TOWARDS A SAFER MINIBUS TAXI INDUSTRY IN SOUTH AFRICA

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ABSTRACT

There are presently about 130 000 minibus taxis on South Africa's roads. Currently this industry is not fully regulated. The impact of this on the transport system is immense since 65% of all commuter trips are undertaken by minibus taxis. South Africa's roads are among the most dangerous in the world, with accidents claiming the lives of no fewer than 10 000 people every year - a large portion of them in taxi related crashes. A study recently done by the Automobile Association of South Africa recorded an annual total of 70 000 minibus taxi crashes which indicates that taxis in SA amount for double the rate of crashes than all other passenger vehicles .

Detailed accident data is not available for this category of vehicle, so there is insufficient evidence to support a clear cause for the number of fatalities in minibus taxi accidents . It is apparent that we do not know enough about the causes of many minibus taxi crashes. It is too easy to simply speculate without reviewing all the contributing factors. Any crash results from a combination of circumstances converging to a point where the driver does not have the skills or the options to avoid the crash. Systematic investigation is necessary to identify patterns of failure resulting in a crash. This could be associated with driver behaviour, road conditions or/and vehicle features.

Little is known about the various causes of minibus taxi collisions. Unaware commuters continue to board these vehicles, which are under-researched. This paper will examine police records and case studies of minibus taxi accidents to increase knowledge of the factors causing these accidents.

1. INTRODUCTION

The taxi industry continues to flaunt traffic regulations, which are difficult to enforce due to the industry's informal nature. The industry is suffering from a cycle of unsustainability. MSA (Moving South Africa) found that in 1997 the industry spent only 35% of the needed investment to replace the fleet. As a result of this the average fleet age of these taxis continues to climb and this creates safety hazards on the road. There are presently about 130 000 minibus taxis on South Africa's roads and these are already on average in excess of 13 years old. The impact of this on the transport system is immense since 65% of all commuter trips are undertaken by minibus taxis. The impact of this on the transport system is immense since 65% of all commuter trips are undertaken by minibus taxis. South Africa's roads are among the most dangerous in the world, with accidents claiming the lives of no fewer than 10 000 people every year - a large portion of them in taxi related crashes. Minibus taxis account for 4.5% of the total vehicle population but are involved in 8.6% of all crashes which indicates that taxis in SA amount for double the rate of crashes than all other passenger vehicles (NDoT, 2001) .

1.1 Accident Statistics

Accident data of sufficient detail is not available for this category of vehicle, so there is insufficient evidence to support a clear cause for the number of fatalities in minibus taxi accidents (NDoT, 2003). This is evident in Table 1 below that shows contributory factors in fatal crashes

TABLE 1: Contributory Factors

VEHICLE FACTOR	% OF TOTAL
Overloading	0.15
Faulty brakes	0.31
Tyre burst	1.12
Smooth tyres	0.03
Faulty lights	0.13
Other	3.48
Unknown	29.60

Source : NDOT, 2003.

1.2 Objectives of the Study

Based on the above, the specific objectives of this study is:

- To conduct thorough analysis on the data contained in police fatal Accident Reports (AR) for the Toyota Hiace[1] minibus taxi
- To interpret these data and identify underlying trends; and
- To carry out more in-depth analysis of specific causes of minibus taxi accidents.

1.3 Aims of the Study

The research aims to

- provide scientific information on the common causes of minibus taxi accidents.
- to make the industry safe and at the same time economically viable for the operator.
- reduce the carnage on our roads .

(1) – the Toyota Hiace was selected since it represents majority of the vehicles used in the minibus taxi industry.

1.4 Methodology

- Police AR will be analyzed, site measurements and vehicle inspections will be conducted for further assessment.

- Vehicle kinematics will be identified using “AR Pro 7” software package.

- Laboratory test will be performed to find variables that may not be determined mathematically.

- Vehicle dynamics will be verified using the software “Advanced VehIcle SimulatOR (ADVISOR)”

- Check road geometry using Interactive Highway System Design Model (IHSDM) to identify any contributing factors

2. COLLISION INVESTIGATION UNIT (CIU)

Detailed crash investigation is carried out in all cases of fatalities and most serious injury crashes. However, the primary role of the Collision Investigation Officer is to determine cause in order to establish criminal negligence. While the role does include responsibility to identify contributing factors that may indicate strategies to prevent similar crashes in the future, Police Collision Investigators are not trained adequately for this type of work.

3. DEFINING FATAL/SERIOUS CRASH

For crash investigation purposes, a crash is determined to be 'serious' if there is a fatality or if surgery is required. In such cases the first response police will notify the CIU who may attend the scene, however even serious crashes are not always investigated by the CIU. The essential principle is that the police role is to determine fault for prosecution. If the injured party was at fault in the crash, then they are not generally considered to be 'a victim' in criminal justice terms. If there is no 'victim', there may be no criminal case of negligence for prosecution and therefore no need for investigation.

4. CRASH DATA COLLECTION

The reporting system used by the Police when attending a crash is based on all available data on the incidence and causes of crashes. However the system is designed to identify factors in relation to enforcement issues. It is not intended as the basis for research into the causes of crashes nor for the collation of data on crash trends. There are a number of specific disadvantages for motorists that arise from the limitations of the crash reporting system. Perhaps most importantly, the system does not allow for a comprehensive assessment of the contribution of other factors such as road condition in crashes. Police who attend a crash site make written notes from which they subsequently enter details into encoded fields in the AR form which is then captured into the National Collision Database. The data fields in the crash reporting system were designed primarily for car crashes and do not accommodate factors which would only be relevant to other vehicle crashes. While there are mandatory fields that must be completed, these relate to location, vehicle and casualty details – provision is available for more detail to be entered into other optional fields.

Police tend to complete only the mandatory fields and leave the rest blank. The blank field is a weak point in the system as the level of detail required is the specifics in a particular collision. If provided, this usually varies from one officer and crash to another. In addition the text is then subject to interpretation at the point of data entry by the National Collision Database. Of particular concern is the suggestion that incidents involving 'faulty brakes' and 'tyre bursts' may be generally interpreted as 'maintenance' problem and coded accordingly even though overloading may have been the primary cause. This has no bearing on the outcomes for the controller in any particular crash, but it may obscure the causes of the crash and repeated over a large number of crashes create misinformation about the nature and causes of minibus taxi crashes. Also the high percent of "unknown" is cause for concern. This simply means that the reporting mechanisms are flawed and needs to be improved if a clear cause for any accident is to be established.

The Police who attend a minibus taxi crash will also determine whether a driving offence has been committed. In the case of single vehicle crashes, there is a common view that the driver lost control and therefore is charged with speeding and/ or negligent driving. There is reason to believe that this may explain under-reporting of crashes by motorists who believe reporting will be to their disadvantage. Research suggests that only 8% of

non-injury crashes and 24% of injury crashes involving single vehicles are reported (James, 1991). Severity of injury, involvement of other vehicles and degree of vehicle damage were all factors determining whether the crash was reported.

5. CASE STUDY – "ACCIDENT KILLS 12 PEOPLE"

Twelve people were killed in a minibus crash when the taxi they were traveling in veered out of control and collided with an oncoming vehicle in rainy weather near Stanger, KwaZulu-Natal. According to police reports the cause of the accident could have been speed and overloading since the vehicle had 20 occupants. Five men and four women died instantly. Three others, including the driver, died later in hospital. Eight were injured, including a five-year-old girl, and taken to the Stanger Provincial Hospital. (Beemadew, 2003).

5.1 Police Response to this Case – Police Accident Report

The police AR recorded the cause of this accident to be overloading and excessive speed. It's easy to infer the possible cause of the accident. Judging by the wreckage one may conclude that there was excessive speed. 20 occupants in a 16-seater must constitute overloading in terms of the traffic regulations.

5.2 Our Investigation

Detailed analysis of the accident site, revealed two skid marks which was consistent with the front axle. No skid marks were visible for the minibus taxi's rear axle.

The sedan is fitted with anti-lock braking (ABS) and that explains why no skid marks were present on it's track or the encroachment into his lane was so quick that the driver had no time to react.

Although no conclusive vehicle speeds could be determined from the skid marks, it posed a very important question, "Why didn't the rear wheels lock on the minibus taxi?"

According to one of the injured passengers in the minibus taxi, he only noticed a slow moving car in front of them as they came around the curve and the driver tried to brake but the taxi veered to the oncoming lane and collided with the car. He also heard a loud noise and suspected tyre failure to be the cause.

The witness' perception of the cause of the accident may not be consistent with the findings, as our investigation revealed that the front left tyre did not contribute to the crash since it was damaged after the vehicle lost control which was evident by the rim scours on the approach lane. However his statement warranted an investigation into the sight distance.

5.3 Defining Sight Distance

Sight distance is a fundamental criterion in the design of any road, be it urban or rural. It is essential for the driver to be able to perceive hazards on the road, with sufficient time in hand to initiate any necessary evasive action safely. On a two-lane two-way road it is also necessary for him to be able to enter the opposing lane safely while overtaking. In intersection design, the application is slightly different from its application in design for the open road but safety is always the chief consideration

5.4 Findings – Sight Distance

Detailed analysis in the vicinity of the accident, revealed that the roadway's sight distance was adequate for the posted speed. According to the geometric design manual the sight distance on a 100km/h road should be 205m. A friction test was conducted to test the pavement skid resistance and the results yielded a coefficient of friction of 0.5. This value was sufficient for the posted speed of 100 km/h as the design standard calls for 0.3.

5.5 Environment and Road Condition

Simply blaming road condition to absolve driver responsibility is not the answer either, but a better understanding of the circumstances that trigger a critical incident would help to determine the means to avoid them. If the road surface is a problem, the incident may have been very difficult to avoid, even for the highly experienced. Where driver error is the cause, the consequences of even a minor error of judgment are far more severe on a laden minibus taxi than in a car. While these are issues that need to be assessed in accident reports, informed feedback and analysis of crashes in police reports could be an aid in developing strategies to be used in identifying collision causations.

On the other hand, the police attending crashes may ascribe fault to the motorist simply because they do not have the experience to recognize other relevant contributing factors. If this is the case, this failure results in missed opportunities to remedy road conditions before they cause further injury. It also serves to perpetuate misunderstanding of the causes of minibus taxi crashes. This is, at least in part, due to the involvement of general duties, police who, in addition to the whole range of other crime prevention duties, are expected to attend crash scenes and make determinations on complex engineering matters without any specialist training. While it is not feasible to expect highly trained collision investigators to attend every crash, it would be more feasible to require crashes to be attended by the Traffic Patrol, who could be provided with some training in the preliminary assessment of crash causes.

5.6 Brake Performance

The next step was to investigate why the rear wheels didn't lock. Brake performance could not be assessed on the vehicle since the entire braking mechanism had been damaged in the crash.

Then it was to assess the tyres in order to evaluate any braking patterns. Inspection of the rear axle tyres did not reveal anything significant. However the tread depth of the rear axle tyres (2.32 mm L & 2.52 mm R) were significantly lower than the front axle tyres (5.25 mm L & 5.91 mm R). Furthermore the vehicle was fitted with a radial on the right rear and a cross ply on the left, both of which were for private use and the regulations state that minibus taxis should be fitted with only commercial tyres.

Our investigation now started to focus on the vehicle loading and the tyres. All passenger mass and seating position and any luggage had to be identified. This information was used to calculate the vehicle's Centre of Gravity and weight transfer just prior to the crash.

5.7 Centre of Gravity

The 'Centre of Gravity' is the point at which an object is in balance in all three dimensions. In vehicles, the height is measured from the road surface. All the vehicles kinetic energy which keeps it moving is concentrated at this point. Any force exerted at this point should not cause rotation.

The COG was calculated to be 1164.3mm behind the front axle, 580mm from the left axle & 1375mm from the ground. A position unfavourable for a right hand down grade due to added weight transfer during the maneuver.

5.8 Overloading

The following cases constitute overloading:

- the gross vehicle weight (gvw) of the vehicle is too high and/or
- the load on one or more axles is too high.

Exceeding the allowed seating capacity in a vehicle puts occupants at risks for injury in a crash, and can result in vehicle overloading, which can affect vehicle handling and increase the risk for a crash. This is what may have also contributed to the high fatality in the crash as more occupants were concentrated closer to the point of impact.

However exceeding the seating capacity will not always constitute overloading, as in this case the Gross vehicle Mass was not exceeded. The researcher doesn't encourage this practice but had to take into consideration that had this vehicle been carrying fewer heavier passengers totaling the same mass it would not have been in violation of the traffic regulation but the consequences could have been the same.

During the 1980s when the kombi-style taxi originated, these eight-seaters were transformed first into 10-seaters and then up to 16-seaters or more, where the safety design limitations were pushed to the limit. The vehicles currently on South Africa's roads were never intended to be used to transport human beings in their country of origin, but were instead used as panel vans (RMI, 2002).

Although the minibus was carrying more than the permissible seating capacity (20 instead of 16), actual passenger mass shows the vehicle to be within its Gross Vehicle Mass (GVM) of 2800 kg.

However the way the load was distributed due to the seating pattern may have caused the driver to lose control of the minibus due to over steer (when the vehicle's rear tyres will slide or break away before the front tyres on a curve).

This is determined by the slip angles of the front and rear tyres. That is, if the slip angle of the rear tyres of a vehicle is different than that of the front, the vehicle will rotate from this phenomenon alone.

5.9. Testing Tyres

Wet testing conducted during the investigation found coefficients of friction for the rear axle tyres of 0.25 on the left and 0.35 on the right (average of 5 tests), values significantly lower than those of the front tyres (0.48 and 0.50), primarily because the drive axle tyres had a much lower tread depth (2.32 and 2.52 mm resp). As was demonstrated by the testing, the tread depth can significantly affect the friction available when wet; which is critical to the vehicle's ability to stop or when cornering.

Calculations, based on the tyre coefficients of friction derived from friction testing and the configuration of the brakes, indicated that the rear axle brakes would have locked up at a brake application pressure of about 152 for left and 157 kPa for right tyres and the front would have required a brake pressure of about 220 and 227 kPa, respectively.

This simply means that the rear wheels should have locked before the front as can be seen in Figure 1 below.

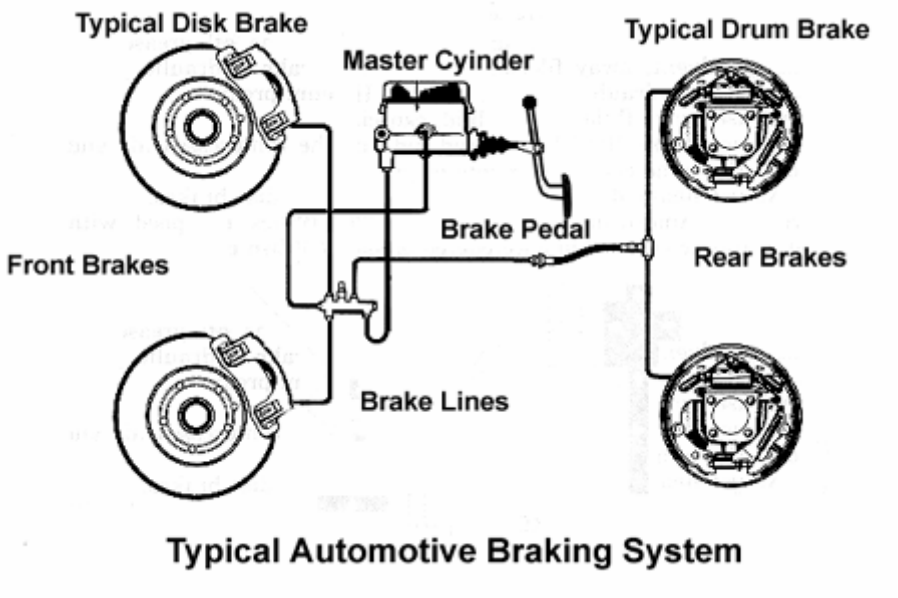

Fig 1. Sequence of Brake Lock.

5.10 Findings

Although varying thread depths on the front and rear axles caused the vehicle to over steer, the imbalanced load also contributed to a small extent. It is common practice for larger passengers as well as mothers with babies to be seated on the left near the entrance of the vehicle. This drastically affects the vehicle stability.

This research also indicated that the lateral friction of worn tyres decreases sufficiently enough to slip. Furthermore, when the worn tyres are placed on the rear of commuter vehicles, the handling of the vehicle changes, since the rear tyres have more tendency to slide. Had the drive axle tyres been the same tread depth as the front axle tyres, they would not have locked up until a brake application pressure of 324 kPa was applied. A simulation of this accident indicated that the driver more than likely applied the brakes at a pressure of 242 kPa

If tyres with tread depths similar to those of the front tyres (5.25 or 5.91 mm on all the wheels) were used, the driver would likely have been able to maintain sufficient control of the minibus to avoid crossing into the opposite lane. Had the drive axle tyres been the same tread depth as the front axle tyres, they would not have locked up until a brake application pressure of 324 kPa was applied.

5.11 Profitability

The mini bus taxis gets most people to their destination, sometimes in record time and at the expense of other road users, but it also kills many users. Furthermore, the pressure is on the driver to meet strict daily requirements of numbers, both in trips made and passengers ferried. This in turn determined his earnings. Bribing rank marshals to secure more passengers is the order of the day as this has a direct bearing on the driver’s wages.

Overloading affects the running cost of the minibus taxis, and owners need to focus their attention on this in order to maintain their profitability. This study also looks at the significant operating variables that affect profitability for the current Toyota Hiace range of taxis.

There are many factors that affect profitability and that the potential gains and losses are huge. Most of these factors are directly controlled by the taxi associations themselves, like the lucrative routes and pickup points.

It can be also seen that what is good for one route is not necessarily good for another, and that certain driver perceptions regarding best techniques to make more money are not always the best and could be detrimental to the commuters.

6. CONCLUSION

A minibus taxi moving along a roadway is a highly complex mathematical and scientific component with an infinite range of possibilities and outcomes. Although regulations currently require that the tyre tread depth be at least 1.5 mm, the impact of varying thread depths for minibus taxis needs to be further assessed.

This paper will also examine the influence of loading on operating costs with a view towards providing recommendations to enhance savings and at the same time without sacrificing safety. Generally fares collected is considered one of the direct recovery costs of this industry. As is evident by increased fares whenever the fuel price increases, this means that fuel is the key player in running costs. The impact of overloading on running and operating costs needs to be analyzed. Trends show an increase in vehicle price does not warrant fare increases.

However for the minibus taxi to be economically viable, all variables need to be evaluated, so the challenge is to find a solution to the problem.

7. RECOMMENDATIONS

Problems arise from the design of the crash reporting system as well as from its implementation. The reliability of the information could be improved by police using more than the mandatory fields or by working from a check list of factors when completing the narrative text. The value of the system could also be enhanced by extending the fields to take account of factors more likely to be associated with other vehicle crashes such as minibus taxis. Training in the assessment of crashes and completion of crash data reports is essential.

Police accident report (AR) forms to include mass of all occupants and their seating positions in all vehicles involved in crashes. The seating pattern and load distribution in a fully laden minibus taxi need to be further investigated. Although this accident and research show that reduced tread depth can lead to reduced friction and, ultimately, loss of control in wet weather, stricter control need to be exercised with the type of tyres fitted to the public transporting minibus taxi. This is not a difficult aspect to police as a visual inspection is all that’s needed to identify if commercial tyres with the correct ply are used.

Because no requirement exists that the tyres must have similar tread depths, the researcher believes that further testing should be conducted on the effects of differing tread depths for the front and rear axle tyres on minibus taxis. This study has also recommended that once more testing is completed, the regulators should modify the tread depth requirements for each axle to reflect the results of the research.

Owners who violate safety standard in most other industries are liable for any accidents or loss of lives usually by imprisonment of hefty fines. However the desperate driver is usually the culprit in most minibus taxi accidents. The determination of 'fault' by attending police therefore has significant implications for the investigation of minibus taxi crashes.

The assumption in most minibus taxi crashes is that the vehicle operator was at fault, essentially because he has control of the vehicle and this is generally assumed to mean they were going too fast for the conditions. The consequences can include the loss of job or prison detention for drivers, as they may be charged with negligent driving. However, lack of maintenance by the owners may be the contributing factor and this needs to be investigated and addressed accordingly.

8. REFERENCES

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