

# **TRAFFIC FATALITY CAUSES AND TRENDS IN MALAYSIA**

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## ***Abstract***

Relative to its population, Malaysia has one of the highest traffic fatality rates in the world. This paper analyzes Malaysian traffic accidents and fatality rate trends in an effort to (1) understand how private vehicle use patterns affect fatality rates, and (2) explore policy changes that might reduce the number of traffic fatalities in Malaysian cities.

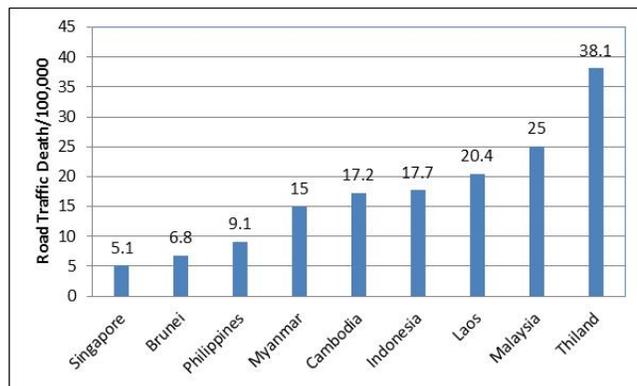
Private vehicles in Malaysia—i.e., passenger cars and motorcycles—represent more than 90 percent of all registered vehicles. Only 1.3 percent of accidents involve motorcycles—and yet, motorcyclists comprise a staggering 60 percent of all traffic fatalities. The trend for the rate of fatalities per 100,000 Malaysians shows almost a constant value over the study period. There is a decreasing trend, however, when considering the fatality rate per 100,000 registered vehicles. At the same time, the percentage of motorcycle fatalities increases over the study period. Although there are no specific months when traffic fatalities are significantly higher, almost 40 percent of traffic accidents occur during the late afternoon and early evening. This paper suggests short-term and long-term strategies that might reduce motorcycle fatalities in Malaysia, including the enforcement of traffic regulations.

## ***Introduction***

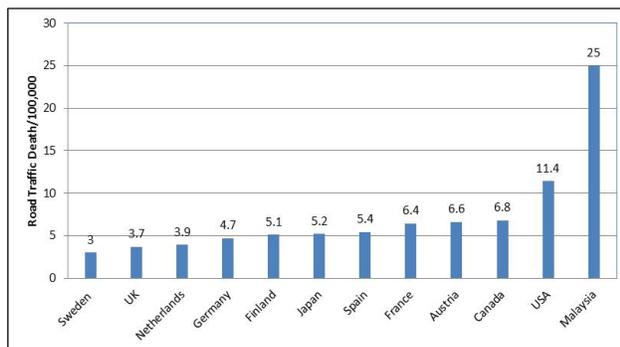
Sustainable transportation systems are vital elements of sustainable cities. One of the major factors that influences transportation system sustainability is traffic safety. Traffic accidents represent a major problem facing many countries around the world. In fact, traffic accidents have been reported as the ninth most common cause of death, according to the World Health Organization (WHO). The total number of annual traffic accident fatalities is estimated to be approximately 1.3 million [1]. In a later study, WHO estimated the number of fatalities to be approximately 1.24 million [2].

Many cities around the world are working to reduce the traffic fatality rate (i.e., the number of fatalities relative to the population or the

number of registered vehicles). However, WHO's data revealed that the estimated fatality rate in Malaysia is among the highest in the world in 2013. In addition, Malaysia has one of the highest traffic fatality rates in the region (Figure 1) [2]. The ninth and tenth Malaysian Plans [3, 4] indicated that Malaysia aspires to be a "developed country" by 2020. Figure 2 shows the fatality rate in Malaysia in comparison to selected developed countries, based on WHO data [2]. The data in Figures 1 and 2 confirm that Malaysia has a significant traffic problem based on the high fatality rate.



**Figure 1. Comparing the fatality rate in Malaysia to other countries in the region [2]**



**Figure 2. Comparing the fatality rate in Malaysia to other developed countries [2]**

At the risk of stating the obvious, this degree of traffic-related carnage engenders high costs far beyond the human toll. In 2009, for example, the Malaysian government spent RM 9.3 billion as a result of traffic accidents [5].

### ***Literature review***

The following literature review is divided into two main sections. The first provides a summary of studies that have investigated the rates and causes of traffic accidents/fatalities in various countries around the world. The second provides suggested interventions that might help reduce the traffic accident/fatality rate.

#### ***Traffic accident/fatality rates and causes***

Most traffic fatality rate studies consider the fatality rate in relation to the population or number of registered vehicles in the study area. Zhao [6, 7] studied road traffic accidents in China from 2000-2005. He concluded that the main factors related to traffic fatalities in China included the experience of the driver, the road classification, and the level of urban development surrounding the road. He further identified other factors linked to safety issues and significantly high fatality rates. These factors include drunk driving, poor road conditions, and expensive tolls (which lead to overloaded trucks). In addition, population growth in China is considered to be one of the main causes of the high traffic accident rate [8, 9]. In a more recent study, Zou and Sun [10] considered the characteristics of traffic accidents in some parts of China and found that the drivers' behavior was the most significant factor affecting traffic accidents. More specifically, they indicated that speeding and driving in the wrong lane caused the majority of traffic accidents.

The developed world shows some similar patterns. For example, driver behavior has also been listed as one of the major reasons for traffic accidents in Norway [11]. Age and gender were identified as significant factors influencing driver attitudes [11].

Melchor et al. [12] studied the trends of fatalities due to car accidents in Spain for the period from 1987 to 2011, focusing on the effect of gender and age on fatality rates. They noted that the fatality rate was reduced over the study period, with the highest reduction in the fatality rate occurring in the 15-34 age group (about 90 percent reduction). They noted further that the fatality rate among women was much lower than among men.

In Japan, Jiang and Zhang [13] investigated the effect of traffic congestion caused by accidents, and the provision of real-time traffic information on the drivers' behavior. The study was based on a stated preference survey that comprised 2,500 drivers. The results indicated that accident-clearance time had the largest influence on drivers behavior, and that information about accident clearance should be provided as an interval, rather than an exact time.

Bhagyaiah and Shrinagesh [14] analyzed traffic-accident data in India using Geographic Information Systems (GIS). They found that between 2001 and 2013, traffic (both motorcycles and cars) had increased more than 200 percent, without a concomitant increase in road capacity. They also demonstrated that GIS can help analyze traffic-accident data, and help determine the trends of traffic accidents on the road network.

Hisleius [15] concluded that the traffic vehicle mix (i.e., only light vehicles, or a combination of heavy and light vehicles) has a major effect on accident trends. Bener et al. [16] applied regression analyses to determine the relationships between accidents and the population or number of registered vehicles. The study developed models using traffic accident data from Jordan, the United Arab Emirates (UAE), and Qatar. Exponential models proved most effective at estimating the number of fatalities based on population or number of vehicles. Those models showed an acceptable average absolute error of 20.9 percent for Qatar, 10.9 percent for Jordan and 5.5 percent for the UAE. In addition, the authors concluded that the gross domestic income and the fatality rate showed a strong linear relationship. Abdelfatah et al. [17] examined the accident causes and trends in Dubai, UAE, where speeding is cited as the major reason for accidents.

In Iran, Mahdian et al. [18] analyzed one year of traffic-accident data within the Kashan region. The results there indicated that the fatality rate in Iran was very high (about 25 per 100,000 populations). Furthermore, men represented more than 80 percent of the fatalities. There was no significant difference between data for different seasons of the year.

Abdel-Aty et al. [19] examined the impact of driver age on traffic accidents in Florida, in the United States. The driver's age showed a significant correlation with average daily traffic figures, speed, severity of the accident, type of collision, road design, and involvement of alcohol.

A study in Malaysia indicated that more than half of the total traffic fatalities in Malaysia are motorcycle fatalities [20]. The study determined that the majority of the motorcycle fatalities (90 percent) occur during the evening and on weekends, and most of these motorcycles are privately owned. In addition, approximately 35 percent of the motorcycle drivers don't have an appropriate driver's license [20].

Oxely et al. [21] conducted a telephone survey with a sample of motorcyclists to identify the major factors that contribute to motorcycle accidents. The surveyed group included both motorcyclists who had been previously involved in traffic accidents and others who had not. According to the authors, the most significant factors contributing to motorcycle accidents were speeding and mobile phone use. Furthermore, the motorcyclists who were involved in accidents tended to be younger, riding

on higher-volume and/or higher-speed roads, traveling longer distances for work, and working longer shifts.

The first motorcycle safety performance function in Malaysia was developed by Abdul Manan et al. [22]. The two factors that exhibited the highest statistical significance were the number of motorcycles and the number of access points per kilometer of the road. The effect of the motorcyclist's behavior on traffic safety has been investigated by Abul Manan [23], who indicated that the most statistically significant factors affecting traffic safety were traffic volume and speed limits. Salehi et al. [24] evaluated the effect of traffic and road factors on the safety perception of motorcycle riders. They concluded that a higher traffic volume, narrower lane width, and higher speed limit all resulted in a decreased perception of traffic safety.

### *Interventions*

Several studies have recommended interventions to improve traffic safety on road networks. This section provides some examples of such recommendations.

In China, Zhao [6, 7] suggested allocating more funds for the development of the transportation infrastructure. He also indicated that such development will have a significant impact on both traffic safety and the national Gross Domestic Product (GDP). Knapp [25] suggested the use of traffic-calming measures as a tool to reduce traffic accidents. Three types of speed control measure categories were considered, including speed humps (vertical control), forcing drivers to change their direction (horizontal control), and reducing the space available for vehicles via extending the curbs (narrowing).

In an effort to facilitate accident analyses in Malaysia, Liang et al. [26] developed a Geographic Information System (GIS) method for analyzing traffic accident data. Also, Bhagyaiah and Shrinagesh [14] suggested the use of GIS and considered a case study in India. Schelin [27] advocated for the use of Intelligent Transportation Systems (ITS) to improve traffic safety in Malaysia. That study concluded that while the Malaysian government supports improving traffic safety, private-public partnerships appear to be one of the most significant contributors to the success of such initiatives. Furthermore, Mat et al. [28] considered the promotion of a sustainable transportation system based on non-motorized transportation. They proposed strategies to increase the mode-share for non-motorized trips through the simultaneous consideration of land use and transportation planning, although they did not consider the safety impacts of such strategies. Finally, Abdelfatah et al. [17] concluded that tougher penalties and more strict traffic regulations could significantly reduce the number of traffic accidents.

The majority of the previous Malaysian traffic studies focused on accidents or fatalities caused by motorcycles. Few studies, however, have investigated the trends, causes, and characteristics of fatalities, which are the focuses of this study.

### ***Methodology***

This section provides an overview of the available data and the methods used in this study.

#### ***Available data***

The data used in this study includes:

1. Census data from 1980, 1991, 2000 and 2010 [29].
2. GDP, at constant price, from 2000 to 2011 [30].
3. Classified vehicle registration information from 2003 to 2012 [31].
4. The available Malaysian road network length from 2003 to 2012 [31]. The road network length figures comprise all types of roads.
5. The available railroad network length from 2006 to 2013 [32, 33].
6. The number of rail network trips from 2003 to 2011 [34].
7. Traffic accident data from 2008 to 2013 [35, 40]. Each report includes detailed data for one of the years from 2008 to 2013. In addition, each report includes a traffic fatality summary for previous years. Accordingly, the analyses will consider the fatalities over a 10-year period (from 2004 to 2013). It should be noted that the accident reports include the total number of accidents and fatalities on all road classifications in Malaysia.

Unfortunately, the available data does not include additional factors that could have improved this study. For example, the traffic-accident data does not provide details regarding the exact location of the accident, the weather conditions, and the speed at which the accident happened. In addition, as will be illustrated in this paper, reported accident causes tend to be inaccurate,.

#### ***Procedures***

Abdelfatah et al. [41] evaluated the sustainability of traffic growth in Malaysia using all of the data described in Section 3.1 except for the traffic accident reports. Their analysis showed that private transportation (passenger cars and motorcycles) account for more than 90 percent of the total registered vehicles in Malaysia. They also concluded that the private

transportation registration rate (private vehicles and motorcycles) is rapidly increasing. The results showed that for each person increase in the population, almost one car and one motorcycle are added to the road network. For each 1,000 people added to the population, however, there are fewer than four buses added to the network, including both private and public buses. The study also determined that road infrastructure development is occurring at a much higher rate than public transportation development.

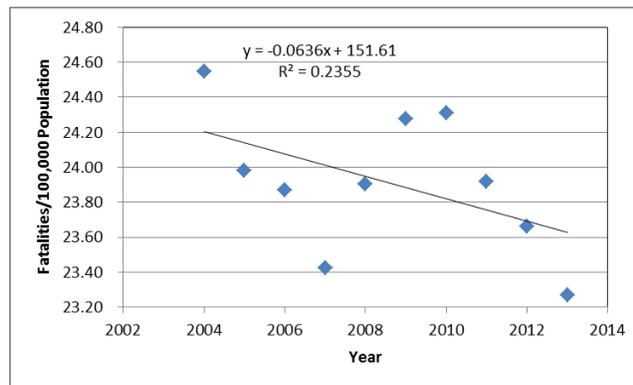
This paper considers traffic fatalities in Malaysia using the following metrics:

1. The fatalities per 100,000 people over time.
2. The fatalities per 100,000 registered vehicles over time.
3. The percentage of fatalities for each month of the year, and the percentage of accidents during each hour of the day.
4. The percentage of each vehicle type involved in accidents, and the percentage of fatalities for different vehicle types.
5. The motorcycle fatality rate compared to all other vehicles.
6. The number of traffic tickets issued to drivers, and the number of fines collected by the police.
7. The major causes of accidents in Malaysia.
8. The characteristics of accidents and resulting fatalities in Malaysia (type of injury and the ages of those involved).

In most cases, regression analyses are applied to determine the best fit to the data.

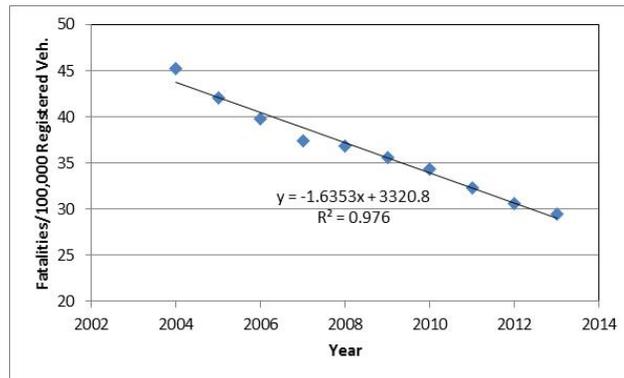
### ***Results and discussion***

In this section, the metrics listed above are examined and discussed. Figure 3 illustrates the number of fatalities per 100,000 people and its associated regression line. The coefficient of determination ( $R^2$ ) is very small (0.24), which indicates a weak correlation between the year and fatality rate. It should be noted that the range of the fatality rate per 100,000 people is very small, spanning from approximately 23.2 to 24.6 over a period of ten years.



**Figure 3. Fatalities/100,000 people in Malaysia**

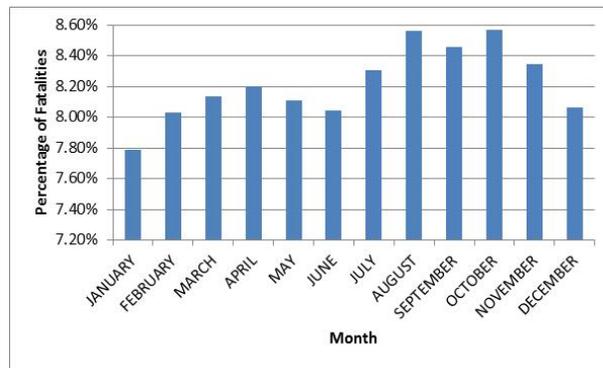
The trend line in Figure 4 shows a significant reduction in the fatality rate over the study period, decreasing from approximately 45 to 29 (i.e., a 35 percent reduction).



**Figure 4. Fatalities/100,000 registered vehicles in Malaysia**

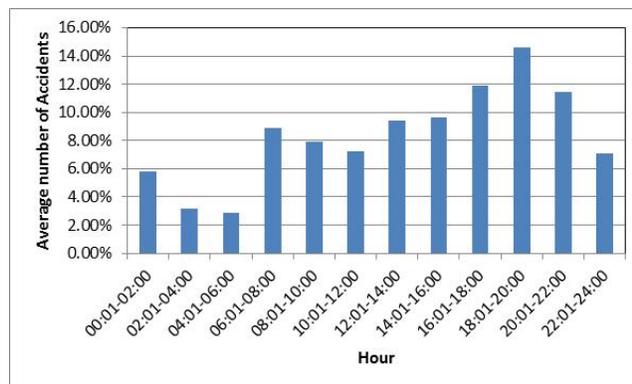
The results in Figures 3 and 4 can be attributed to the fact that the population growth rate is significantly smaller than the number of registered vehicles growth rate.

The percentage of fatalities by month ranges from approximately 7.78 to 8.57 throughout the year, (Figure 5). Note that the data presented in Figure 5 shows the average for each month based on a 10-year record (from 2004 to 2013), and it has been normalized to account for the number of days in each month. These results suggest that there is no specific month during which the accident rate is significantly larger.



**Figure 5. Percentage of fatalities by month**

More than one-third (approximately 38 percent) of the daytime accidents occur between 4 and 10 p.m., with the highest percentage (14 percent) occurring between 6 and 8 p.m. (Figure 6).



**Figure 6. Percentage of fatalities by hour of the day**

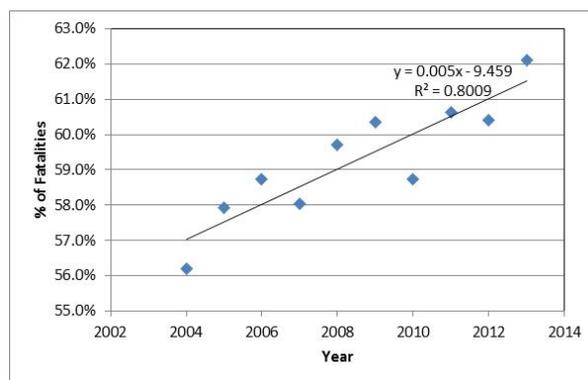
The percentage of each type of vehicle involved in accidents is summarized in Table 1. These percentages did not display specific trends over the study period. Therefore, the average percentages over the 10-year period have been provided in Table 1.

Year	% of Registered Vehicels Involved in Accidents				
	PRIVATE VEHICLES	PRIVATE MOTORCYCLES	LORRIES/ VANS	BUSES	TAXIS
2004	6.44%	1.51%	8.42%	22.12%	10.94%
2005	5.85%	1.39%	7.62%	15.06%	10.49%
2006	5.93%	1.40%	7.80%	16.19%	11.01%
2007	5.77%	1.41%	7.92%	16.52%	12.12%
2008	5.01%	1.22%	4.91%	29.57%	8.90%
2009	5.58%	1.28%	7.06%	14.17%	11.00%
2010	5.68%	1.28%	7.20%	13.95%	11.83%
2011	5.65%	1.30%	7.14%	13.94%	12.47%
2012	6.37%	1.23%	6.84%	14.49%	12.58%
2013	6.11%	1.11%	6.48%	16.28%	11.83%
Average=	5.84%	1.31%	7.14%	17.23%	11.32%

**Table 1. Percentage of each vehicle type involved in accidents**

Table 1 shows that buses have the highest accident-involvement rate (17 percent), followed by taxis (11 percent), lorries (7 percent) and passenger cars (6 percent), while motorcycles represent the smallest percentage (less than 1.5 percent). The high percentage of taxis involved in accidents can be attributed to the nature of the operation of this type of vehicle. Taxis possess higher Vehicle Kilometers Travelled (VKTs) than passenger cars and motorcycles, which increases their chances of a traffic accident. In addition, the lack of driver training may be an important factor. The high bus accident rate can be attributed to the VKT and driver skills. The very small percentage for motorcycles is expected, as the motorcycle VKT is typically much lower than for other vehicles. The lower percentage of private vehicles and lorries involved in accidents indicates that these drivers are reasonably skilled.

The fatality percentage among motorcyclists ranges from approximately 56 to 62 percent (Figure 7), which is significantly high in relation to the percentage of motorcycles involved in accidents (1.3 percent).



**Figure 7. Percentage of motorcyclist fatalities**

Furthermore, this trend has increased over time, with a very strong correlation ( $R^2=0.80$ ). This fatality percentage and its associated trend line are alarming. Recommendations should address strategies to reduce motorcycle accidents. This situation was further investigated by analyzing the fatality rate per 100,000 motorcycles and the fatality rate per 100,000 other vehicles, as shown in Figure 8.

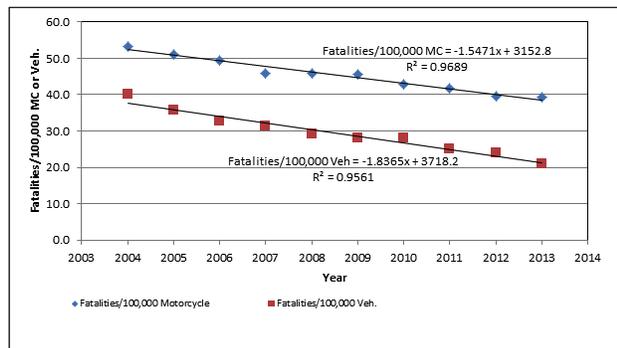


Figure 8. Fatality rates for motorcycles and other vehicles

Both the motorcycle and other vehicle fatality rates showed a very strong correlation with a decreasing trend. The fatality rate per 100,000 motorcycles, however, ranges from 53 in 2004 to 39 in 2013. The fatality rate of other vehicles ranged from 40 in 2004 to 21 in 2013. The motorcycle fatality rate is approximately 1.3 to 1.8 times larger than the rate for other vehicles. This result confirms the need for short-term and long-term motorcycle fatality reduction strategies.

Traffic enforcement is one of the major factors that can improve traffic safety, as indicated by Abdelfatah et al. [17]. Therefore, evaluating the level of enforcement in Malaysia is crucial to the conclusions of this research. Table 2 presents a summary of the number of traffic summonses and summonses compounded by the police, as well as the total summons percentages issued for the study period. Note that the number of traffic summonses was not reported for 2007 and 2008.

Year	Number of traffic summonses issued	Number of traffic summonses compounded by police	Percentage of traffic summonses compounded
2004	5,387,038	2,427,092	45.1%
2005	5,170,406	3,786,952	73.2%
2006	4,779,668	2,620,698	54.8%
2007	4,336,184	-*	N.A.

2008	4,028,710	-*	N.A.
2009	4,443,053	1,651,211	37.2%
2010	4,949,529	2,150,127	43.4%
2011	4,969,870	1,764,553	35.5%
2012	6,311,311	2,047,314	32.4%
2013	5,079,614	1,653,065	32.5%

\* No available data (not included in the Road Accident Statistics Report)

**Table 2. Summary of traffic summonses**

As illustrated in Table 2, the percentage of summonses compounded by police is very small, especially during recent years (from 2009 to 2013). The average percentage of traffic summonses compounded by the police over the study period ranges from approximately 44 percent to 36 percent. This lack of enforcement encourages more drivers to violate traffic rules and regulations. For example, motorcyclists may ride between traffic lanes, stop in pedestrian crossing areas, drive on the sidewalk, or run a red light at intersections.

This research also considers the main causes of accidents, as reported by the Royal Police in Malaysia. The traffic accident reports provide data on 15 causes, as shown in Table 3.

<b>Code</b>	<b>Accident Cause</b>
1	Careless at exit/entrance
2	Negligent signaling
3	Overloading (goods)
4	Overloading (passengers)
5	Inappropriate parking
6	Drugs
7	Careless driving
8	Dangerous driving
9	Dangerous turning
10	Dangerous overtaking
11	Driving too close
12	Speeding
13	Not conforming to T/light
14	Other offenses
15	Not at fault

**Table 3. Summary of accident causes**

Based on the number of accidents for each cause of accidents during each year (from 2008 to 2013), the percentage of each cause has been calculated and presented in Table 4.

Surprisingly, the official traffic reports show that the highest cause of accidents is cause number 15—“not at fault”—which exhibits a percentage of approximately 60 percent to 80 percent. Most of the percentages linked to other causes are less than 8 percent. The high percentage linked to “not at fault” indicates that the persons investigating the accidents lack experience preparing accident reports. Using such data may not be useful in this study. Thus, a second analysis was conducted that excluded case 15, and recalculated the percentage of each cause based on the number of accidents for each remaining case), as shown in Table 5.

The most commonly reported causes of accidents in Malaysia are ‘Dangerous Turning’ (28.8 percent), ‘Speeding’ (16.1 percent) and ‘Other offenses’ (15.8 percent). All other causes display percentages that are less than 10 percent. However, these results may be insignificant due to the data weaknesses mentioned previously.

Year	% for each Cause of Accident														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2008	0.2%	0.2%	0.3%	0.5%	0.4%	0.0%	1.4%	0.4%	7.6%	2.4%	2.2%	4.3%	1.5%	4.7%	73.9%
2009	0.4%	0.0%	0.0%	1.1%	0.3%	0.0%	2.1%	0.6%	12.3%	3.9%	3.6%	5.4%	4.0%	5.7%	60.8%
2010	0.2%	0.3%	0.0%	0.7%	0.3%	0.0%	1.4%	0.4%	7.6%	2.3%	2.1%	4.0%	1.7%	4.8%	74.5%
2011	0.2%	0.3%	0.0%	0.7%	0.3%	0.0%	1.5%	0.4%	7.5%	2.2%	2.0%	4.4%	1.7%	4.8%	74.1%
2012	0.3%	0.3%	0.0%	0.6%	0.2%	0.0%	1.8%	0.4%	7.5%	2.4%	1.9%	4.5%	0.4%	1.9%	77.9%
2013	1.0%	1.1%	0.1%	0.7%	0.7%	0.0%	2.4%	1.0%	5.1%	2.1%	1.7%	3.5%	1.8%	4.2%	74.5%

**Table 4. Percentage for each cause of accident**

Year	% for each Cause of Accident													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
2008	0.9%	0.8%	1.2%	1.7%	1.7%	0.1%	5.3%	1.6%	29.2%	9.1%	8.3%	16.3%	5.7%	18.1%
2009	0.9%	0.0%	0.0%	2.7%	0.9%	0.1%	5.4%	1.5%	31.2%	9.9%	9.1%	13.6%	10.1%	14.5%
2010	0.7%	1.1%	0.0%	2.7%	1.1%	0.1%	5.3%	1.4%	29.6%	8.9%	8.1%	15.6%	6.5%	18.9%
2011	0.7%	1.2%	0.0%	2.6%	1.0%	0.1%	5.8%	1.4%	29.0%	8.7%	7.7%	16.9%	6.5%	18.4%
2012	1.2%	1.3%	0.0%	2.9%	1.0%	0.1%	8.0%	2.0%	33.7%	10.6%	8.5%	20.1%	1.9%	8.6%
2013	4.0%	4.4%	0.6%	2.9%	2.6%	0.2%	9.3%	3.8%	20.2%	8.0%	6.6%	13.9%	7.0%	16.6%
Average	1.4%	1.5%	0.3%	2.6%	1.4%	0.1%	6.5%	1.9%	28.8%	9.2%	8.0%	16.1%	6.3%	15.8%

**Table 5. Percentage for each cause of accident (without cause 15)**

At least half of all fatalities (approximately 54 percent) were a result of head injuries, which are especially common among motorcyclists. Some motorcyclists were interviewed for this study and they indicated that they

do not wear safety helmets at all times. Clearly, an expanded use of safety helmets would reduce the number of motorcycle accident-related head injuries.

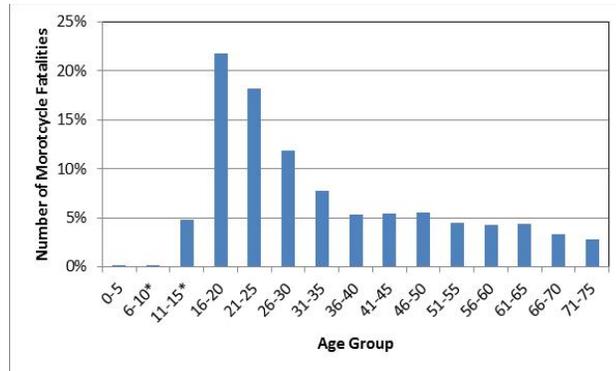


Figure 9. Fatalities by age per 100,000 people in Malaysia

Finally, the percentage of motorcycle fatalities versus age is presented in Figure 9. The data shows that the highest percentage of fatalities (22 percent) occurs within the 16-20 age group, followed by 18 percent within the 21-25 age group, and 12 percent within the 26-30 age group. Collectively, the majority of fatalities (52 percent) occur among the 16-30 age group. This result may impact the Malaysian workforce and negatively impact the country's development. In addition, these results suggest that motorcycle fatalities are often due to driver inexperience.

### Conclusions

The following is a list of conclusions based on the analyses conducted in this paper:

1. Although the fatality rate per 100,000 people is not significantly decreasing, the rate of fatalities per 100,000 registered vehicles does display a reasonable decrease. In addition, the fatality rate based on the number of registered vehicles exhibits a much better correlation than the fatality rates based on the population.
2. No significant accident percentage difference exists between months. However, more than one third of the daily accidents (38 percent) occur during the late afternoon and evening (from 4:00-10:00 pm).
3. The percentage of motorcycles involved in traffic accidents is only about 1.3 percent. However, the percentage of motorcycle fatalities ranges from 56 percent to 62 percent. Furthermore, this trend has increased during the study period. It is clear that the majority of fatalities on Malaysian roads are linked to

motorcyclists. Accordingly, there is a need for strategies to reduce the use and improve the safety of motorcycles.

4. The motorcycle fatality rate is about 1.3 to 1.8 times the rate of other vehicles.
5. Traffic rules and regulations are not regularly enforced in Malaysia, as the percentage of summonses compounded by the police from 2009-2013 was only 35 percent.
6. Dangerous turning and speeding are the most common causes of accidents.
7. Head injuries (at 54 percent) are the most common type of injury linked to traffic fatalities. The traffic-accident reports do not provide accurate data regarding the causes of accidents, as the cause “not at fault” is reported for between 60 percent and 80 percent of all accidents.
8. The majority of the motorcyclist fatalities (52 percent) occurred within the 16-30 age group.

### ***Implications for policy and practice***

Based on the conclusions of this research, a significant percentage of fatalities are linked to motorcyclists. Accordingly, this paper presents a number of short-term and long-term strategies that can reduce the number of motorcycle fatalities.

#### ***Short-term strategies***

1. Enforce stricter licensing procedures for motorcycles. For example, increase the motorcycle driving license age, cancel production and stop the use of old motorcycle models, and increase registration fees.
2. Implement higher levels of enforcement through the use of technology—for example, using automated systems at traffic signals and for speed control. Such systems can reduce the number of traffic violations shown in the video.
3. Impose tougher penalties on traffic violations, especially for motorcycles. In addition, enforce fine collection procedures.
4. Use campaigns to improve awareness and educate motorcyclists about traffic and safety regulations. A focus should be placed on the 16-20 age group, which comprises high school and university students.
5. Improve the traffic-accident reporting procedures so that more informative accident statistics are available.

#### ***Long-term strategies***

The following are some possible long-term strategies that focus on the increased use of public transportation, which may attract some motorcyclists. Thus, a reduction in motorcycle use can be achieved, leading to a lower fatality rate among motorcyclists in Malaysia.

1. Provide safe, affordable, and reliable public transportation systems. Urban areas should prioritize safe, affordable, and efficient public transportation to provide a sustainable and feasible alternative to private vehicle ownership. Improving the skills of bus drivers will increase the level of safety for buses, and contribute to a better perception of the public bus system.
2. Use Intelligent Transportation Systems (ITS) applications, such as those related to transit signal priorities. This will help to improve the performance of the public transport system, which will encourage more road users to shift from motorcycles and passenger vehicles to public transport.
3. Develop urban planning interventions that consider transit-oriented development. Such strategies encourage the use of public transportation and reduce the use of private transportation.

### ***Acknowledgments***

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