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OPTIMISING VEHICLE FLEET REPLACEMENT AND DISPOSAL FOR SMALL TO MEDIUM TRANSPORT COMPANIES IN ZIMBABWE

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ABSTRACT

Little is known about optimizing route map to vehicle fleet replacement and disposal for small to medium transport companies (SMTCs) in Zimbabwe. The study of replacement is concerned with the situations that arise when some vehicles need replacement due to changes in their performance. Different vehicles have limited useful service life and the operating costs of each vehicle increases as they grow older. The longer the service life, the higher the maintenance costs up to the time the company consider a replacement. In carrying out the study, the pragmatic analytic survey was employed. The researchers employed both qualitative and quantitative data collection and analysis research techniques. Structured questionnaires, observation guides and interview guides were used during fieldwork. Data were analyzed using both quantitative (descriptive statistics) and qualitative techniques where data were scored by calculating the percentages, mean and standard deviation. This was done using the Statistical Package for Social Sciences (SPSS) computer software. Secondary data collected were scrutinized to determine their suitability, reliability and adequacy and accuracy. Findings show that vehicle fleet replacement and disposal for small to medium transport companies in Zimbabwe is influenced by different factors such as anticipation of costly failure, failure to efficiently perform, deterioration and higher maintenance costs. It was observed that companies are replacing vehicles without employing company policies on how replacement and disposal should be done. The researchers recommended different replacement policies that gives a guideline of how replacement should be undertaken, and on such policies lays the group vehicle replacement policy and the individual vehicle replacement policy.

Keywords: vehicle fleet replacement; group vehicle replacement policy, individual vehicle replacement policy, optimizing.

1.0 INTRODUCTION

Replacement is done when vehicles are economically inefficient or when components are worn out. Traditional hypothesis for the timing of the replacement of motor vehicles assumes that, as vehicle ages, maintenance costs rise. Vehicle fleet ageing is a common issue in the logistics industry based on the various effects that ageing has on productivity and cost of

vehicles. Vehicles are just normal machines and they lose efficiency due to time and usage.(Map, 2011). Replacement is therefore critical because it reduce the operating costs. Other costs such as fuel and oil also rise with age but in practice, these increases appear to be insignificant in magnitude in comparison with rises in maintenance costs. When they have risen sufficiently to offset exactly the extra depreciation and interest cost of a new vehicle, the vehicle will be replaced. Replacement of vehicles will lead to the reduction of the unreliability of small to medium transport companies in Zimbabwe particularly when vehicles break down in service (Bandauko, Bobo and Mandisvika, 2016). An organisation can have this replacement done in different forms. This is either replacement of vehicle parts which fails suddenly like bulbs, replacement of the vehicle which deteriorates with time and age(group vehicle replacement policy) or we can utilise the individual vehicle replacement where the faulty vehicle is replaced not considering vehicle age, (Munuhwa, et al., 2020).

According to Sgarbossa and Russo, (2017), older vehicles constitute a small proportion of the entire vehicle fleet and yet they contribute to a disproportionate amount of both economic and social motor vehicle costs. Trends suggests that a higher percentage of older vehicles which are 15 years and older are more frequent in today's small to medium transport companies in Zimbabwe than 30 years ago. Some of the increased longevity may be attributable to improvements in in-vehicle technologies that have improved vehicle durability. Small to Medium Fleet companies around the world need to optimize the average annual costs of their fleet sizes using different tools for managerial decisions to determine vehicles to be replaced. One of the most used is the cost analysis of the life cycle of an asset which is best known as the life cycle cost. This is characterized by performing deterministic analysis of the situation which allows the administration to evaluate the process of fleet replacement but is limited by not contemplating certain intrinsic variations related to vehicles and for disregarding variables related to exigencies of fleet use. Broadly speaking, the requirement of a replacement may be in any of the following situations, an item fails and does not work at all or the item is expected to fail shortly, an item deteriorate and need expensive maintenance, a better design of the equipment is available, is it economical to replace equipment in anticipation of costly failure.

Chien, and Chen, (2007) alluded that better vehicle utilization lowers operating cost through better planning. Implementing an optimum fleet size has proven to reduce operating costs while increasing responsiveness of small to medium transport companies globally. Fan, Gemar and Machemehl, R. (2013) retorted that optimum fleet size is a function which allows small to medium transport companies to rely on transportation in their business to minimize the risks associated with vehicle investment, improving efficiency, productivity and reducing their overall transportation costs, providing 100% compliance with government legislation.

Research has proven that during the last twenty years, a tendency has emerged for a very high proportion of new vehicles purchase to go to replace existing vehicles rather than to expand the size of the vehicle fleet, (Pedraza Martinez, Stapleton and N. Van Wassenhove, 2009). When studying the problem of replacement, there is a need to consider the concept of the time value of money. In this regard, it seems unsafe to assume that motor vehicles depreciate at a constant annual rate and therefore that the replacement demand is a fixed proportion of the current stock of vehicles. (Munuhwa, et al., (2020b) expounded that the boom in replacement sales of motor vehicles appears to be not solely an echo effect of previous sales

but to result also from a shortening of the average life of vehicles. The aim of this paper is to shed more light on the reasons why motor vehicles in small to medium companies fleets are replaced at a certain age. If implemented successfully, vehicle replacement will result in potential savings by means of a decrease in variable cost per kilometer. This will minimize volatility in addition to receiving better recovery on the vehicles within small to medium fleet companies in Zimbabwe.

The researchers designed a tool that can be used by small to medium fleet companies in Zimbabwe to determine the optimal replacement policies within great ease and efficiency. The model combined all the variables that are important in making vehicle replacement policies. The problem was referred to as optimising a route for vehicle replacement due to the fact that it involved the achieving of specific objectives while being subject to a set of constraints. In this regard, the specific objective is to minimize the total cost (both fixed and variable) of operating a vehicle through developing an optimization model which determines the optimal replacement policy for the vehicles within the optimized fleet mix.

Vehicle fleet replacement problem is deeply rooted in the history of the management of small to medium fleet companies in the Zimbabwean transport industry. Managers in these transport firms are constantly concerned with decreasing the route times, route costs and labour intensity within a contract for efficiency and effectiveness whilst ignoring costs associated with vehicle fleet replacement. In some instances, especially in Zimbabwe, small to medium vehicle fleet companies are not aware of the salvage value of old vehicles. They are only concerned about owning large numbers of the fleet even if they are redundant. Instead of going to the root of the services and decreasing the costs of fleet management which includes the ever-important consideration of fleet composition which entails the combination of fleet mix and vehicle age. Within the context of this research, fleet mix refers to an optimum fleet size of vehicles while vehicle age refers to whether the vehicle within the fleet is either new or used and age will be a combination of both years and kilometres travelled.

1.1 Research objectives

The objectives guiding this research are;

- To establish factors affecting vehicle replacement and disposal in SMTCs
- To identify relevant vehicle replacement and disposal models for an effective and sustainable fleet operation
- To recommend the most appropriate vehicle replacement and disposal policy for SMTCs in Zimbabwe.

The research paper is structured as follows, Section 2 deals with literature review, section 3 focuses on the research study area. Section 4 focuses on a methodology study whilst section 5 looks at findings. Section 6 looks at the research discussion and section 7 concludes with conclusion and recommendations.

2.0 LITERATURE REVIEW

2.1 Factors Affecting Vehicle Replacement and Disposal

2.1.1 Depreciation

According to Pojani and Stead, (2015), depreciation refers to the loss in value of a vehicle due to wear and tear caused by its use over time. Depreciation is simply the difference between how much you spend buying a vehicle and the amount you get back when selling. On average, a new car will have a residual value of around 40% of its new price after three years (assuming around 10,000 miles/year) or, putting it another way, it will have lost around 60% of its value. More fuel-efficient vehicles tend to depreciate more slowly because cars that will be cheaper to run are always popular. Depreciation is also affected by the model replacement cycles of manufacturers. This means a brand new model may depreciate more slowly than the model that's on the way out, (Giannopoulos, 2004) argues that vehicle depreciation or loss in value can be a result of the passage of time without being in use.

2.1.2 Maintenance cost

Vehicle maintenance means vehicle and equipment rehabilitation, mechanical repairs, painting, fuelling, and lubrication. Factors such as terrain, temperature, weather, trip length and environment, driving behavior and load all affect the performance of a vehicle over time,(Kumar and Kushwaha, 2014). The more a vehicle is exposed to one of these conditions the more it generates maintenance costs in a short time. Usually when maintenance costs are equal to or exceed the vehicle acquisition cost organisations take decisions to replace or dispose of the said fleet, (Sebego et al., 2014)

2.1.3 Fleet Obsolescence

Sometimes called 'built-in obsolescence', planned obsolescence is the process of designing a product to fail at a certain point; usually at a certain stage in its lifespan. The reasons for this vary, but generally, it's to encourage consumers to purchase the next product in a series. Planned obsolescence (also called built-in obsolescence or premature obsolescence) in industrial design and economics is a policy of planning or designing a product with an artificially limited useful life so that it becomes obsolete (i.e., unfashionable, or no longer functional) after a certain period of time. The rationale behind this strategy is to generate long-term sales volume by reducing the time between repeat purchases (referred to as "shortening the replacement cycle"). It is the deliberate shortening of a lifespan of a product to force consumers to purchase replacements,(Map, 2011).

2.1.4 Hidden costs

Expenses that are not normally included in the purchase price for a piece of equipment or machine-like supplies, training, support and upgrades(Choocharukul, Length and Saruchera, 2011). Hermans, Brijs and Wets, (2014) , expounded that examples of hidden cost include tolls, insurance, parking, and antitheft devices. Depending on where you use the car and how difficult it is to park, you'll need to add this to your auto expenses. For example, it can cost $500 to $1,000 for a monthly parking space in a New York City garage, (Map, 2011).

2.1.5 Downtime

Vehicle downtime refers to the period of time when a vehicle is unavailable. This unavailability may be caused due to factors such as planned or unplanned maintenance, repairs, and replacements. The period during which equipment or machine is not functional or cannot work. It may be due to technical failure, machine adjustment, maintenance, or non-availability of inputs such as materials, labour, power. Average downtime is usually built into the price of goods produced, to recover its cost from the sales revenue, also called waiting time.(Zenina and Borisov, 2012; Sebego et al., 2014).

2.1.6 Vehicle Age and mileage

Age and mileage are major factors determining when vehicles will be replaced. Some vehicles have lengthy drives on a regular basis, while others are only used occasionally. Mileage and engine life can both be used to help determine the appropriate vehicle replacement time, (Hermans, Brijs and Wets, 2014)

2.2 Vehicle Replacement Models

2.2.1 Optimum operational life

Vehicle replacement is influenced by different factors. Replacement can be done when vehicles are economically inefficient or when components are worn out such that the maintenance costs of that same vehicle will be too high. These vehicles lose efficiency due to operational time and usage. Replacement is therefore important because it reduces the operational costs for small to medium vehicle fleet companies in Zimbabwe (Government of Zimbabwe, 2002). Varsei, (2016), noted that replacement has to be done using an appropriate vehicle replacement method and policy which determines the age and time at which the replacement has to be done as illustrated in Figure 1.Optimal vehicle replacement policy can be determined by calculating the annual cost of the vehicle at a time (t) which is given as- $C - S(t) + m(t)$. It can also be calculated by finding the total maintenance costs over n years are given as $\sum_{t=o}^{n} m\ (t)$ when time is discrete or $\int_0^n m(t)dt$ (time-continuous) where:

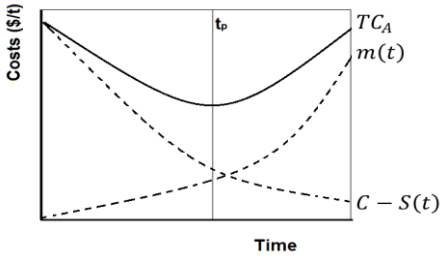
TC_A is the total average costs

$m(t)$Operating or maintenance cost of the vehicle

$C - S(t)$ the rate of vehicle depreciation in its value every year

t_p is the optimum operational life of the vehicle

Figure 1: Optimum Operational life Model



Source: Fan, Gemar and Machemehl, R. (2013)

Suppose the capital cost of the machine is C.S(t) is the scrap value of the machine at time(t), m(t) is the operating costs or maintenance costs at time t and n is the number of years. The annual cost of the machine at time t is given as$C - S(t) + m(t)$. The total maintenance costs over n years are given as $\sum_{t=o}^{n} m\ (t)$ when time is discrete or $\int_0^n m(t)dt$ (time continuous

For a continuous vehicle replacement time case, the total cost TC after (n) years is expressed as:

TC = Capital cost – scrap value + maintenance cost

- $TC = C - S(t) + \int_0^n m(t)dt$
- The average annual costs TC_A (divide by the number of years n)
- $TC_A = \frac{1}{n}[C - S(t) + \int_0^n m(t)dt]$
- To find the value of n which will minimise TC_A differentiate w.r.t to n
- $\frac{\partial TC_A}{\partial n} = -\frac{1}{n^2}\big(C - S(t)\big) - \frac{1}{n^2}\int_0^n m(t)dt + \frac{1}{n}m(n)$

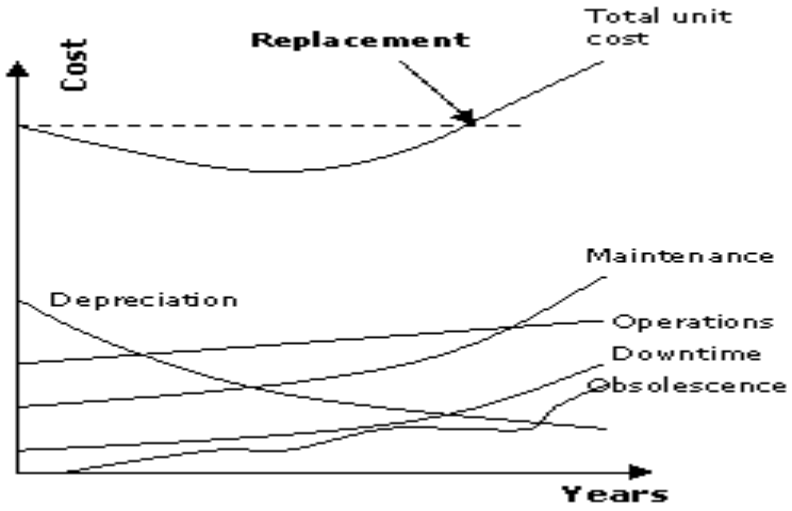
Thus the vehicle replacement is profitable when $TC_A = m(n)$

Small to medium vehicle fleet companies in Zimbabwe are constantly faced with the dilemma of deciding when to replace their fleet and determining what effect their replacement decisions will impact the financial output of the company in the long run. In other companies around the globe, they can utilise Dynamic Programming (DP) to anticipate the best decision in optimising the fleet size and deciding which vehicle to be replaced. The general decisions that can be made regarding vehicle fleet replacement policies can be whether to keep the vehicle, maintain the vehicle (overhaul) and replace the vehicle. Bagui, Chakraborti and Bhadra, (2012)). To fully utilise the benefits of vehicle replacement in an effective recursive function as well as obtaining an optimal solution, small to medium vehicle fleet companies need to design a tool that succumbs the characteristics of a dynamic programming model. There is a need to consider other factors like maintenance costs, salvage value and weight allocation when small to medium vehicle fleet companies need to make an optimal decision when the need for replacement arises. (Winton and Venkataramanan 2003).

2.2.2 Replacement Point Model

The New Zealand Transport Agency (2005) answered the major begging questions by small to medium vehicle fleet companies. These questions are, when does one need to replace a vehicle? At what point does a vehicle start operate inefficiently? They refer to the point in time when a vehicle should be replaced as the replacement point. The illustration on Figure 2 below reveals costs overtime for a vehicle which includes depreciation, maintenance costs, obsolescence and operations downtime as a result of service, age or breakdown.

Figure 2: Replacement Point Model



The top curve on the graph is the total cumulative cost of all the bottom costs, excluding the initial cost of purchasing the vehicle. The point marked with an arrow as 'replacement' is the optimal point in time to replace the vehicle; after which the cost of operation exceeds the replacement cost. As can be seen in Figure 2, we do not replace the vehicle at the minimum total cost but rather where the line surpasses the initial cost point. Over time, the cost graph will appear as a series of U-shapes with the apex representing the acquiring of a replacement vehicle.

2.3 Vehicle replacement Policies

Different vehicles have limited useful service lives and the operating costs of each vehicle increase as they grow older. The longer companies use their vehicles, the higher their maintenance costs rise up to the time where companies should consider a replacement. Companies employ different replacement policies that give a guideline of how replacement should be undertaken, and on such policies lies the group vehicle replacement policy and the individual vehicle replacement policy. Strategic decisions have to be undertaken when companies consider trading in new vehicles to replace their current fleet, either underperforming or according to their policy on a time frame for holding vehicles. Small to medium companies in Zimbabwe should have some guiding policies which direct them whether to keep their fleet or co consider replacing those vehicles underperforming with the new fleet.

2.3.1 Group Vehicle Replacement Policy

This entails a policy which guides companies on how to replace their vehicles traded in as a batch at the same time. It does not consider vehicle performance but takes into consideration the agreed time frame which companies will hold their vehicles. Companies will replace their vehicles as a batch when their time of replacement is reached. This is normally done by well-established vehicle fleet companies unlike the small to medium vehicle companies. All the feet which were acquired at the same batch will be replaced as a batch. Some companies have policies to hold their vehicles only for five (5) years. The group vehicle replacement policy awards the salvage value of the fleet as a once-off. According to Cho and Rust (2008), the salvage value is a function of age or odometer of the vehicle. In group vehicle replacement policy, the age is determined by the batch upon acquisition of the vehicle. It allows for proper

budgeting since the period for replacement is known and constant. A large number of vehicles that not easily managed can be disposed of effectively and efficiently without disrupting the operational activities in an organisation and unnecessary replacement costs will be eliminated since some better-conditioned vehicles are included for replacement.

2.3.2 Individual Vehicle Replacement Policy

It is a replacement policy used by companies that guide transport managers to replace only one vehicle in a batch that is in need of replacement mainly guided by its condition and performance level. Vehicles may have been traded in as a group but only the one in poor condition or underperforming is considered for replacement. It is cost-effective since only underperforming vehicles are replaced. It allows companies to keep their better-conditioned vehicles. It also allows maximum utilisation of vehicles till the capital level reaches a low level. Does not allow for proper budgeting since the time for replacement is determined by vehicle performance and condition than the time which in known. It is difficult to use on a company with a large number of vehicles

Vehicles can be replaced by the use of financial modelling. This tool will anticipate the cost associated with the fleet which includes both initial costs and running costs. The initial costs of acquiring a new vehicle should be minimized while reaching the desired service requirements. Running costs includes depreciation, maintenance and labour. Companies have to look into consideration some financial indicators that could aid decision making when replacing vehicles. According to Seal et al., (2006), depreciation is the spreading of the cost of a vehicle or asset over its useful life. This cost is a result of wear and tear or obsolescence. It is an important factor to consider as it decreases the book value of the vehicle and therefore the vehicles salvage value. Ajibade (2014), concurs that depreciation is what it is and there is no way to change the value thereof. The only way in which depreciation will affect the optimal replacement strategy is by weighing in on the salvage value, which if decreases, decreases the advantage of having the said vehicle.

3.0 STUDY AREA

The study area used was Chinhoyi Metropolitan area in Mashonaland West province of Zimbabwe. This study area was specifically chosen to get more respondents from across the province. Most operators from within the province come to Chinhoyi urban to find a business or doing their own transport operations within Chinhoyi Central Business District(CBD).

4.0 METHODOLOGY

The research design used in this study is descriptive survey research design because it helps give answers to the inquiries of who, what, when, where, and how connected with a specific research issue, descriptive research is utilized to get data concerning the ebb and flow status of the marvels and to portray "what exists" as for Variables or conditions in a circumstance. The population was comprised of small to medium vehicle fleet companies in Zimbabwe. The study population was 40 small to medium transport companies in Chinhoyi. The sample size was 36 respondents as determined by the Krejcie and Morgan,(1970) formula. Researchers utilised stratified random sampling to get a sample population that best speaks to the whole population being studied. Stratified random sampling precisely reflects the population being considered in light of the fact that researchers are studying the whole

population before applying random sampling methods. It guarantees that every subgroup within the population gets a proper representative within the sample. As a result, the stratified random sampling gives better inclusion of the population since analysts have command over the subgroups to guarantee every one of them is represented in the sampling. The study used structured questionnaires and interviews to collect data. Respondents and interviewees were given ample time to be prepared and fill in the questionnaires. The statistical package for the social science programme (SPSS) was used to analyse the data coded and ANOVA to test the level of significance of the variables on the dependent variable (depreciation, vehicle age, vehicle usage, legislation, maintenance costs and labour) at 95% level of confidence and 5% level of significance Information presentation and examination assumes a fundamental job in each field.

5.0 Findings

5.1 Causes of vehicle fleet replacement and disposal for Zimbabwean small to medium transport companies.

In order to identify the causes of vehicle fleet replacement and disposal for Zimbabwean small to medium transport companies, respondents were asked to indicate the extent to which the suggested causes lead to vehicle fleet replacement and disposal on a Likert scale of 1-5 where 1=very low extent, 2= low extent, 3=medium extent, 4=higher extent and 5=very higher extent. The responses given by the respondents enabled the researcher to calculate the mean and standard deviation to measure the variation in the opinion of respondents on the causes of lead-time variability. Their responses are presented in table 5.1 below.

Table 5.1: Causes of vehicle fleet replacement and disposal

Causes of vehicle fleet replacement and disposal			
Causes	**N**	**Mean**	**Std. Deviation**
Maintenance costs	32	4.81	.49
Vehicle age and Mileage	32	4.73	.47
Vehicle usage	32	4.52	.53
Vehicle Hidden Costs	32	4.21	.46
Total			

The study sought to examine the causes of vehicle fleet replacement and disposal. The study established that maintenance costs had a mean score of (M=4.81, SD=0.49). This shows that maintenance costs contributed to vehicle fleet replacement and disposal for Zimbabwean small to medium transport companies to a greater extent. Following Brosh et al (1975), researchers included the cost of spare parts in the analysis. Vehicle parts are replaced as a function of the odometer except for batteries. Maintenance costs according to the New Zealand Agency (2005) makes up between 5% and 10% of a vehicle's operating cost in developed countries. In addition, maintenance costs increase with vehicle age and operation intensity. Research has indicated that the maintenance percentage rate will increase as the delivery distances and weights increases as is the case in Zimbabwe where maintenance costs

are much higher than in developed countries reaching between 25% and 35% of operating costs.

As the vehicle gets older, there are a number of factors which are influenced. The study also revealed that vehicle age and mileage had a mean score of (M=4.73, SD=0.47). This shows that vehicle age and mileage affected vehicle disposal for small to medium transport companies in Zimbabwe to a greater extend. Wu etal (2001) postulates that the operating costs of vehicles increase with age due to increasing maintenance costs. In addition, older vehicles have a lower book value and as such can be sold for less in year z+1 than in year z.

The study findings also revealed that vehicle hidden costs had a mean score of (M=4.21, SD=0.46). Seal etal (2006) suggests that vehicle hidden costs can also be viewed as vehicle variable costs. These are those cost that vary in direct proportion to the activity level. Each unit variable cost is always constant, resulting in an increased level of activity and these variable costs include fuel (due to different consumption levels), lubricants, oil and tyres. In practice, these costs appear to be more insignificant in magnitude in comparison with maintenance costs that can also be part of these variable costs hence the study revealed that vehicle hidden costs/variable costs were the major cause of vehicle disposal in SMTC. Alternate factors that influence vehicle disposal in SMTC include depreciation and optimal fleet size.

6.0 DISCUSSION

Vehicle replacement and disposal is a somewhat difficult decision to take especially for small to medium transport operators who may not have stable revenue and resources to abide by a given policy. Most SMTC may be faced with a lack of enough money to buy a new fleet after the lapse of time or when maintenance costs reach a certain level. Sometimes it is difficulty under economic conditions such as the Zimbabwean one where it is difficult to thrive in business generating reasonable revenue to replace any fleet. Hence for that reason even if an organization follow a certain replacement model or policy they may still be unable to replace a fleet due to unavailability of funds to do so at the appropriate time. In this regard, a universal way of disposing and replacing vehicles is not ideal but to ensure that replacement is done when the organization has enough funds. Mbara, (2015) notes that keeping on using a vehicle when its replacement period and value has elapsed results in the fleet being ineffective and contributing to unnecessary operational costs.

7.0 CONCLUSION AND RECOMMENDATIONS

It is ideal for SMTC to follow the individual vehicle policy in replacement of vehicles. This helps these growing organisations to commit funds on procuring vehicles in bits and pieces than to buy a fleet a one time. SMTCs are also encouraged to engage with financial institutions for funding when they need to make vehicle fleet replacement. However, SMTCs must only engage lending institutions after carefully making project feasibility to repay the loan and interest from operational proceeds.

REFERENCES

Ajibade, A.D., Odusina, M.T., Rafiu, A.A., Ayarinde, A.W., Adeleke, B.S., and Babarinde, S.N. (2014). The use of replacement model to determine the appropriate time to replace a deteriorating industrial equipment. IOSR Journal of Mathematics, 10 (2), 9-13.

Bagui, S.K,,Chakraborti, A.K., &. Bhadra, S.M. (2012). Application of replacement theory in determination of pavement design life. Jordan Journal of Civil Engineering, 6 (1), 147 – 160.

Bandauko, E., Bobo, T. and Mandisvika, G. (2016) 'Towards smart urban transportation system in Harare, Zimbabwe', Smart Cities as a Solution for Reducing Urban Waste and Pollution, i(October 2017), pp. 126–147. doi: 10.4018/978-1-5225-0302-6.ch005.

Chien, Y.H. and Chen, J.A. (2007). Optimal age-replacement model with minimal repair based on cumulative repair cost limit and random lead time; Proceedings of the 2007 IEEE IEEM

Cynthia Chen & Jie (Jane) Lin (2006) Making an Informed Vehicle Scrappage Decision, Transport Reviews, 26:6, 731-748, DOI: 10.1080/01441640600752545

Choocharukul, K., Length, F. and Saruchera, F. (2011) 'The African e-Journals Project has digitized full text of articles of eleven social science and humanities journals . This item is from the digital archive maintained by Michigan State University Library . Find more at ':, 2(April), pp. 72–76.

Fan, D.W., Gemar, M. and Machemehl, R. (2013). Equipment replacement optimization; a paper presented at the 91st annual meeting of the transportation research board, Washington DC; 22nd January.

Giannopoulos, G. A. (2004) 'The application of information and communication technologies in transport', European Journal of Operational Research, 152(2), pp. 302–320. doi: 10.1016/S0377-2217(03)00026-2.

Government of Zimbabwe (2002) 'Urban Councils Act (Chapter 29:15)', 2000, p. 29. Available at: http://faolex.fao.org/docs/pdf/zim80651.pdf.

Hermans, E., Brijs, T. and Wets, G. (2014) 'Developing a Theoretical Framework for Road Safety Performance Indicators and a Methodology for Creating a Performance Index', (July 2015), pp. 1–85. Available at: www.steunpuntmowverkeersveiligheid.be.

Kumar, A. and Kushwaha, G. S. (2014) 'Food supply chain management sustainability: a review', Research Journal of Science & IT Management, 3(10), pp. 30–42. Available at: http://kar.kent.ac.uk/26066/.

Map, O. S. (2011) 'Better fleet management with Tramigo Why TLD Landmarks are the best solution for vehicle tracking T22 Case Study Zimbabwe', pp. 17–19.

Munuhwa, S., Muchenje, K., et al. (2020) 'Approaches for Reducing Urban Traffic Congestion in the City of Harare', Journal of Economics and Sustainable Development, 1700, pp. 1–17. doi: 10.7176/jesd/11-4-01.

Munuhwa, S., Mandere, T. S., et al. (2020) 'Sustainability of Informal Shuttle Transport in the City of Harare', 11(8), pp. 144–155. doi: 10.7176/JESD/11-8-14.

Pedraza Martinez, A., Stapleton, O. and N. Van Wassenhove, L. (2009) 'INSEAD. The Business School for the World. Faculty & Research Working Raper. Field Vehicle fleet Managament in Humanitarian Operations.', pp. 1–54. Available at: https://sites.insead.edu/facultyresearch/research/doc.cfm?did=44315.

Pojani, D. and Stead, D. (2015) 'Sustainable urban transport in the developing world: Beyond megacities', Sustainability (Switzerland), 7(6), pp. 7784–7805. doi: 10.3390/su7067784.

Sebego, M. et al. (2014) 'The impact of alcohol and road traffic policies on crash rates in Botswana, 2004-2011: A time-series analysis', Accident Analysis and Prevention. Elsevier Ltd, 70(October 2008), pp. 33–39. doi: 10.1016/j.aap.2014.02.017.

Sgarbossa, F. and Russo, I. (2017) 'A proactive model in sustainable food supply chain: Insight from a case study', International Journal of Production Economics. Elsevier, 183(2016), pp. 596–606. doi: 10.1016/j.ijpe.2016.07.022.

Varsei, M. (2016) 'Sustainable supply chain management : An integrated model for optimising supply chain network design', (May 2016), p. 212. Available at: https://www.researchgate.net/publication/319056482.

Zenina, N. and Borisov, A. (2012) 'Transportation Mode Choice Analysis Based on Classification Methods', Scientific Journal of Riga Technical University. Computer Sciences, 45(1), pp. 49–53. doi: 10.2478/v10143-011-0041-2.

