Each year, an estimated 1.3 million people die in car accidents around the world, and 20 to 50 million more sustain injuries. In this project, we explore factors that affect road transportation safety. We examine correlations between road casualties and four contributing factors: speed limit laws, vehicle safety standards, transportation infrastructure spending, and road congestion. We create data products exploring the relationships between each of these variables and death statistics. The first data product is a set of maps comparing death rates with maximum speed limits per country. A second set of maps depicts relationships between road deaths and vehicle safety standards. A third set of maps compares death rates with adherence road infrastructure investment spending. A fourth set of maps examines rates of road congestion as a possible cause road injuries. All four sets of maps provide insights in understanding the factors that contribute to road deaths.

1

As the world advances more in a technological aspect, cars have gained multiple features to make them safer to drive. However, this still does not completely mitigate the fact that the roads are still dangerous due to multiple other circumstances. It is important for drivers to understand the factors that could cause these fatal car crashes in order to possibly avoid them in the future. We will investigate the possible cause of road accidents by drawing from multiple different data sets. This project hopes to illuminate some of the factors that may hint in the right direction of more road safety around the world. Nevertheless, the data that we are looking at includes more correlations than true fact. Each and every one of these data sets can be seen as a cause of the accidents but with just removing or increasing the one factor will not completely erase the risk and associated death toll. It may improve road safety, but we can see some of the preventable causes of these fatal accidents.

2

Data used in this project correspond to four factors related to road vehicle travel: maximum speed limits, vehicle safety standards, road infrastructure investment, and road congestion. The research team weighed the inclusion of several other factors, such as rates of vehicle ownership, costs of driver registration, seatbelt laws, blood-alcohol content laws, and emergency response times. The four selected factors were chosen as the most appropriate representatives respective to four general aspects of vehicle travel that could impact death rates: driver behavior, vehicle design, road quality, and traffic environment. Road deaths are used in favor of road injury accidents based on the assumption that death data is more consistent due to underreporting of other types of injuries.

2.1

Data for road deaths and two of the variables–speed limits and vehicle safety standards–come from a study published by the World Health Organization (WHO) [1]. The study included data from 2013 and includes nearly every country in the world. Data for the other two variables–road infrastructure investment per capita and passenger-kilometers traveled–come from the International Transportation Forum (ITF) of the Organization for Economic Co-operation and Development [2]. The ITF data cover 59 countries in Europe, North America, Asia, and Oceania. The ITF has annual statistics from recent decades. For this study, figures from 2013 were chosen for compatibility to the WHO data. Finally, the ITF statistics for passenger-kilometers traveled were used in tandem with the CIA World Factbook’s figures on total kilometers of road per country [3]. The ratio of passenger-km per km of road provides a reasonable method for estimating the density of road travelers.

All data is available on the websites of the WHO, the ITF, or the CIA. The WHO and ITF data are exportable in CSV format. This data is read into R and columns representing the relevant variables selected with minimal manipulation. The WHO speed limit data list values for urban and rural speed limits. This study utilizes the rural values, which were invariably equal to or greater than the urban values. The WHO vehicle safety data has columns for seven distinct vehicle safety regulations, with each row (country) listed as a “yes” or a “no” for each regulation. After replacing “yes” and “no” with the Boolean values 1 and 0, this data frame was aggregated so that a value between 0 and 7 was associated with each country to represent the number of vehicle safety standards in place. For the ITF data, values for all years other than 2013 were removed.

The CIA data is downloadable in TXT format and requires additional cleaning to arrange appropriate columns representing “country” and “km of road.” As described in Section 2, the km of road values were combined with passenger-km figures from the ITF to create a measure of traffic congestion. After modifying the format of country names to ensure that strings matched as appropriately, data frames representing annual road deaths, maximum speed limits, aggregated safety standards, infrastructure investment, and congestion were merged to create a Road Mortality Factors data frame for use in analysis.

3

The merged Road Mortality Factors data frame allows for easy analysis and visual representation of the variables. The data products for the project are (1) scatter plots (2) world maps, and (3) an interactive app. The following subsections provide an overview of these products, which are presented in full in Section 4.

3.1

Geographic information plays a crucial role in this project. Each country differs in the discrete aspects of road safety that we are analyzing. For instance, the amount of vehicle safety regulations and the amount of people on the road varies from country to country. Analyzing this information from the country level allows more insight to what could be causing these accidents and what rules we may be able to apply from other countries to make our roads at home safer. Through the use of color scales, maps allow for a visual representation of which country has the most fatal accidents and which factor might lend into the number.

3.2

For each of the studied variables, a scatter plot illustrates the relationship between the variable and rates of road mortalities. Each data point represents a country. A line of best fit is applied to each plot using a linear model method in the R package ‘ggplot2’.

3.3

An interactive application created using the R package ‘shiny’ allows the user to cycle through maps of the variables and compare them with maps of death rates for a visual understanding of the relationships. Along with these maps, each sheet includes a plot of the forty countries with the highest values of the subject variable.

4.1

There is reason to believe that a higher maximum speed limit in a country would create more fatal accidents, however, this is not quite the case. Countries all around the world have differing speed limits ranging from approximately 50 to 130 kilometers per hour, with the United States at 121 kilometers per hour. The data suggests that there is a slight correlation between the two factors by advocating that a higher speed limit leads to a higher death rate. However, the mortality data is far more spread out suggesting a weaker effect on the road deaths that occur. Countries like Australia and the United States suggest that speed limit does not cause high death rates but Brazil and many countries in Africa show a much stronger correlation between the maximum speed and death.

4.2

The seven different standards included in the WHO data are seatbelt laws, seatbelt anchorages, frontal impact, side impact, electronic stability control, pedestrian protection, and child seats. Each of these measures are designed to minimize the severity of injuries incurred by passengers and bystanders during accidents. Different countries have adopted these standard measures to differing degrees. Many countries in Europe and North America have adopted all seven; many in Africa and the Middle East have adopted none of them. The data suggests that the number of safety standards adopted has a strong effect on road mortality rates. The more safety standards a country has adopted, the fewer are the road deaths that occur. The trend is most clearly seen in Africa, where many countries have not adopted any safety standards and where rates of road deaths are high. The case of Egypt offers a stark comparison. Egypt is the only country in Africa to have adopted all seven safety standards, and its road mortality rate is conspicuously lower than that of surrounding countries.

4.3

The more money spent on the roads, the higher the expectation that the roads are safe for travelers. In theory, spending reduces the number of imperfections in the roads, thereby reducing the external factors that could cause accidents to even the most cautious of drivers. The data suggests that higher amounts of road spending does in fact decrease road mortality rates. The relationship is best demonstrated in Norway, Canada, and Australia, three countries with high amounts of road infrastructure investment and low rates of road deaths.

4.4

As more people and cars are on the road, it is to be expected that there would also be a higher chance of a road fatality due to the congestion of the roads. However, the data suggests that the congestion of the country has little to no effect on the road death rates. India and Greenland, for instance, have a higher congestion but a low vehicle mortality rate. Other countries, like the United States, are low in both aspects. The data is fairly spread out on the lower end of the congestion spectrum. This data being so sparse could also contribute to the statistical insignificance of this particular factor.

Conclusion

There are two factors that are more likely to attribute of the cause, and therefore the prevention of, fatal road accidents. These two factors are the safety standards implemented and the amount of money spent on maintaining and fixing the roads. The information included in this report can help governments apply a standard to help regulate drivers and lower the amount of deaths in their country. This can also apply to the people themselves by helping them understand what they would need to do in order to create a better environment to drive in. If nothing else, this report shows that the number of safety standards and the amount of money spent on maintaining the roads have the highest correlation to reducing the number of fatal accidents globally.