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# TITLE Urban bus productivity and maintenance costs in Zimbabwe

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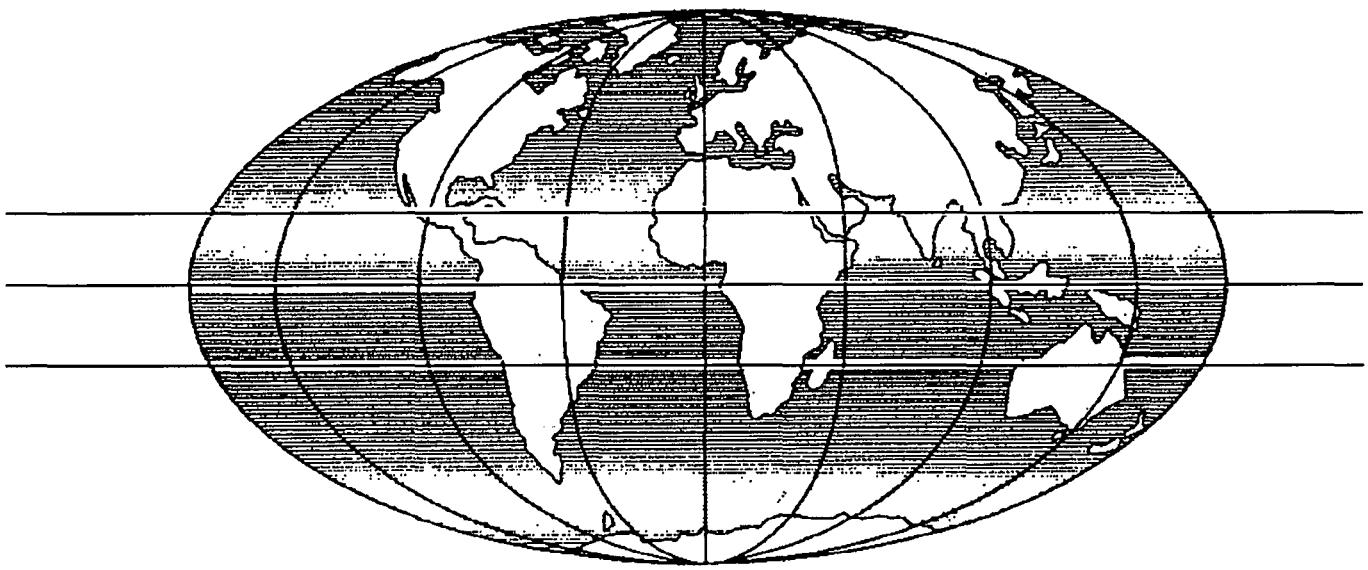

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# Urban Bus Productivity and Maintenance Costs in Zimbabwe

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*This paper describes the findings of a study of different aged buses operated by the Harare Division of the Zimbabwe United Passenger Company. The objective was to assess the impact of vehicle age on productivity and maintenance costs. The study was undertaken as part of a collaborative research programme on urban bus operations by the Transport Research Laboratory and the Zimbabwe Department of Physical Planning. The findings may be of particular interest to other urban bus operators in the Third World.*

## INTRODUCTION

In the major towns and cities of Zimbabwe, public transport services are supplied by the Zimbabwe United Passenger Company (ZUPCO) which has two shareholders, the Government of Zimbabwe (51%) and the United Transport Group (49%). The Government became the majority shareholder in 1988 because it regarded public transport as a strategic sector of the economy and hence its participation was necessary for determining the future development of the sector. There was concern at the level of service being provided in Harare (prior to Government participation) as the fleet was ageing and vehicles past their economic lifetime were not being replaced. As a consequence vehicles were frequently breaking down and commuters were facing considerable problems travelling both to and from their work places.

Following direct participation by Government in October 1988 a new Franchise Agreement between the Government and ZUPCO was agreed. The designated area of the Franchise was extended from 26 to a 30-kilometre radius from the Harare Central Post Office to reflect the expansion of the city. This continued to give ZUPCO the monopoly to provide stage bus services within the capital. Greater emphasis was placed on the acquisition of buses and spare parts with Government ensuring whenever possible the availability of foreign currency for these purchases. The Harare Division of ZUPCO has enlarged its fleet from 653 to 823 vehicles, and in addition a considerable number of over-aged and under-utilised vehicles such as Mercedes, Leyland Albions and Daf 615s have been replaced by new Daf 825s. The fleet has also been diversified to include five M.A.N. articulated (train) buses and 100 Toyota and Mazda minibuses. The effect of the fleet modernisation and expansion programme has been to reduce the average age of the fleet to 6.2 years (1991-92). Despite this, there are still considerable numbers of Daf-615's in use which are in excess of 12 years old.

Throughout the transport industry it is generally accepted that old vehicles (frequently operated beyond their recognised operational life) incur higher maintenance costs, breakdown more frequently and are generally less productive than new vehicles. To assess the validity of this view and in addition, to analyze the 'real costs' (in terms of actual maintenance costs and lost productivity) of continuing to operate over-aged vehicles, a study was undertaken of age related bus performance in Harare. The study was implemented as part of

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a joint programme of research undertaken by the Transport Research Laboratory and the Department of Physical Planning (Maunder and Mbara, 1993).

## STUDY METHODOLOGY

The study involved three separate surveys of vehicles over a two year period; each survey involved the monitoring of about 100 buses, representing over 10 percent of the fleet. Monitoring during each survey was continuous over a three week period, and included observations on vehicle utilisation, output and maintenance expenditure. The data from each of these surveys have been aggregated to provide the data-set for cross-sectional analysis. The samples were chosen to represent the different models and ages of the total fleet operated by ZUPCO's Harare Division (see Table 1). No attempt was made to monitor the same set of vehicles from one survey to the next (except in the case of train buses, of which there are only five in the fleet) because of the problem of drop-out: over time, vehicles may be shifted to other depots (outside Harare), 'cannibalised', or written-off in accidents. Rather, each survey contains a small set (usually ten) of a particular model and age range; average values for each set are used to indicate the relative performance of that particular group.

**Table-1 : Survey Sample Sizes**

| Survey | Model | Fleet size | Sample size | Age range (years) |
|---|---|---|---|---|
| May, 1990 | Leyland Albion | 119 | 8 | 13-18 |
| | Daf 615 | 395 | 10 | 4-13 |
| | Daf 825 | 135 | 13 | 0-3 |
| | MAN Train bus | 5 | 5 | 0-1 |
| | Toyota Dyna | 53 | 8 | 0-1 |
| May, 1991 | Leyland Albion | 30 | 10 | 14-19 |
| | Daf 615 | 395 | 30 | 5-14 |
| | Daf 825 | 208 | 20 | 0-5 |
| | MAN Train bus | 5 | 5 | 1-2 |
| | Toyota Dyna | 59 | 20 | 0-2 |
| May, 1992 | Daf 615 | 397 | 30 | 6-15 |
| | Daf 825 | 321 | 40 | 0-6 |
| | MAN Train bus | 5 | 5 | 2-3 |
| | Toyota Dyna | 70 | 20 | 0-3 |
| | Mazda | 30 | 10 | 0-1 |

Vehicle productivity was monitored by recording the out-shedding of vehicles from depots and by analyzing drivers' waybills. The Engineering Department monitored the maintenance of the vehicles, noting parts consumed for costing purposes. Vehicle time was classified as 'operational','idle', 'awaiting maintenance' and 'being maintained'. Idle time was defined as time when a vehicle was available for operation but was not operated by the Traffic Department and thus was parked in the depot.

Vehicles were idle for two main reasons: the nature of split shift operations and driver shortage, which has been a critical problem for ZUPCO during the last 2-3 years. The older, less reliable vehicles tend to be used for split shift duties, i.e. during peak time operations only.

The time a vehicle was 'awaiting maintenance' was defined as time when a vehicle was not operationally available and was thus parked in the depot waiting to be maintained by the Engineering Department. ZUPCO undertake two routine maintenance checks : the 'A' and 'B' checks. These checks are designed to frequently monitor the condition of a vehicle. The 'A' check includes a safety examination (tyres, brakes, steering, lights etc.) which is undertaken every 10 days. The 'B' check is a preventive maintenance check of key components undertaken on 'overworked' vehicles every 4, 6 or 8 weeks, depending on circumstances. In addition every 12 months a vehicle undergoes a thorough examination in preparation for its "Certificate of Fitness". Every 2-3 years extensive examinations are made of potentially worn parts such as fuel pumps, engines, compressors, differentials and gear-boxes. Between 5-8 years major engine overhauls are implemented to ensure continued availability beyond 8 years to at least 12 years.

Breakdowns were defined as vehicles which broke down whilst in operational service; the vehicles could not be made operational without engineering assistance. In many cases drivers were requesting assistance for relatively minor problems, particularly if the vehicle had reached a central terminal where mechanical assistance is readily available. These incidents were reported as breakdowns, though they would not normally be recorded as such by ZUPCO. As a result, the breakdown rate reported in the surveys is almost double that which is officially recorded.

**BUS PRODUCTIVITY**

Figure 1 illustrates the time utilisation of standard single-deck buses, train buses and Toyota minibuses against vehicle age. The classic general trend of diminishing utilisation with increasing age is self evident as is the percentage of time a bus was idle, which increased substantially with vehicle age. The first five vehicle sets (all Daf 825s with an average age of less than four years) all attained more than 70 percent use; all the more aged vehicles displayed a marked drop in operational use to 50 percent of total available time and less.

The percentage of time 'waiting to be maintained' ranged from less than 1 percent for the newer Daf 825s and the oldest group of Daf 615s to 52 percent for the Toyota's aged 1-2 years old. Between September 1992 and January 1993, up to 50 percent of the minibus fleet were off the road awaiting spare parts.

The amount of time 'being maintained' ranged from less than 2 percent, for the oldest group of Daf 615s, to almost 20 percent for the very old Albions and 15 percent for the oldest group of Daf 825s, i.e. those aged between 5-8 years old. As noted earlier, it is in this age range that major engine overhauls are undertaken and so this percentage of time is consistent with expectations. Generally, vehicle maintenance time constitutes only about 10 percent of total time.

Figure 2 shows the average daily kilometerage of the different aged vehicles operated during the survey period. It is evident that output tends to decline with increasing vehicle age. There is also a very clear distinction between the performance of the minibus and single-deck fleets, though this must be qualified by noting the small number of observations for minibuses and the fact that the minibuses were particularly hard hit by some industrial action prior to the last round of surveys. Generally, however, the life-expectancy of a minibus is likely to be considerably shorter than that of a conventional large bus.

The decline in output with age is probably not linear. To illustrate this Figure 3 presents only the data sets for the two main types of standard single deck bus: the older technology Daf 615s and the newer Daf 825s. There is a suggestion here that the rate of decline in output decreases with increasing vehicle age. (Of course, the difference in vehicle type could very well explain this change, but because the two model types are quite similar, it is likely that age is the most important explanation of the change in slope.) The situation may be even more complex, with the probability that an S-shaped curve best represents the decay in output.

Figure 4 shows the breakdown rate of vehicles related to average age. The scatter is quite marked, though there is a discernible upward trend with increasing age. Typically the breakdown rate doubles every five years.

## MAINTENANCE COSTS

For the ZUPCO Harare Division, total maintenance costs as a proportion of total operational costs are relatively stable at about 15 percent. The cost of spare parts (including tyres and tubes) is, however, a major cost component, which at the end of the 80s was as much as 25 percent of total operational costs. However, since the fleet renewal programme began in the 90s, the contribution to total costs of spare parts acquisition has dropped to around 20 percent.

For the surveys, maintenance costs were defined to include both direct labour (but not support and administrative labour) and spare parts. For all the vehicles monitored the consumption of spare parts accounted for approximately 90 percent and labour only 10 percent of maintenance costs. Average maintenance costs per km from the surveys are shown in Figure 5. The chart distinguishes between minibuses and large buses, though again the number of minibus observations is small. Maintenance costs per km rise with increasing vehicle age, and at a faster rate for minibuses as compared to large buses.

## SUMMARY

This cross-sectional study of the age-related performance of buses in Harare has demonstrated the increased productivity and lower maintenance costs of young as compared to older vehicles. There are also some differences as between minibuses and large buses, though the sample sizes are too small to be confident of these effects.

In comparing performance across a number of years and different models there is the possibility that changes in technology will contribute to the observed differences in performance. However, taken at face value the data presented suggest that in Harare, output from a standard single-deck bus will decline to about half its initial value over about 10 years. During the same period, maintenance costs might quadruple and breakdowns increase ten times.

## REFERENCE

Maunder D.A.C. and T.C. Mbara, 1993. The effects of ownership on the performance of stage bus services in Harare, Zimbabwe. TRL Project Report 25. Transport Research Laboratory, Crowthorne.

## ACKNOWLEDGEMENTS

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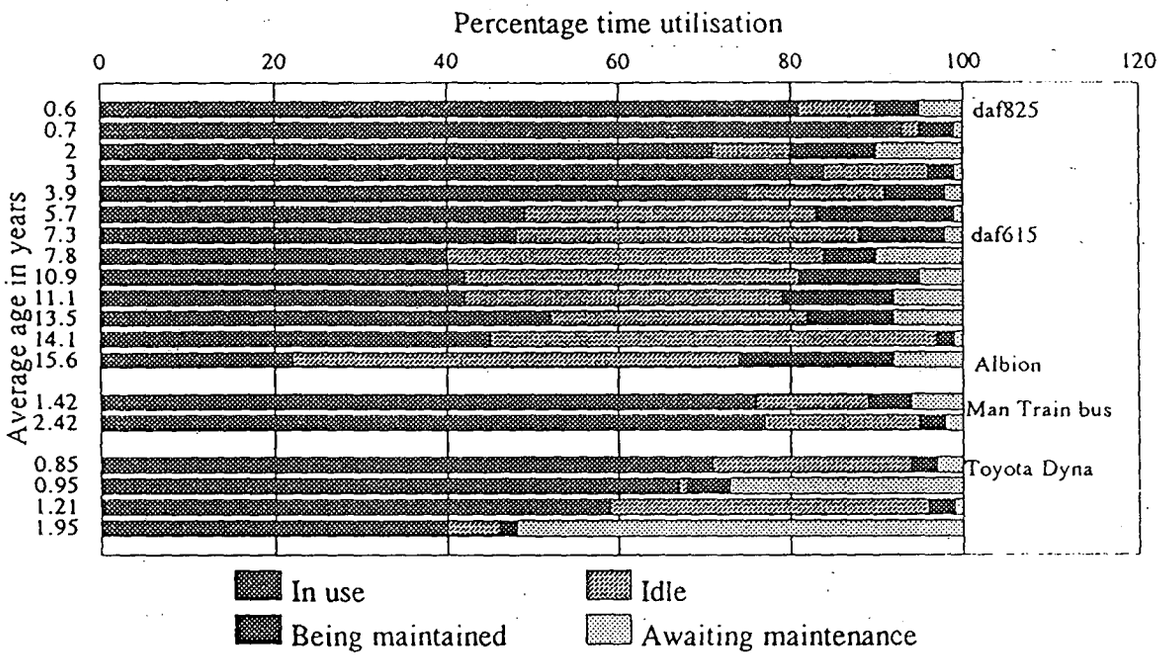
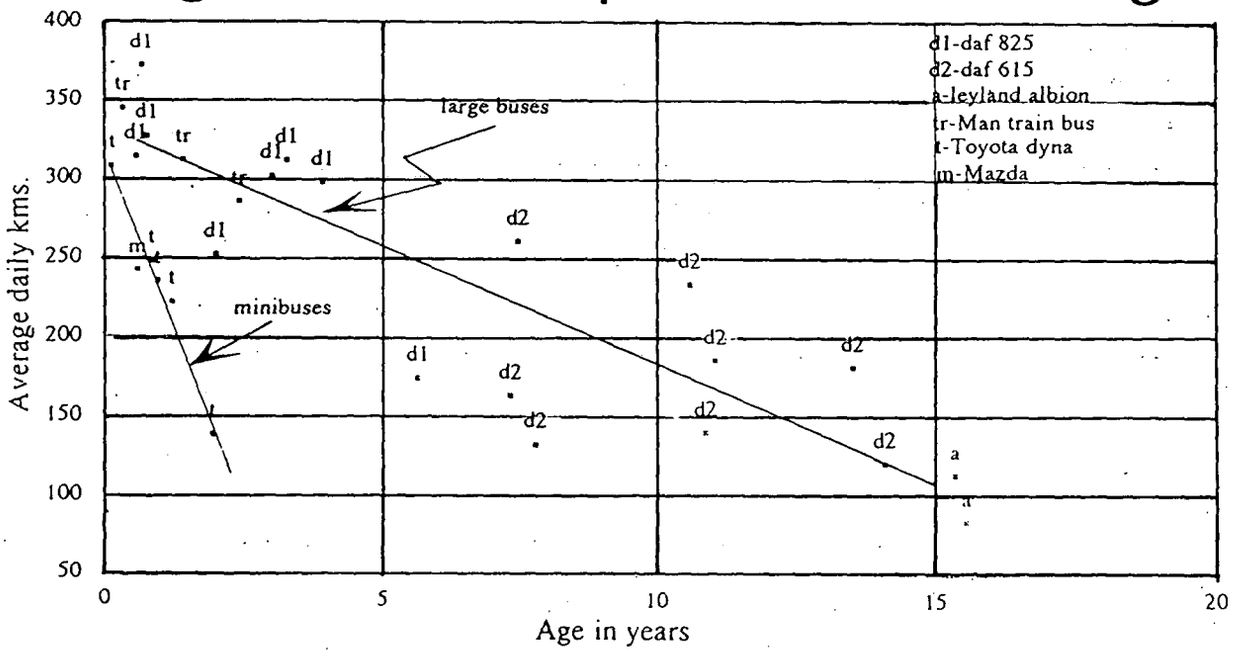
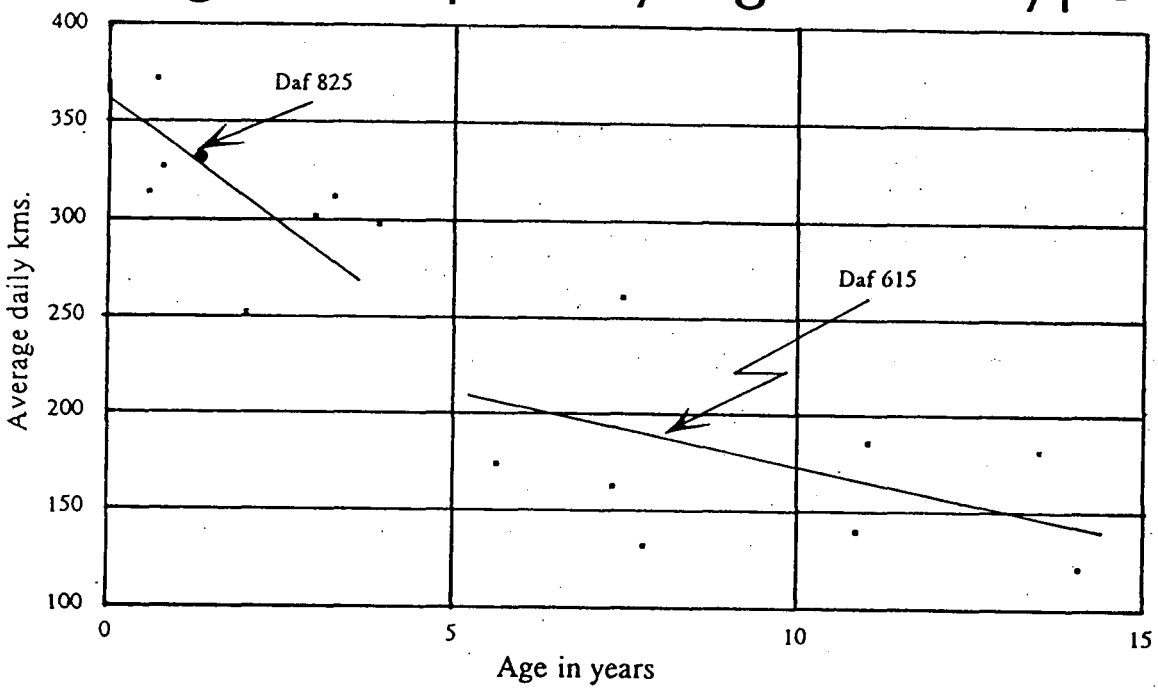
# Fig 1 Time utilisation with age



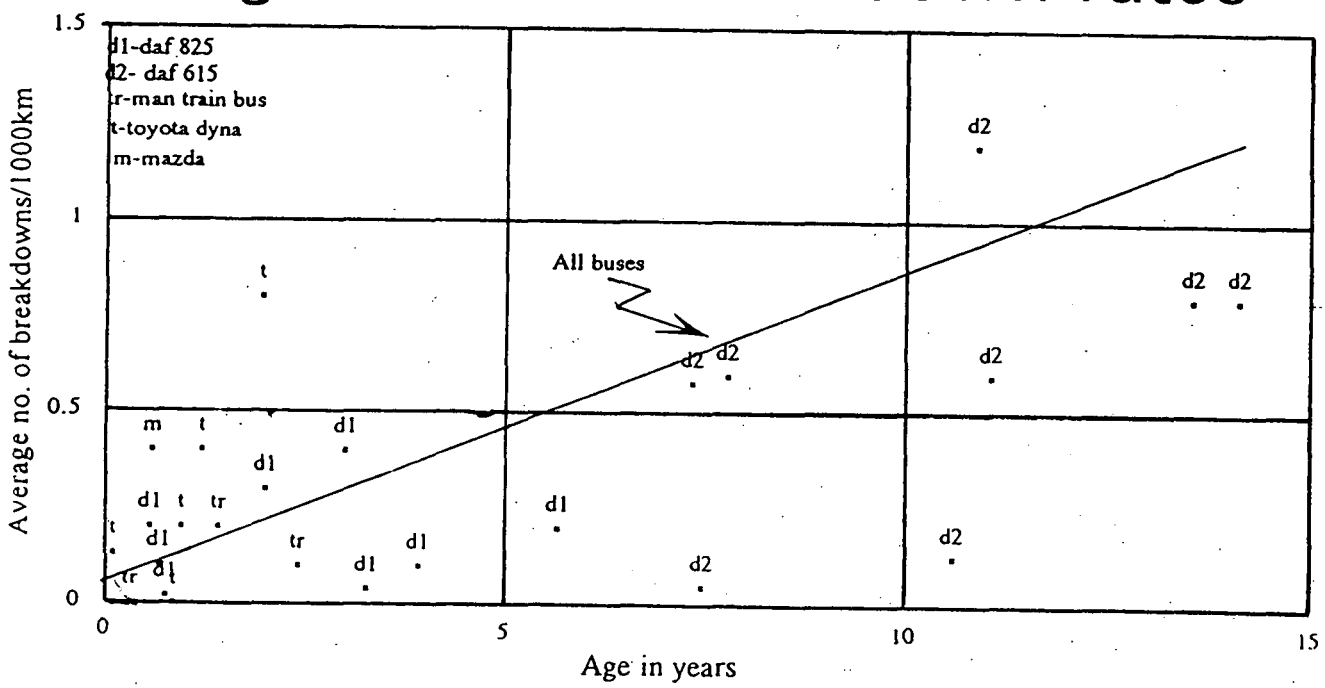

# Fig 2 Bus output related to age



# Fig 3 Output by age and type




# Fig.4 Vehicle breakdown rates



# Fig 5 Bus maintenance costs and age