ANALYSIS OF MOTORIST BEHAVIOR ON HIGHWAY-RAILROAD AT-GRADE CROSSING INTERSECTIONS

ABSTRACT

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This project studies the effectiveness of the structure of transportation by applying R-Software to analyze the safety of highway-railroad at-grade crossing intersections (HRGC) operating with descending gates. The motive behind this research is to quantify the number of unsafe driver actions and maneuvers that occur when the gates are in motion and to investigate the correlation between influential factors and demographics -like gender and age- on undesirable driving behaviors at HRGC. This paper will focus on the factors that may influence driving behaviors of vehicle drivers at a signalized at-grade crossing intersection during the ascent/descent of gates.

PROBLEM STATEMENT

One of the leading concerns of the highway, railroad and transportation industries is safety. Even though there is plenty of research in the study of traffic safety, there are still not enough studies that report on or analyze the motor vehicle driver behavior at or around HRGC (Khattak 2013) [3]. There have been many campaigns aimed at educating motorists about the dangers of HRGC yielding messages such as the following obtained from (oli.org) [9]: (Every 3 hours a person or vehicle is hit by a train) or (The force of a 30-car freight train hitting your car = the force of your car hitting an aluminum soda can), yet we still incur thousands of collisions per year on HRGC.

When we look at HRGC, a sizeable proportion of crashes between trains and motor vehicles are the result of driver error (Ku 2010) [5]. Drivers are often unaware that trains are not capable of stopping as quickly and efficiently as motor vehicles to avoid a crash. In some cases, drivers recklessly ignore all warnings because they are in a hurry or impatient and would rather speed to beat the train than wait until it passes. A motor vehicle driver's ignorance and impatience are amongst the most common factors contributing to motor vehicle/train collisions at HRGC. Not only does this endanger their own lives, but it could also endanger the train passenger's lives if flying debris are a result or even worse, a train derailment may occur.

To understand drivers' actions, their behavior must be observed and analyzed in order to find possible solutions that may contribute to the decrease of the number of crashes and consequently result in saving precious lives and preventing financial loss. Predicting such driver behavior with respect to the given influential factors can also help allocate funds to aid in the safety enhancement (Khattak 2007) [11].

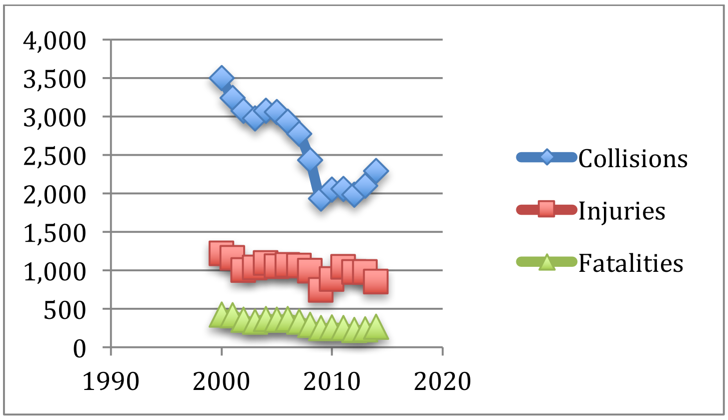

Figure 1: Highway Railroad at-grade crossing collisions and casualties at public crossings, 2000-2014.

Objectives:
To observe undesired motor vehicle drivers' behavior at a Highway-Railroad grade crossing and find solutions to correlations amongst the influential factors that may govern this behavior.

STUDY LOCATION

The area of the HRGC studied is located on a major road leading to and from the Cal Poly Pomona campus. The train tracks cross Temple Avenue east of the intersection of Valley Boulevard and Temple Avenue. This part of Temple Ave at the intersection includes a protected left turn, two through movement lanes and an exclusive right turn. It is Important to indicate that the track crosses adjacently with Valley Blvd and at a distance of about forty feet between the nearest rail and the far edge of the crosswalk as illustrated, leaving about twenty feet clearance for a car between the crosswalk and the train tracks where a single car may be parked when the train passes. This location also includes an island separating the opposing directions with a break in the island pavement to allow the trains to pass. This opposing direction is a three-lane segment crossing over the tracks.

What is important to note is that the protected left turn is somewhat narrower than the other lanes in the westbound direction. This smaller lane may sometimes cause confusion among drivers in considering the through lane on the left and the protected left turn as one lane.

An important thing to point out is that this HRGC is located on an intersection where two major arterials intersect. These arterials (Temple Avenue and Valley Boulevard) are primary roads that lead to two schools, Cal Poly Pomona and Mount San Antonio College. The reason for choosing such a unique location is that there will most likely be a higher volume of relatively new drivers who are unfamiliar with this crossing every year. Moreover, slightly higher populations of younger, less experienced motorists are more likely to be found driving along this segment due to the observed age at which students are admitted to college. This presents a higher risk of being involved in an undesired maneuver on the HRGC intersection.

There are no sight distance or visibility problems when approaching the stop line before the railroad tracks. It is also important to note that the speed limit on Temple

Avenue is 45 miles per hour and the distance between the gates of the HRGC and the preceding traffic signalized intersection is around 800 feet. This setting is likely to be susceptible to drivers speeding up to beet the train and that may cause serious endangerment.

DATA COLLECTION

The data for this project can only be collected by manual observation on sight. This will be to ensure the accurate behavior of drivers at the crossing. The participants considered are categorized into demographics of males and females, and then further into other categories based on age ranges that include 18-69 years of age. Driver behavior will be categorized into three main groups: the first group are drivers who speed up when they see the flashing lights in order to beat the closing gates – this includes pulling forward ahead of the gates to the intersection traffic signal pedestrian crossing line. The second group includes the drivers who pass under the gate as soon as the train passes and before the gates have completely ascended. The third group of drivers includes those who make a complete stop and determine a sufficient gap between the vehicle and closing gates.

These three groups can be summarized into two categories when it comes to the actions and decisions taken. The non-law-abiding group that includes those who do not adhere to the law regarding warning signs at the HRGC, and the law-abiding group that includes those who do adhere to the law regarding warning signs at the HRGC. The former includes driving through ascending or descending gates and driving through flashing red lights when a train is approaching.

The participants selected for the study include drivers from approximately eighteen to seventy years old in the study area. The data collected at the Temple Avenue HRGC on an almost daily basis includes safe and unsafe actions on the part of motor vehicle drivers. These unsafe maneuvers included gate rushing to beat an oncoming train, illegal U-turns (where motorists were using the track to make a U-turn while the light at the intersection ahead was red), taking an alternate route, vehicles reversing (this is not an unsafe action if it is done to clear the tracks, but it was monitored in this study), red-light running to beat a train at the traffic signal direction intersecting with the HRGC, and any other generally unsafe maneuver. Additional variables that were collected included day and time of observation, weather (clear, rain, etc.).

Data will be collected during daylight and darkness to examine whether or not this factor of visibility had any affect on driver decisions and behavior. It will also be noted separately when heavy vehicles such as trucks or busses are approaching or stopped at the crossing when a train is approaching.

Table 1: A sample of factors included in the data collection process.

Gender	Age	day.night	Weather	Movement	Red.Cross	Heavy Veh.	Other.Unsafe	gate.rush	illegal
Male	18-29	day	rain	Throgh	no	No	none	2	1
Male	18-29	day	clear	Throgh	yes	No	none	1	1
Female	18-29	night	clear	Throgh	no	No	none	3	0
Male	30-39	day	clear	Throgh	no	No	none	2	1
Male	18-29	day	fog	Right	no	No	none	2	1
Male	50-59	day	cloudy	Throgh	no	No	none	2	1
Female	18-29	night	clear	Left	no	No	none	2	1
Female	18-29	night	clear	Throgh	no	Heavy	none	3	0
Male	30-39	day	clear	Throgh	no	No	none	2	1
Female	30-39	day	clear	Throgh	no	No	lanechangeAS	1	1
Female	18-29	day	clear	Throgh	no	No	none	2	1

As part of the research, the accident reports for this grade crossing will be examined for similarities with the data collected. The grade crossing inventory is also part of the data collected to observe any changes or upgrades done to the grade crossing.

PROPOSED METHODOLOGY

The method of this study finds quantitative results by utilizing observational data collection from a field study. There are several necessary statistical procedures on creating a reasonable and accurate model. Initially, the data will be analyzed statistically using Excel spreadsheets. The data will then be investigated using R software to conduct statistical analysis in linking driver behavior to influential factors. R Software is a statistical computer programming language intended to facilitate the application of statistical methods to correlate information.

The anonymity is protected for each participant in this study, so it is needless information to non-existent effects (adverse or otherwise). The data and findings are un-manipulated and not forged or plagiarized. The ethical considerations are taken for this research, and it does not exercise prejudices and subjectivity to include and/or exclude any sampling entity, in reporting the data and findings, and acknowledging the contribution of other researchers as used in this thesis research.

There were only two other kinds of unsafe maneuvers at two separate gate-rushing incidents while the gates were descending. These maneuvers were:

1) Making a U-turn through the divider on the train's path.
2) Switching lanes from a stationary position to overtake the car that stopped behind the gate to beat the train and go through the gates.

RESEARCH OUTCOMES

On the multinomial regression level, none of the influential factors had a higher confidence level of being involved in undesired driver behavior when compared to observations of male gender adherence to traffic control devices at the HRGC of Temple Avenue at Valley Boulevard. This research outcome is consistent with most research on accidents based on gender, as males tend to be significantly dominant of the accidents and fatal accidents percentages on a global scale.

When we go to the earlier models such as the binomial influential factors that are most likely to follow the multinomial male gender influential factor closely, we find that the age range (30-39) was the prevalent influential factor amongst the independent variable 'age'. However the latter result in R meant that the (30-39) age range were more likely to abide by traffic laws and stop at moving gates. The only detail worth mentioning around this influential factor is that the observed ages of 40 years old and above were somewhat scarce compared to the younger population. Especially the population in their 50s and 60s of age.

Internationally, nearly three times as many males as compared to females perish as a result of road injuries. A six-hospital study in Spain found that seventy percent of collision injury incidents above the age of 14 years old were amongst males, and the total mortality rate was more than three times greater for men than women.

A World Health Organization (WHO) report in the eastern Mediterranean area discovered that traffic collisions are accountable for a much higher degree of injury and fatality among men, by a ratio of about 4:1 (WHO) [7]. Also, over seven in ten of the road accident deaths in 2002 were male and less than 30 percent were female. Research in Pakistan found that there were 22.4 male traffic collisions per 1000 populace where only 6.9 female road collisions were found per 1000 populace in 2004. In Tehran, a hospital-based study of road accident victims found the male/female ratio for car accident victims was 4.2:1 (WHO) [7].

The (WHO) concluded in a study that there is a higher risk of road injuries and death amongst males associated to a noteworthy degree with larger exposure to driving in addition to trends of high-risk behavior when driving (WHO) [8]. The relationship of masculinity with risk-taking, gender role socialization and a negligence of probable injury may also be factors controlling dangerous actions among males. These may include aggressive behavior to be in control of situations, risky driving and possibly excessive alcohol consumption (SIRC 2004) [6].

DISCUSSION & RECOMMENDATIONS

The Fox River Grove accident was a HRGC crash that killed seven students riding aboard a school bus in Illinois on the morning of October 25, 1995. The reason why this is important to note, is that the Temple Avenue grade crossing intersection is geometrically similar and is located at a main arterial that leads to not one but two colleges and a high school.

There are many ways in which the Temple Avenue railroad grade crossing can be upgraded to avoid a serious collision that may result in deaths. Some of these upgrades mentioned by Heathington, Richards, and Fambro (1990) [2] include:

1- A "Stop Here" sign that indicates stopping behind the gates at all times when the light is red or when the rail track warning signs are active.
2- Lane markings and a different color road segment defining the crossing area, with a "Do Not Block the Box" sign as shown in the below figure.
3- Signage on the gates that inform the stopped drivers to clear the crossing only after gates have completely ascended and warning signs have deactivated.
4- Prohibit U-turns coming from the westbound direction to avoid cars driving along tracks between the median break that allows the train to pass.
5- Nighttime illumination.
6- Increase enforcement and violation penalties.
7- Pedestrian Crossing control
8- Reducing the speed of the segment leading up to the grade crossing.
9- Grade separation between the road and track.

The ninth upgrade solution may be the most expensive to take, however it most definitely the safest in avoiding a motor vehicle-train collision.

FURTHER RESEARCH IMPLICATIONS

The field of research related to HRGC safety is immense, as can be seen from the literature reviews. There are still many possibilities to expand on the present knowledge and to study new methods for improving safety, especially in the

environment of common corridors between rail and automobiles.
Ultimately, the results of ongoing and future research on collision likelihood, collision severity, and driver behavior can be integrated as a tool to assess the risks and benefits of alternative safety measures.

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