



FACTORS AFFECTING PILGRIM'S PEDESTRIAN CASUALTIES IN AL MADINAH AL MONAWARAH IN KSA

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ABSTRACT

Purpose: The purpose of this paper is to investigate pedestrian-vehicles pilgrims accidents in Al Madina in KSA.

Methodology: In this context, investigation of pedestrian-vehicles pilgrims accidents using statistical analysis have been carried out.

Findings: One of the main findings of this research is that the serious accident pattern indicates the need for improved pedestrian facilities for pilgrims. This is the major outcome of the modelling and the analysis in general.

Originality: The integrating of spatial data with the conventional data to assess factors that affect pedestrian accidents.

Keywords: pedestrians; land use; road accidents; traffic safety; Madinah and Pilgrims.

INTRODUCTION

The growing fatality of road traffic accidents in most cities constitutes a public health challenge. Annually, about 1.24 million people are killed from road accidents, among which more than one fifth of these deaths occur among pedestrians. Pedestrian collisions are even more prevalent in cities that host mass gathering events such as the Hajj. Yet this phenomenon has been neglected within the existing literature. Correspondingly, this research examines the relationship between pilgrims' pedestrian casualties and the land use type in Madinah. The relationship between the land use and pedestrian casualty was determined from pilgrims pedestrian casualty data ($N = 2204$) from 2001 to 2005 supplied by the Madinah Police Department. The accident data is characterised by the personal and socio-demographic attributes of the victims as well as the land use type of the accident.

The significant findings from this study show that male pilgrims were over represented in pedestrian casualty in Madinah. This is consistent with other road accident studies in Arab-Muslim countries which also recorded higher male casualty compared to female. Again, more men embark on pilgrimage than their female counterpart. Young pilgrim (12–20's) pedestrians suffer the most casualties; while the least casualty was recorded for child pilgrim pedestrians (<12). In terms of day of the week, the high casualty occurs on Friday which is an important day for prayer that usually cause high incident of traffic and over-crowdedness. Though almost three-quarter of the pilgrim pedestrians sustained their casualties during high season months as most Moslem pilgrims embarks on pilgrimage during this period. However, most pilgrims' pedestrians suffer casualty during non-praying time because during prayer time, most of them would either be in the Mosque or residence fulfilling their obligation to pray, thereby, making them less exposed to pedestrian-vehicle collisions.

In modelling the relationship between pilgrims' pedestrians and land use type, quasi-Poisson regression models fitted the accident data better than Negative Binomial regression models. Most of the models developed indicate strong association between pilgrims' pedestrian casualties and commercial and religious land use types. For the major land use types, fatalities were more prevalent in the commercial and religious land use types. In terms of road type, the highest casualties occurred on single carriageway-2 lanes and mostly on roads around the Holy site. Whilst the results indicate that there is a greater number of accidents occurring in proximity to junctions or close to T,Y or staggered junctions categories taken together, the large single category of accidents occurred 'not at junction or within 20 m of junction'. Nevertheless, majority of coefficients for road type and junction details variables were insignificant. Main findings from this research are discussed and suitable recommendations are made to assist policy makers in proffering countermeasures to will help improve safety and reduce accidents. One of the main findings of this research is that the serious accident pattern indicates the need for improved pedestrian facilities for pilgrims. This is the major outcome of the modelling and the analysis in general.

In order to achieve the aims and objectives of the research, extensive literature review was carried out to explore the background of road traffic accidents and other related topics that will assist in answering the research questions such as critical review of literature of previous studies of road accidents with emphasis on pedestrian casualty. This paper concisely presents the main research findings and attempts to answer the research question and hypothesis proposed in Chapter One. The study undertook extensive literature review of studies on pedestrian accidents' as well accident analysis and investigation in Saudi Arabia and elsewhere. Most of the findings in the literature review were consistent with the findings in Madinah. A typical example is the contribution of over-crowdedness or increase in population in pilgrims' pedestrian casualty.

Again, this study also found strong association between pilgrims' pedestrian casualties and commercial and religious land use types. Hence, the hypothesis proposed in Chapter One has been answered.

CAUSES OF PEDESTRIAN/MOTOR VEHICLE COLLISIONS IN MADINAH

It is not uncommon for society to hastily conclude that pedestrian errors (e.g. violation of traffic laws, being confused or distracted and sometimes in a hurry) are responsible for most pedestrian-automobile collisions that often lead to pedestrian casualties. Nevertheless, it seems that this conclusion may be overstated for several reasons (Brustman, 1999; Roberts and Coggan, 1994). In addition to pedestrian error, there are several causes of pedestrian/motor vehicle collisions which need to be considered to provide insight on how best to tackle the problem. For instance, those factors that influence the motorists (i.e. drivers) and/or the vehicles (e.g. brake failure) may also culminate in pedestrian/motor vehicle collisions. In general, factors contributing to pedestrian/motor vehicle collisions can be subdivided into three broad categories (Ha and Thill, 2011):

1. Human factors;
2. Environmental factors and
3. Vehicular factors.

In some cases, pedestrian/motor vehicle collisions may be caused by a complex combination of these factors (Peden et al., 2004). This section will discuss the likely causes of pedestrian casualty in Madinah.

HUMAN FACTORS

Since pedestrian casualty usually involves the interaction between pedestrians and vehicles, the behaviour of both the pedestrians and drivers could contribute adversely to road accidents. Drivers' behaviour could lead to errors or deliberate violation of road traffic laws which contributes significantly to 90–95% of crashes (Ha and Thill, 2011). Consideration of driver's behaviour is a complex issue that should be dealt with caution. Fast driving is but one of many dangerous and harmful driving habits acquired partly through faulty education and training (Mekky, 1984). There are many other aspects of driver's behaviour that contributes adversely to road traffic accidents. For instance, some drivers are disobedient to authority, thereby, violating road traffic laws. Some drivers may also be addicted to narcotic and other hard drugs which may hamper their judgement while driving resulting to fatal accidents. The attitudes of drivers are also influenced by their socio-economic background. Wrong driving attitudes of drivers could lead to road accidents, which sometimes affect pedestrians.

Pedestrian casualty does not only depend on drivers' behaviour, but also depend on the behaviour of the pedestrians (Damsere-Derry et al., 2010). Hence, the wrong attitudes of pedestrians (e.g. wearing headphones, talking on a cell phone and eating, drinking, smoking or talking while crossing the roadway) could also cause road traffic accidents culminating in pedestrian casualty (Bungum et al., 2005). Similar to the behavioural problems of drivers, pedestrians could also be disobedient to authority by violating traffic laws. In fact, most road accidents involving pedestrians are caused by non-compliance with road safety regulations. The consumption of alcohol, narcotics and other hard drugs by pedestrians could impair their judgement, which may result in erroneous road traffic decision culminating in pedestrian casualty. However, the violation of road safety regulations due to alcohol intoxication and other hallucinating drugs are almost non-existence in Saudi Arabia.

Almost all Islamic countries, including Saudi Arabia, the consumption of alcohol and other hallucinating drugs are prohibited, and culprits of this heinous crime could face severe punitive measure. Again, Madinah is exclusively an Islamic city which adheres to the strict compliance to alcohol and drugs prohibition. Consequently, the consumption of alcohol and drugs by both drivers and pedestrians in Madinah is very minimal. Therefore, the influence of alcohol and drugs on pedestrian-vehicle collision is very low in Madinah.

Over-speeding of motorists has been shown to be the major cause of road accidents which often lead to pedestrian casualty. 'Excess speed' is defined as a vehicle exceeding the relevant speed limit; whereas 'inappropriate speed' refers to a vehicle travelling at a speed unsuitable for the prevailing road and traffic conditions. The speed of a driver is influenced by several factors such as the nature of the road (e.g. its width or alignment or markings), the type of vehicle (e.g. maximum speed of vehicle), road traffic (e.g. congestion, density), environment (e.g. weather, road lighting, etc.). In addition, the demographic factors (e.g. age and sex) and behavioural attributes of the driver also influences the speed the vehicle would be travelling (Peden et al., 2004). Several studies have established the relationship between vehicle speed and crash risk (Peden et al., 2004). The probability of a crash involving an injury is proportional to the square of the speed. The probability of a serious crash is proportional to the cube of the speed. The probability of a fatal crash is related to the fourth power of the speed (Andersson and Nilsson, 1997; Nilsson, 1982).

According to Peden et al. (2004) speed has an exponentially detrimental effect on safety. Hence, the number and severity of the casualty rises as the speeds increase. Evidence have shown that pedestrians have a 90% chance of surviving car crashes at a speed of 30 km/h or below, but less than a 50% chance of surviving impacts at 45 km/h or above. Another study have indicated that the probability of a pedestrian fatality rises by a factor of eight as the impact speed of the car increases from 30 km/h to 50 km/h. Over-speeding has been identified as the main cause of road traffic accidents in most developing countries, including Saudi Arabia (Mekky, 1984).

Drivers' fatigue or tiredness can be caused by a range of factors such as long-distance driving, sleep deprivation and the disruption of circadian rhythms. As a result of fatigue, drivers can fall asleep while driving resulting to road accidents which sometimes wreak havoc on pedestrians. However, most fatigue related crashes occur at night during which pedestrian activities are usually reduced. Paradoxically, pedestrians killed or injured at the peak of fatigue related crashes are less at night. But fatigue related crashes at day time are likely to result in greater number of casualty. For the above reasons, more pilgrims' pedestrian casualty caused by fatigue related crashes are likely to occur at daytime in Madinah.

Pedestrian-automobile collision can also be caused by impaired eyesight of either the vehicle driver or pedestrians. A driver needs a good vision to be able to see and avert looming danger such as pot-holes that could lead to road accidents. Without a good vision vehicle drivers would not be able to see on-coming pedestrians to avoid unnecessary collision. Similarly, pedestrians need good vision to avoid impending danger that could lead to collision. Furthermore, traffic lights and Zebra (or Pedestrian) crossing must be clearly seen by pedestrians to enable them effectively comply with road safety regulations.

There are other medical conditions of drivers or pedestrians that could cause pedestrian-vehicle collision. For example, certain prescribed medications taken by drivers (or pedestrians) due to their medical conditions may cause drowsiness or hallucination that could lead to fatal road traffic accidents. *Epilepsy, which is a diverse set of chronic neurological disorders characterised by seizures can also pose danger to road safety. Sufferers of this medical condition could experience seizure while driving or walking leading to fatal road accidents. Another typical health condition that poses danger*

to road safety is heart attack. Hence, road users (e.g. drivers and pedestrians) are advised to stay in-doors after taken certain medications in order to avoid any unpleasant road disaster. Again, sufferers of certain medical conditions (e.g. epilepsy) are advised not to drive. In extreme cases, these persons are not issued drivers' license based on their medical conditions to prevent them from driving.

In many high-income countries such as Saudi Arabia, the use of hand-held mobile telephones has become very rampant because they affordable by most Saudis. The use of hand-held mobile telephones is invaluable for effective communication, but it can adversely affect driver behaviour. For instance, the process of dialling or receiving calls influences a driver's ability to react to impending danger such as pot holes or pedestrians. According to a report by Peden et al. (2004) researches have shown that the reaction times of vehicle drivers can be increased by 0.5–1.5 sec when communicating through a mobile telephone and drivers who use hand-held mobile phones while driving are four times likely to crash compared to those who do not use them. Similarly, the use of hand-held mobile phones by pedestrians while crossing roadway could cause road accidents leading to pedestrian casualty (Bungum et al., 2005). Many causes of pedestrian-vehicle collisions in Madinah might be as result of the inappropriate use of mobile phone while driving or walking, however this needs further research.

ENVIRONMENTAL FACTORS

Good visibility (which is the ability to see clearly and be seen) is a fundamental prerequisite for the safety of all road users. Hence, poor visibility is a major factor cause of road traffic accidents which affects all types of road users (Peden et al., 2004). This problem of inadequate visibility of roadways seems to be less serious in developed countries because of the strict implementation of road safety regulations and maintenance of street lightings. According to the World Report on Road Traffic Injury and Prevention, in the state of Victoria, Australia, poor visibility contributes to 65% of crashes between cars and motorised two-wheelers and the sole cause in 21% of them. While in Germany, nearly 5% of severe truck crashes can be linked to poor visibility of the truck or its trailer at night (Peden et al., 2004). The impact of inadequate visibility on pedestrian casualty have also been highlighted by a review of European in-depth research which indicated that about 33% of pedestrian casualties had difficulty in seeing the striking vehicle; while 40% of drivers had difficulty in seeing the pedestrian (Allsop, 1999). However, in most developing countries including Saudi Arabia, the poor visibility of motorways and road users (e.g. pedestrians and motorists) is a serious problem. In Saudi city such as Madinah, there are fewer roads with adequate illumination at night time due to the absence of street lightings. In places where street lights are installed, some may not be functioning as a result of poor maintenance. Again, some motorists drive vehicles with faulty head-lights without been arrested due to the ineffective implementation of road safety measures in most of these developing countries. These harmful practices in Madinah decrease the visibility of roadways at night. Consequently, they expose road users to the danger of road accidents. The more conspicuous the road users (i.e. motor vehicles and non-motorists e.g. pedestrians) are to one another, the better the opportunity of averting road accidents.

The road network of a city greatly affects how road users perceive their environment and also provides instructions for road users, through signs and traffic controls (Peden et al., 2004). Hence, the choices of the route taken by road users, the time spent on the route and the congestion (or traffic volume) encounter by the road users are influenced by the road network. The type and nature of the roads in any given environment influences the frequency and severity of road traffic crashes. As a result of the disparity in road-type or nature, road traffic accidents are unevenly

distributed throughout the network. For example, road type such as a single carriageway is most likely to lead to a fatality rather than roundabouts, one-way streets or dual carriageways. While not being at a junction or within 20 m of one has been found to be associated with the most severe injuries (Gray et al., 2008). Again, there are safety concerns of the nature of roads because they contribute to crash risk. For instances, driving on bent or hilly roads may prevent the driver of the vehicle from seeing afar. Similarly, pedestrians may be unable to see approaching vehicles on certain bent or hilly roads. Slippery roads also pose danger to both drivers and pedestrians. A common example is the weakening of the effectiveness of the brake system of vehicles by slippery roads, which may lead to road accidents. Pedestrians may also trip-over while crossing a slippery road (or walking on slippery foot path) leading to pedestrian casualty. In fact, many fatal accidents occur along bent, hilly and slippery roads.

Understanding the contribution of road-related factors to road crashes enable road engineers to effectively tackle this menace by constructing roads that will help in reducing the frequency and severity of road traffic crashes. Poor construction of roads can contribute to crashes (Peden et al., 2004). Consequently, the planning, designing and maintenance of the road network usually involves four important elements which affects road safety as highlighted below (Ross et al., 1991):

1. safety-awareness in the planning of new road networks;
2. the incorporation of safety features in the design of new roads;
3. safety improvements to existing roads and
4. remedial action at high-risk crash sites.

These four road safety elements are less taken into consideration in most developing countries due to several factors which may include poor governance, corruption of government officials and poor implementation of road projects. Hence, road-related factors have greater impact on Madinah being a city in a developing country. The environmental conditions such as bad weather, storms, dust, rain, hail snow, fog and numerous other factors can adversely affect driving. For instance, severe weather conditions can result to poor visibility which will affect the safety of road users. The trends show that vehicles either ram into the rear of a stationary/slow-moving vehicle or there may be angled/head-on collisions. In other cases, the poor visibility results to the collision between pedestrians and vehicles.

VEHICULAR FACTORS

Mechanical failure (e.g. braking failure, burst tyres, etc.) has been found to be one of the main causes of road accidents. In addition, the design of the vehicle, its handling, maintenance and overloading are prerequisites that influence the tendency of the vehicle to involve in road accidents. For instance, the design of a motor vehicle has been found to contribute to crashes to a level of 3% in the developed world, while for Kenya its contribution has been found to be 5%. The maintenance of vehicles in Saudi Arabia is poorly regulated. Hence, the contribution of vehicular factor to pedestrian casualty could be much higher in Madinah due to poor maintenance of vehicles.

RISK FACTORS INFLUENCING THE SEVERITY OF PEDESTRIAN CASUALTY IN MADINAH

Well-established risk factors that contribute to the severity of pedestrian/motor vehicle collisions are concisely presented below since most of these issues (e.g. demographic factors) that highlight

the difference between gender with regards to accidents have already been discussed in detail in the previous sections.

The severity of pedestrian casualty is usually proportional to the impact between the pedestrian and vehicle. Excessive and inappropriate speed above the safety regulations are prohibited because its tendency of causing death. Consequently, drivers are urged to drive at low speed by complying with the road safety regulations.

The age and gender of pedestrians may also influence the severity of their injuries. Children and elderly people are known to suffer more severe injuries than other age categories due to their fragility. Similarly, females are more susceptible to suffer severe injuries compared to their male counterparts. Roadside protections such as rails or bars protect pedestrians from getting into contact with vehicles. Hence, it protects pedestrians from sustaining severe injuries. Vehicular roads that lack such roadside protections as commonly found in developing countries exposes pedestrians to greater impact of collision with vehicles thereby increasing their tendency of sustaining severe injuries.

RISK FACTORS INFLUENCING POST-ACCIDENT INJURY OUTCOME OF PEDESTRIANS

Studies worldwide have shown that death was potentially preventable in a large proportion of those who died as a result of road crashes before they reached hospital. Again, many studies have clearly indicated that the probability of dying increased as the socioeconomic level of the victim decreased. Morbidity outcomes are also influenced by factors related to post-impact care. In the case of major injuries, the potential help towards recovery that survivors can receive can be viewed as a chain with several links:

- actions or self-help, at the scene of the crash, by the victims themselves or more frequently by bystanders;
- access to the emergency medical system;
- help provided by rescuers of the emergency services;
- delivery of medical care before arrival at the hospital;
- hospital trauma care and
- rehabilitative psychosocial care.

Weak public health infrastructure in many low-income and middle-income countries is a major risk factor. In high-income countries, the pre-hospital risk factors are not so pronounced, but where they exist, are associated with the need to improve the existing elements of post-impact care. Evacuation and transport to hospital is more often carried out by bystanders, relatives, commercial vehicles or the police.

CONCLUSIONS

Pedestrian casualty contributes more than a third of all traffic-related deaths and injuries worldwide. This high casualty rate is an indication that pedestrians are among the most vulnerable road users. The risk factors exposing pedestrians to road accident in Madinah have been identified to include: increased motorisation; demographic factors (e.g. age, gender or socio-economic status); lack of pedestrian facilities; land use; increased need for travel. The causes of pedestrian/motor vehicle collisions in Madinah have been categorised into – human, environmental and vehicular factors. While excessive vehicular speed, age and gender of

pedestrians and inadequate roadside protection are among the factors that affect the severity of pedestrian casualty in Madinah. Furthermore, sub-standard medical care and lack of trained medical personnels are some of the factors that aggravate the severity of post-crash injuries of pedestrians in Madinah. One of the main findings of this research is that the serious accident pattern indicates the need for improved pedestrian facilities for pilgrims. This is the major outcome of the modelling and the analysis in general. Other research findings show that male pilgrims are over represented in pedestrian casualty in Madinah. Male and female pedestrian casualties were found to represent 59% and 41%, of the sampled data, respectively. Hence, the male to female pedestrian casualty ratio was 1.4:1, which is similar to those obtained from other road accident studies in Arab-Muslim countries which also recorded higher male casualty compared to female. Again, it is consistent with the fact that more men embark on pilgrimage than their female counterpart. The percentage of fatalities of pedestrians pilgrims' was 16.3%, while a vast majority (83.7%) of the pilgrims sustained serious injuries. In terms of road type, the highest casualties occurred on single carriageway-2 lanes and mostly on roads around the Holy. While for the junction, most of the accidents occurred not at junction or within 20 m of the junction. The results indicate that the majority of accidents appear to occur in proximity to junctions or close to T, Y or staggered junctions.

In terms of pilgrims' pedestrian casualty based on days, the highest fatality occurred on Fridays, which is a very important day of worship for Moslems. Whereas on Sundays has the lowest. The seasonality of accidents was obvious during the three months of Du Alhijn, Du Alqadeh and Rammadan. Again, these are important months in the Islamic calendar. Consequently, significantly greater numbers of Moslems embarked on pilgrimage during these periods. Almost three-quarter of the pedestrians pilgrim sustained their casualties during high season months.

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BIOGRAPHICAL NOTES

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