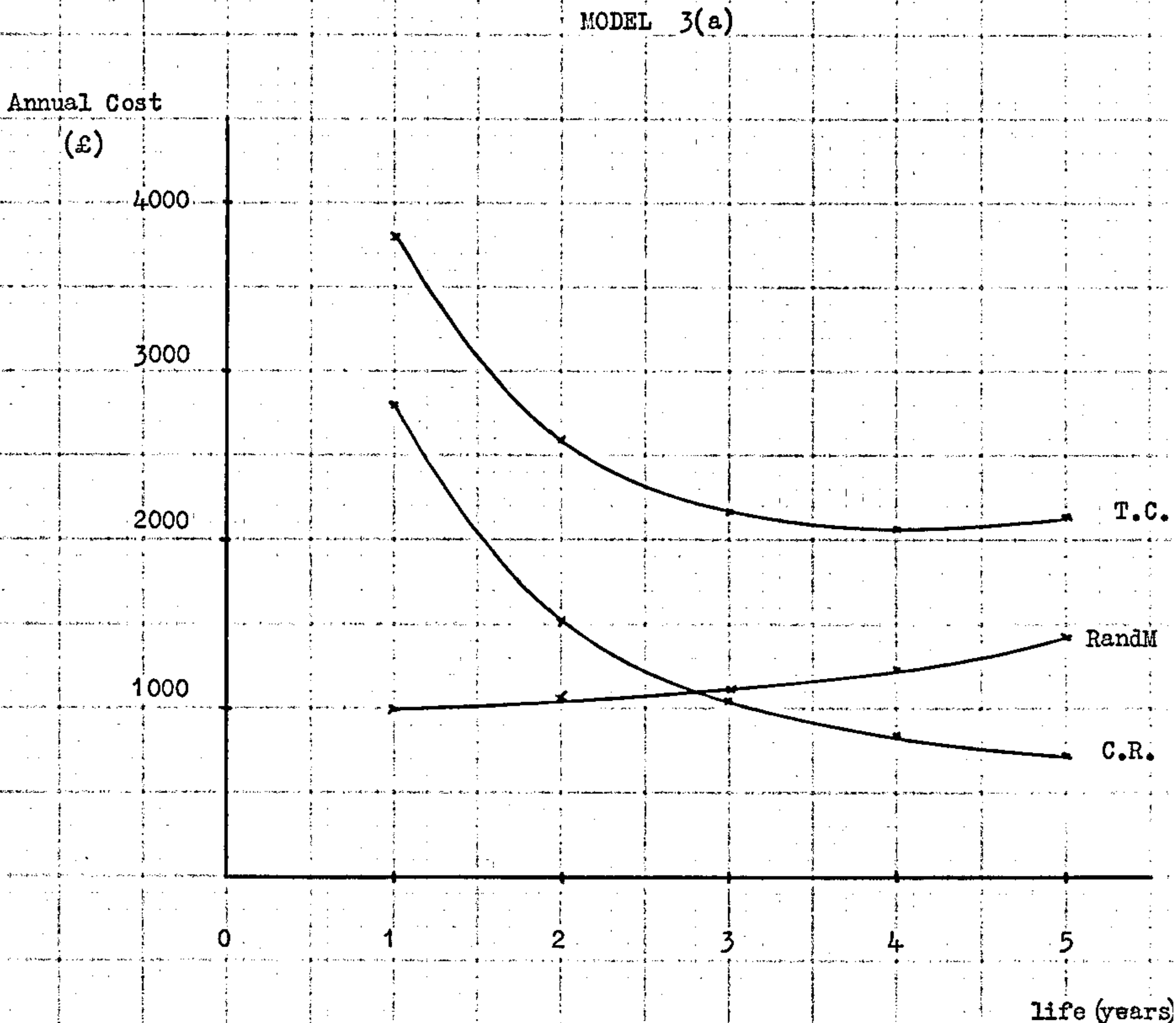

MODEL 3(a)
Annual Cost
(£)
4000
3000
2000
1000
0
1
2
3
4
5
life (years)
T.C.
RandM
C.R.

Figure 7.3

7.5.2. Model 3(b)

7.5.2 The argument of Section 7.5.1 is now extended to Model 2. As Table 7.3 already shows the method of obtaining the effective capital expenditure this step is not necessary here. The following Table 7.5 and Figure 7.4 show cost patterns obtained.

Life (years)	Effective Capital Expenditure	Capital Recovery Factors	Capital Recovery	Uniform Series R and M costs	Total annual costs
1	2545	1.1	2800	1000	3800
2	2605	.576	1501	1095	2596
3	2646	.402	1062	1125	2187
4	2673	.315	841	1549	2390
5	2693	.264	710	1494	2204
6	2705	.229	620	1450	2070
7	2714	.205	556	1469	2025
8	2715	.187	507	1558	2065

Table 7.5

MODEL 3(b)

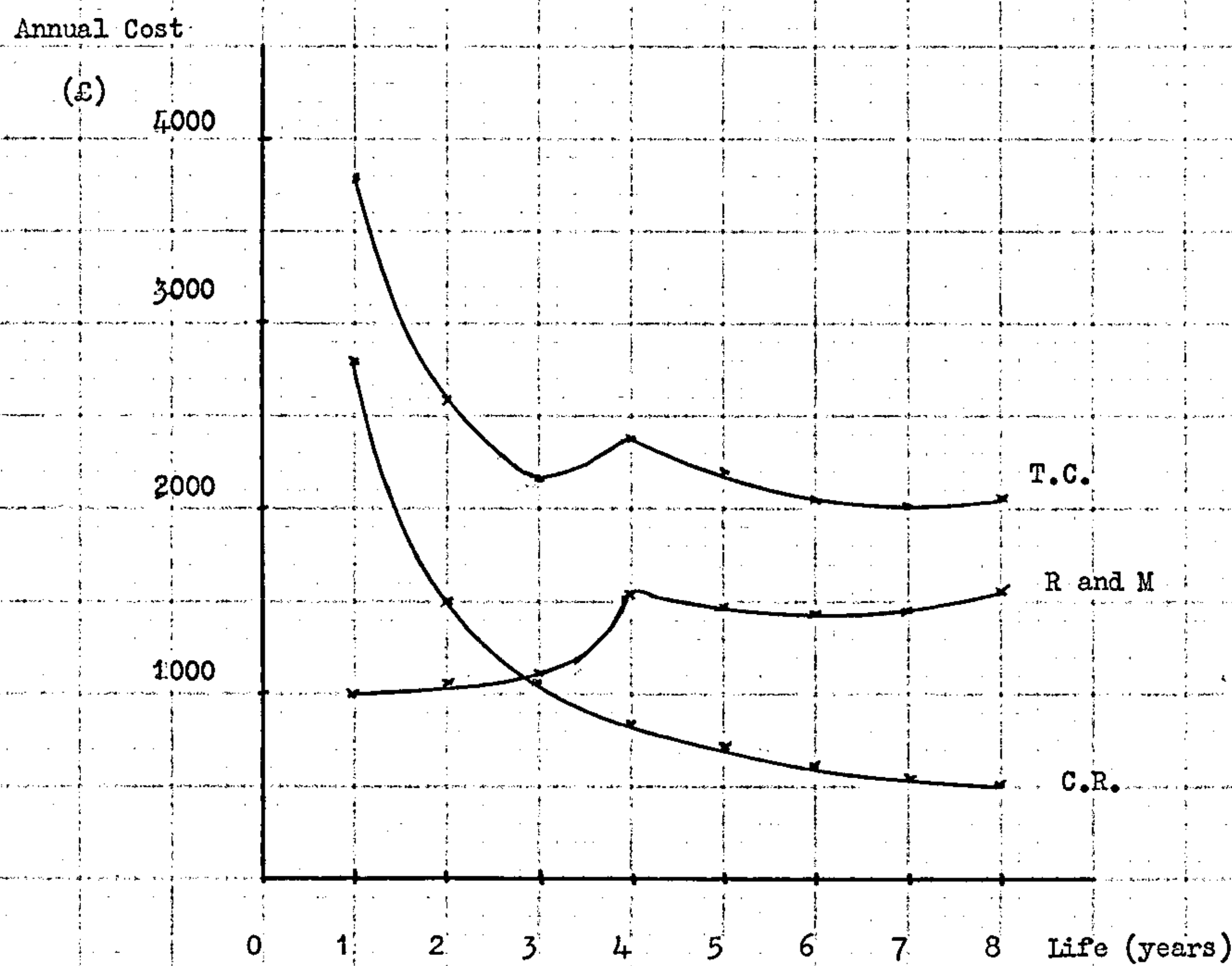


Figure 7.4

7.6 Model 4 Accounting for Salvage Value In the preceding models no account has been taken of any salvage value which will accrue to the vehicle upon disposal. To construct a model similar to those already presented clearly requires the salvage value of the vehicle for each year of its life. That is, salvage values if the vehicle were sold after the first, second, third years and so on. As this does not ever happen in actual practice the figures of salvage value for the first and second years are open to discussion while those in the second and third years are rather more easily substantiated.

The effect of the salvage value upon the earlier models is to decrease the level of the effective capital expended. The following Table 7.6 shows the method of arriving at the effective capital employed in relation to the life of the vehicle.

Life (years)	Σ P.W. of V (c.f. Table 7.3) (£)	Salvage Value (S.V.) (£)	P.W. of S.V. (£)	Value of Balancing Allowance	P.W. of Balance Allow.	Tptal present worth of receipts.	Effective capital expenditure
1	800	1200	1090	240	218	2108	1892
2	949	700	579	260	215	1743	2257
3	1050	500	376	205	154	1580	2420
4	1119	450	307	124	85	1511	2489
5	1166	400	248	68	42	1456	2544

Table 7.6

Model 3 as presented in Section 7.5.1 is now Modified incorporating the changes introduced by accounting for salvage value as shown in Table 7.6. The results of this are shown in Table 7.7 and Figure 7.5.

Model 4b

An exactly similar procedure can now be applied to this model represented in Section 7.5.2. in order to show the effect of salvage values in the situation where an engine overhaul is carried out. This situation is illustrated in Tables 7.8 and 7.9 and in Figure 7.5(a).

Life (years)	Effective Capital Expenditure (£)	Capital Recovery Factors	Capital Recovery	Uniform Series R and M costs (£)	Total Annual costs (£)
1	1892	1.1	2080	1000	3080
2	2257	.576	1300	1095	2395
3	2420	.402	974	1125	2099
4	2489	.315	784	1228	2012
5	2544	.264	672	1432	2104

Table 7.7

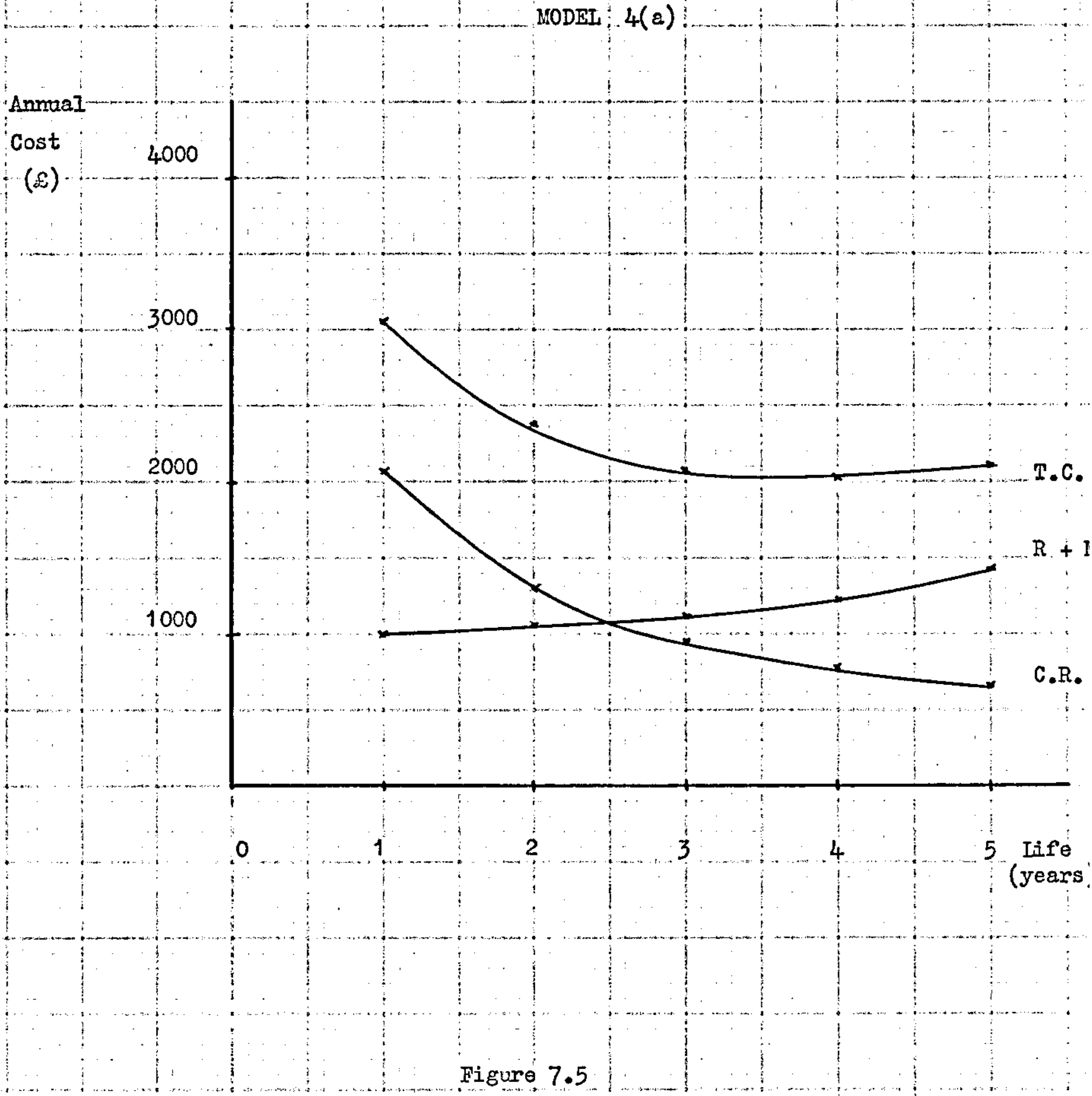

MODEL 4(a)
Annual
Cost
(£)
4000
3000
2000
1000
0
1
2
3
4
5
Life
(years)
T.C.
R + M
C.R.

Figure 7.5

Life (years)	£ P.W. of V c.f.(Table 7.3) (£)	Salvage Value (S.V.) (£)	P.W. of S.V. (£)	Value of Balancing Allowance	P.W. of Balancing Allowance	Total Present Worth of Receipts	Effective Capital expenditure
1	800	1200	1090	240	218	2108	1892
2	949	700	579	260	215	1743	2257
3	1050	500	376	205	154	1580	2420
4	1119	700	478	24	16	1673	2327
5	1166	550	342	8	5	1513	2487
6	1223	400	226	11	6	1455	2545
7	1266	300	164	8	4	1424	2576
8	1298	140	28	40	19	1330	2670

Table 7.8

Life (years)	Effective Capital Expenditure (£)	Capital Recovery Factors	Captial Recovery	Uniform Series RandM costs (£) c.f.Table7.2	Total Annual Costs (£)
1	1892	1.1	2080	1000	3080
2	2257	.576	1300	1095	2395
3	2420	.402	974	1125	2099
4	2327	.315	735	1549	2284
5	2487	.264	657	1494	2152
6	2545	.229	584	1450	2034
7	2576	.295	528	1469	1997
8	2670	.187	500	1558	2058

Table 7.9

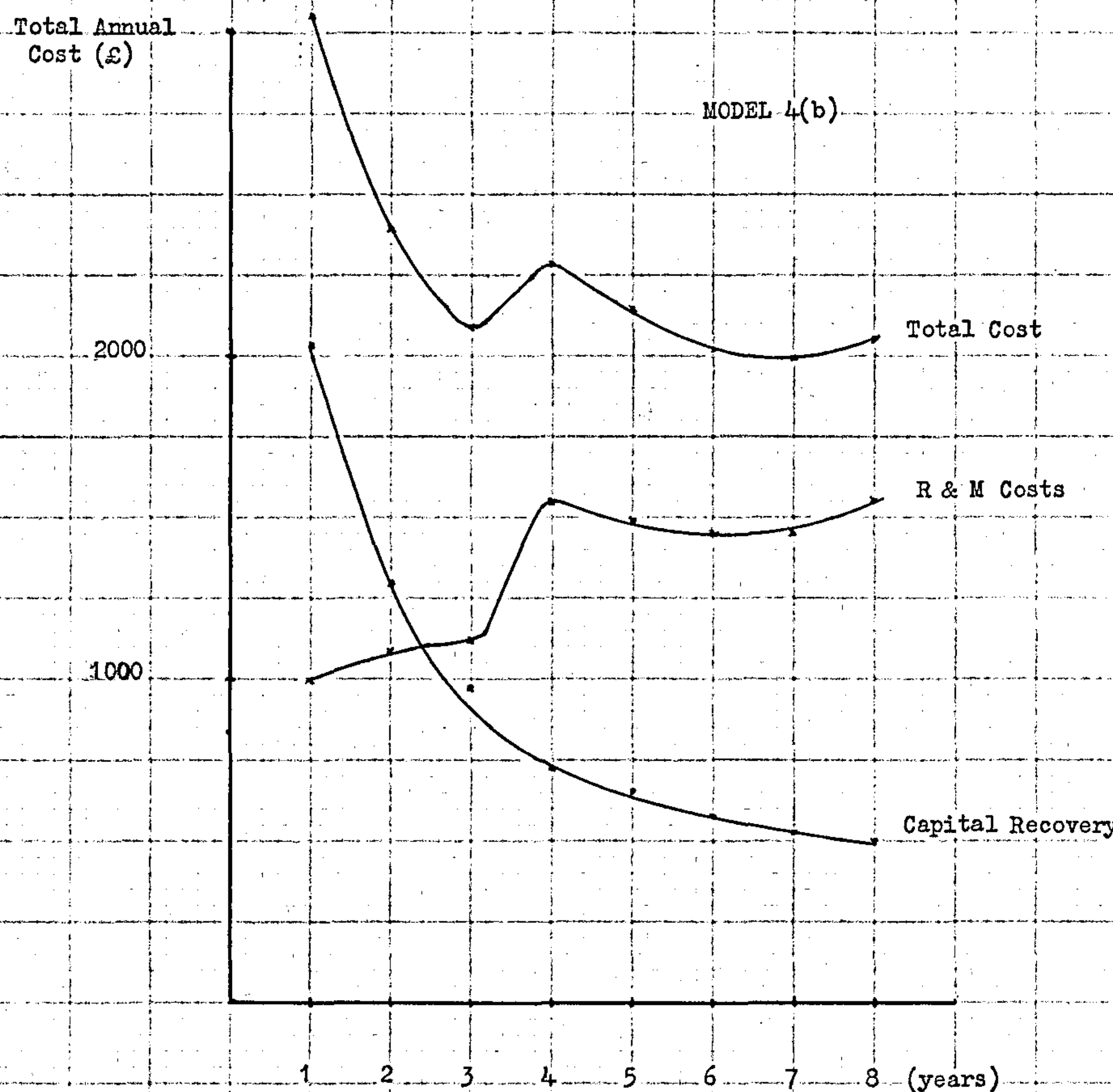

Total Annual Cost (£)
MODEL 4(b)
2000
1000
Total Cost
R & M Costs
Capital Recovery
1
2
3
4
5
6
7
8
(years)

Figure 7.5 (a)

7.7 <u>An Alternative Treatment of the Cost of the Major Overhaul</u> In Model 2 the cost of the overhaul has been treated as a repair and maintenance cost and is therefore a revenue item. In the majority of situations this is the correct treatment for this expense. However, under certain circumstances the cost of the overhaul may well be treated as capital expenditure. This has naturally a very marked effect upon the pattern of costs.

7.7.1 Model 5(a) In this illustration the overhaul cost is treated as a capital expenditure. No account has been taken of either the capital allowances available or of the salvage value. This model is illustrated in Table 7.10 and Figure 7.6

7.7.2 Model 5(b) In this case model 5(a) is further developed to take account of both capital allowances and salvage values. The computational procedure is identical with that indicated in Sections 7.5 and 7.6. Tables 7.11, 7.12 and Figure 7.6(a) illustate this development.

Life (years)	Capital Recovery Factors	Capital Recovery (£)	SPPWF	R and M costs (£)	Discounted R + M costs (£)	Σ R + M costs (£)	Uniform Series R+M costs (£)	Total Annual costs T.C. (£)
0	1.0	4000	1.0					4000
1	1.1	4400	.909	1000	909	909	100	5400
2	.576	2300	.826	1200	990	1899	1095	3395
3	.402	1600	.751	1200	900	2799	1125	2725
4	.315:1.0	1260+1022	.683	1600	1092	3891	1228	3570
5	.264:1.1	1056+1122	.620	1200	744	4645	1225	3403
6	.229:.576	920+ 588	.564	1200	677	5322	1219	2727
7	.205:.402	820+ 410	.513	1600	820	6142	1259	2489
8	.187:.315	752+ 322	.466	2500	1164	7306	1368	2442

Table 7.10

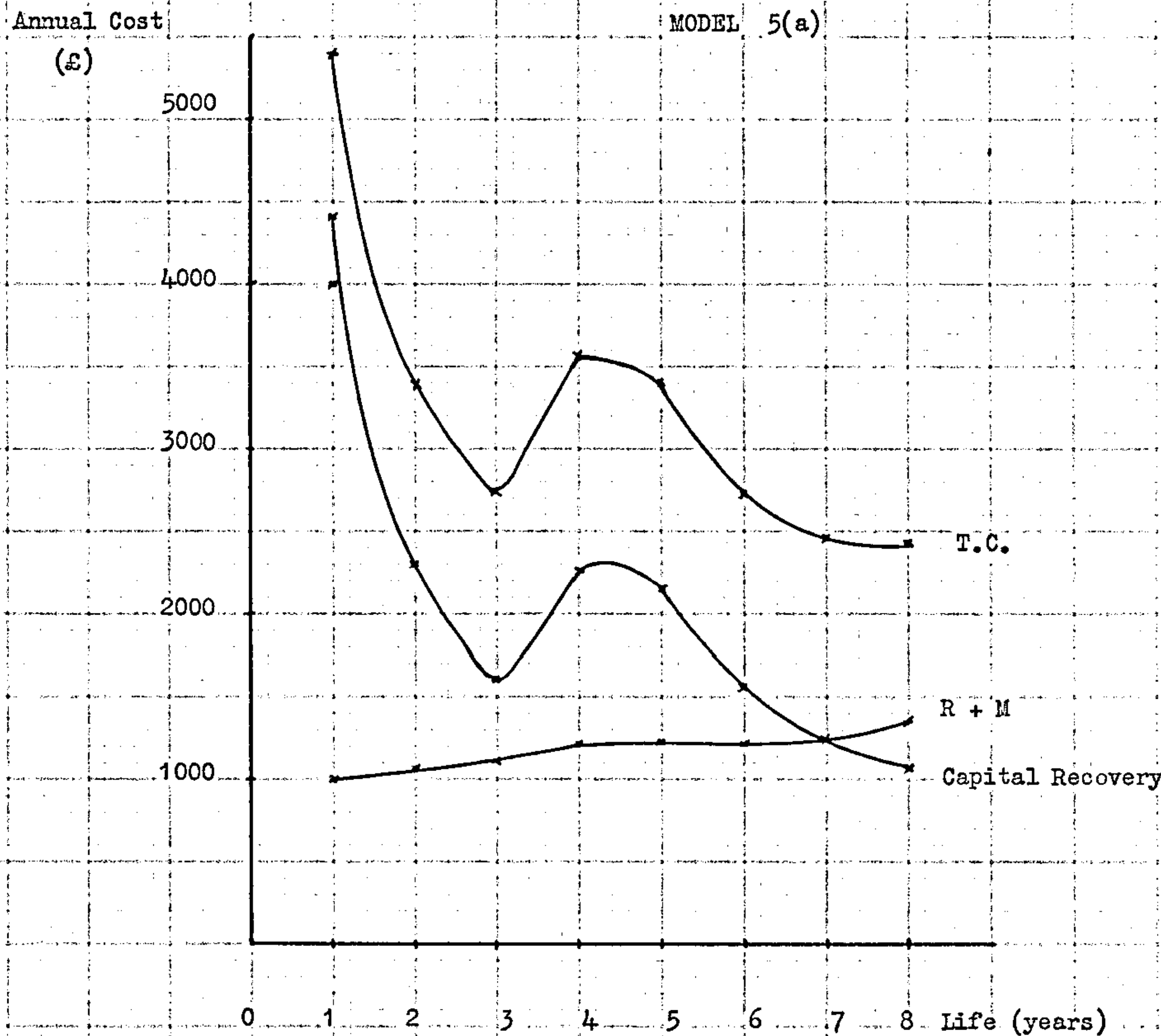

Annual Cost
(£)
MODEL 5(a)
5000
4000
3000
2000
1000
T.C.
R + M
Capital Recovery
0
1
2
3
4
5
6
7
8
Life (years)

Figure 7.6

Life (years)	Σ P.W. of V (£) c.f.Table7.8	P.W. of Salvage Value (£) c.f.Table 7.8	Value of Balancing Allowance	P.W.of Balancing Allowance	Total Present Worth of Receipts	Effective Capital expenditure
1	800	1090	240	218	2108	1892
2	949	579	260	215	1743	2257
3	1050	376	205	154	1580	2420
4	1119	478	624	426	2023	2999
5	1496	342	278	172	2010	3012
6	1621	226	200	113	1960	3062
7	1714	154	160	82	1950	3072
8	1784	28	154	72	1884	3138

Table 7.11

Life (years)	Capital Recovery Factors	S.P.P.W.F.	Effective Capital Expenditure (£)	Capital Recovery (£)	Uniform Series R and M Vosts c.f.Table7.10 (£)	Total Annual Costs (T.C.) (£)
1	1.1	,909	1892	2080	1000	3080
2	.576	.826	2257	1300	1095	2395
3	.402	.751	2420	974	1125	2099
4	.315:1.0	.683	2999	945	1228	2173
5	.264:1.1	.620	3012	795	1225	2020
6	.229:576	.564	3062	700	1219	1919
7	.205:.402	.513	3072	630	1259	1889
8	.187:.315	.466	3138	586	1368	1954

Table 7.12

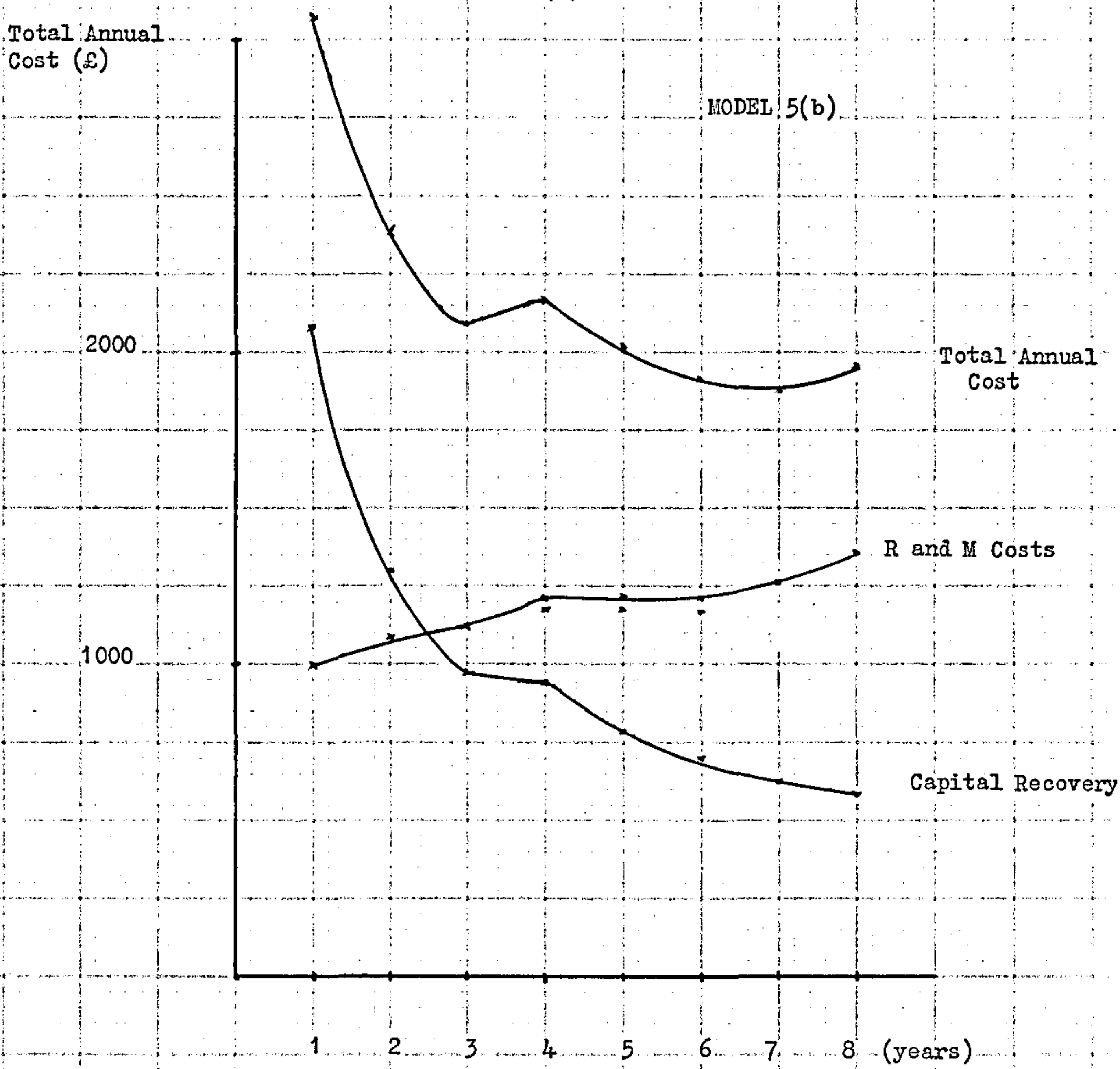

Total Annual
Cost (£)
MODEL 5(b)
2000
1000
Total Annual
Cost
R and M Costs
Capital Recovery
1
2
3
4
5
6
7
8
(years)

Figure 7.6 (a)

7.7.3 Hitherto (and correctly) operating costs charged to revenue have been calculated at full face value: that is, although tax deductible they have not been calculated at their net of tax cost. At the risk of being inconsistent, it is interesting to show the major overhaul cost charged to revenue only at its net of tax cost. This adjustment to Model 4(b) permits precise comparison with Model 5(b). For comparative purposes Table 7.13 shows the situation where the overhaul cost is shown net of tax. This is effedtively merely a modified form of Table 7.9, the modification showing itself in the altered figures in the uniform series, R and M costs.

Life (Years)	Capital Recovery Factors	Capital Recovery (£) c.f.Table 7.9	R and M costs (£)	Discounted R and M Costs (£)	ΣDiscounted R and M Costs (£)	Uniform Series RandM Costs (£)	Total Annual Cost	Total Annual Cost of Model 5(b) c.f.Table 7.12
1	1.1	2080	1000	909	909	1000	3080	3080
2	.576	1300	1200	990	1899	1095	2395	2395
3	.402	974	1200	900	2799	1125	2099	2099
4	.315	735	2500	1710	4509	1420	2155	2284
5	.264	657	1200	745	5254	1390	2047	2151
6	.229	584	1200	678	5932	1358	1942	2034
7	.205	528	1600	820	6752	1384	1912	1997
8	.187	500	2500	1170	7922	1480	1980	2058

Table 7.13 Comparison Table for Models 4(b) and 5(b)

7.8 Assessment of the Models of Cost Patterns

7.8.1 Models 1 and 2. These are clearly quite simple representations but do serve the important function of introducing the structure of costs and highlight the relevance of the decision whether or not to go in for the major overhaul in about the fourth year of the vehicle's life.

Further these two models show clearly the patterns of costs encountered and indicate that there are really two minima in the total cost curve. The first being at a higher annual cost than the second.

7.8.2 Model 3. The main effect of the reduction of the annual capital recovery due to the fact that capital allowances are considered, is clearly to depress the costs levels as shown by the total cost curves. This sophistication of the earlier models affects in only one respect the pattern of costs. Since in this situation repair and maintenance costs represents a larger percentage of the total annual cost, the latter is considerably more dependent upon the repair and maintenance costs. This is exhibited by the rather more clearly defined minima in the total cost curves in Figures 7.3 and 7.4.

7.8.3 Model 4. The consideration of the salvage value in model 4 has a considerable and very sensitive effect upon the effective capital expenditure in the very early part of the vehicle's life as shown in Table 7.7. However, as far as the determination of an optimum replacement point is concerned the salvage value has two effects. Firstly, it produces, like the capital allowances, the effect of making the total cost curve relatively more a function of the repair and maintenance cost curve. Secondly, even though the effective capital expenditure is reduced initially this does not effect the minimum points in the total cost curve.

7.8.4 Model 5 This model illustrates the affects of considering the cost of the overhaul as a capital expenditure. There are two main effects.

7.8.4.1 Comparison of tables 7.2 and 7.8 show that in the latter case the level of total costs is higher. Alternatively the vehicle has to be operated for a longer period in order to reduce the annual total cost. This therefore favours more a replacement before the overhaul rather than after in comparison with Model 2.

7.8.4.2 The repair and maintenance cost curve now presents a much more gradual increase in costs. That is in this case it is the capital recovery curve that is the governing parameter in the total curve.

7.8.4 In all the models considered the repair and maintenance cost figures used are not actual values. However, the rising pattern of costs conforms closely to that found in industry. The actual values vary quite considerably depending upon a number of local factors and adjustments for these can be made without materially affecting the hypotheses that have been presented.

7.8.5 In a number of firms it is the practice not to claim balancing allowances upon the sale of any particular asset but to continue to claim annual allowances to infinity. This practice has been adopted in order to avoid certain administrative and accounting loads. The affect of such practice upon Model 4 would be to slightly increase the effective capital expenditure. This would clearly not affect the pattern of costs in any marked way except to raise slightly the capital recovery curve.

7.8.6 No attempt is made to compare models: firstly, because being based upon different management decisions they are not truely comparable: secondly the study periods involved vary from some four to ten years. Therefore, comparison would be mathematically correct only over such series of four years and ten year cycles as would give a common overall study period. This is another aspect of the issue raised on the footnote to para. 6.3.1.

Chapter 8 Criteria which form the basis of replacement decisions in practice.

8.1 Introduction It would not be at all correct to presume that the purely economic and accounting criteria upon which the models in Section 7 are based form, or necessarily should form, the only basis for replacement decisions. There are many criteria which were found to influence strongly management decisions.

8.2 Economic Grounds Generally most of the economic factors affecting the costs of heavy vehicle operation were appreciated. However, there are from a personal point of view, severe shortcomings in the treatment that is meted to costs in an attempt to analyse the pattern of costs.

8.2.1 The costs are always considered at their nominal value and are not in any way discounted for time.

This is inherently an incorrect approach.

8.2.2 The capital expenditure is not treated as if it had a definite cost. That is depreciation is charged almost always upon a straight line basis over the projected life of the vehicle. Capital recovery techniques as used in Section 7 are not in general use.

8.2.3 Further, the depreciation is based upon the gross cost of the vehicle and no account is taken of the capital allowances that accrue. Prior to 1965 the Investment allowances which were quite substantial did not also enter into any economic analysis.

8.2.4 In most cases the examined records of repair and maintenance costs were free of distortion due to the inclusion of any warrantee and/or insurance claims. Whether this treatment is general practice is open to question.

8.3 Availability of Capital One of the single most important factors governing the replacement decision is the availability of capital forfresh investment. However,imperative it might be upon economic grounds, if capital is not allocated by general management for specific purpose replacement, such replacement is not possible. Availability of capital is dependent upon an extremely large number of influences. General retrenchment of the economy initiated either by government policy or business cycles will probably be the most important factor governing the availability of capital. It is seen therefore that the manager has to keep abreast of macro-economic trends in as much as they will eventually affect his decisions and not merely take note of immediately pertinent criteria.

8.4 Local Factors Certain local factors will impose constraints upon the models and assumptions on which they are constructed, as presented in this study. In most instances, however, compensation can relatively easily be made for such distorting influences.

8.4.1 The type of commodity that is being transported plays an important role. For example the haulage of liquid nitrogen and perhaps corrosive acids will each impose their own constraints. Corrosive liquids might reduce that life of the body or tank to a figure below that of the motive unit. In such a case entirely separate economic studies of the motive unit and the tank would become essential.

8.4.2 Terrain Consideration. Whether a fleet is being operated in plain flat country or in a hilly district, or whether on trunk roads or under off road conditions will certainly effect the life of the vehicle. The main effect will be a relative shift of the pattern of costs in relation to the time (mileage) axis. This can easily be catered for from the individual fleet's historical records and presents little difficulty.

8.5 Management Politic factors Senior management is often faced with replacement decisions taken at board level which may well be on arbitrary grounds.

Though in a large number of instances such decisions will be based upon personal experience, this is no excuse for a more thorough economic examination of the situation.

8.6 Advertising and prestige factors It was found that in certain cases the replacement decision is influenced by considerations of public image and publicity gain. Management likes to have rather newer vehicles displaying their trade and brand images. Clearly this ought not to be a consideration. If the transport fleet is to be utilised as a means of publicity one should allocate publicity and advertising funds towards offsetting any losses arising out of such activities!

8.7 Obsolescence Effects As already mentioned in Section 6, obsolescence does not play a very important role in the Heavy Vehicle industry in so far as replacement is concerned. However, it does have some effect upon the type of vehicle which forms the replacement, usually upon the occasion of new regulation as to the maximum permissable loads. For example, the recent increases in the maximum loads permissable will make for replacement with newer types of vehicle. This tendency is again some what moderated by other factors such as turn round time in association with higher driver costs.

Further it is this sustained periodic change in vehicle fleets which cushions against any drastic obsolescence effects.

Chapter 9 Summary and Conclusions

9.1 The heavy goods vehicle transport industry by virtue of its very nature presents a complex and varied picture. In view of this it has not been feasible to formulate any general overall replacement policy. This has necessitated the division of the industry into various categories and specific analysis of these categories have to be carried out.

9.2 This study has established that the model which Taylor[1] has put forward, though perhaps quite appropriate for the machine tool industry, is not at all applicable to the heavy vehicle field. The reasons for this rejection are summarised below.

In the first instance an arithmetically progressive increasing pattern is assumed by Taylor for both the effects of deterioration and obsolescence. This does not at all represent the situation in the heavy vehicle field. The study has shown that in this field the primary criteria in the replacement situation is the progressively increasing costs due to deterioration and the need for major overhaul at specific points in the life of the vehicle. Further, obsolescence of the technical type does not impinge to any great extent and very definitely not in anything like the pattern assumed by Taylor. There is an obsolescence effect introduced by statutory changes, however, this occurring as it does at irregular and unpredictable intervals does not lend itself to a priori analysis.

9.3 In practice it is found that no rigorous examination of the replacement situation is carried out. In the event of such an analysis being conducted, very often basic considerations such as the time value of money and the cost attributable to the usage of capital do not enter into the study. Further depreciation charges are arrived at on a strainght line basis without regard to the capital allowances that are available on the vehicles or the Investment allowances that were available prior to 1965.

9.4 Any analysis requires some rigorous basic foundation. Such is presented in the series of models in Section 7. These models show that, providing the major overhaul is considered, there appear two minima in the total cost curve and that not withstanding the degree of sophistication of the models, this fact holds true.

9.5 This study has not been conclusive in the sense that it was not found possible in the time to obtain specific data which would establish the economic advantage of one or other of the two minima exhibited by the models in Section 7. The British Road Services Federation Limited[2] is in fact in the process of conducting detailed cost studies under controlled conditions. Information regarding these studies was not available. It is important to note that such a controlled study cycle has to be at least

9 to 10 years in order to be at all indicative.

9.6 There are a number of non-quantifiable politic factors which can place very effective contraints upon the replacement situation. One of the most important of these is the general level of economic activity in the country and the consequent availability of capital.

9.7 It must also be realised, if only to absorb the ethos of feeling in the road haulage field that the change over to Corporation tax has placed a tremendously increase burden of capital cost upon the operator. A comparison of Figures 5.1 and 5.2 shows that in nominal terms there has been an increase of about 250% in the effective cost of a vehicle as a result of the combined effects of th e withdrawal of the Investment Allowances and a decrease of the value of the annual allowances. This accounts for the very suspicious attitude of the industry which will no doubt be further antagonised by the fresh proposals for legislation to further reduce drivers' hours.

9.8 It is hoped that this study will provide some of the fundamental principles and precepts upon which further study and research, into the replacement situation in the heavy vehicle field, might be usefully based.

1. Capital Budgeting and Company Finance
A.J.Merret and A. Sykes
A very similar approach is suggested in this book
See Bibliography

2. Paper entitled "Operation and Maintenance of Commercial Goods Vehicles". T.G. Gibb. B.R.S. Federation Limited.

Note! This paper has been delivered at the Institution of Mechanical Engineers but is not yet available.

Appendix No 1

Alternative method of viewing the Model of Cost Patterns in Sedtion 7.3

	t = 1			t = 2			t = 3		
K	4000	1.10	4400	4000	1.21	4840	4000	1.33	5320
R_1	1000	1.00	1000	1000	1.10	1100	1000	1.21	1210
R_2				1200	1.00	1200	1200	1.10	1320
R_3							1200	1.00	1200
R_4									
R_5									
Totals			5400			7140			9050

The following terminal cost series is thus obtained

Year	Terminal Cost	SFDF	Uniform series (Annual costs) T.C
1	5400	1.00	5400
2	7140	.476	3395
3	9050	.302	2725
4	11542	.215	2488
5	15208	.164	2488

N.B. It will be seen that the total cost pattern is indentical with that obtained in Section 7.3

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