The comparison of car accident fatality rate between developed and developing countries

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Abstract

Social media platforms are convenient for sharing information about world events, personal life, and daily news in which videos about car accidents and road rage are included; however, with the increasing number of the videos being from developed countries, this situation begs the question: "Are developed countries have lower car accident fatality rates than developing countries?" The data for this research is collected from the World Health Organization (WHO)[1], which is for the car accident fatality rates in nearly every country in the world, and the Organization for Economic Co-operation and Development (OECD)[2, 3], which is for the organization's member country's spending on building and maintaining the road infrastructure. Then the country list is filtered based on the member status in OECD and the GDP per capita level. After cleaning the data sets, they are processed by using linear regression and then used for generating linear regression models. Using the results from the regression, it is concluded that there is a relationship between the country's car accident fatality rate and its state of development.

Key words: car accident, fatality, developed countries, developing countries, highway infrastructure.

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1 Introduction

Car accident fatality has always been a problem for not only carmakers but also the governments trying to limit its frequency. While the department of transportation of each region and car manufacturers have been trying to update their vehicle safety requirements, the governments also have a part in building the law of transportation, road infrastructure, and citizens' road safety awareness.

However, one aspect that many people omit from that equation is the state of development of each country is different. From my observation, while most developed countries have the more cohesive infrastructure, newly developing countries are now having the edge of using more state-of-the-art technology in their infrastructure. This leads to my question: Are developed countries have lower car accident fatality rates than developing countries?

2 Related Work

There have been many papers writing about traffic safety related to the state of development of a country. In Oppe's paper, the writer has done the research in six different developed countries, in which the writer looked into the development of traffic and traffic safety in each country.[16] The data revealed that the volume

of traffic and car accident fatalities rate had a correlation when both increased until 1970, when the energy crisis happened, and both decreased. Whereas in Jacob and Sayer's paper, they went to investigate the road accidents in developing countries in 1972.[17] After many requests made by developing countries for aid and guidance in the road safety field, they went to find out not only the cause of that but also the solution to solve it. However, both papers did not compare directly developed and developing countries. Many people would assume that the developed country group would have the advantage in this category because they have the economic might, yet in recent years, more and more developing countries now utilize modern, state-of-the-art traffic technology to make the road safer.

3 Design Implementation

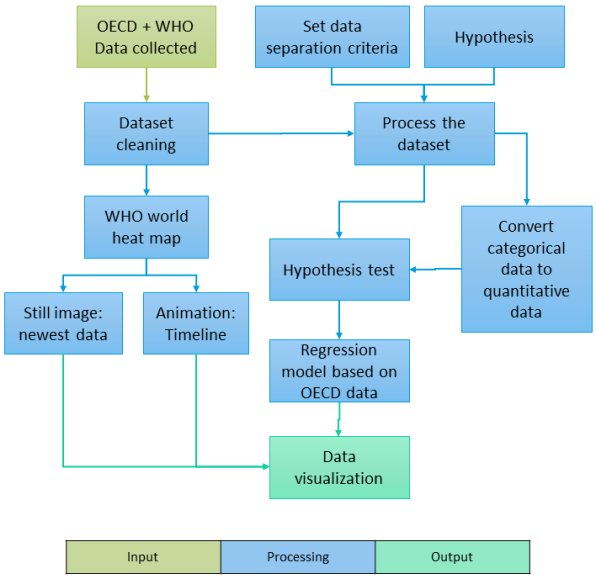

Figure 1: Data Structure Diagram

4 Statistical Analysis and Method

The Hypothesis:

- Null Hypothesis: There is no correlation between car accident fatality and the state of development of the countries.
- Alternative Hypothesis: There is a correlation between car accident fatality and the state of development of the countries.

The state of development of a country is determined by the GDP per capita of the respective country: If the country has a GDP per capita less than $25,000, that country is considered to be a developing country; if the country has a GDP per capita more than $25,000, that country is considered to be a developed country.

- If the country has a GDP per capital less than $25,000, that country is considered to be a developing country.
- If the country has a GDP per capital more than $25,000, that country is considered to be a developed country.

The variables of the regression model are:

- Independent variables: The amount of money that each country spends on building and maintaining the infrastructure (in Euro) per capita.
- Dependent variable: The car accident fatality rate.

After the data is collected, they will be divided into two groups: developed countries and developing countries. However, due to the lack of standardized data, the data sources used to do the regression are taken from the Organization for Economic Co-operation and Development (OECD), whose members are limited.

5 Data Collected

The car accident fatality rate data is taken from World Health Organization (WHO) database, and the spending and maintenance budgets of countries that are members of the OECD are taken from the OECD database.[1, 2, 3]
Through the data cleaning process, many countries are not chosen to be included for the data regression due to lacking data needed whereas other countries are qualified.
The data from WHO has a limitation in which the actual data cells needed have brackets that cannot be used in R program; therefore they need to be removed before the data can be used for regression.

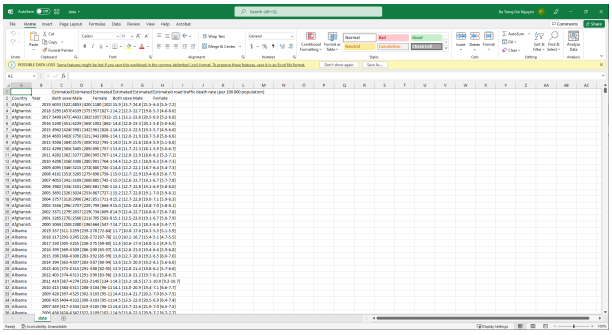

Figure 2: The raw car accident fatality rate data from WHO

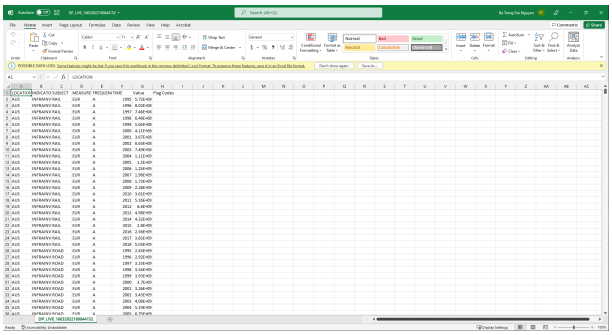

Figure 3: The raw spending budget data from OECD

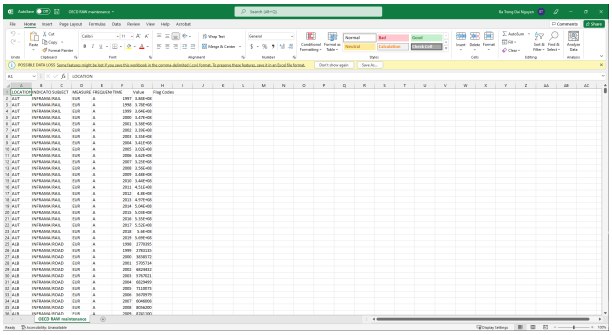

Figure 4: The raw maintenance budget data from OECD

6 Data Visualization

In this section we wanted to visualize what happened to fatalities over time. For this visualization we used Tableau.5

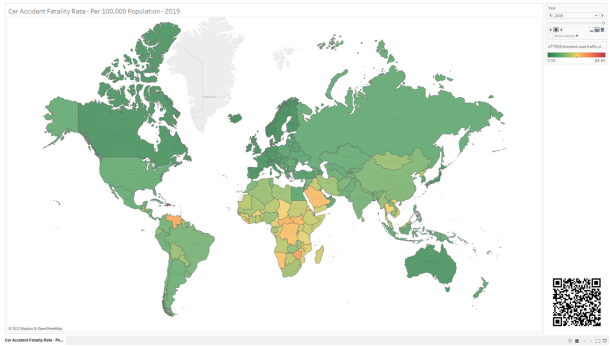

Figure 5: Heat map of car accident fatality rate.

For the animated version of the heat map, please scan the QR-code. Based on the heat map animation, we can see that while the major trend of most countries were declining in terms of the fatality rate, some countries did have fluctuation or inclining trends. To demonstrate even further, I had created chart visualizations of two example countries that from both country groups: representing the developed and developing countries are Japan and India, respectively.

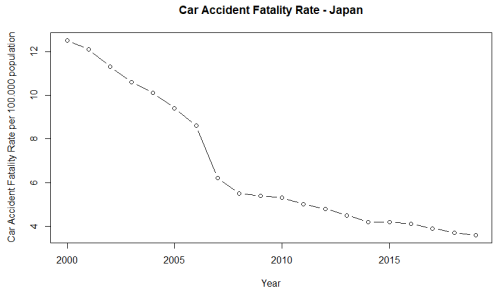

Figure 6: Japan's car accident fatality rate from 2000 to 2019.

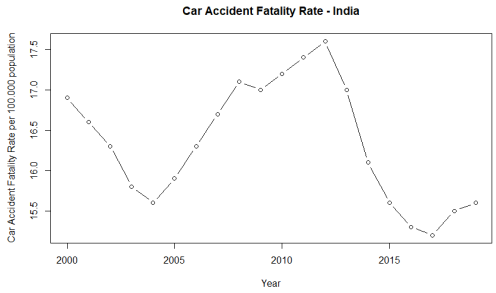

Figure 7: India's car accident fatality rate from 2000 to 2019.

7 Regression Models

From the data collected we noticed there was more of a polynomial regression pattern in some cases and having applied that to developed countries for building and maintaining infrastructures and its effects on car accident fatality. In the captions of 8, 9, 10, and 11, we have variables D_n, I_n and M_n which represent represents the death rate for the n-th country, the infrastructure spending and the maintenance spending of the n-th country, respectively.

From the plots for the regression model, we can see that there are correlations between both the spending for building and maintaining the infrastructure per capita and the car accident fatality rate for developed and developing countries. However, there are oscillation patterns and anomalies that prevent the regression of the model, even with polynomial regression.

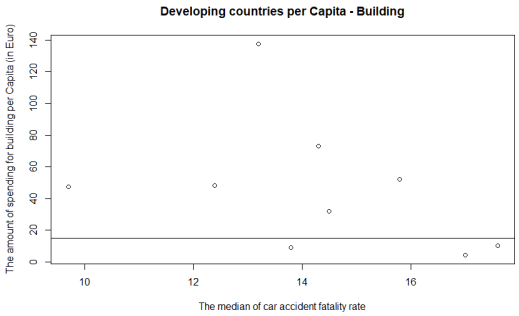

Figure 8: $D_n = I_n^{-0.0816} \times e^{2.9189}$

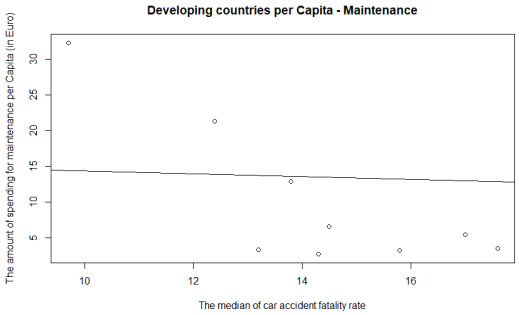

Figure 9: $D_n = M_n^{-0.1492} \times e^{2.9291}$

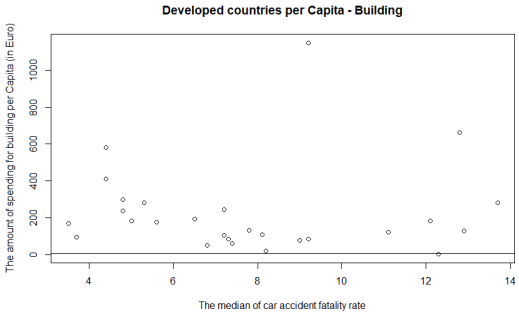

Figure 10: $D_n = I_n^{-0.0798} \times e^{2.3729}$

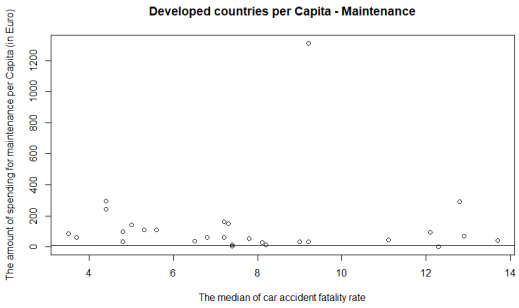

Figure 11: $D_n = M_n^{-0.0698} \times e^{2.2661}$

8 Conclusion

From the data visualization and the regression models, we can conclude that we reject the null hypothesis, meaning that there is a correlation between the state of the country and its car accident fatality rate.
We had tried to use a multi-linear regression model:

$$D_n = r_1 I_n + r_2 M_n$$

in which D_n represents the death rate for the n-th country, I_n and M_n represent the infrastructure spending and the maintenance spending of the n-th country, respectively. However, due to the lack of additional data, this conclusion could be not as accurate as possible, therefore, further work is required.

Acknowledgements. We thank the referee for valuable comments and suggestions

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