AN ANALYTICAL STUDY OF VEHICLE DEFECTS AND THEIR CONTRIBUTION TO ROAD ACCIDENTS

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ABSTRACT

In general, the occurrence of an accident is due to the combined effect of a number of deficiencies associated with road users, vehicles, road layout and environmental conditions. Accidents are therefore complex events and the elimination of any deficiency associated with the aforementioned may prevent an accident from occurring.

While human error is found to be the most frequent contributing factor to road accidents, vehicle defects are reported as playing a role much less frequently. For example, the “Arrive Alive Campaign” revealed that vehicle defects was a contributory factor in 7 per cent of the 2 383 fatal crashes that occurred during the period October 1997 and January 1998. This may not seem substantial, but if one considers that 3 001 people died in those fatal accidents, the lives of approximately 210 people may have been saved if the vehicles were totally roadworthy.

Subjectively, however, it appears that a significant and rapidly increasing number of vehicles suffer from serious blatant defects – such as bald tyres and severely cracked windscreens. Vehicle defects, therefore, would play a much larger role as a contributory factor to road accidents than is currently being reported. The aim of this study therefore, is to measure objectively the extent of vehicle defects, and to attempt to correlate this with the rate of occurrence of vehicle defects as a conditional antecedent in accidents.

This paper focuses on the extent of vehicle defects and discusses the findings of a pilot survey undertaken at randomly selected shopping centres in the eThekwini Metropolitan area.

1. INTRODUCTION

1.1 Background

Death rates usually fall as countries develop. This is especially the case for diseases that affect the young and result in substantial life-years lost. However, deaths resulting from road traffic accidents are a notable exception. Economic growth inevitably leads to a growth in motor vehicle ownership and urbanisation (Kopits and Cropper, 2005). The increased number of vehicles on the road and an increase in the speed at which they travel coupled with the need for commuters to be transported over longer distances, leads to an increase in road traffic accidents that often result in serious and fatal injuries (van Schoor *et al*, 2001). According to the World Health Organisation (WHO), the burden of disease attributed to road traffic accidents in developing countries is comparable with malaria, HIV/Aids and

tuberculosis. It has been forecasted by the WHO that traffic fatalities will be the sixth leading cause of death worldwide and the second leading cause of disability adjusted life-years lost in developing countries by 2020 (CGRS, 2006).

Table 1 Change in traffic fatality risk (deaths/10,000 persons), 1975-1998

Country	% Change (1975-1998)
Canada	- 63.4
Hong Kong	- 61.7
Finland	- 59.8
Austria	- 59.1
Sweden	- 58.3
Israel	- 49.7
Belgium	- 43.8
France	- 42.6
Italy[a]	- 36.7
New Zealand	- 33.2
Taiwan	- 32.0
United States	- 27.2
Japan	- 24.5
Malaysia	44.3
India[b]	79.3
Sri Lanka	84.5
Lesotho	192.8
Columbia	237.1
China	243.0
Botswana[c]	383.8

[a] % Change 1975-1997
[b] % Change 1980-1998
[c] % Change 1976-1998

Traffic fatality risk (F/P) is the product of vehicles per person (V/P) and fatalities per vehicle (F/V). Therefore, the rate at which fatality risk grows depends on the rate of growth in motor vehicle ownership and the rate of change in fatalities per vehicle. Table 1 indicates that Sub-Sahara Africa and other developing countries have shown an increase in fatality risk (fatalities/population) between 1975 and 1998 while high-income countries have shown a downward trend in fatality risk over the same period. This is attributed to the fact that while vehicle ownership in developing countries grew faster than the rate at which fatalities per vehicle fell, the opposite prevailed in industrialized countries (Kopits and Cropper, 2005).

South Africa displays trends similar to those of other developing countries when the information in Table 2 is considered. Between 2001 and 2006, the vehicles per population (V/P) and the fatalities per vehicle (F/V) grew by 14% and 11% respectively. The subsequent growth in the traffic fatality risk (F/P) over the same period was 28%. This implies that an increase in the number of vehicles on the road has contributed to an increase in the number of road traffic fatalities. It would appear therefore, that road safety measures aimed at reducing road traffic fatalities have had little significant effect in this regard.

Table 2 Basic South African Road Traffic Indicators 2001-2006

	Year					
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
Motorized Vehicles	6 159 679	6 245 392	6 417 484	6 677 239	7 128 791	7 653 044
Human Population (million)	44.25	45.17	46.13	46.59	46.92	47.42
Road Fatalities	11 201	12 198	12 354	12 727	14 135	15 393
Fatalities per vehicle (x10 $^{-3)}$	1.818	1.953	1.925	1.906	1.983	2.011
Vehicles per population	0.139	0.138	0.139	0.143	0.152	0.161
Traffic Fatality Risk (10 $^{-3}$)	0.253	0.270	0.268	0.273	0.301	0.324

1.2 Causes of accidents

Rivers (1970) defines a road traffic accident as that occurrence in a series of events which usually produces injury, death or property damage. Traffic accident investigation and reconstruction is used to identify the events of the accident or what caused the accident. This is a complex matter as there are many circumstances and factors to be considered in a cause analysis. The Concise Oxford English Dictionary defines cause as *"those antecedents, which are invariably and unconditionally followed by certain phenomenon"* (in this case a road accident). However, only a few antecedents are invariably and unconditionally followed by an accident. The complexity of the task thus lies in trying to assign a cause to an event that is unexpected. By its very unpredictable nature, an accident is a random chance event that only occurs when a combination of factors, circumstances or conditions are present and fulfilled simultaneously (Department of the Environment-UK, *circa* 1973).

Conditions and events are closely interrelated when accident factors are considered. Some may be obvious while others are difficult to establish. A "factor" is a circumstance that contributes to an accident. The accident would not have occurred without a particular factor being present, but the factor alone is an element that, by itself, cannot produce the accident. The term "contributing factor" is therefore meaningless if this definition is accepted. A factor must be contributing if it is present otherwise it is not a factor. The term "primary factor" is also used to indicate a factor that was strong in its contribution to the accident. This is misleading as there can be no one factor more important than any other if all the factors must have been present to produce the accident (Limpert, 1976).

A combination of factors such as speed, driver capability, vehicle condition and environmental conditions all come into play. It is difficult to determine all the factors present in a single accident since many factors and circumstances that are present before and during the accident may disappear before an accident report is completed. The temptation in reviewing an accident after the event is to say that one or more of the prevailing conditions, if they did actually exist or occur, was responsible for, or contributed to, or caused, or was a factor in the

accident. However, not all the factors present in an accident may be sufficiently relevant for consideration. The mere presence of a factor is insufficient since it must have in some significant way contributed to the accident. Antecedents, as used in the context of accidents, are those conditions that are present prior to the occurrence of an accident. A set of conditions that has to be fulfilled for an accident to occur is termed conditional antecedents. Conditions that are present but do not cause nor contribute to the accident are known as non-conditional antecedents. Not every antecedent to a particular accident is a conditional antecedent. There is therefore some theoretical difficulty in defining a universal and unequivocal system of assigning causes in individual accidents.

In general, the occurrence of an accident is due to the combined effect of a number of deficiencies associated with road users, vehicles, road layout and environmental conditions. While human error is found to be the most frequent contributing factor to road accidents, vehicle defects are reported as playing a role much less frequently. According to van Schoor *et al* (2001) proper identification of vehicle defects and appropriate action taken by road transport authorities could help reduce accidents on South African roads.

1.3 Aim of paper

The aim of this paper is to measure objectively the extent of vehicle defects, and to attempt to correlate this with the rate of occurrence of vehicle defects as a conditional antecedent in accidents.

1.4 Scope of paper

The paper discusses the findings of studies into vehicle defect related accidents that have been done both internationally and nationally. The results of a pilot survey to establish the extent of vehicle defects is then discussed.

2. INTERNATIONAL STUDIES INTO VEHICLE DEFECT RELATED ACCIDENTS

That vehicle defects play a role in accident causation in overseas countries is evident from the numerous reports published on vehicle safety. Much of the international research is dated and does not adequately reflect the South African situation. However the findings of some of these reports are discussed briefly.

The Tri-Level Study of the causes of road traffic accidents was conducted by the Indiana University for the United States Department of Transportation in 1973 using multidisciplinary accident investigation teams (Treat, 1977). Vehicle defects were the sole contributor to 5% of defect related accidents and contributed to 13% of defect related accidents when considered in correlation with either the human factor or the environment. Brake systems were identified as the major cause followed by tyres and wheels. The National Traffic Safety Newsletter of the United States Department of Transportation (1975) indicated that approximately 12% of all accidents were caused by or contributed to by defects in the vehicle: two thirds being in the area of brakes and tyres. Wolf (1968) stated that mechanical defects contributed to 6% of the 1588 truck accidents that occurred in the United States in 1962. Wheels, bearings and tyres were identified as the primary contributors. The Road Research Laboratory in the United Kingdom conducted on-the-spot investigations of 247 accidents from July 1968 to January 1969. Vehicle defects were found to have contributed to 18% of the accidents. In a later study between March 1970 and April 1972, it was found that vehicle defects contributed to 24% of the accidents. The most prevalent defects were related to tyres and brakes. Rompe and Seul

(1985) investigated road accidents in developing countries and concluded that in Ghana and Botswana, vehicle defects contributed to 16% and 12% of road accidents respectively.

3. VEHICLE DEFECT RELATED ACCIDENTS IN SOUTH AFRICA

It is misleading to assume that the information recorded in the Accident Report (AR) form constitutes a proper investigation that may be used in accident reconstruction. The police or traffic officer at the scene does not investigate the accident but merely records accident information on the AR form. Unless proper accident investigations are conducted, the contribution of vehicle defects to road accidents in South Africa remains uncertain. As much of the research in this field is now dated, it has become common practice to rely on the fatal accident statistics provided by the Road Traffic Management Corporation (RTMC).

Erlank (1973) indicated that vehicle defects contributed to 5,2% of the 226 accidents investigated in a Pretoria study. An “on-the-spot” investigation of 502 accidents involving commercial vehicles and busses revealed that vehicle defects contributed to 9% of the accidents (Kinsey, 1976). The study also indicated that unroadworthiness due to gross neglect of even elementary maintenance was the predominant cause of vehicle deficiencies associated with tyres, brakes and lights. van Schoor *et al* (2001) conducted a study to establish the contribution of vehicle defects to road traffic accidents in the Pretoria area. The data obtained from the Accident Response Units of the SAPS indicated that tyres and brakes contributed to 3% of the accidents resulting from mechanical failures. There appears to be an upward trend with respect to the contribution of vehicle defects to fatal road accidents as reflected in Table 3.

Table 3 Contribution of vehicle factors to road accidents

Period	Contribution of Vehicle Factors to Road Accidents (%)
October 1997	9,4
November 1997	11,4
December 1997	12,3
April 1998	17,0
December 2000 – January 2001	33,3

There were 15 major road traffic accidents in December 2005 in which five or more persons were killed per accident. A total of 110 persons were killed involving 26 vehicles at an average severity rate of 7,3 persons per accident (RTMC, 2005). Vehicle factors (tyre burst) were deemed contributory in two accidents. This equates to 13% of the total number of accidents. Vehicle factors not only contribute to accidents to a varying degree when comparisons are made between South Africa and other countries but also within South Africa itself. Interestingly, there are also variances in countries with a lower accident rate and a higher general standard of vehicle maintenance than South Africa. It follows therefore, that in the South African accident context vehicle factors probably play a greater role than the available statistics indicate (Kinsey, 1976).

4. UNROADWORTHY VEHICLES IN SOUTH AFRICA

South Africa's vehicle population is ageing. The average age of motorcars is 10 years, minibuses 13 years, buses 11 years and trucks 12 years (RTMC, 2005). These statistics need to be looked at in conjunction with the increase in the number of unroadworthy vehicles. The total number of unroadworthy vehicles increased by 12.69% and 16.19% between the periods 2004-2005 and 2005-2006 respectively. A traffic offence monitoring survey conducted by Arrive Alive during 2001 and 2002 revealed that on average 23% of the vehicles had damaged or smooth tyres while approximately 6% had defective lights. An ageing vehicle population and an increasing number of unroadworthy vehicles indicate a greater potential for vehicle defect related accidents.

5. RESEARCH METHODOLOGY

The survey involved examining a sample of vehicles for defects by means of a visual inspection. Survey locations were chosen on a more or less random distribution based on their position within the eThekwini Municipality. Factors such as traffic flow, traffic type, socio-economic environment and the safety of the surveyor were also considered. In view of the aforementioned, the parking areas in the following shopping centers, as shown in Figure 1, were chosen as survey locations:

Legend	Location	Area
A	Musgrave Center	Musgrave
B	Overport City	Overport
C	Game City	Stamford Hill
D	The Workshop	Durban Center
E	Gateway	Umhlanga
F	Phoenix Plaza	Phoenix
G	Pinecrest	Pinetown
H	Pavilion	Westville
I	Chatsworth Center	Chatsworth
J	Umlazi Mega City	Umlazi

Figure 1 Map of Survey Locations

A vehicle in every third parking bay in each row of parking bays was visually inspected for defects. The vehicles were not touched or handled in any manner. Tyres were recorded as smooth if the treads on a part of the tyre measuring more than approximately 5 cm x 5 cm or a strip measuring more than approximately 10 cm x 1,5 cm was worn to less than 1 mm in depth. No tread depth meters were used as the tread depth indicator was used as a guide. The surveyor spent two days at a tyre fitment center in order to become familiar with tyre wear so that the estimates were accurate enough for the purposes of the study. Any damage such as tears, cuts and holes that would influence the strength of the tyre was recorded as a defect. Lights were recorded as defective if a lens was cracked, missing and faded as well as if a bulb was missing. A defect was recorded if the windscreen was cracked to such a degree

that the view of the driver was obscured. The nature of the survey is such that a subjective element could not be avoided. A total number of 438 vehicles were inspected in the survey and the sample was distributed as shown in Figure 2.

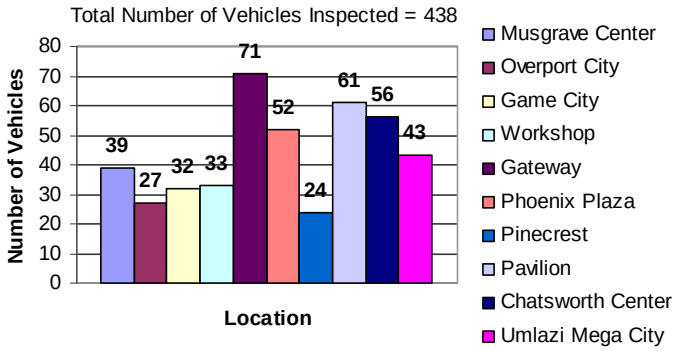

Figure 2 Distribution of Survey Sample

6. FINDINGS OF SURVEY

6.1 Fig. 3 indicates that on average, 24% of the vehicles inspected had tyre defects. Of concern, however, is that the percentage of vehicles with defective tyres in low income areas such as Phoenix, Chatsworth and Umlazi is almost twice as much as those in high income areas such as Umhlanga and Musgrave.

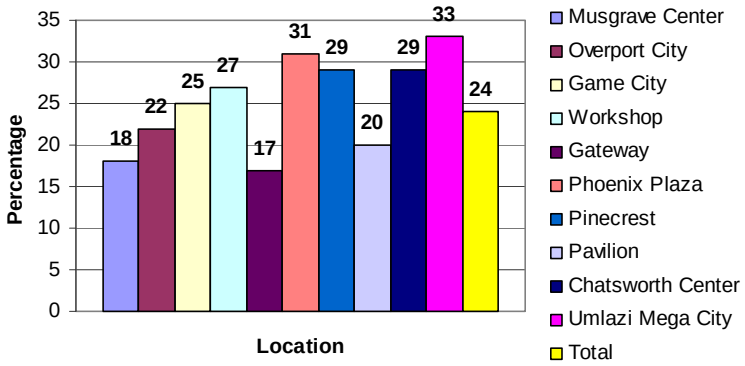

Figure 3 Percentage of vehicles with defective tyres

6.2 The most common tyre defect according to Fig. 4 was smooth tyres where the tread depth was less than 1 mm or where the tread depth was below the tread depth indicator.

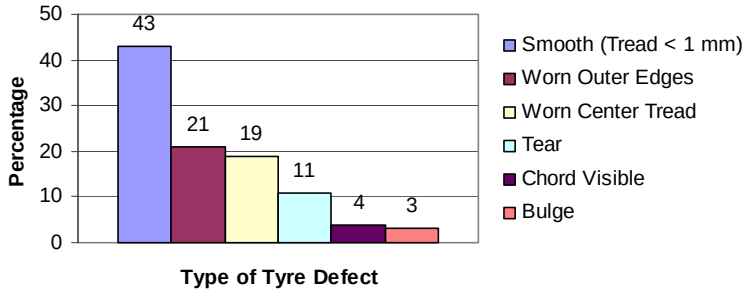

Figure 4 Distribution of the type of tyre defect

6.3 11% of the vehicles inspected had defective lights (Fig. 5) ranging from cracked and missing lens covers to missing bulbs. Ideally, the lights must be physically checked to establish that they are in fact in proper working order.

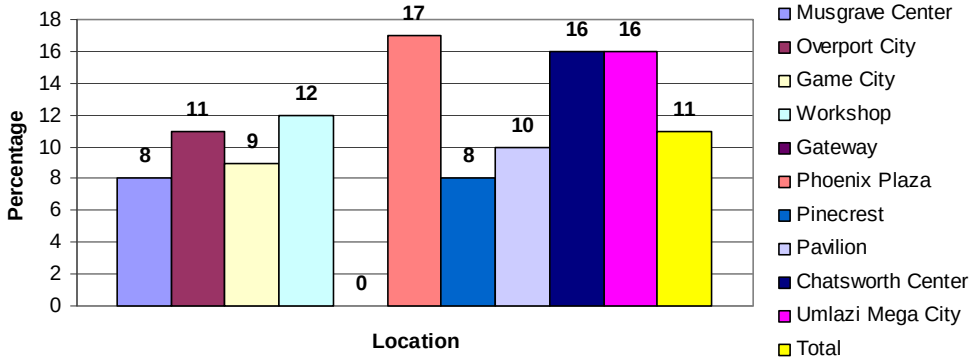

Figure 5 Percentage of vehicles with defective lights

6.4 Only 2% of the vehicles had window/windscreen defects as indicated in Fig. 6. In three of the nine instances recorded, the crack appeared to obstruct the driver's view in the control zone.

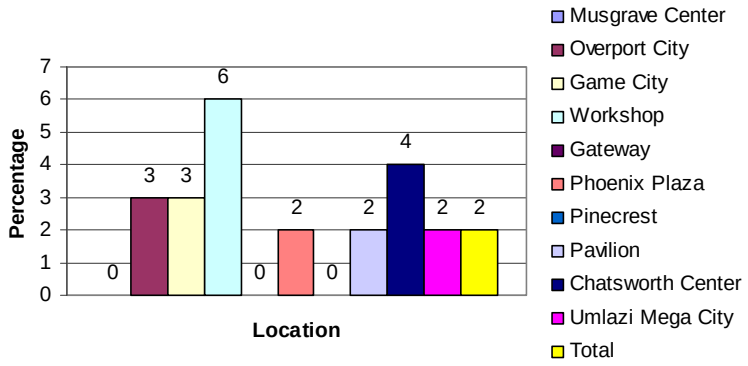

Figure 6 Percentage of vehicles with defective windscreens

6.5 7% of the vehicles inspected had two defects while 4% had more than two defects. This is reflected in Fig. 7 and Fig. 8 respectively.

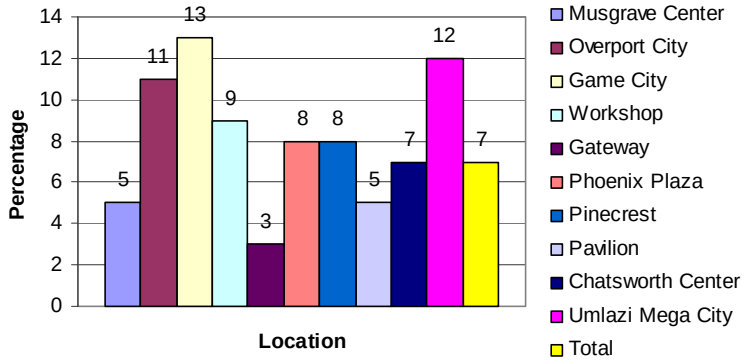

Figure 7 Percentage of vehicles with two defects

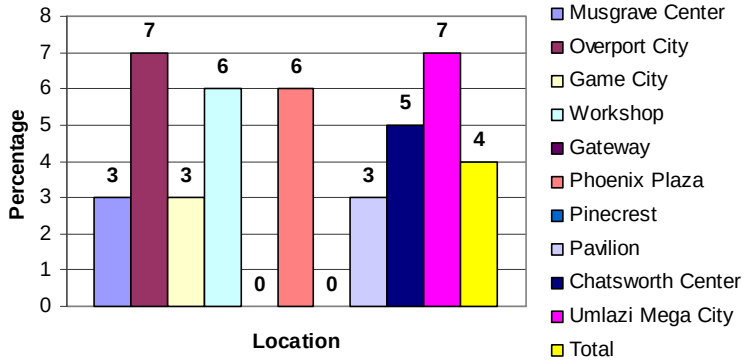

Figure 8 Percentage of vehicles with > two defects

7. CONCLUSION

The pilot study revealed that blatant vehicle defects are widespread and that tyre defects were the most common. This is consistent with research that suggests that defective tyres are one of the main vehicle factors that contribute to accidents. Tyres are undoubtedly the most critical safety component on a vehicle as it affects traction, handling, steering, stability and braking. Of concern is that those vehicles that were regarded as roadworthy during the visual inspection, may be deemed unfit when other crucial components such as the brakes, suspension and steering are tested. An overall observation is that the condition and age of the vehicle appears to be a function of socio-economic factors since vehicles in low income areas were generally poorly maintained.

International studies using multidisciplinary accident investigation teams indicate that mechanical failures contribute to between 5% and 15% of accidents. In South Africa there is no consensus with regards to the contribution of vehicle defects to accidents. The statistics provided by the RTMC in this regard are inconsistent as the reported contribution of vehicle defects to accidents varies considerably. In the absence of proper accident cause analysis, there appears to be little correlation between the extent of defective vehicles and the extent to which vehicle defects contribute to road traffic accidents. The problem is that the current AR form has been designed with statistical analysis in mind and that very little information contained therein can be used or applied for proper investigative purposes.

8. RECOMMENDATIONS

8.1 As indicated previously, South Africa's vehicle population is ageing. It may be beneficial in the long term to investigate the feasibility of mandatory general roadworthy inspections of older vehicles.

8.2 Drivers need to be educated on the importance of general vehicle maintenance especially with regards to tyres. This could be achieved by various media campaigns.

8.3 Traffic officers need to be given basic training on examining a vehicle for defects by means of a simple visual inspection. The inspection should include the brakes, tyres, loading, steering, visibility and conspicuity.

8.4 There has to be a paradigm shift from recording accidents for the purpose of statistical analysis to the proper investigation of accidents for the purpose of cause analysis. It is imperative for the relevant stakeholders to understand the nature of accidents in order to implement effective interventions.

8.5 Road fatalities in South Africa have reached such levels that it may be considered a national disaster that impacts on the economy and society. Consideration should be given to the formation of a Department of Road Safety within Government to formulate policies that would ensure safer roads.

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