Correlation Analysis of Global Distribution of Road Deaths

Abstract

This study sought to find out a causal relationship between total lengths of road networks and the number of registered vehicles with the number of road deaths worldwide. The data mined from the World Health Organization and the CIA fact book were analyzed using the descriptive correlation method. It was found out that the total number of registered vehicles has a direct correlation with the number of road traffic deaths, while the total length of road networks has only an indirect correlation. These results supported the postulate of the Multiple Causation theory of accidents. It is recommended that reducing the number of vehicles on the road is key to the reduction of road traffic deaths.

Keywords: global distribution of road deaths, total length of road networks, number of registered vehicles

1.0 Introduction

This study sought to find out a direct association between total lengths of road networks and the number of registered vehicles with the number of road traffic deaths worldwide. In recent years, road traffic accidents had become one of the leading causes of injuries and deaths worldwide. According to Moroz and Spiegel (2014), road traffic crash-related death, injury, and chronic disability continue to be a major worldwide burden to drivers, pedestrians, and users of mass transit, especially in low- and middle-income countries. Furthermore, the global fraction of global death due to injuries have been observed to be increasing in recent decades caused by traffic accidents (Lozano, Naghavi, Foreman, Lim, Shibuya, Aboyans, and Cross, 2013).

Studies on the factors associated with road traffic accidents indicated excess speed and non-compliance with traffic rules (Ansari, Akhdar, Mandoorah, and Moutaery, 2000; Singh, Bhardwaj, Pathak, and Ahluwalia, 2012; Burgut, Bener, Sidahmed, Albuz, Sanya, and Khan, 2010), personal problems, weather conditions, time of day, and vehicle condition (Mishra, Sinha, Sukhla, & Sinha, 2010; Leles, Santos, Jorge, Silva, and Leles, 2010), substance use and/ or abuse (Orriols, Philip, Moore, Castot, Gadegbeku, Delorme, and Lagarde, 2011; Mondal, Kumar, Bhangale, and Tyagi, 2011; Ravera, van Rein, De Gier, and de Jong- van den Berg, 2011; and Orriols,
Delorme, Gadegbeku, Tricotel, Contrand, Laumon, and CESIR research group, 2010) as the main factors.

Other studies on traffic accidents were focused on specific factors, which include specific countries (Mohan, 2009; and Mondal, Kumar, Bhangale, & Tyagi, 2011); prediction for insurance purposes (Jilani, Burney, & Ardil, 2007); on road safety (Elvik, Christensen, & Amundsen, 2004), behavioral factors (Farchi, Molino, Rossi, Borgia, Krzyzanowski, Dalbokova, & Kim, 2006; Petridou, & Moustaki, 2000; Elvik, 2006; and Thiffault, & Bergeron, 2003; Taylor, & Dorn, 2006), strategies to reduce accidents (World Health Organization, 2007) fatalities (Sánchez-Mangas, García-Ferrrer, De Juan, and Arroyo, 2010), road safety design (Zuriaga, García, Torregrosa, and D'Attoma, 2010; and Karlaftis, and Golias, 2002); and traffic congestion and road accidents (Wang, Quddus, and Ison, 2009).

No study yet has established a causal relationship between the number of deaths from traffic accidents with the total length of road network and the number of registered vehicles. This study attempted to fill in this gap by establishing a causal relationship between the identified variables through correlation.

2.0 Methodology

This study used the descriptive-correlation method to determine if road length and the number of registered vehicles directly correlate with the global distribution of road deaths. The data on the global distribution of road deaths and the number of registered vehicles mined from the World Health Organization data repository and the estimated length of the road network by country mined from the CIA Fact book were statistically treated through linear regressions to determine correlations. To obtain a maximum measure of comparison between the three variables, the data from 2010, which was available from the two sources was obtained.

3.0 Theoretical and Conceptual Framework

Multiple causation theory postulates that for a single accident, there may be many contributory factors, causes and sub-causes, and that a certain combination of these gives rise to accidents. The global distribution of road deaths, according to this theory, can therefore be caused by several factors acting independently or in connection with each other, and that the total road
lengths and the number of registered vehicles are two of the many contributory factors of road traffic accidents resulting in fatalities.

Figure 1. Theoretical/Conceptual framework.

4.0 Results and Discussions

To be able to have a clear picture of the relationship between the number of road traffic deaths with the total length of road network and the number of registered vehicles, the data of these variables were shown and analyzed.

Table 1 showed the data on the number of road traffic deaths by country. It shows that the top ten countries with the highest number of road deaths include China, India, Nigeria, Brazil, Indonesia, United States of America, Pakistan, Russia, Thailand and Iran. On the opposing end of the distribution, the bottom ten countries with the least number of road traffic deaths include Maldives, Tonga, St. Vincent and the Grenadines, Marshall Islands, Andorra, Palau, Cook Islands, Micronesia, Niue, and San Marino all of which are islands or island states. Initial analysis of the data showed that large countries tended to have the most number of deaths from road traffic, while small states like the island states tended to have the least number of deaths from road traffic.

Large countries like China tends to have more road networks and as the result also have more vehicles running on those networks. In contrast, small countries have less road networks and thus will have less number of vehicles running on road networks. These observations were supported by the study of Warren and Enoch (2010) in Mauritius, Cuba, Malta, and Singapore, which found out that Island populations tend to be concentrated in a limited number of centers and that the transport system networks are also heavily focused on the capital cities thereby limiting the overall number of road networks and number of vehicles. The observations suggested that more road traffic deaths were expected to occur in large countries because they have longer road networks and more vehicles running compared to small countries. In addition, when roads are long there
is less crowding of vehicles, thus they tend to run faster compounding the risk of accidents.

Table 2 revealed the total length of road networks by country. It can be gleaned from the table that the United States of America, India, China, Brazil, Russia, Japan, Canada, France, Australia, and South Africa were the top ten countries in terms of the total length.

Table 2. Data on the number of road traffic deaths by country.
(Source: WHD Global Health Observatory Data Repository)

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of road networks. On the other hand, islands and/or island states like Niue, St. Pierre, Maldives, Norfolk Island, Monaco, Sint Maarten, Nauru, Gibraltar, Cocos islands, and Tuvalu belonged to the bottom ten in terms of the total length of road networks. The data were consistent with the assumption that large countries will have more road networks compared to small countries or states. Governments will always want to find ways to spread development across their territories. Spreading development across the country means connecting trade and government centers through communication and transportation. Large countries tend to have numerous trade and government centers found in different parts of their territories, hence they tend to build more road networks.

Table 3 was also consistent with the initial assumptions that large countries will also have a number of vehicles on the road compared to smaller countries or island countries. As can be seen in table 3, the top ten countries in terms of the number of registered vehicles included the United States of America, China, India, Indonesia, Brazil, Italy, Germany, Russia, and United Kingdom, with the exception of Japan which is a small country but still belongs to the top ten. Meanwhile, small and island countries like Equitorial Guinea, Micronesia, Tonga, Palau, Vanuatu, Marshall Islands, Kiribati, Sao Tome and Principe, and Niue with the exception of Central African Republic, have the least number of registered vehicles on the road.

Large countries with more road networks to connect different trade and government centers across their territory will also have more communication and transportation traffic compared to smaller countries. It means that there are more vehicles when there are more road networks, hence large countries have more vehicles.

To determine the causal relationship between the global distribution of road deaths, roadways and number of registered vehicles, a path analysis was conducted. Figure 2 below showed the result of the path analysis. Using multiple linear regressions, only the total number of registered vehicles has a significant correlation with the total number of road deaths, with a coefficient of 0.938. It means that an additional unit of vehicles registered will result to 0.938 units of death due to traffic accidents. When the number of vehicles travelling on the road increase, the propensity of accidents will also increase. The study of
Table 2. Data on the total length of road network

Source: WFD Global Health Observatory Data Repository
Singh and Suman (2012) supported this when they found out that the number of accidents that occurred in a road section per km per year increases with increase in traffic volume.

The total length of the road network has no significant direct correlation to the number of road traffic deaths, but it affected the number of deaths indirectly through the number of registered vehicles, with a coefficient of 0.981. It means that for every one unit of road built, results in a 0.981 unit increase of the number of registered vehicles. This
will indirectly result in road traffic death because more roads built mean more vehicles travelling. But the length of roads alone cannot directly increase the likelihood of traffic accidents without the increase of the number of vehicles travelling. The study of O’Cinneide, Murphy, and Ryan (2004) supported this finding when they found out that higher values of vehicle kilometers of travel on a given road section appear to increase the likelihood of accidents occurring in the section.

The effects on the total number of road traffic deaths are summarized as follows: 0.938 (direct effect from the total number of registered vehicles) + 0.920 (indirect effect of total length of road networks via the total number registered vehicles computed as 0.981 x 0.938) = 1.858. This means that 1.858 unit increases in the number of road traffic deaths are caused by the total number of registered vehicles (direct) and the total length of the road network (indirectly). The larger unit of increase in the number of road traffic accidents when road length and number of registered vehicles are combined is due to the combined effects of speed and volume of traffic. In addition to the number of vehicles travelling on the road, more speed will be observed when road length is increased.

In addition to the effects of the number of registered vehicles, there is a 0.28 of road deaths caused by other factors not covered in this study. Aside from the length of roads and the number of registered vehicles, there are also other factors which caused traffic accidents mentioned earlier, ranging from excess speed and non-compliance with traffic rules, personal problems.

Figure 2. Results of the multiple regressions
weather conditions, time of day, and vehicle condition, and substance use and/or abuse.

5.0 Conclusion

The study supported the postulate of the Multiple Causation theory of accidents. The number of road traffic deaths was caused directly by the total number of registered vehicles, indirectly by the total length of road networks, and other factors. In addition, a large portion of the total number of road deaths was caused by the total number of registered vehicles (0.938) but only a small portion from other factors (0.028).

To reduce the number of deaths from road traffic accidents, countries must focus their attention on the ownership of vehicles. There must be a control on the number of vehicles registered, or else technology must come up with solutions so as to reduce the number of deaths from accidents.

6.0 References cited


Mishra, B., Sinha, N. D., Sukhla, S. K., & Sinha, A. K. (2010). Epidemiological study of road traffic accident cases from Western
Nepal. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine*, 35(1), 115.


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