Analysis of factors contributing to road fatalities in the Emfuleni local Municipality, South Africa

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**Abstract**

The objective of this study is to examine and analyze the many factors that contribute to the occurrence of automobile deaths within the Emfuleni Local Municipality. This study employed a hybrid analytics approach, employing a non-probability convenience sampling strategy. The researchers employed a descriptive study methodology to gather a sample of 168 participants, consisting of both traffic cops and motorists. The primary outcomes of the investigation revealed that road configuration, including small roads, hills, and sharp curves, was one of several influential elements in the occurrence of road traffic accidents (RTAs). The dataset under analysis reveals that a substantial proportion of respondents possessing a standard 10/matric/grade 12 certificate had a higher level of agreement compared to those with a diploma/bachelor’s degree in the primary responsibility of road layout in road traffic accidents (RTAs). The majority of participants identified stray or wild animals as a significant contributing cause to road accidents. Notably, female respondents and motorists residing in Emfuleni Municipality exhibited the highest level of agreement. The results ultimately demonstrated that a majority of the participants concurred that a significant portion of the drivers and automobiles present on the road were not suitable for sharing the roads with other drivers, leading to the elevated occurrence of road traffic fatalities. The present circumstance necessitates prompt attention. Suggestions were proposed to provide assistance to the pertinent parties.

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**Introduction**

The elevated occurrence of vehicle accidents in South Africa has engendered doubt over the safety of road transportation inside the nation. This phenomenon can be attributed to the significant loss of human life, as substantiated by the yearly data on road fatalities. According to the World Health Organization (WHO, 2015), the annual number of fatalities resulting from traffic accidents in South Africa is estimated to be over 1.3 million. Road accidents pose a significant risk to the socio-economic and political aspects of South African society. In numerous developing nations, road safety continues to be disregarded despite the increasing prevalence of various causes that contribute to road traffic accidents (RTAs). The health sector has been notably sluggish in acknowledging road safety as a crucial public health concern. South Africa does not deviate from the norm (Modipa, 2022; [WHO], 2018). According to Montle and Moleke (2021:98), it has been observed by the researchers that the country’s economic growth has been significantly inflated due to the persistent occurrence of traffic accidents. Therefore, the rationale behind conducting this research is based on the anticipation...
of its significance and potential impact. The road accidents have resulted in the loss of breadwinners from low-income homes, leading to significant burden on these families. It has been emphasized by scholars that the unexpected loss of a primary income earner can have a profound impact on the well-being and mental health of the surviving family members, potentially leading to adverse effects such as illness and depression (Montle & Moleke, 2021:99).

According to Crowell (2019), the sudden and unexpected death of a loved one resulting from tragic circumstances, such as vehicle accidents, crime, or suicide, can have a traumatic impact. This is mostly due to the absence of any prior warning, which often undermines the affected families’ feelings of safety and ability to cope with the situation. The issue of fatal road accidents raises concerns regarding the effectiveness of the Road Accident Fund (RAF) in addressing personal injuries sustained by third parties, while overlooking the financial implications associated with the damage inflicted on material possessions, such as the vehicles involved. It is estimated that approximately 35% of vehicles in South Africa are uninsured (Verster & Fourie, 2018:63). Several studies have indicated that the likelihood of road fatalities is lower for those residing in urban regions compared to their counterparts in rural areas. The inclusion of supplementary research supports the assertion that individuals residing in rural areas engage in around 33% more travel compared to those residing in urban areas. Furthermore, rural inhabitants exhibit a greater reliance on private transportation as a result of limited or nonexistent public transportation options (Casado-Sanz, Guirao, & Attard, 2020). It is evident from the findings that residing in urban regions confers certain benefits in relation to road safety in comparison to rural locations. While there exists a prevailing agreement regarding the research requirements pertaining to rural road safety, it is important to acknowledge the intricate nature of this field of study. This complexity arises from the diverse array of rural road classifications, each serving distinct purposes such as facilitating accessibility, enabling inter-urban mobility, and accommodating crosstown traffic. Hence, the purpose of this study is to examine the many factors that contribute to the occurrence of road deaths within the Emfuleni local municipality in South Africa.

According to Abegaz and Gebremedhin (2019), empirical evidence suggests that road traffic accidents (RTAs) can be effectively prevented, as demonstrated by the successful reduction of their occurrence in numerous high-income nations. These countries have implemented interventions that have been proven to be both cost-effective and efficient. Drawing upon the notable progress achieved via the Millennium Development Goals (SDGs), it is imperative to acknowledge South Africa’s steadfast dedication to actively pursuing and attaining the SDGs within the designated timeframe of 2030, as highlighted in the Road Safety Report of 2019. South Africa, like the rest of the developing world, is facing massive road fatalities. Based on data provided by the Road Traffic Management Corporation (RTMC), as referenced in the International Transport Forum/OECD (2019:2), the number of reported road deaths in 2018 amounted to 12,921, indicating a reduction of 8% in comparison to the figures recorded in 2017. In the year 2017, a total of 14,050 individuals who were using roadways experienced fatal outcomes as a result of traffic accidents. This number closely approximated the figure recorded in the preceding year of 2016, which reported 14,071 fatalities. The elevated occurrence of Road Traffic Accidents (RTAs) in South Africa can be attributed to various factors, namely the prevalent presence of irresponsible driving behaviors, inadequate road networks, subpar road conditions, insufficient enforcement of traffic regulations, and the inadequate maintenance of vehicles.

The primary aim of this study was to conduct a comprehensive analysis of existing literature and administer a survey to gather the perspectives of participants on the many elements that contribute to road traffic accidents (RTAs) in the Emfuleni Local Municipalities. The objective of this study was to administer research surveys to participants within the designated study region in order to determine their perspectives on potential causes that contribute to road deaths in Emfuleni Local Municipality. This study would provide advantages to the local municipality and pertinent stakeholders, including the Department of Transport (DoT), transportation agencies, and other safety stakeholders. The benefits would involve enhancing resource allocation and strategic decision-making processes with the aim of further decreasing road traffic accidents (RTAs). The research paradigm employed in this work was grounded in the positivist tradition. As a result, a quantitative methodology was employed utilizing a cross-sectional research design.

The following objectives which guide this paper are:

i. To determine the potential factors contributing in traffic fatalities directly or indirectly in Emfuleni Local Municipality;

ii. To identify possible relationships between the vehicle type factors and road design elements;

iii. To identify possible relationships between the occurrence of main human factors and road design elements; and

iv. To use the results of the research to make recommendations for decreasing RTAs.

This paper is structured as follows: subsequent to the introductory section, the subsequent section comprises a comprehensive assessment of existing literature encompassing both theoretical and empirical research, which provide insights into the relationship between theory and practice. The third section provides an introduction to the background material pertaining to the research and technique employed in the study. Following the examination and results of the investigation, the writers proceed to engage in debates and explore the potential ramifications. In conclusion, this paper presents a summary of the main findings, offers recommendations for further action, suggests potential avenues for further research, and acknowledges the limits of the study.
Literature Review

Vulnerable groups at a glance

South African roads impact certain groups more than others and consequently, these groups are at a higher risk than others. A child born in South Africa is more likely to be killed walking on the roads, with pedestrian crashes being the leading cause of injury and death for children under the age of 15 (Arendse, Swart, van Niekerk & Van As, 2012). Overall, young breadwinners, aged 20–34, are the leading victims of this road safety epidemic, whether they use the South African roads as pedestrians, passengers, drivers or cyclists (RTMC, 2015). Males are four times more likely to be killed on the road than females (Vanderschuren & Zuidegeest, 2017). As road users, pedestrians constitute the majority (37.6 percent) of road deaths in South Africa, followed by passengers (32 percent) and drivers (27 percent) (RTMC, 2015).

Considering that pedestrians were considered vulnerable road users in the South African context. In the case of Cape Town, most of the pedestrian deaths have been found to occur in low-income areas (Jannmohammed, 2018), where a significant majority walk more than 10 minutes (in certain cases 60 minutes or more), to access their destination (Jannmohammed, 2018). This is observed to be the norm across African countries, with the most vulnerable found to come from low-income households that depend on walking as their primary mode of transport to access services and public transport (FIA Foundation, 2016).

The risk of road fatalities varies depending on the province considered as well, meaning that residents of certain provinces are at a higher risk than others. This is found to be the case in Mpumalanga Province, where the road fatality rate is the highest at 37.9 fatalities per 100 000 population (Jannmohammed, Vanderschuren, Roux & Van As, 2018).

Significant Contributing Factors to Road Fatalities

The scope of this study focused on understanding factors that could lead to road fatalities in the area of the study. Contributory factors to road fatalities vary between rural and urban regions. For instance, in rural areas, stray animals on the road are seen to cause road fatalities, while in urban areas this kind of problem is minimal or non-existent entirely. However, in the specific case of South Africa, certain risk factors are found to be the leading cause of fatalities and injuries on the road. These factors in this literature review are grouped into four categories:

i. Roadway geometry: number of lanes, work zones, alignment (with curves and/or grades) of the roadway, locality, etc;
ii. Driver characteristics: age, gender, ethnicity of the driver, etc;
iii. Driver and driving behavior: alcohol, distraction, secondary task, pre-incident maneuvers, speed choices, average miles travelled, etc; and
iv. Vehicle characteristics: vehicle type, etc.

Theoretical and Empirical Review

Road Traffic Injury Theory

This study looked into the bodies of theories related to road traffic injuries and fatalities. Emphasis was on system theory. The reason for using this theory is because it is relevant in the stating of the research title as well as the problem statement. The theory guided the researcher in choosing the research methodology.

System Theory and Safety Concept

The system theory approach can be traced and dated back to the 1930’s and 1940’s (Rizzi, Kullgren & Tingvall, 2014). It started as a response to tackling limitations in the availability of classical analysis techniques in traditional scientific approaches to explain social, socio-technical and biological phenomenon. An important aspect of the systems theory concept is the emergence and interaction of various independent parts. When they stop being independent and start to influence each other in correlation to their existing relationships and social engagement (WHO, 2009). It was further argued that relationships between the components of a system is a function of the nature of the components themselves that determine the properties and behaviour characteristics. This was in conformity with researchers who argues that road accidents occur when components of a system interact with each other and these interactions cannot be foreseen, because of their complexity (Hollnagel, Braithwaite & Wears, 2013).

System theory is an integral part of safety as it relates to different complex socio-technical systems in the society. As concluded by Hollnagel, Braithwaite & Wears (2013) the road transport system is such a system and for that reason, system theory is applicable to it from a safety point of view. In the same vein, Salmon, et al., (2008), stated that a system perspective-based model in the road transport domain could lead to a greater understanding of the latent conditions and road errors within the road transport system. This in turn could inform the development of strategies designed to promote error tolerance within the road transport domain. The environment as a system, comprises of natural components, the built environments and transportation networks, which should be studied as an integrated system. This is the same manner in which the behavioural components of humans comprise of demographic characteristics of road users: age, sex, education, socio-economic status, stage in the life cycle, people’s perceptions of risk and people’s general behaviour on the street are studied (Hollnagel, Braithwaite & Wears, 2013).
The driver/human factor and environmental factors

Driving a vehicle is a complex, cognitively challenging task requiring drivers to make safety critical decisions (Cattermole, Horberry, Wallis & Cloete, 2014; Diels, 2011). In human factors terms, when driving in complex road environments, there is a constant and adaptive interaction between drivers and their environment (Cattermole-Terzic, 2017; Salmon, Stanton, Walker, Baber, Jenkins, McMaster & Young, 2008). The term situation awareness is used to describe the complex interplay between the environment, human perception, memory/experience, cognition, individual goals and subsequent actions (Barry, Howell & Dennis, 2011; Cattermole-Terzic, 2017; Salmon, Stanton, Walker, Baber, Jenkins, McMaster & Young, 2008). In a study by Duke (2010), the results demonstrated that risk estimates of percent accident involvement per percent of travel for drivers of large heavy vehicles continue to be overinvolved until the age of 27 years, when the risk generally decreased until the age of 63, after which increases were observed. Therefore older drivers display high accident involvement. In a study by de Winter and Dodou (2010), violations increased with age, whereas for all other samples in the study, violations decreased with age. Errors, on the other hand, decreased stronger with age for the younger drivers than they did for the older drivers. Thus showing mistakes are easily made by the older driver.

For efficiency and reduced effort, human minds categorise information into mental models or schema. Experience is a good teacher for one to always expect the unexpected. The same holds truth with the road usage. The fact that many of these incidents occur in daylight hours with good visibility meaning that there should be enough time for detecting, recognising and responding to the scene ahead, suggests that cognitive factors play a role (Cattermole-Terzic, 2017: 45). Regarding driver cognitive biases, research indicates, that when noticing the brake lights ahead, motorists reacted by slowing and changing lanes, not having noticed that there is a parked car in the other lane. Women have been reported to be more affected by this type of bias. This paper reveals that women are known to take fewer risks when driving they are over-represented in 'looked but failed to see' accidents and this could be explained by their higher tendency towards salience bias (Cattermole-Terzic, 2017).

Research Hypotheses

Based on the theoretical background and framework, four hypotheses were formulated to highlight the various dimensions and relationships under investigation in this study. The following hypotheses directed this study:

H0: There is no possible link between the occurrence of main human factors and road design elements.
H1: There is a possible link between the occurrence of main human factors and road design elements.
H0: There is no possible link between the vehicle type and road design elements.
H1: There is a possible link between vehicle type and road design elements.

Research and Methodology

For this study, the research paradigm was rooted in positivism. Consequently, a quantitative approach was adopted following a cross-sectional design was employed. The data-gathering instrument was a paper-based, self-administered structured questionnaire, which included a standardised measuring instrument using a five-point Likert scale. The first author distributed 260 questionnaires between the motorists and traffic officers in the Emfuleni Local Municipality. The responses from the respondents yielded 168 completed questionnaires from the Emfuleni Local Municipality inclusive of the motorists residing in the same municipality for a period of over 5 years. Respondents in the survey were asked to state their level of agreement with those given statements, as discussed below from strongly agree to strongly disagree. The data collected was analysed by coding and was computerised.

Answers within the questionnaire were assigned numerical codes and entered Microsoft Excel. The codes from Excel were subsequently transported into the Statistical Programme for Social Sciences (SPSS) (Field, 2013; International Business Machines Corporation (IBM), [sa]; SPSS, [sa]) for coding and further analysis (McCormick, Salcedo & Poh, 2015). The quality of the data was ensured through demonstrating validity and reliability. A structured questionnaire was used to survey the respondents. Ethical considerations are an important aspect of any research, especially research that deals with human participants. Hence, all research requires ethical clearance and approval to be conducted. For the purposes of this study, ethical clearance was granted by the university, initially on the condition that the Emfuleni Local Municipality Traffic Department approved the request to conduct research. This was later changed to full ethical clearance following the approval of the research request by the municipality.

Findings and Discussions

Demographic Characteristics of Respondents

Female constituted of 93 (55.39%) respondents whereas male respondents represented by 75 (44.64%). This can be attributed to the history of South Africa where females are in majority as compared with male population. Most of the respondents were aged 33–47, (92) 55.42%, followed by ages youth 18–32 (42) 24.7%. Few respondents were over 55 years old, (2)1.6%. Twenty-nine respondents occupied the third spot representing eighteen percent (17.47%). The elderly or those advanced in age-group (above 58), was the least represented in this study, with 4 (2.41%). The distribution of the respondents by years of residence indicated that the majority 98 (60.12%) spent over 16 years in the area of study, followed by 50 (30.67%) who stayed between 5-15 years of residence. The least represented were 15 (9.20%) with less than five years. The distribution of respondents that motorists who resided in the area of study where in majority 91 (55.15%), followed by traffic officials 62 (37.58%), and the least with those respondents who indicated other

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12 (7.27%). These could be the taxi drivers who came to the taxi rank from other neighbouring towns. Regarding level of qualification, 98 (59.39%) respondents were in possession of a Matric Certificate, followed by 63 (38.19%) with post school qualifications. Four (2.42%) respondents did not indicate their level of qualification.

**Responses to Statements**

Cronbach’s alpha is a measure used to assess the reliability, or internal consistency, of a set of scale or test items. In other words, the reliability of any given measurement refers to the extent to which it is a consistent measure of a concept, and Cronbach’s Alpha is one way of measuring the strength of that consistency. A score below .70 suggests that the items within the tool may not be measuring the same underlying construct. For this study, the scores of above 0.90 for all the items forming the measuring instrument showed that these measurements were consistent measure of the concept of various factors contributing for road accidents in the Emfuleni Local Municipality (Table 1). None of the Cronbach’s Alpha was less than 0.70. The results are provided below.

**Findings**

**Road environment factors**

An overwhelming majority of respondents (n= 132; 81.48%) agreed that factors responsible for road fatalities were due to slippery roads caused by weather conditions. Followed by (n=20; 12.35%) who disagreed. Ten respondents (n=10; 6.17%) were not sure. Regarding Road layout (narrow road, hill, sharp bend), the responses indicated that most respondents (n=111; 69.81%) agreed to this statement whereas (n=27; 16.98%) disagreed and (n=21; 13.21%) were not sure. Regarding whether the fatalities were caused by deposit on road (oil, diesel, mud), (n=110; 67.48%) agreed to the statement whereas (n=27; 17.79%) disagreed and (n=24; 14.73%) were not sure. The findings painted a bleak picture when it highlighted that an overwhelming majority (n=148; 91.92%) of the respondents attributed fatalities to poor or defective road surfaces. Only a mere (n=7; 4.35%) disagreed and (n=6; 3.73%) were not sure. Another concern detected when the respondents highlighted that inadequate or invisible road markings are the second highest contributing factor to fatalities where (147; 90.18%) agreed, whereas (n=11; 6.75%) disagreed and only (n=5; 3.07%) were not sure. Stray or wild animals were considered as the third contributing factor where (n=98; 61.26%) agreed whereas (n=41; 25.63%) disagreed and (n=21; 13.13%) were not sure. Of all the statements, only statements “Stray or wild animals” under road environment factors and “lack of reflectors on back of the vehicle” under vehicle factors are statistically different between the male and female participants. Among the female participants, “Strongly Agree” i.e., 38.64% (34) was the highest response while “Agree” i.e., 36.11% (26) was the highest for the males. (Figure 1) when asked if stray or wild animals were most responsible for road accidents. Similarly, most female (46.91%) and male (40.28%) participants strongly agreed and agreed respectively that lack of reflectors on the back of a vehicle could be one of the vehicle factors responsible for road accidents (Figure 2).

**Table 1:** Fischer’s exact test of the factors and gender

<table>
<thead>
<tr>
<th>No</th>
<th>Statement</th>
<th>Sample size</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.6</td>
<td>Stray or wild animals</td>
<td>160</td>
<td>0.011</td>
</tr>
<tr>
<td>8.4</td>
<td>Lack of reflectors on back of the vehicle</td>
<td>153</td>
<td>0.033</td>
</tr>
</tbody>
</table>

**Figure 1:** Stray or wild animals and gender
Defective traffic signals were considered as the fourth serious contributing factor to fatalities where (n=137; 85.63%) agreed whereas (n=11; 6.88%) disagreed and (n=12; 7.50%) were not sure. It was extremely disturbing to observe the responses that traffic calming (humps, potholes) were the leading factors relating to fatalities where staggering majority (n=159; 96.95%) of the respondents agreed whereas a mere (n=4; 2.44%) disagreed and only one (n=1; 0.61%) was not sure. Inadequate visibility (making it hard to detect vehicles and other road users) were also considered as one of the highest factors leading to fatalities where (n=136; 83.95%) agreed whereas (n=3; 1.85%) disagreed and (n=11; 6.79%) were not sure.

The variable with the strongest association to the underlying latent variable, Factor 1, is “slippery road”, with a factor loading of 0.7722. This means that statement “slippery road” (6.1) as depicted in Table 1 below, has a correlation of 0.7722 with Factor 1. Others are “Road layout” (6.2), “Deposit on road” (6.3) and “Stray or wild animals” (6.6). Based on these statements loading highly on factor 1, this can be called “Problematic Roads from natural causes” Inadequate or invisible road markings (6.5), defective traffic signs (6.7) and inadequate visibility (6.9) have high factor loadings on Factor 2. They seem to indicate signage problem, so one may want to call Factor 2 “Signage problem”. Poor or defective road surface and Traffic calming have high factor loadings on Factor 3. This may suggest the name “Problem Roads from government’s negligence”.

### Table 2: Factor analysis of road environment factors

<table>
<thead>
<tr>
<th>Variable</th>
<th>*Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>0.7722</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>0.5899</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>0.7013</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.4</td>
<td>0.7696</td>
<td></td>
<td>0.8282</td>
</tr>
<tr>
<td>6.5</td>
<td>0.6697</td>
<td>0.5234</td>
<td>0.5027</td>
</tr>
<tr>
<td>6.6</td>
<td>0.5297</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.7</td>
<td>0.8209</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Latent variable name**

- Problematic Roads from natural causes
- Signage problem
- Problem Roads from government’s negligence

Note: the word “Factor” is a term in factor analysis. It is not the same as “factors” in the questionnaire.

### Human factors

Driving under influence of alcohol, medicinal or recreational drugs was considered as one of the leading factors under this category, where majority (n=149; 90.85%) agreed whereas (n=11; 6.71%) disagreed and (n=4; 2.44%) were not sure. Inappropriate or excessive speed was also another leading factor where the majority (n=142; 92.21%) agreed whereas (n=3; 3.9%) disagreed and another (n=3; 3.9%) were not sure. Disobedience of existing traffic regulations counted amongst the leading factors as well, where the majority (n=144; 88.35%) of the respondents agreed whereas (n=7; 4.28%) disagreed and (n=12; 7.36%) were not sure. Having youths driving in the same vehicle also indicated high response where the majority (n=115; 71.42%) agreed whereas (n=25; 15.53%) disagreed and (n=21; 13.04%) not sure. Poor eyesight of road users also ranked high as one of the leading factors that contribute to fatalities where the majority (n=122; 74.85%) agreed whereas (n=16; 9.82%) disagreed and (n=25; 15.34%) not sure. Only two statements from each
of road-environment factors and human factors were statistically significant when cross-tabulated with levels of education. However, of the 4 statements in vehicle factors, three were statistically significant with levels of education.

The results are shown in Table 3. Options strongly disagree and disagree were merged to generate strongly disagree/disagree and strongly agree and agree were merged to generate strongly agree/agree because there were few numbers in some of the cells.

Table 3: Fischer’s exact test of the factors and levels of education

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Sample size</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td>Road layout (narrow road, hill, sharp bend)</td>
<td>157</td>
<td>0.004</td>
</tr>
<tr>
<td>6.7</td>
<td>Defective traffic signals</td>
<td>157</td>
<td>0.001</td>
</tr>
<tr>
<td>7.4</td>
<td>Having youths driving in the same vehicle</td>
<td>159</td>
<td>0.012</td>
</tr>
<tr>
<td>7.11</td>
<td>Obstruction (kids, loose items, passengers, eating)</td>
<td>162</td>
<td>0.034</td>
</tr>
<tr>
<td>8.1</td>
<td>Tyres illegal, defective or under inflated</td>
<td>157</td>
<td>0.001</td>
</tr>
<tr>
<td>8.3</td>
<td>Mechanical fault of the vehicle</td>
<td>151</td>
<td>0.007</td>
</tr>
<tr>
<td>8.4</td>
<td>Lack of reflectors on back of the vehicle</td>
<td>151</td>
<td>0.001</td>
</tr>
</tbody>
</table>

The results indicated that tiredness/illness featured high as well where the majority (n=123; 76.4%) of the respondents disagreed whereas (n=17; 10.56%) disagreed and (n=21; 13.04%) not sure. Insufficient attention to integration of road function with decisions about speed limits, road layout or design was also, indicated as one of the highest leading factors where the majority (n=135; 83.95%) of the respondents agreed whereas (n=13; 8.03%) disagreed and (n=13; 8.02%) not sure. Reckless or unsafe behaviour by road users was considered the highest in this category where the majority (n=158; 94.05%) of the respondents agreed whereas (n=8; 4.76%) disagreed and (n=2; 1.19%) not sure. Lack of tolerance by road users (road rage) is the second highest contributing factor in this category where majority (n=148; 90.79%) agreed whereas (n=9; 5.52%) disagreed and (n=6; 3.68%) not sure. Use of hand-held was also considered as one of the leading contributing factors where the majority (n=148; 90.79%) of the respondents agreed whereas (n=9; 5.52%) disagreed and (n=6; 3.68%) not sure.

Obstruction (kids, loose items, passengers, eating) still ranked high where most of the respondents (n=123; 74.55%) agreed whereas (n=18; 10.91%) disagreed and (n=24; 14.55%) not sure. Unskilled drivers (training, due to fake or invalidly issued licenses) was ranked high where most respondents (n=146; 89.57%) agreed whereas (n=10; 6.13%) disagreed and (n=7; 4.29%) not sure. Finally, pedestrian who failed to look properly before crossing the road also ranked high where majority of the respondents (n=143; 87.2%) agreed whereas (n=14; 8.54%) disagreed and (n=7; 4.27%) not sure. Variables as depicted in Table 3 below, shows the strongest correlation with factor 1 are “Insufficient attention to integration of road function with decisions about speed limits, road layout or design” (7.7), “Reckless or unsafe behaviour by road users” (7.8), Lack of tolerance by road users (road rage) (7.9), “Use of hand-held mobile telephones” (7.10), “Unskilled drivers (training, due to fake or invalidly issued licenses)” (7.12) and “Pedestrian failed to look properly before crossing the road” (7.13). This may suggest the name “unlawful behaviour”. “Having youths driving in the same vehicle” (7.4), “Poor eyesight of road users” (7.5), “Tiredness/illness” (7.6) and “Obstruction (kids, loose items, passengers, eating)” (7.11) have the strongest correlation with factor 2. This suggests the name “Controllable circumstances”. “Driving under influence of alcohol, medicinal or recreational drugs (7.1), “Inappropriate or excessive speed” (7.2), and “Disobedience of existing traffic regulations” (7.3) are all strongly correlated with factor 3 and this suggests the name “Inefficiency of traffic officers”.

Table 4: Factor analysis of human factors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
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<tbody>
<tr>
<td>7.1</td>
<td>0.7417</td>
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<td>7.2</td>
<td>0.8313</td>
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<td>7.3</td>
<td>0.7626</td>
<td></td>
<td></td>
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<td>7.4</td>
<td>0.8175</td>
<td>0.6455</td>
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<td>7.5</td>
<td>0.5506</td>
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<td>0.7105</td>
</tr>
<tr>
<td>7.7</td>
<td>0.7105</td>
<td>0.7933</td>
<td>0.8130</td>
</tr>
<tr>
<td>7.10</td>
<td>0.7928</td>
<td>0.7155</td>
<td>0.8130</td>
</tr>
</tbody>
</table>

Latent variable: Unlawful behaviour, Controllable circumstances, Inefficiency of traffic officers.
Vehicle factors

Under this category, unroadworthy vehicles was considered as the highest leading factor contributing to road fatalities where majority of respondents (n=143; 88.82%) agreed whereas (n=8; 4.97%) disagreed and (n=10; 6.21%) not sure. Second leading contributing factor was a mechanical fault of the vehicle where most of the respondents (n=127; 82.47%) agreed whereas (n=15; 9.74%) disagreed and (n=12; 7.79%) not sure. Thirdly, most of the respondents indicated that illegal, defective or under inflated tyres was a leading contributing factor to road fatalities where (n=124; 77.99%) agreed whereas (n=16; 10.07%) disagreed and (n=19; 11.94%) not sure. Lack of reflectors on back of the vehicle was considered as the least yet high contributing factor where many of the respondents (n=119; 77.77%) agreed whereas (n=18; 11.76%) disagreed and (n=16; 10.47%) not sure. All these vehicle variables/statements are correlated with only one factor and the name vehicle factor is maintained.

Table 5: Factor analysis of Vehicle factors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>0.8355</td>
</tr>
<tr>
<td>8.2</td>
<td>0.8199</td>
</tr>
<tr>
<td>8.3</td>
<td>0.8748</td>
</tr>
<tr>
<td>8.4</td>
<td>0.7900</td>
</tr>
</tbody>
</table>

Latent variable Vehicle factor

Discussion

This study found that RTAs were caused by various factors namely various contributing factors namely, road environment factors such as lack of reflectors on back of vehicle, gender, human factors, and vehicle factors. The responses above highlighted that the effect of road design is obscured by the presence of many factors. Potholes, cracks and uneven or loose road surfaces identified as the highest factors that contributed to road accidents. In fact, based on the respondents’ responses, most accidents result from a combination of factors interacting in ways that preclude determining a single accident cause such as but not limited to texting while driving, lack of experience, especially in poor road or weather conditions, failure to use seatbelts, being distracted by other passengers. Even when a vehicle leaves the road owing to driver error or mechanical failure, the road design may still mitigate accident severity. This intersection between road, driver and vehicle characteristics complicates attempts to estimate the accident reduction potential of a particular safety improvement. The construction of a road is typically a trade-off between ideal roadway conditions and the economic use of scarce resources. Wide road reserves, high fills and deep cuttings, and long roadway structures to separate conflicting traffic streams are extremely expensive to expropriate and construct. The associated expropriation to acquire the necessary reserve width is also expensive.

Road designs are often based on future demands for roadway capacity, which are evaluated mainly in terms of economic considerations, such as construction costs and the value of time. Safety should be a primary objective during all maintenance operations. Changes to the basic design should not be undertaken without consulting the designer and considering the effect on road safety. Frequent replacement of damaged road furniture should be reported, as it may indicate the need for redesign, which may eliminate the maintenance problem and improve safety. Enforcement should have as its basic objective the safety of the motoring public. Enforcing the regulations in accordance with the operational intent of the regulation is most important. Enforcement personnel can add greatly to safety improvements by identifying hazardous locations. By means of a good working relationship between the engineering and enforcement fraternity, many of these problem areas can be located and rectified before major accidents occur.

The results on human factors contributing to RTAs have several implications. There are possibilities that at night and in bad weather conditions, the driver might not be aware of the changing situation and may end up on the wrong side, probably travelling in the opposite direction. Safety can often be improved without reconstruction, by widening lanes or shoulders, flattening side slopes, removing, or relocating roadside obstacles, and installing traffic control devices. The responses above were so disturbing. Amongst other factors pointed out by the respondents as leading to fatalities, reckless or negligent driving lead the pack and this includes actions like overtaking when it’s unsafe to do so, not stopping properly at stop signs or traffic lights, and changing lanes into tight spaces. It’s easy to see how these behaviours contribute to the high number of road accidents. It is the view of the researcher that motorists and other road users must perceive and process information, make decisions and react, all within specific time frames.

Comfortable and safe driving and riding occurs when motorists are operating well below a stressful processing and decision-making rate, and above the minimum level of arousal (Kexuan, Pei, Chen, & Xu, 2022; WHO, 2010). The driver should not be over-stimulated or lulled into boredom. This aspect is a critical component in the development and maintenance of a safe road environment. The safety, security, reliability, and quality of service of some modes are currently unacceptable. The findings of this study corroborated with a literature review. According to Road Safety Annual Report, South Africa 2019 as cited in International Transport Forum/OECD (2019), behaviour of road users is an important determinant of a country’s road safety performance. Human factors are the main causes of road crashes. In South Africa, jaywalking by pedestrians is reported to be major issue, with a contribution of 24% to the total number of fatalities for 2018. Speeding and inappropriate speed are also a major issue, as is “hit and run” (International Transport Forum/OECD, 2019).
The government is committed to a concentrated and integrated effort to bring them into line with international best practice. Particular attention will be paid to road safety. The unacceptable traffic conditions on South African roads, and especially the high accident and casualty rates, must not continue. Road traffic safety is not a function, but rather the result of the efficient and harmonious operation of road and traffic-related management systems, functions, and activities developed and implemented with the purpose of improving quality in road traffic. Based on the responses above, it is evident that a stronger approach will be needed to bring a more drastic improvement in road user discipline and reduce collisions. It is the view of the researcher that since taxpayers’ money is used to provide for the planning, construction, and maintenance of public roads, it is incumbent on all spheres of government and road agencies to ensure the safety of road users. This may be achieved by means of road safety awareness programs, driver training, incident management systems, adequate road traffic signs and markings, visible law enforcement, safety assessments and audits, and designing for road safety. The responsibility for safety rests with many disciplines involved in administering, planning, designing, constructing, maintaining, and operating roads.

The relative safety of a road depends largely on the priority attached to safety programs and projects. It is important that political and official sanction be given to implementing safety in all phases of road infrastructure provision. Safety begins and ends with decisions made during the planning process. For example, policies regarding intersection spacing and access to properties have a direct bearing on the safety of a particular road. Similarly, planners establish and control land use policies, thereby affecting the safety of the facility. Sight distance restrictions were also highlighted as one of the leading contributing factors as per the responses above, which might have resulted from obstructions on the inside of horizontal curves, at intersections, or at sharp hill crests. Although obstructions at horizontal curves can often be eliminated without changes to the geometry, obstructions at hill crests can only be corrected by changes in vertical alignment, which can by lengthening the existing vertical curve. Studies of matching sites with and without sight distance restrictions found that accident frequencies at sites with sight restrictions were 52% higher than the control group (Olson, Yuen & Balsiger, 1984).

Another important factor to be considered, based on the responses and which has been commonly cited in the literature, is driving under the influence of alcohol amongst other causes of road crashes in South Africa (Govender, Sukhai & van Niekerk, 2020; International Transport Forum/OECD, 2019). Based on the 2018 figures, about 3.4% of fatal crashes occurred due to intoxicated drivers, pedestrians, and cyclists with liquor usage. In South Africa, the maximum authorised blood alcohol content (BAC) is 0.5 g/l. There is a lower limit of 0.2 g/l for professional drivers of public transport and heavy goods vehicles. A crash is defined as alcohol-related when one of the participants has a BAC above the legal limit (International Transport Forum/OECD, 2019; Kraha, 2013). Data on the role of drug use by road users for road crashes in South Africa is unavailable. Driving while under the influence of intoxicating liquor or drugs having a narcotic effect, or with an excessive amount of alcohol in the blood or breath is prohibited. Drug driving measures are not yet enforced. An increasing problem for traffic safety in South Africa is distraction, for instance using mobile phones while driving (Ortega, Mariscal, Boulagouas, Herrera, Espinosa & García-Herrero, 2021; Owens, McLaughlin & Sudweeks, 2011).

The National Road Traffic Act states that no person shall drive a vehicle on a public road holding a cellular or a mobile telephone or any other communication device in one or both hands and with any other part of the body. Seat belt wearing has been compulsory in South Africa since 2005 in front seats and rear seats for cars and minibuses registered after 1 January 2006. All new motor vehicles must be fitted with seat belts for all passengers. The driver is responsible for ensuring that infants are seated with appropriate child restraint. The seat belt wearing rate is very low, estimated in 2010 at 4.5% for the drivers and 5% for front seat passengers. There has not been any more recent survey on the use of seatbelts. The National Road Traffic Act, 1993 (No. 93 of 1996) requires cyclists of all ages to wear helmets. This is compulsory for all cyclists. The regulation requires the use of protective helmet that is properly fastened and fitted while riding a bicycle or being carried as a passenger (International Transport Forum/OECD, 2019).

The above responses regarding vehicle factor clearly painted a bleak picture regarding poorly maintained and un-roadworthy vehicles which contributed to accidents when parts, such as brakes or tyres, fail. An absence of mirrors, fractured windscreens, defective lights and indicators, and no windscreen wipers all increase the likelihood of a collision. The rate of road traffic accidents in South Africa, is too high, and could be caused by negligence, illiteracy, unawareness and disorder, the old fleets of cars, taxis, heavy vehicles such as buses and freight trucks, lack of vehicle maintenance, and inadequate funds for proper road construction and maintenance (Modipa, 2022). The findings also corroborate with the previous research that causes of road traffic accidents, to varying degrees, are to be found in defects in the vehicle, the driver and the road, or combinations of these defects (Jima, 2019). In most cases, accidents are the result of road users failing to obey the law. By studying accident statistics and patterns, designers can concentrate on hazardous locations with a view to safety-conscious design (Martinussen & Somhoud, 2019). Festive season is known as the bloodiest period on South Africa’s roads. The disastrous combination of increased traffic volumes, drunk driving and unroadworthy vehicles manifests as carnage on the country’s carriageways (Xu, Dong, Li, Yang, Lin & Ou, 2021). To mitigate the wanton death and destruction during
the festive season, the current road safety measures or strategies have managed to limit the fatalities on South Africa’s roads. Still, based on the responses from the respondents, as well as the official figures remain shockingly high, a cause for serious concern among government officials and the public alike.

To determine possible links and the hypotheses and the research objectives, the following was observed with Table 6:

**Objective**

**H_0:** There is no possible link between the occurrence of main human factors and road design elements.

**H_1:** There is a possible link between the occurrence of main human factors and road design elements.

**Table 6: Association between road-design elements and human factors**

<table>
<thead>
<tr>
<th>Problematic natural causes rho(P-value)</th>
<th>Signage problem Rho(p-value)</th>
<th>Problem government’s negligence rho(P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlawful behaviour</td>
<td>0.3205 (p&lt;0.001)</td>
<td>0.5438 (p&lt;0.001)</td>
</tr>
<tr>
<td>Controllable circumstances</td>
<td>0.4106 (p&lt;0.001)</td>
<td>0.3749 (p&lt;0.001)</td>
</tr>
<tr>
<td>Inefficiency of traffic officers</td>
<td>0.3404 (p&lt;0.001)</td>
<td>0.5545 (p&lt;0.001)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.2504 (p&lt;0.01)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.3678 (p&lt;0.001)</td>
</tr>
</tbody>
</table>

Table 6 shows that all the p-values are less than 0.05, therefore this study rejects the H_0. This means that there is possible association/link between human factors and road design elements. There is Spearman's correlation coefficient, (Rho) measures the strength and direction of association between two ranked variables. Off all the factors, inefficiency of traffic officers and signage problem have the strongest association (Rho=0.5545, p<0.001) while the association between controllable circumstances and problematic roads from government’s negligence is the lowest (Rho=0.2504 (p<0.01). The association i.e., the link is in a positive direction, for all the elements, the higher level of the human factors, the higher road design elements.

**Objective**

**H_0:** There is no possible link between the vehicle type and road design elements.

**H_1:** There is a possible link between vehicle type and road design elements.

**Table 7: Association between road –design elements and vehicle factors**

<table>
<thead>
<tr>
<th>Problematic natural causes rho(P-value)</th>
<th>Signage problem Rho(p-value)</th>
<th>Problematic government’s negligence rho(P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle</td>
<td>0.3973 (p&lt;0.001)</td>
<td>0.3295 (p&lt;0.001)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.2267 (p&lt;0.01)</td>
</tr>
</tbody>
</table>

Like objective 3, there was an association between vehicle factor and all the road design elements. Therefore, this study rejects the null hypothesis which says there is no possible link between the vehicle type (factors) and road design elements. The strengths of association are low and in a positive direction as depicted by Table 7 above.

**Conclusions**

The primary aim of this study was to ascertain the factors that contribute to the occurrence of road deaths within the Emfuleni Local Municipality. The results of this study underscored the impact of paved roads in mitigating traffic fatalities. Moreover, within the context of South Africa, numerous fatalities are attributed to a multitude of reasons, as elucidated by the findings of this study. Nevertheless, the findings of this study give rise to many policy consequences. There is a pressing need for policymakers in the field of traffic management, along with other pertinent stakeholders, to establish a shared understanding and agreement on the evident realities surrounding the significant number of fatalities occurring on roadways. This urgent situation necessitates a proactive response to revise existing strategies, which are widely recognized as ineffective, in order to address this critical issue. It is imperative to question and confront the prevailing state of affairs, as well as recognize that reforms are an inevitable outcome. There exists a necessity for a novel paradigm change. The prevailing paradigm, or the previous paradigm, has been implicated in the majority of vehicular accidents involving young individuals, older adults, drivers under the influence, and those who are preoccupied. The novel paradigm necessitates the assessment of crash rates per capita, the level of adolescent engagement in road safety programs, and the alteration of attitudes. The utilization of public transit as an alternate means of commuting to work, engaging in sporting activities, or visiting family members presents an opportunity for a significant decrease in deaths in South Africa. However, the acceptance and support of this mode of transportation by a broader range of road users is still lacking.
The implementation of measures aimed at reducing vehicle travel has various advantages, such as enhanced safety, cost savings for consumers, higher affordability, alleviation of road and parking congestion, improved mobility for individuals who do not drive, and promotion of public fitness and health. Consequently, the adoption of this new paradigm necessitates a full examination of its overall impact. The emerging paradigm, meanwhile, will encounter multiple challenges, such as the inclination of numerous stakeholders towards safety initiatives that are specific in nature and their reluctance towards methods aimed at reducing car traffic. Nevertheless, the integration of new paradigm tactics into current programs has the potential to enhance their effectiveness, equity, and acceptability. This can be achieved by including enhanced mobility options that assist individuals at higher risk of accidents in reducing their reliance on driving. It is important to note that the proposition of eliminating motor travel for the purpose of ensuring safety is not being advocated. Nevertheless, according to survey data, a significant portion of individuals express a preference for reducing their reliance on driving and increasing their utilization of alternative modes of transportation, as long as these alternatives offer convenience, comfort, and affordability. The results of the study revealed that a majority of the participants expressed agreement with the inappropriateness of certain drivers and vehicles sharing the road with others. This sentiment was attributed to different factors, which in turn contribute to the elevated occurrence of road traffic deaths. The present circumstance necessitates immediate attention.

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All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to restrictions.

Conflicts of Interest: The authors declare no conflict of interest.

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