SAFETY PERCEPTION OF PEDESTRIANS AT LEVEL CROSSINGS

BY

PRETOM MD TAHMIDUR RAHMAN (180051235)

MAISHA HOSSAIN (180051238)

TASFIA YOUSUF (180051239)

A Thesis Submitted in Partial Fulfilment of the Requirements for Achieving the Degree of

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

ISLAMIC UNIVERSITY OF TECHNOLOGY

JUNE 2023

Approval

The paper with the title “Safety Perception of Pedestrians at Level Crossings” prepared by Pretom Md Tahmidur Rahman, Maisha Hossain and Tasfia Yousuf has been accepted as partial attainment of the requisite for the degree, Bachelor of Science in Civil Engineering.

Supervisor

_____

Dr. Shakil Mohammad Rifaat

Professor

Department of Civil and Environmental Engineering (CEE)

Islamic University of Technology (IUT)

Board Bazar, Gazipur, Bangladesh.

Declaration

It is hereby declared that this thesis/project report, wholly or partly, has not been submitted to somewhere else for the award of any Degree or Diploma.

Pretom Md Tahmidur Rahman
Student ID: 180051235

Maisha Hossain
Student ID: 180051238

Tasfia Yousuf
Student ID: 180051239

Supervisor

Dr. Shakil Mohammad Rifaat

Professor

Department of Civil and Environmental Engineering (CEE)

Islamic University of Technology (IUT)

Board Bazar, Gazipur, Bangladesh.

Dedication

To our beloved family members and learned teachers
for
their guidance, forbearance, and most notably, for trusting us.

Acknowledgement

All the praise to Almighty Allah, by Whose mercy we were able to accomplish our research agenda. Our deepest obedience will always be directed towards Allah, the Kindest and Most Compassionate.

Our heartfelt gratitude to our thesis supervisor, Dr. Shakil Mohammad Rifaat, Professor, Department of Civil and Environmental Engineering, IUT, without whose proficient direction we would have never been able to finish our assigned task. We are grateful to you for your diversified insights, invaluable guidance, and endless inspiration, Sir.

In the end, we would like to express our gratitude to our cherished family members and everyone else who explicitly or implicitly provided us their support in carrying out our research.

Preamble

The study was aimed in order to evaluate the trespassing behavior of the pedestrians from the view point of safety. It also recommends the policy makers to make the high risk-taking cohort more conscious. The research is entitled as “Safety Perception of Pedestrians at Level Crossing”. The research proceeds in order to achieve its three final goals or objectives. The objectives are, i) Assessing rail-road crossing behavior. ii) Identifying significant factors related to safety perception and iii) Recommend policies for ensuring safety at rail crossing.

Contents

List of Tables

List of Figures

Abstract

Rail-pedestrian crashes are a persisting tragedy in Bangladesh, with a growing magnitude of fatalities. Pedestrian crashes on road are prevalent but it's not highly noticed on railway lines. Hence, a good number of studies have been done on pedestrian accidents involving roads, however, insignificant numbers of studies, if any, addressed the safety perception of pedestrians at road-rail crossing specifically in developing countries' perspective. Moreover, road-pedestrian might result in severe injuries but rail-pedestrian collisions often end up in fatalities. With a view to finding the influence of the demographic traits of the victims, for instance, age, education, and gender, alongside propensity for suicides, and distractions due to electronic gadgets and other numerous reasons behind pedestrian crashes on railways, this paper will explore the safety perception of pedestrians at a level crossing. A questionnaire was prepared reviewing previous literatures, local context, and pilot survey. Questionnaires were again divided into 8 sub-groups namely socioeconomic characteristics, situational case, accident experience, safety knowledge, safety perception, personal crossing characteristics, surrounding conditions, and awareness. The survey was conducted by collecting data from level crossings of 8 different locations from 250 pedestrians, who use level crossings frequently. Independent variables were formed using the responses from this survey. The dependent variable is formed from the perceived safe distance of the respondents to cross the railway track in front of an oncoming train. The ordered probit model has been used because of ordinal behavior of the dependent variable considered in the study to find the significant factors effecting the safety perception of pedestrians. The model assists to find out the most and least risk-taking cohort. Moreover, independent variables with substantial impacts on the safety perceptions of pedestrians are also perceived. The study will disclose the less safety-conscious cohort of pedestrians to the policymakers so that necessary measures can be taken by introducing safety education to them and implementing robust monitoring systems near railroads.

Keywords: Safety perception; level crossing; pedestrian; ordered probit model; risk-taking cohort.

CHAPTER 1: INTRODUCTION

1.1 Background

Pedestrian fatalities at railroad crossings and non-crossings occur frequently due to various factors, including unfavorable pedestrian behavior and negligence on the part of railroad authorities. An analysis of a ten-year database (2006-2015) collected from the Federal Railroad Administration's safety records (Savage, 2016) was conducted to understand rail-pedestrian trespassing crashes. Out of a total 7,157 crashes, 6,236 (87%) took place at non-crossings, while 921 (13%) take place at level crossings. Approximately 60% of these collisions resulted in fatalities, both at crossings and non-crossings.

The most common trespassing action before crash was running or walking, accounting for 63% of incidents at level crossings and 44% at non-crossings. Leaning back or dozing off was a contributing factor in 29% of non-crossing crashes but only 3.6% of level crossing crashes. Constructing robust models, such as a mixed-effect logistic regression, allowed researchers to examine the ten-year database and investigate the outcomes. The analysis revealed a greater likelihood of train-pedestrian trespassing fatalities when individuals were lying down or asleep during a crash, particularly at grade crossings.

Walking or running was the most prevalent behavior overall, causing more harm at grade crossings compared to non-crossings. Actions such as climbing, jumping, crossing, or crawling were less common but were more likely to be fatal at non-crossing, while they were not significant contributors to grade crossing crashes. Crashes occurring at night at grade crossings resulted in more injuries, but they were less dangerous during the summer and away from crossings in yards. Additionally, seniors aged 65 and older faced a higher risk of fatality compared to younger individuals.

The pattern of the crashes at crossings exhibited more peaks, while non-crossings remained relatively consistent over the ten-year period.

Although railroad and pedestrian accidents happened seldom, they were significantly more severe than other accidents in history. Numerous factors influence the severity of the damage and the rise in the number of fatalities following collisions. As per data from the Federal Railroad Administration (FRA), around sixty five percent of recorded pedestrian-train accidents at highway-rail grade crossings (HRGCs) in 2013 were deadly, compared to about 7% of all pedestrian crashes in the United States in 2013 (NHTSA, 2013). Approximately 4 out of every 5 railroad-related fatalities (79.8%) occurred as a result of pedestrian-train collisions from 2012 to 2014 (Savage, 2016). The probability of these collisions was said to be significantly influenced by the amount of alcohol in the blood of the pedestrians (Lerer & Matzopoulos, 1996; Pelletier, 1997). Although Cina et al. (1994) and Moore et al. (1991) indicated that the majority of the casualties were young, pedestrians aging from 20 to 50 were recognized to be victimized highest in number in pedestrian-train crashes (Pelletier, 1997; Lerer & Matzopoulos, 1997). More collisions involved male pedestrians (Cina et al., 1994; Pelletier, 1997). The incidence of pedestrian associated with train crashes were also found to be significantly influenced by other factors, including peak-hour traffic (morning and evening peaks), health of the pedestrian, marital status, and receiving less than a high school education (Cina et al., 1994; Lerer & Matzopoulos, 1996; 1997; Pelletier, 1997). The literature review revealed that the majority of studies on pedestrian-train crashes has concentrated on the incidence and occurrence of crashes. Age, sex, health problems, marital status, degree of education, insobriety, peak-hour traffic, and pedestrian traffic volumes are among the characteristics of both pedestrians and trains. Train speed and land usage were linked to the frequency of pedestrian-train collisions at HRGCs. Crash data clustering was successfully used in numerous research to take data heterogeneity into account. In the vast majority of pertinent research, the LCC's performance was adequate.According to a report by the Transportation Safety Board of Canada, crossing accidents were a noteworthy concern in rail collisions during 2020. Of all these incidents, 19% resulted in serious or fatal injuries.

There was a total of 129 crossing accidents in Canada during 2020, which decreased of 28% compared to the previous year's count of 178. It was also 24% lower than the average collisions over the past decade, which stood at 170. The report further stated that collisions occurring at

public automated crossings reduced from 87 in 2019 to 54 in the year 2020. It was also below the average count of 86 over the past ten years. On the other hand, accidents at public passive crossings increased from 49 to 56 in 2019 to 2020, having a close alignment with the 10-year average of 57. Finally, collisions at private and farm crossings decreased from 42 in 2019 to 19 in 2020, representing a 31% drop below the 10-year average of 27.

In 2020, public automated crossings were involved in 42% of crossing accidents, while public passive crossings were in 43% of the incidents. Despite there being almost twice as many public passive crossings compared to automated crossings, the comparable number of collisions at automated crossings can be attributed, at least in part, to higher volumes of vehicle and train traffic. The Transportation Safety Board (TSB) is currently occupied in continuous research efforts aimed at gaining a deeper understanding of the factors that contribute to crossing accidents. (Government of Canada, Transportation Safety Board of Canada, 2021).

The Greater Sichuan-Chongqing area in China recorded a significant number of train-pedestrian collisions during the period of 2011-2020. Over the course of the decade, there were a total of 2,090 train-pedestrian collisions, which tragically led to the injury of 963 individuals and 1,173 fatalities. Considering the significant number of populations residing in this area, which consists of millions of people, the annual collision rate per million people averaged at 1.4. (Guo et al., 2022)

Approximately 300 people die in railway accidents every year. The number of injuries is about 250 people (Jugantor, 2020).

In the year 2005 to 2011 there were 68 collisions in 44 manned Authorized Level Crossing Gate

75 collisions in 62 unmanned Authorized Level Crossing Gate & 20 collisions in crossings where no identifications about manned or unmanned were found (Azzacy, 2012).

The major reasons for railway pedestrian crashes are observed as the using headphones while crossing the railway track: Since 2010, a disturbing number of 535 individuals lost were the victims of fatalities in and around the city of Dhaka, Bangladesh, because of train accidents while wearing headphones on railway tracks. (Ogwu, 2019). Suicidal Tendency: A total of 1239 suicidal cases in the Railway Range in 2017 (Ferdous & Alam, 2021). Vendors: Every day, vendors erect

unauthorized makeshift shops on the rail tracks in Tejgaon and Karwan Bazar and when trains are approaching, the hawkers withdraw their wares, and when the trains have passed, they are back on the tracks (Dhruba, 2014).

Slums: Numerous fatalities and injuries occur on a regular basis in the slum areas near railways and it happens due to lack of official railway regulations regarding these slum areas (A24 News Agency, 2021).

Bangladesh holds the top position globally when it comes to railway accidents because of level crossings. In present, around 95 percent of railway accidents transpire at different level crossings. The primary factor contributing to this alarming statistic may be the absence of guards at a minimum of 85 percent of legally designated level crossings. Moreover, the situation is further worsened because of the rising number of unauthorized constructions along the railway lines and the poor state of marketplaces, which lack any form of barriers or protective measures. As a result, the railway service system of Bangladesh is significantly impacted. (Rahman, 2022). Unfortunately, a strong existing law, which is the Railway Act of 1890 stated that it is prohibited to traverse railway tracks by foot, constituting an offense that carries a maximum penalty of two years of imprisonment (The Business Standard, 2022). However, this could not stop pedestrians from taking the tracks and cannot even ensure safe trespassing in Bangladesh because no one is obliged to watch them over and impose penalties. These massacres on railway tracks in BD should be stopped in no time.

1.2 Objectives

The study focuses on the analysis of safety perception of the pedestrian around rail crossing and identifying the major factors responsible behind their high risk-taking tendency. The study is proceeded with purposes-

i) Evaluating the railway crossing behavior of the pedestrians based on their socio-economics, demographic features, travel characteristics and attitudes.

ii) To identify factors influencing the safety perception among pedestrians from diversified background.

iii) To help related authorities in finding ways for the development of safer railway crossing facilities for the pedestrians around the level crossings the finding the most risk-taking cohort of people.

1.3 Thesis Outline

The thesis contains five chapters in total. Their brief discussion are as follows:

Chapter 1: Introduction- The introduction contains background and objectives.
Chapter 2: Literature Review- This chapter contains information obtained from previous literatures which helped in creating workflow in the research.
Chapter 3: Data and Methodology- This chapter includes data collection procedure and discussion of the model.
Chapter 4: Result and Analysis- This chapter focuses on the overall data analysis and briefs of the results obtained.
Chapter 5: Conclusion & Recommendation: This chapter represents findings of the research and provides suggestions regarding policy implications.

CHAPTER 2: LITERATURE REVIEW

Several studies were conducted previously regarding rail-pedestrian crashes in different nations of the world. But almost no study has ever been conducted regarding train pedestrian crashes and safety perception of the pedestrian in Bangladesh. The literature review of the research has been compiled taking several features into consideration. Relevant studies that focus on the factors affecting rail-pedestrian crashes, safety issues, unsafe behaviors, reasons of jaywalking at level crossing, effect of time on rail-pedestrian crashes and punishment were considered.

2.1 Factors Affecting Pedestrian-Rail Crashes

2.1.1 Age:

Age is an important issue in case of train-pedestrian collisions. The age range of people involved in train-pedestrian collisions differ from cities to cities, country to country. In the study of Lobb et al. (2003) with title "An evaluation of four types of railway pedestrian crossing safety programme", it was stated that in New Zealand from the previous data over one year period 50% of total train-pedestrian fatalities and 40% injuries include people aging from 10 to 19 years. On the contrary, Pelletier (1997) stated that North Carolina faces below 4% fatalities involve children below 18 and most of the fatalities which is 81% were 20 to 49 years old in his study "Deaths among railroad trespassers: the role of alcohol in fatal injuries". Besides this, there are also issues of suicides in case of train-pedestrian fatalities. In a study of Silla and Luoma (2012) regarding train-pedestrian fatalities in Finnish, 44.3% of the suicide victims belong to 20 to 39 years of age and 51.4% of all crashes involved pedestrian from 10 to 29 years. It was mentioned in a study that most of the victims of rail crashes are young ("Rail Trespasser Fatalities Demographic and Behavioral Profiles," 2013). In a study (Zhang et al., 2018) it was mentioned that the age range from 17 to 64 years are more involved in train crashes which is 89% of the total. According to Illinois Commerce Commission (2009) in case of frequency, people aging between 40-49 are highly victimized with crashes (Ghomi et al., 2016). To conclude, neither the little ones nor the older ones, rather that age range where people should remain active in every aspect becomes victims of railway crashes.

2.1.2 Gender:

Gender is sometimes considered as a factor that may influence the fatalities and injuries rate in case of railway crossing. In case of the study of both Cina et al. (1994) and Pelletier (1997) they observed the number of deaths mostly included male. From the study of Silla and Luoma (2012) it is seen that the male and female ratio in case of railway fatalities, for suicides was 2.4:1 and for accidents was 3.4:1. The results from the study (Patterson, 2004) showed that most victims in train-pedestrian crashes were men. In the study of ("Rail Trespasser Fatalities Demographic and Behavioral Profiles," 2013) it was again mentioned that most of the deaths in train crashes were boys. In the study of (Ghomi et al., 2016) it was mentioned that both males and females are equally responsible for the accidents which were investigated by the Illinois Commerce Commission (2009). So women are mostly seen to face dilemma in crossing a rail but the fatality rate is severe while talking about men in most cases.

2.1.3 Education:

Education is considered as a crucial factor that influences the number of train-pedestrian fatalities and injuries. This is because it is esteemed that educated people follow the rules properly and remain aware while level crossing in case of railway. Many authors proposed to provide education to the public regarding risk and illegality to prevent unsafe pedestrian railway crossing behavior (Blazar et al., 1997). A scheme of educative intercessions was organized in Auckland, New Zealand where people walked across the tracks although there was the presence of an over bridge by Lobb et al. (2001). Immediately after the session the people started using the over bridge instead of walking across the tracks. It decreased after three months. But three months after the program, even though consciousness regarding illegal sides about crossing the track increased a bit, people were still taking the risk of walking through the tracks. Highly educated people are also involved with lesser fatalities at level crossing (Zhang et al., 2018). A session forty five minutes regarding railway safety was given to some schools and the result of this was that education regarding railway safety is effective in unsafe crossings (Silla & Kallberg, 2016). Even if, initiative like education is implemented, the effect of it is less to mitigate such problems (Lobb et al., 2003) Yet the discussion provides us a knowledge that education puts little effect in case of saving oneself from pedestrian crashes in a railway line.

2.1.4 Mental illness and suicidal tendencies:

Mental illness can be considered as a factor that can influence the train-pedestrian collisions. Mental stress has now become a tragedy in this world. Many times, due to mental illness, pedestrians do not remain aware of the situation and try to walk through the tracks which is quite risky and sometimes also become the reason for the crash. Mental illness also influences a person to commit suicide which is an aspect of railway collision. A recent report published by the Statista Research Department (2022) based on a survey from 2013-2021 in Great Britain shows that there were 286 suicidal fatalities in the network of British Railway and 23 non-suicidal fatalities during the fiscal year 2014-15 which lessened to 253 and 23 respectively in 2020-21 ("Total Number of Railway Fatalities Including Suicides in Great Britain (UK) From 2013/14 to 2020/21," 2021). The Washington Post in 2018, a statistical report of Federal Railroad Administration, shows 266 cases out of 300 attempts to suicide by train was successful in the United States (Halsey III, 2018). Again, in De Leo and Krysinska (2008) a psychiatric detection was found in 40.4% of all suicide victims. In addition, 65% of the history of psychiatric disorders was observed in Netherlands (Van Houwelingen & Kerkhof, 2008) and for Denmark it was 81% (Lindekilde & Wang, 1985). Symonds (1985) stated that most train fatalities involve suicides, the sufferers were psychologically sick. In the study of (Silla & Luoma, 2012) it was found that the suicide victims suffered more mental health problems (39.2%) than accident victims.

Moreover, it was discovered by Schmidtke (1994) that most of the deaths on railroad in Germany is due to suicides. But Pelletier (1997) stated none of the trespasser committed suicide in North Carolina. Nixon et al. (1985) remarked that 12% of train related accidents were recorded as suicides in Queensland, Australia. Lerer and Matzopoulos (1996) stated in Cape Town 71% of rail related deaths were documented as suicides. Silla (2022b) states that 4% to 5% of all suicides happened on railroad tracks. In other countries of Europe, this suicide rate is 5% in Sweden (Rådbo et al., 2008), 6% in Austria (Deisenhammer et al., 1997) and 5% in England and Wales (Symonds, 1994). In a European report, it was reported that the cause of more than 3000 rail accidents were because of suicides (Bukhardt et al., 2014). In case of train crashes, about 20% to 27% noted as suicides (Gabree et al., 2014). It was mentioned that one of the main reasons of trespassing was suicide in a study (Silla and Luoma, 2012). In a study (Zhang et al., 2018) it was shown that out of 2848 crashes there were a total of 32 crashes that were suicides. And such behavioral

characteristics of the pedestrians are certainly leading the rail network to a more vulnerable condition.

2.1.5 Maturity:

Pedestrians lacking in maturity make many decisions which results in train-pedestrian crashes. They do not tend to follow the rules and try to take risks. Sometimes it is observed that many people try to take selfies in front of the moving train which is quite risky. It was mentioned in a study that people are walking and lying down in the rail tracks which are causing many rail crashes (Savage, 2007). It is reported in the study (Zhang et al., 2018) that about 29% of crashes occur due to lying or sleeping on the track. It was reported from different research like in South Carolina (Cina et al., 1994), and Cape Town (Lerer & Matzopoulos, 1996) that most rail-pedestrian deaths is because pedestrian walk across or along the tracks or sitting or lying on the tracks. In North Carolina (Pelletier, 1997) it is stated that many people use tracks as a site to talk or relax. These kinds of activities are done by people due to lack of maturity and proper decision-making sense. It was stated that one of the possible reasons of young people less than 16 years being involved in train crashes is their daring nature like jumping and climbing (Wang et al., 2016). So, whatever our level of maturity is, taking unusual decisions while trespassing railroads is indeed an act of immaturity.

2.1.6 Pedestrian Distraction:

Pedestrian distraction has become a serious issue in case of crossing a railway line which is resulting a lot of rail crashes every year. Distraction has become a vital cause of pedestrian crashes. In this present era of science and technology, the use of mobile phone is quite prevalent, especially among the young generation. Many pedestrians are seen to cross railway lines while talking over the mobile phone or busy in texting, even while playing different video games on phone. A study by Filtness et al. (2021c) titling “Improving the safety of distracted pedestrians with in-ground flashing lights. A railway crossing field study” stated that they made an observation and video recording over railway pedestrians in Brisbane, Australia and found this pedestrian distraction of railway section to be an emerging issue and they levelled it as low, medium and high levels. 41.9% out of a total of 585 pedestrian were found to talk on mobile or looking at its screen. Wali et al. (2021) in a study titled as “Injury severity analysis of pedestrian and bicyclist trespassing crashes

at non-crossing: A hybrid predictive text analytics and heterogeneity-based statistical modeling approach" based on data of 2006-2015 from Federal Railway Administration showed that a higher number of railway trespasser fatalities are due to uses of headphones and cellphones. Such distractions provide an alarming issue regarding lots of crashes and fatalities in future.

2.2 Safety Issues

2.2.1 Use of Over Bridge to Cross the Railway Track:

It is important to use the over bridge when there is a chance of a train arriving to avoid any kinds of accidents. But in most of the cases it is observed that people tend to take risks more instead of using the over bridge. In a study it is observed that pedestrians tend to select the shorter alternative (Hill, 1984) but from another study it is seen that they like to use the easiest approach even if it is not the smallest (Marchand, 1974). In another study it is seen that 70% of people will use over bridge if it requires similar period as the level crossing but none will use it if it takes 50% longer. In the study of (Lobb et al., 2001) it was found that it takes 10 times more to trespass using an over bridge instead of walking across the track but though one third of the pedestrians used the over bridge. So, in most of the cases it is seen that the use of the over bridge depends on the time taken to cross. Choosing a shorter or more easy way was one of the most common reasons for not using over-bridge (Board 2007) which was studied in a study (Zhang et al., 2018). The same reason was also mentioned in another study (Silla & Luoma, 2009). Again, in a study it was stated that there are limited options for the pedestrians to cross the railway safely (Filtness et al., 2018). So had there been better and less time-consuming opportunities for crossing a railway line using an over bridge, it would have been much more preferable to the pedestrians which would save lives of lots of pedestrians eventually.

2.2.2 Safety Awareness:

Many authors asked to increase the awareness among the pedestrians to decrease the train-pedestrian collisions. It is considered that being aware of the rules, regulations and risks of crossing the railway track people may follow the rules properly for safe crossing. Many researches were done to find out the influence of awareness in reducing the crashes. But unfortunately, from the studies it was observed that intercessions to raise consciousness possess finite influences in

lessening unsafe road crossing (Hill, 1984). It was mentioned in another study that though education and awareness is effective but not that much (Lobb et al., 2003). It is seen in Auckland, New Zealand, a program was started to raise awareness regarding this issue attempted by Lobb et al. (2001) to use an over bridge. Though after the program immediately the use of track for crossing decreased but after three months pedestrians again started taking risks. So these evidences did not refer awareness to be an efficient parameter in saving oneself from rail crashes as a pedestrian.

2.2.3 Warning signs and devices:

Most pedestrian-rail transportation conflicts occur as the person passes the location of the rail and pedestrian crossing. The massive crash occurs when several people fail to correctly see the traffic signal indications. When train-pedestrian accidents were increasing gradually, it was advised by many authors to use warning signs and devices to inform pedestrians about the arrival of trains so that the pedestrians do not walk through the tracks for crossing. Later on, after the use of warning signs and devices it was studied whether the warning signs are effective for decreasing unsafe crossings. The results from these studies ((Ward & Wilde, 1995) estimated that safety signals are not sufficient to lessen unsafe attitude in on coming uncontrolled railway crossings. Many locations lack any sort of traffic signals. Information by Illinois Center For Transportation (2013) stated that a 2005 report by the Illinois Commerce Commission examined 39 instances of Northeastern trains strike pedestrians (including bikes and other non-motorized users) between 2000 and 2004 in Illinois, it was discovered that out of the 33 pedestrian-train incidents examined, 66% (22 of 33) had apparent to have resulted from the pedestrian disobeying the warning signs, many of these crossings had signs that said a train was coming, gates for pedestrians (Metaxatos & Sriraj, 2013). In another study it was seen that train-pedestrian crashes are sometimes reduced by warning devices and sometimes they are not reduced (Wigglesworth, 2001). Warning devices like horn warning can be used to warn the intoxicated pedestrians not to cross the rail if observed (Zhang et al., 2018). With developed warning system, the number of trespassers reduced in two locations in Finland by 18% and 44% (Kallberg & Silla, 2017). Flashing light is suggested to use for giving warning while the train is approaching (Filtness et al., 2019). So proper uses of warning signs and devices would certainly be an efficient way for the pedestrian to reduce crashes while crossing a railway line.

Reviewing consequences of installing a rail-activated signal aimed to when multiple trains are approaching a crossing with a main road, pedestrians should be warned, conducted by Khawani in Los Angeles (2001). The study used the amount of time that passed between the pedestrian and the entering the rails and a train's arrival or departure. According to the report, installing the signal decreased the frequency of dangerous pedestrian activity. The investigation discovered the overall 14% showed warning sign to be successful to lower risky attitudes less than 15 seconds before the LRT train arrives at its destination, fewer people are crossing the tracks and LRT train is approaching. In addition, there were 6 pedestrians who crossed the LRT tracks. The time in seconds or less before an LRT train crossed the intersection decreased by around 32%. Nine methods were outlined in the FRA Secretary's Action Plan to improve pedestrian security at highway-train crossings. Increased specific tactics included enforcement and education. The research suggested pedestrian-friendly fencing and to decrease trespassers, well-known trespassing spots are channelized and video monitored, conflict and mentioned having a good working relationship with Canadian officials in this area. As a result by Illinois Center For Transportation (2013) when choosing which warning devices to install at pedestrian-train level crossings, a number of factors are taken into consideration, such as the frequency of bad weather, the volume of pedestrians, velocity of the train, the quantity of trains, railroad traffic designs, nearby land uses, the sight distance for people going towards the crossing, the skew angle of the crossing relative to the railroad tracks, the presence of many tracks, and the vicinity. Communities also employ fencing, planting, warning signs, keeping track through video, education, and enforcing trespassers to deter at or near grade crossings. The potential of emerging approaches is not fully recognized, and some tools required to consider in case of the selection method.

2.3 Closing of the Crossing

2.3.1 Passive Crossing:

Passive crossing mostly prevailed in most of the countries. But later on, it was replaced by automatic crossing in many places. But still there are many places and countries where passive crossing is still being used. In Bangladesh, only passive crossing is used. In a study in Great Britain by Evans and Hughes (2019) it is remarked that there are 2094 passive crossings which are only

open to pedestrians and 2201 passive crossings which are open to both vehicles and pedestrians during March, 2017. And the number of pedestrian fatalities from 2003 to 2017 using passive crossing which is open to both vehicles and pedestrians is 16 and in the case of open only to pedestrians is 47. So the evaluation says that pedestrians remain less aware regarding crossing while there is passive crossing prevailing.

2.3.2 Automatic Crossing:

Automatic crossing is taken as a replacement of passive crossing for reducing the unsafe crossing of pedestrians. In the study done by Evans and Hughes (2019) in Great Britain it is seen that there are 688 crossings open to both vehicles and pedestrians but only 60 crossings open to pedestrians only. The fatalities of pedestrian for automatic level crossing open to both pedestrian and vehicle is 18 and only open to pedestrian is 5 from 2003 to 2017.

2.3.3 Railway Controlled:

In the same study by Evans and Hughes (2019) in the UK the number of crossings controlled by railway is 820 and the fatality number of pedestrians is 11 from 2003 to 2017.

From the above three parts it can be remarked that the number of fatalities is more in case of automatic crossing open to pedestrians only in comparison with the number of crossings. In both of the cases of automatic crossing the amount of crossings are less but fatalities amount of pedestrians is more in comparison with the passive crossings. In this case, the railway-controlled crossing has the smaller number of fatalities in comparison to passive and automatic crossing. So, the assumption of decreasing the fatalities rate by using automatic crossing in case of Great Britain is not accepted. Australian Transport Council, 2010 stated that for active grade crossing, number of fatal crashes is more than the passive level crossings which was mentioned in a study (Stefanova et al., 2015). Railway controlled crossing is the most well performed crossing with falling rate of fatalities and in case of automatic crossing the fatality rate is the highest. In 2009, about 5% fatal accidents took place in railway-controlled crossing, 43% in passive crossing but the highest was in case of automatic crossing which is 52%. (Evans, 2011).

2.4 Unsafe Behaviors

2.4.1 Jaywalking of School Boys across the Rail Track:

In many studies it was observed that the train-pedestrian fatalities rate is more within the age of 10 to 19 which involve the school boys (Lobb et al., 2003). In this study, done by the students of the school which is adjacent to the station revealed that before taking any kind of actions the unsafe crossing by the students were 37.5% to 57%, after raising awareness it became 25% to 50% and after proper education program it decreased to 15% to 40%. The factors that influence the school boys for such unsafe crossing were feeling lazy, being unbothered, to find out if there is probability for finding the timetable of a train, and peer pressure.

2.4.2 Risk-taking Behavior of Young People:

The young people tend to have more curiosity to find out new things and to take risks. They are more daring than the people of other ages to do different kinds of things, taking risks. They do not think about the negative impacts before taking any kind of risks. Even though there is no data prevailing it, in a study Nixon et al. (1985) asserted that accidents were more frequent among the youngers who are daring and adventurous. In addition, a study by Lobb et al. (2003) found out that 37.5% to 57% school boys were crossing unsafely, to show bravery is one of the reasons for these crossings. Lerer and Matzopoulos (1996) revealed that many deaths and wounds detected in their research as falls-from-trains were due to the rush into or out of the moving trains by risk takers. It was also stated in a study (Witte & Donohue, 2000) that thrill seeking work is a factor of many train-pedestrian accidents. It was mentioned in a study (Zhang et al., 2018) that 188.8%, 4.1% and 8.2% of rail crashes are taking place due to climbing or jumping, running or walking and crawling respectively. And it was also reported in the same study that there is an occurrence of crashes due to the daring tendency of young people but the number is less compared to other reasons of crashes. Thrill seeking tendencies is a major cause for crashes among the youngers (Amelia et al., 2012; Beanland et al., 2013). In a study it was stated that youngers are more responsible in case of gate related violations like passing under descending gate or fully lowered gates (Khattak & Luo, 2011). But all these adventures of the teenage are actually leading them towards something for which they suffer in the long run.

2.4.3 Use of Narcotics:

Crossing the railway track being intoxicated is one of the reasons for increasing the train-pedestrian fatalities and accidents rate. It was reported in the study of Pelletier (1997) that in North Carolina 82% deaths were due to intake of alcohol and 78% having above 100 milligrams per deciliter alocohol levels in their blood. Lerer and Matzopoulos (1996) reported that in Cape Town 78% of the train-pedestrian deaths had high blood alcohol levels. Cina et al. (1994) stated that in South Carolina, 80% of 25 fatalities had blood alcohol levels in surplus of 99 mg/dL. The study by Moore et al. (1991) discovered 13 of 15 victims injured had presence of alcohol. Again, Symonds (1994) reviewing train fatalities in southern England (Symonds, 1985), stated alcohol to be a factor. It was reported that there are many cases where crashes took place when people were due to the control of drugs (Silla and Luoma, 2009). It was stated that in an Australian study 47.3% of suicide victims and 29.8% of total train suicide victims had the trace of alcohol within them before the crash (De Leo & Krysinska, 2008). The study by U.S FRA (2008) stated that from 2002 to 2004 the fatalities were 936 where the sufferers were trespassers under the control of alcohol which was mentioned in the study (Ghomi et al., 2016). So, these deadly narcotics are not only ruining someone's life but also taking away their safety from life.

2.5 Reasons of Jaywalking at Level Crossing

2.5.1 Running Late:

Most of the pedestrians cross the railway track taking the risks as they are running late. Even if there is an over bridge most of the pedestrians chose to cross the railway walking through the track instead of over bridge if it takes more time to use it. Pedestrians give importance to time instead of the rules and safety. In a survey, about 55% of the people stated that they violate the rules of crossing safely when they are running late (Freeman & Rakotonirainy, 2015). In the current context, it is found that running late to be a crucial cause for violating trespassing rules. A study collected data from (Board 2007) where it was found that people tend to use shorter paths so that they do not run late to their destination instead of having to cross bridges (Zhang et al., 2018).

Rush is a cause to take risk while crossing the railway (Beanland et al., 2013). So, putting life at stake just to save a minute and jumping under the train can never be the goal in anyone's life.

2.5.2 Warning and Waiting Time:

If the warning time is more, pedestrians have to wait for a longer time for railway level crossing. At a point, they get impatient and take risky decisions of crossing through tracks which may result in accidents. Longer warning duration can decline warning reliability and motivate the pedestrian to take risky decisions and break the crossing rules (Kadiyala et al., 2016). In the study of Larue et al. (2019) in Brisbane, Australia 28s was used as the minimum warning time and 75s was used as high warning time. And in the case of the US, warning times above 60s are taken to be long (Yeh et al., 2014). From the current study it is observed that people tend to break the crossing rules deliberately when waiting times increase (Yeh & Multer, 2008). So, the authority should put an optimum time interval and pedestrians also should understand that the importance of their lives is much more important than these few minutes of warning time.

2.5.3 Violation of laws and order:

Violation of pedestrian rules and regulations to greater threats to rail pedestrian crashes and fatality. Freeman and Rakotonirainy (2017) made a study with 636 volunteers where 24.52% violated the laws related to level crossings whereas this rate was only 3.46% who made crossing errors. The most effective ways to deter such violations were by facing injuries and feeling ashamed of their misdeeds. Moreover, it was mentioned that the violations were further reduced by increasing the presence of police. A study of Beanland et al. (2015) with title "Variability in decision-making and critical cue use by different road users at rail level crossings" provides information that pedestrians were more interested in crossing railway lines violating rules and orders just before a train approaches. So, the stoppage of rules violation will certainly pave a way to decrease the pedestrian crashes to a greater extent.

2.6 Effect of Time on Pedestrian-Rail Crashes:

Time of occurrence of train-pedestrian accidents mostly in cases of suicides vary from age to age, months and weekdays. From a study of Silla and Luoma (2012) of Finnish it was observed that more than half which is 52.3% suicides took place in May, July, August, November or December

and higher number of train-pedestrian crashes take place in March and November. Both accidents (65.7%) and suicides (49.2%) take place more frequently during the weekends (from Friday to Sunday). Suicides are seen mostly in afternoon, evening and after midnight. Crashes are mostly seen in the afternoon rush hour which is between 3 p.m. to 6 p.m. In case of suicides, people less than age of 30 years commit suicide at evening and night whereas it is from noon to midnight for older people. Most of the crashes took place in the darkness and are less in case of summer month (Zhang et al., 2018). Most of the accidents that were noted took place during 7:00 pm to 12:00 am. (Ghomi et al., 2016). So, there should be arrangements for both security and enough light systems around the railway lines.

2.7 Punishments:

In many studies it was observed that punishments are more effective to decrease unsafe crossing than education and awareness. In a book (Cooper et al., 2019) different kinds of ways were implemented to reduce the unsafe crossing like education, awareness, punishments. The result from the study depicted that punishments are more effective than other ways to reduce the unsafe crossing of pedestrians. In other studies (Hill, 1984; Lobb et al., 2001) states that there may be a need to enforce penalties along with education and awareness programs to reduce the unsafe crossing. According to the results of many studies, it is stated in the study of Lobb (2006) that punishment alone may be sufficient. In another study of Lobb et al. (2003) the unsafe crossing of school boys was able to decrease by continuous and intermittent punishments which resulted in approximately 12.5% and 12.5% to 20% respectively from 37.5% - 50%. In Rail Safety and Standards Board, 2007 it was stated that to reduce the unsafe crossing punishments should be applied (Silla & Luoma, 2012). So, from all these studies it can be concluded that punishments are more efficient to reduce the unsafe crossing by pedestrians than any other way.

Figure 1: Different types of incautious pedestrians

Figure 2: Pedestrian walking on track in front of an oncoming train

CHAPTER 3: DATA AND METHODOLOGY

3.1 Introduction

This chapter explains the procedure of data collection procedure, formulation of data and the methodology used in the determination of different risk-taking cohorts. Ordered probit model has been used because of the ordinal nature of the dependent variable used in the study. The formulation of this model will help us to find out the significant factors influencing safety perceptions of the pedestrian to accomplish the prime purposes of the study.

3.2 Questionnaire Preparation

Our study proceeded with the preparation of questionnaire. The questionnaire was made taking ideas from literature reviews done previously in researches about the pedestrians at level crossings in different nations of the world. Local context of the surrounding areas of the grade crossings were taken into considerations in order to find the real scenario and a pilot survey or a preliminary study was done as well in order to check feasibility regarding different issues.

The whole of the questionnaire were again divided into 8 sub-groups namely socioeconomic conditions, demographic traits of the individuals, experiences regarding any train-pedestrian crashes interviewees ever faced or witnessed, situational cases, personal crossing characteristics, safety related knowledge and perception as well as awareness.

3.3 Data Collection

Data were collected in two ways. There were a total of 250 respondents who took part in the interview. 202 of them responded via direct interview around the grade crossings. These interviews were taken in 6 different locations of Dhaka city. Those include the level crossings located at Kawranbazar, Moghbazar, Malibagh, Mohakhali and two crossings at the Tejgaon region. The rest 48 interviewees were those who reside around us.

Age, gender, education, area of living and many more were asked to know about the socioeconomic condition of the individuals. Different situations about the presence of safer alternative, absence of rail gates and so on were mentioned and their decision was asked about those situational cases. They were asked to know whether they have ever witnessed any run-over

incident or any of their near and dear ones got victimized with crashes in order to know about their accident experiences. The interviewees shared their ideas regarding safety rules and regulations and various safety signals while questions were asked about safety knowledge. Safety perceptions related questions included usages of different electronic gadgets and distractions while trespassing. Pedestrians' frequency of level crossing, destinations etc. were questions about their personal crossing characteristics. Surrounding condition related questions include the level of congestions in the crossings they use, its quality conditions of the lights and so on. Lastly, they were asked about different punitive measures taken while breaking the law, participations in safety related programs to get idea about their awareness issues.rossing characteristics, safety related knowledge and perception as well as awareness.

3.3 Discussion of the Model

Ordered probit model has been used in the study since the dependent variable is ordinal in nature. This model assumes normal distribution of the error.

Ordered Probit Model Equation:

$$y_i^* = x_i\beta + \varepsilon_i$$

here, y_i^* is considered to be a dependent variable which is latent, unobservable and continuous, xi refers to a (1 x K) row vector of explanatory variables, β is unknown parameter having column vector of (k x 1) and εi are the random errors or independent variables which are distributed identically having a probability density function denoted as f (ε,θ), where θ is considered as a distributional parameter. (Johnston et al., 2020)

In order to set the dependent variable, three different distances from the position of a pedestrian to the train were mentioned. The distances were <10m, in between 10 to 20m above 20m. These were ordered as 3,2, and 1 respectively. And here, ordered probit model has been used since the dependent variables are ordinal in nature. On the other hand, the total number of independent variables obtained from questionnaire survey were 54.

The ordered probit model was run using the STATA 15 software and Microsoft Excel was also used in order to sort out different issues of the data obtained from the questionnaire survey.

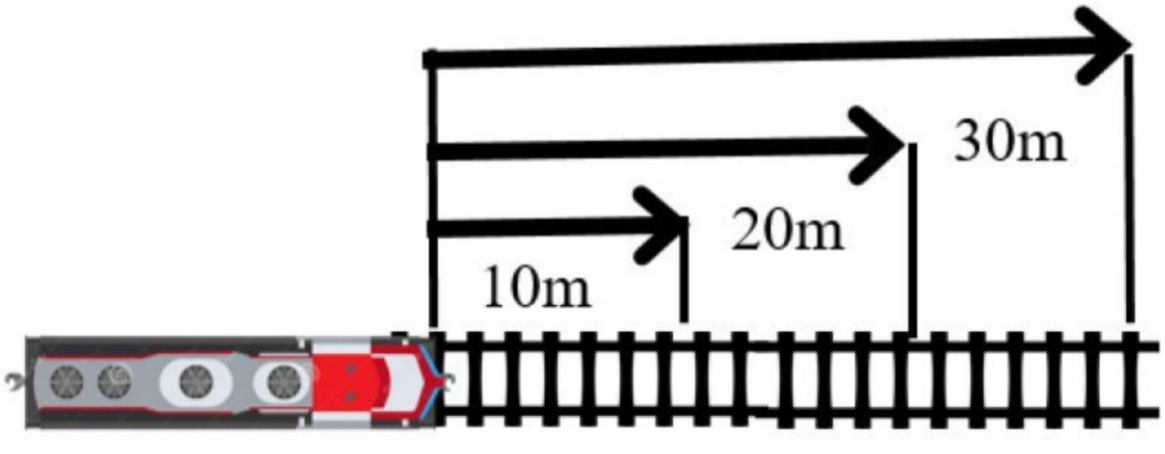

Figure 3: Distance between pedestrian and oncoming train

Table 1: Summary Statistics of the Explanatory variables used in the models

Explanatory variables(factors in bold)	Description of the variables	Mean	Standard Deviation
1. Situational Case			
i. Cross a railway line when flash lights are lightened up	If No=1, otherwise=0	0.6	0.491
ii. train coming in two different tracks from both sides	If Cross=1, otherwise=0	0.144	0.352
iii. Decision of pedestrian in case of presence of a child, aged or disabled person with him when a train is coming	If Waiting until the train is gone=1, otherwise=0	0.924	0.266
iv. Crossing the track while remain intoxicated	If No=1, otherwise=0	0.892	0.311
v. Decision in presence of safe alternative when distance is same	If Crossing the track=1, otherwise=0	0.248	0.433
vi. Being warned while not crossing a railway track safely	If Yes=1, otherwise=0	0.568	0.497
vii. Crossing a railway track out of rush when a train is coming	If No=1, otherwise=0	0.648	0.479
viii. Warning anyone for unsafe crossing	If No=1, otherwise=0	0.652	0.477

ix. Decision when an oncoming train is too near	If Cross=1, otherwise=0	0.196	0.398
x. Detection of train's presence when barrier remains non-functional			
When the train is visible	If the train is visible=1, otherwise=0	0.412	0.493
Hearing the train noise	If hearing the train noise=1, otherwise=0	0.248	0.433
Hearing the bell ringing	If hearing the bell ringing=1, otherwise=0	0.34	0.475
xi. Decision when something got fallen off on the other side of the track but train is too near	If No=1, otherwise=0	0.812	0.391
xii. Risking while staying in a group	If No=1, otherwise=0	0.688	0.464
xiii. Decision to cross in between two trains coming at a very short interval	If Yes=1, otherwise=0	0.54	0.499
2. Accident Experience			
i. Any known victim	If Yes=1, otherwise=0	0.292	0.456
ii. witnessing any run over incident during level crossing	If Yes=1, otherwise=0	0.736	0.442
iii. Any idea or knowledge about road signs used in level crossing	If Yes=1, otherwise=0	0.512	0.501
3. Safety Knowledge			
i. Any idea or knowledge regarding the rules and regulations to be followed as railway pedestrian	If Yes=1, otherwise=0	0.548	0.499
ii. Any idea about different types of signals and flash lights	If Yes=1, otherwise=0	0.54	0.499
4. Safety Perception			
i. Reason behind using the main railway track when an alternative safer option is present			
Running Late	If Running Late=1, otherwise=0	0.424	0.495
Shorter Distance	If Shorter Distance=1, otherwise=0	0.576	0.495
ii. Checking both sides while crossing a railway line	If Yes=1, otherwise=0	0.888	0.316
iii. reason behind unsafe crossing			
Running Late	If Running Late=1, otherwise=0	0.608	0.489
Unconscious Mind	If Unconscious Mind=1, otherwise=0	0.392	0.489
iv. Frequency of using unsafe crossing			
Often	If Often=1, otherwise=0	0.644	0.48
Sometimes	If Sometimes=1, otherwise=0	0.268	0.444
Rare	If Rare=1, otherwise=0	0.088	0.284
v. Using mobile phone while crossing railway lines	If No=1, otherwise=0	0.696	0.461
vi. Getting distracted in any other ways while crossing railway lines	If No=1, otherwise=0	0.548	0.499

vii. Jaywalking other than railway crossing	If No=1, otherwise=0	0.48	0.501
viii. Cross the railway track when the barriers are closed	If No=1, otherwise=0	0.5	0.501
ix. Safer option between Manually Controlled and Automatic	If Automatic=1, otherwise=0	0.54	0.499
x. Supporting vendors and slum dwellers around the railway line	If No=1, otherwise=0	0.692	0.463
xi. Safe timing to cross a track	If Day=1, otherwise=0	0.892	0.311
xii. Sitting or lying inside a railway track	If No=1, otherwise=0	0.72	0.450
xiii. maximum duration preferred for the warning bell to ring			
25 seconds	If 25 seconds=1, otherwise=0	0.16	0.367
50 seconds	If 50 seconds=1, otherwise=0	0.456	0.499
75 seconds	If 75 seconds=1, otherwise=0	0.384	0.487
xiv. Using railway track for recreational purpose	If No=1, otherwise=0	0.628	0.484
5. Personal Crossing Characteristics			
i. Frequency of using railway track			
Daily	If Daily=1, otherwise=0	0.532	0.500
Weekly	If Weekly=1, otherwise=0	0.24	0.428
Monthly	If Monthly=1, otherwise=0	0.228	0.420
ii. Reason of crossing the railway track			
Home	If Home=1, otherwise=0	0.336	0.473
Market	If Market=1, otherwise=0	0.404	0.492
Office	If Office=1, otherwise=0	0.26	0.440
iii. Returning using same crossing	If Yes=1, otherwise=0	0.728	0.446
iv. Any sort of physical problems restricting movement	If Yes=1, otherwise=0	0.188	0.391
v. Most frequent crossing hour for the pedestrian			
Morning	If Morning=1, otherwise=0	0.452	0.499
Afternoon	If Afternoon=1, otherwise=0	0.268	0.444
Evening	If Evening=1, otherwise=0	0.24	0.428
Night	If Night=1, otherwise=0	0.04	0.196
vi. Location of the crossing used by the Pedestrian			
Moghbazar	If Moghbazar=1, otherwise=0	0.208	0.407
Malibagh	If Malibagh=1, otherwise=0	0.181	0.301
Mohakhali	If Mohakhali=1, otherwise=0	0..178	0.295
Tejgaon	If Tejgaon=1, otherwise=0	0.232	0.375
Kawranbazar	If Kawranbazar=1, otherwise=0	0.201	0.326
vii. Suffering from depression	If Yes=1, otherwise=0	0.208	0.407

6. Surrounding Conditions			
i. Surrounding land use pattern around the railway crossing which you usually use			
Residential Area	If residential area=1, otherwise=0	0.304	0.461
Market Place	If Market Place=1, otherwise=0	0.408	0.492
Commercial Area	If commercial Area=1, otherwise=0	0.288	0.454
ii. Traffic condition around the railway crossing			
Congested with all types of vehicles	If congested with all types of vehicles=1, otherwise=0	0.368	0.483
Congested with larger vehicles (bus, truck)	If congested with larger vehicles (bus, truck)=1, otherwise=0	0.084	0.278
Congested with small and medium vehicles (bike, CNG, rickshaw, car)	If congested with small and medium vehicles (bike, CNG, rickshaw, car)=1, otherwise=0	0.496	0.501
Traffic density is less most of the time	If traffic density is less most of the time=1, otherwise=0	0.052	0.222
iii. If the quality condition of the lights around the surroundings good	If No=1, otherwise=0	0.524	0.500
iv. Any alternative ways to cross other than the rail track crossing	If Yes=1, otherwise=0	0.216	0.412
7. Awareness			
i. Hearing anything regarding safe level crossing	If Yes=1, otherwise=0	0.512	0.501
ii. Participation in awareness programs	If Yes=1, otherwise=0	0.196	0.398
iii. If punishment is an effective measure to control violation of rail crossing rules	If Yes=1, otherwise=0	0.66	0.475
iv. Media of hearing about Safety issues			
No	If No=1, otherwise=0	0.16	0.367
Radio	If Radio=1, otherwise=0	0.048	0.214
TV	If TV=1, otherwise=0	0.228	0.420
Road Safety Week	If Road Safety Week=1, otherwise=0	0.064	0.245
Safety Awareness Day	If Safety Awareness Day=1, otherwise=0	0.072	0.259
Newspaper	If Newspaper=1, otherwise=0	0.184	0.388
Internet	If Internet=1, otherwise=0	0.244	0.430
8. Socioeconomic Characteristics			
i. Age			
Less than 25	If Less than 26=1, otherwise=0	0.34	0.475
25 to 45	If 26 to 45=1, otherwise=0	0.408	0.492
45 to 65	If 46 to 65=1, otherwise=0	0.22	0.415
Above 65	If above 66=1, otherwise=0	0.032	0.176

ii. Gender			
Male	If Male=1, otherwise=0	0.632	0.483
Female	If Female=1, otherwise=0	0.368	0.483
iii. Profession			
Student	If Student=1, otherwise=0	0.336	0.473
Vendor	If Vendor=1, otherwise=0	0.152	0.360
Teacher	If Teacher=1, otherwise=0	0.116	0.321
Housewife	If Housewife=1, otherwise=0	0.08	0.272
Serviceholder	If Serviceholder=1, otherwise=0	0.052	0.222
Others	If others=1, otherwise=0	0.264	0.442
iv. Education			
Uneducated	If Uneducated=1, otherwise=0	0.072	0.259
Primary	If Primary=1, otherwise=0	0.156	0.364
SSC	If SSC=1, otherwise=0	0.12	0.326
HSC	If HSC=1, otherwise=0	0.32	0.467
Graduate	If Graduate=1, otherwise=0	0.188	0.391
Post Graduate	If Post Graduate=1, otherwise=0	0.144	0.352
v. Area of Living			
Solvent Area	If Solvent area=1, otherwise=0	0.076	0.266
Average Solvent Area	If Average Solvent area=1, otherwise=0	0.352	0.479
Less Solvent Area	If Less Solvent area=1, otherwise=0	0.304	0.461
Economically Disadvantageous Area	If economically disadvantageous area=1, otherwise=0	0.268	0.444
vi. Mode of transport most frequently used			
Pedestrian	If pedestrian=1, otherwise=0	0.716	0.452
Bus	If bus=1, otherwise=0	0.048	0.214
Car	If car=1, otherwise=0	0.052	0.222
Rickshaw	If rickshaw=1, otherwise=0	0.136	0.343
CNG	If CNG=1, otherwise=0	0.04	0.196
Others	If others=1, otherwise=0	0.008	0.089
vii. If pedestrian resides beside a railway track	If Yes=1, otherwise=0	0.54	0.499

CHAPTER 4: RESULT AND ANALYSIS

4.1 Introduction

The main goal of this chapter is to understand the safety perception of the pedestrians along with the factors related to safety issues. Ordered probit model has been developed in this study.

4.2 Result and Discussion

Table 2: Estimated Parameter of the Model

Variables	Estimated Coefficient (β)	t-statistic	p-value
1. Situational Case			
i. train coming in two different tracks from both sides	-1.167	-4.17	0.001
ii. Decision in presence of safe alternative when distance is same	-0.490	-1.94	0.053
iii. Being warned while not crossing a railway track safely	-0.652	-3.53	0.001
iv. Decision to cross in between two trains coming at a very short interval	-0.511	-2.49	0.013
2. Safety Knowledge			
i. Any idea or knowledge regarding the rules and regulations to be followed as railway pedestrian	0.385	1.93	0.053

3. Safety Perception			
i. Frequency of using unsafe crossing			
Often	1.797	5.26	0.001
Sometimes	1.101	3.25	0.001
ii. Supporting vendors and slum dwellers around the railway line	0.454	1.91	0.057
iii. maximum duration preferred for the warning bell to ring			
25 seconds	-1.494	-5.56	0.001
4. Personal Crossing Characteristics			
i. Frequency of using railway track			
Daily	0.673	2.7	0.007
Weekly	0.792	2.91	0.004
ii. Reason of crossing the railway track			
Home	0.694	3.06	0.002
Market	0.707	3.15	0.002
iii. Location of the crossing used by the Pedestrian			
Malibagh	1.256	3.61	0.001
Mohakhali	1.292	3.73	0.001
Tejgaon	1.305	4.16	0.001

5. Surrounding Conditions			
i. Traffic condition around the railway crossing			
Congested with small and medium vehicles (bike, CNG, rickshaw, car)	0.747	3.52	0.001
ii. If the quality condition of the lights around the surroundings good	-0.444	-2.33	0.02
6. Awareness			
i. If punishment is an effective measure to control violation of rail crossing rules	0.438	2.27	0.023
ii. Media of hearing about Safety issues			
Radio	-0.919	-2.12	0.034
7. Socioeconomic Characteristics			
i. Age			
Less than 25	0.023	2.44	0.015
ii. Profession			
Student	0.650	2.28	0.023
Teacher	0.604	1.95	0.051
iii. Education			
Graduate	0.406	1.64	0.101

			Threshold Values	
No. of Obsevation	Log-Likelihood	Pseudo R^2	Cut 1 (τ_1)	Cut 2 (τ_2)
250	-170.305	0.343	2.102	3.755

4.2.1 Situational Case:

Four factors were found to have significant effect which are to cross the track when train is coming in two different tracks from both sides, crossing the track in presence of safer alternative even if distance is same, being warned while not crossing a railway track safely and to cross in between two trains coming at a very short interval.

When two trains converge near a crossing or station, pedestrians should thoroughly observe both directions before stepping onto the crossing, ensure their safety. It is crucial to remain vigilant in such situations. The table demonstrates a higher perception of safety of the pedestrians during crossing the tracks when trains are approaching from two separate tracks, each on a different side (-1.167, p=0.001). Pedestrians watching first train passing may try to remain patient and wait until the second train approaches from the other direction.

The results in Table-2 show a higher safety perception is associated with the pedestrians who prefer safer alternative if same distance is required to traverse while crossing using safer alternative and that very track (0.490, $p<0.1$). People tend to take risks more instead of using safer alternative. They try to prevent risks when same time is required to cross the track at any level crossing (Zhang et al., 2018).

Pedestrians belong to a low risk taking group with higher safety perception about passing a grade crossing who earns motivation when they are being warned by other people and then try to pay attention when a train is very near to them. The coefficient value (β) estimated from the STATA in this case was negative which denotes them to be a low risk taking cohort. The value was 0.652 in the negative and the p-value was 0.001. The mean and standard deviation obtained while summarizing the statistics were 0.568 and 0.497 respectively.

The decision-making of individuals during instances where two trains are approaching closely is critical in preventing rail-pedestrian collisions. Pedestrians show higher safety perception while taking decision to prevent crossing the track in between two trains coming at a very short interval. These type of people don’t usually take risks and the probable reason is their patience in crossing the tracks when a second train is arriving shortly after the first one since they are probably concerned that this risky behavior frequently leads to tragic consequence. The estimated

coefficient was -0.511 and p=0.013. Pedestrians may try to maintain safety protocols and wait when a train has recently passed and another train is expected to arrive shortly.

4.2.2 Safety Knowledge:

Knowledge regarding the rules and regulations which are to be followed as railway pedestrian is considered as a significant independent variable as p=0.053 (less than 0.1). The positive coefficient (0.385) indicates the safety perception of the pedestrians having safety knowledge is less. People may lack in ideas regarding rules and regulations to cross the track and the consequences of disobeying them in a proper manner. So, they perhaps tend to ignore the rules and don't pay any heed while level crossing. They prefer to use safer alternative instead of using the level crossing. These pedestrians seem like they prefer unsafe crossings in the level crossing. Education regarding railway safety is effective in safety unsafe crossings (Silla & Kallberg, 2016).

4.2.3 Safety perception:

Frequency of using unsafe crossing, not supporting the vendors and slum dwellers around the railway line and maximum duration preferred for the warning bell to ring were the three significant factors associated with safety perception.

The frequency at which individuals take risks at level crossings provides insights into their perceptions of safety while crossing railway tracks. It reveals whether people tend to take risks frequently, occasionally, or rarely when crossing the tracks as pedestrians. The table demonstrates lower safety perception in often using unsafe crossing (1.797, p=0.001) and also the same perception in using unsafe crossing occasionally (1.101, p=0.001). People tend to lose patience and cross the tracks while the track is unsafe. People are not seen to follow the right way at the grade crossing despite the presence of sidewalk or pathway, resulting in possibilities of crashes at such a potentially hazardous location (Siques, 2002).

From the analysis in Table-2 it is observed that the pedestrians supporting the vendors and slum dwellers around the railway line have less safety perception (0.454, p=0.057). When there are slum dwellers and vendors residing around the railway track, there are continuous movement of people through the rail tracks and even the kids residing in the slums play in the tracks. In such situation, there are high chance of accidents if they are not conscious enough. For this, pedestrians preferring the residing of slum dwellers and vendors around the railway track probably lack in knowledge

about the consequences. This reflects the lesser safety perception of the pedestrians supporting this situation.

Maximum duration preferred for the warning bell to ring were divided into 3 categories: 25 seconds, 50 seconds and 75 seconds. The results of Table-2 found that, in comparison to 50 seconds and 75 seconds, the safety perception is higher in case of 25 seconds (-1.494, p=0.001). When the warning bell rings for a longer time people may get impatient and tend to cross the railway track in spite of risky situation. Pedestrians preferring 25 seconds possibly remain patient to cross the track and tend to take more risky decisions of crossing through tracks if the warning time increases. People tend to break the crossing rules deliberately when warning time is long (Yeh & Multer, 2008).

4.2.4 Personal Crossing Characteristics:

The three significant factors associated with it were frequency and reason of using railway track and its location.

People who frequently cross railway tracks as pedestrians find it easier to prioritize safety during the crossing. Those who cross the tracks on a daily or weekly basis are found to be less safety-conscious compared to those who do so monthly. People generally exhibit a lower level of awareness and caution when they cross the track on a daily or weekly basis, as opposed to doing so monthly. The results indicate a significant positive estimated coefficient value proving a low perception of safety and the daily crossing of a railway track in people's everyday lives (β=0.673, p=0.007). Similarly, there is also a significant lower perception of safety among the pedestrians crossing a railway track weekly (estimated coefficient: 0.792, p=0.004). It is noteworthy that individuals residing near railway tracks utilize level crossings frequently to traverse the tracks for their everyday activities. As a result, they may not pay any attention to the approaching train which may result in severe crashes.

The questionnaire survey provides an information that a significant number of pedestrians cross the railway track in order to be at two certain locations. One of the destinations is pedestrians' own home and the other is shopping or market place. Both of the home and market possessed a positive value of the estimated coefficient (β) which value of 0.694 and 0.707 respectively proves their lower safety perception in using railway lines, both having p-value of 0.002. The mean values were 0.336 and 0.404 and standard deviation were 0.473 and 0.492 for home and market

respectively. Home is a common destination for every human being. They are destined to return home eventually. And market is a common place for shopping day to day commodities. So there is a high probability that they have higher frequencies of going to home and market. Since most of them requires to cross the track during going to the afore mentioned destination, so these higher frequencies of using railway track have made them habituated with the existing situation of the level crossing and its surroundings, for which they probably do not care about the oncoming trains across the track from any direction. So these high risk taking cohort trespass the railway lines, which sometimes become the reason of severe crashes and fatalities.

Moreover, pedestrian using the Mohakhali, Tejgaon and Malibagh are also a part of this cohort. They also possess a lower perception of safety while crossing a railway track.

This was ensured with their positive β value of 1.292, 1.256 and 1.305 respectively. This high risk taking cohort belonging to Mohakhali, Tejgaon and Malibagh, all have a p-value of 0.001 from Table-2, whereas their mean obtain while summarizing the statistics were 0.096, 0.168 and 0.301 respectively and standard deviation were 0.295, 0.375 and 0.301 respectively from Table-1. They become the high risk taking group for the same reasons mentioned above.

4.2.5 Surrounding conditions:

Traffic and light condition around the railway crossing are the two significant factors related to this sub division.

The traffic condition around the railway crossing of significant cohort is mostly congested with small and medium vehicles e.g., Bike, CNG, Rickshaw, Car. The positive coefficient values 0.7466 and p=0.001 Due to the predominant usage of smaller vehicles, individuals may tend to remain busy focusing on these smaller vehicles while crossing the track and do not usually do not usually pay heed to any on larger vehicles like train, making them less risk cohort. On the other hand, when the lighting conditions near the railway track are adequate, pedestrians experience a sense of safety when crossing the track. The estimated coefficient associated with this aspect was -0.444, with a significant level of p=0.02. Pedestrians may generally feel safe crossing the railway tracks under conditions of proper lighting.

4.2.6 Awareness:

In case of awareness two factors were noticed to be significant which are punishment and media of hearing about safety issues.

According to the analysis as shown in the Table, supporting punishment as an effective measure to control unsafe railway crossing is a significant independent variable having a positive coefficient (0.437, p=0.023) which indicates more safety perception. When any pedestrian break the rules, they can be punished or penalized. Many pedestrians may get terrified due to the penalties that are enforced if rules are broken and tend to follow the regulations while level crossing to avoid penalties. To reduce the unsafe crossings punishment are suggested to be applied (Silla & Luoma, 2012).

In this era of science and technology, the use and expansion of radio has highly increased, thus people are able to listen to radio in mobile phone too. Lessons about the dangers of trespassing and usefulness of crossing the track in safer situation, old technology like radio probably has become a significant reason that increases the safety perception of pedestrian groups.

The table finds a negative value of the estimated coefficient β as 0.919 which proves the low risk taking tendency of the pedestrians who try to get aware after hearing about it via radio. The p-value obtained here is 0.034 with a mean of 0.048 and standard deviation of 0.214.

People using this technology may mostly be considered as a conscious citizen of the nation, resulting them to be highly aware in crossing railway tracks. These types of prevention from such risk taking tendencies would help in gaining safety perception may save them from severe fatalities.

4.2.7 Socioeconomic Condition:

Factors significantly effecting socioeconomic characteristics are age, profession and education.

Pedestrians were categorized into four age groups (<25, 25 to 45, 46 to 65, >65 years old) for the purpose of comparison. It is observed that pedestrians of age less than 25 are the highest risk taker or have least safety perception (0.023, p=0.015) among these four groups. Young people usually

have more interests in different types of adventurous activities. In order to fulfill their interests, they may try ignore the consequences that may arise if not followed and thus take risks even when a train is approaching or remains very near to the grade crossing (Wang et al., 2016). Whereas, many elderly people usually perceive better knowledge about them and remain more conscious, and probably would be able to save themselves from crashes more than the risk taking younger group.

The professions of the pedestrian were divided into 6 categories including student, vendor, teacher, housewife, service holder and others. Among these professions, students (p=0.023) and teachers (p=0.051) have lesser safety perception. Generally, students are adventurous in nature. And teachers may possess more knowledge but education usually play little role in making oneself least risk taker and thus it is not considered as an effective measure to save from train-pedestrian crashes. (Metaxatos & Sriraj, 2013).

The p-value obtained from the table for students was 0.023 and for the teachers, it was 0.051. The mean value of students and teachers were 0.336 and 0.116 respectively. And the standard deviation obtained were 0.473 and 0.321 respectively.

Graduates are seen to have a positive β value 0.406 and p-value of 0.101, this depicts a higher safety perception in them.

CHAPTER 5: CONCLUSION & RECOMMENDATION

5.1 Introduction

The chapter comes to a conclusion with the key findings of the study along with recommending necessary policies to the policy makers to make the high risk takers more aware.

5.2 Key Findings

The purpose of the study was to evaluate the trespassing characteristics of the pedestrians, identifying the significant safety perception factors of the high risk-taking cohort based on multifarious background. This study finds high risk-taking group to be those trespassing even during trains from both side is approaching within a small interval and during presence of safer alternatives. Worse quality condition of surrounding light and using radio to learn about pedestrian safety issues belong to this group as well. Besides high risk-taking pedestrian prefer 25 seconds only for warning bell to ring and they lack in safety perception so much that they are forced to be warned. On the contrary, people under 25, student, teachers, and graduates, pedestrians supporting punitive measures and having higher safety knowledge possess higher sense of safety perception. This cohort also encompasses them who trespass sometimes or often, on a weekly or daily basis, cross to go home or market and use crossings congested with small and medium vehicles and those of Malibagh, Mohakhali and Tejgaon region. Moreover, less risk-taking group discourage the presence of slum dwellers and vendors around the railway track.

5.3 Recommendations

The study would be helpful for the policy makers to make afore mentioned high risk taking more aware by organizing different safety related programs with a robust monitoring system. Furthermore, it would be helpful for strengthening the existing laws and placement of safety of signs around the crossings as required.

References

A24 News Agency. (2021, October 15). Bangladesh- Slums dotted with railway sides in Dhaka. *A24 News Agency*. https://a24na.com/archives/43145

Amelia, S., Lee, D. M., & Drew, D. (2012). *An investigation of risk-takers at railway level crossings* (No. PB020595). SPARK. https://www.sparkrail.org/Lists/Records/DispForm.aspx?ID=19620

Azzacy, M. B. (2012). *Analysis of rail accidents due to collision and their preventive measures in Bangladesh.* Bangladesh University of Engineering & Technology.

Bangladesh's deadliest train accidents in recent times. (2022). In *The Business Standard*. https://www.tbsnews.net/bangladesh/bangladeshs-deadliest-train-accidents-recent-times-467886

Beanland, V., Lenné, M. G., Salmon, P. M., & Stanton, N. A. (2013). A self-report study of factors influencing decision-making at rail level crossings: Comparing car drivers,. . . *ResearchGate*. https://www.researchgate.net/publication/259528131_A_self-report_study_of_factors_influencing_decision-making_at_rail_level_crossings_Comparing_car_drivers_motorcyclists_cyclists_and_pedestrians

Beanland, V., Lenné, M. G., Salmon, P. M., & Stanton, N. A. (2015). Variability in decision-making and critical cue use by different road users at rail level crossings. *Ergonomics*, *59*(6), 754–766. https://doi.org/10.1080/00140139.2015.1095356

Blazar, P. E., Dormans, J. P., & Born, C. T. (1997). Train Injuries in Children. *Journal of Orthopaedic Trauma*, *11*(2), 126–129. https://doi.org/10.1097/00005131-199702000-00011

Bukhardt, J.-M., Rådbo, H., Silla, A., & Paran, F. (2014). *A model of suicide and trespassing processes to support the analysis and decision related to preventing railway suicides and trespassing accidents at railways*. https://www.researchgate.net/publication/259381506_A_model_of_suicide_and_trespassing_processes_to_support_the_analysis_and_decision_related_to_preventing_railway_suicides_and_trespassing_accidents_at_railways

Cina, S. J., Koelpin, J. L., Nichols, C. A., & Conradi, S. E. (1994). A Decade of Train-Pedestrian Fatalities: The Charleston Experience. *Journal of Forensic Sciences*, *39*(3), 13644J. https://doi.org/10.1520/jfs13644j

Cooper, J., Heron, T., & Heward, W. (2019). *Applied Behavior Analysis* (3rd ed.). Pearson.

De Leo, D., & Krysinska, K. (2008). Suicidal Behaviour by Train Collision in Queensland, 1990–2004. *The Australian & New Zealand Journal of Psychiatry (ANZJP)*, *42*(9), 772–779. https://doi.org/10.1080/00048670802277263

Deisenhammer, E. A., Kemmler, G., De Col, C., Fleischhacker, W. W., & Hinterhuber, H. (1997). Eisenbahnsuizide und -suizidversuche in Österreich von 1990-1994. *American Psychological Association*, *68*(1), 67–73. https://doi.org/10.1007/s001150050098

Dhruba, G. M. (2014). Over 200 killed by trains in Dhaka in nine months. *bdnews24.com*. https://bdnews24.com/bangladesh/over-200-killed-by-trains-in-dhaka-in-nine-months?fbclid=IwAR3QWEBwtM4futowM9S-rDifbDVb8L3vCvw9F1rpsHZHGWxzD21NX3wiYFs

Evans, A. (2011). Fatal accidents at railway level crossings in Great Britain 1946–2009. *Accident Analysis & Prevention*, *43*(5), 1837–1845. https://doi.org/10.1016/j.aap.2011.04.019

Evans, A., & Hughes, P. (2019). Traverses, delays and fatalities at railway level crossings in Great Britain. *Accident Analysis & Prevention*, *129*, 66–75. https://doi.org/10.1016/j.aap.2019.05.006

Ferdous, M. Z., & Alam, A. (2021). Present situation of suicide in Bangladesh: A review. *medRxiv (Cold Spring Harbor Laboratory)*. https://doi.org/10.1101/2021.02.23.21252279

Filtness, A. J., Filtness, A. J., & Rodwell, D. (2018). The road user, the pedestrian, and me: Investigating the interactions, errors and escalating risks of users of fully protected level crossings. *Safety Science*, *110*, 80–88. https://doi.org/10.1016/j.ssci.2018.02.007

Filtness, A. J., Watling, C., Black, A., & Wood, J. M. (2019). Getting the Attention of Drivers Back on Passive Railway Level Crossings: Evaluation of Advanced Flashing Lights. *Transportation Research Record*, *2673*(2), 789–798. https://doi.org/10.1177/0361198119828679

Filtness, A. J., Watling, C., Black, A., & Wood, J. M. (2021c). Improving the safety of distracted pedestrians with in-ground flashing lights. A railway crossing field study. *Journal of Safety Research*, *77*, 170–181. https://doi.org/10.1016/j.jsr.2021.02.014

Freeman, J. E., & Rakotonirainy, A. (2015). Mistakes or deliberate violations? A study into the origins of rule breaking at pedestrian train crossings. *Accident Analysis & Prevention*, *77*, 45–50. https://doi.org/10.1016/j.aap.2015.01.015

Freeman, J. E., & Rakotonirainy, A. (2017). Can rail pedestrian violations be deterred? An investigation into the threat of legal and non-legal sanctions. *Transportation Research Part F: Traffic Psychology and Behaviour*, *45*, 102–109. https://doi.org/10.1016/j.trf.2016.11.016

Gabree, S. H., Chase, S., Doucette, A., & Martino, M. (2014, November 1). *Countermeasures to mitigate intentional deaths on railroad rights-of-way : lessons learned and next steps*. https://rosap.ntl.bts.gov/view/dot/12143

Ghomi, H., Bagheri, M., Fu, L., & Miranda-Moreno, L. F. (2016). Analyzing injury severity factors at highway railway grade crossing accidents involving vulnerable road users: A comparative study. *Traffic Injury Prevention*, *17*(8), 833–841. https://doi.org/10.1080/15389588.2016.1151011

Government of Canada, Transportation Safety Board of Canada. (2021, June 27). *Rail transportation occurrences in 2020 - Statistical Summary - Transportation Safety Board of Canada*. https://www.bst-tsb.gc.ca/eng/stats/rail/2020/sser-ssro-2020.html#fn5

Guo, Z., Chen, Z., Zhang, J., Guo, Q., He, C., & Zhao, Y. (2022). Characteristics of Train–Pedestrian Collisions in Southwest China, 2011–2020. *International Journal of Environmental Research and Public Health*, *19*(10), 6104. https://doi.org/10.3390/ijerph19106104

Halsey III, A. (2018, August 7). 'Suicide by train' is in decline, but deaths of people who trespassed on railroad tracks increased in 2017. *The Washington Post*. https://www.washingtonpost.com/local/trafficandcommuting/suicide-by-train-is-in-decline-but-deaths-of-people-who-trespassed-on-railroad-tracks-increased-in-2017/2018/08/06/a3d1a57e-9749-11e8-a679-b09212fb69c2_story.html

Hill, M. R. (1984). Walking, Crossing Streets and Choosing Pedestrian Routes: A Survey of Recent Insights from the Social/Behavioral Sciences. *DigitalCommons@University of Nebraska - Lincoln*, 66.

Johnston, C., McDonald, J. B., & Quist, K. (2020). A generalized ordered Probit model. *Communications in Statistics*, *49*(7), 1712–1729. https://doi.org/10.1080/03610926.2019.1565780

Jugantor. (2020, February 17). অরক্ষিত রেল ক্রসিং, ট্রেনে কাটা মৃত্যু থামছে না. *Jugantor*. Retrieved January 10, 2023, from https://t.ly/IpFI

Kadiyala, S., Gubbala, P., & Schrock, S. D. (2016). *Human Behavior at Railroad Grade Crossings*. https://doi.org/10.1115/jrc2016-5786

Kallberg, V., & Silla, A. (2017). Prevention of railway trespassing by automatic sound warning—A pilot study. *Traffic Injury Prevention*. https://doi.org/10.1080/15389588.2016.1203426

Khattak, A. J., & Luo, Z. (2011). Pedestrian and Bicyclist Violations at Highway–Rail Grade Crossings. *Transportation Research Record*, *2250*(1), 76–82. https://doi.org/10.3141/2250-10

Larue, G. S., Miska, M., Qian, G., Wullems, C., Rodwell, D., Chung, E., & Rakotonirainy, A. (2019). Effectiveness of treatments to reduce congestion at level crossings: A traffic simulation evaluation. *Transportation Research Board*.

Lerer, L. B., & Matzopoulos, R. (1996). Meeting the challenge of railway injury in a South African city. *The Lancet*, *348*(9028), 664–666. https://doi.org/10.1016/s0140-6736(96)02100-9

Lindekilde, K., & Wang, A. G. (1985). Train suicide in the county of Fyn 1979?82. *Acta Psychiatrica Scandinavica*, *72*(2), 150–154. https://doi.org/10.1111/j.1600-0447.1985.tb02587.x

Lobb, B. (2006). Trespassing on the tracks: A review of railway pedestrian safety research. *Journal of Safety Research*, *37*(4), 359–365. https://doi.org/10.1016/j.jsr.2006.04.005

Lobb, B., Harré, N., & Suddendorf, T. (2001). An evaluation of a suburban railway pedestrian crossing safety programme. *Accident Analysis & Prevention*, *33*(2), 157–165. https://doi.org/10.1016/s0001-4575(00)00026-9

Lobb, B., Harré, N., & Terry, N. (2003). An evaluation of four types of railway pedestrian crossing safety intervention. *Accident Analysis & Prevention*, *35*(4), 487–494. https://doi.org/10.1016/s0001-4575(02)00026-x

Marchand, B. (1974). Pedestrian Traffic Planning and the Perception of the Urban Environment: A French Example. *Environment and Planning A*, *6*(5), 491–507. https://doi.org/10.1068/a060491

Metaxatos, P., & Sriraj, P. S. (2013). Pedestrian/bicycle warning devices and signs at highrail and pathway-Rail grade crossings. In *https://apps.ict.illinois.edu/projects/getfile.asp?id=3083*.

Moore, T. A., Wilson, J., & Hartman, M. (1991). Train Versus Pedestrian Accidents. *Southern Medical Journal*, *84*(9), 1097–1098. https://doi.org/10.1097/00007611-199109000-00009

Nixon, J., Corcoran, A., Fielding, L., & Eastgate, J. (1985). Fatal and nonfatal accidents on the railways—a study of injuries to individuals. with particular reference to children and to nonfatal trauma. *Accident Analysis & Prevention*, *17*(3), 217–222. https://doi.org/10.1016/0001-4575(85)90054-5

Ogwu, A. (2019). 535 People Wearing Headsets Crushed by Trains in Bangladesh – Report. *SIGNAL*. https://www.signalng.com/535-people-wearing-headsets-crushed-by-trains-in-bangladesh-report/?fbclid=IwAR38IC2ORWws2qBVMvwRnNWLlSPtDSscMZW3pcCHSjxzUUIlEBuHWycWV_c

Patterson, T. (2004). *Analysis of Trespasser Accidents*.

Pelletier, A. R. (1997). Deaths Among Railroad Trespassers. *JAMA*, *277*(13), 1064. https://doi.org/10.1001/jama.1997.03540370054036

Rådbo, H., Svedung, I., & Andersson, R. (2008). Suicide prevention in railway systems: Application of a barrier approach. *Safety Science*, *46*(5), 729–737. https://doi.org/10.1016/j.ssci.2006.12.003

Rahman, M. A. (2022, August 6). *Unprotected railway level crossings are death traps*. The Asian Age. https://dailyasianage.com/news/291257/unprotected-railway-level-crossings-are-death-traps?fbclid=IwAR2vXYIp5IywPi1omVWBDDHHvIamkbaygEu3fAb7tapzqH8mRQ8X4o7mSq0

Rail trespasser fatalities demographic and behavioral profiles. (2013). In *U.S. Federal Railroad Administration*. https://railroads.dot.gov/elibrary/rail-trespasser-fatalities-demographic-and-behavioral-profiles-june-2013

Savage, I. (2007). Trespassing on the Railroad. *Research in Transportation Economics*, *20*, 199–224. https://doi.org/10.1016/s0739-8859(07)20008-3

Savage, I. (2016). Analysis of fatal train-pedestrian collisions in metropolitan Chicago 2004–2012. *Accident Analysis & Prevention*, *86*, 217–228. https://doi.org/10.1016/j.aap.2015.11.005

Schmidtke, A. (1994). Suicidal behaviour on railways in the FRG. *Social Science & Medicine*, *38*(3), 419–426. https://doi.org/10.1016/0277-9536(94)90441-3

Silla, A. (2022b). Identifying measures with the highest potential to reduce suicides on Finnish railways. *Applied Ergonomics*, *102*, 103748. https://doi.org/10.1016/j.apergo.2022.103748

Silla, A., & Kallberg, V. (2016). Effect of railway safety education on the safety knowledge and behaviour intention of schoolchildren. *Evaluation and Program Planning*. https://doi.org/10.1016/j.evalprogplan.2015.11.006

Silla, A., & Luoma, J. (2009). Trespassing on Finnish railways: identification of problem sites and characteristics of trespassing behaviour. *European Transport Research Review*, *1*(1), 47–53. https://doi.org/10.1007/s12544-008-0005-y

Silla, A., & Luoma, J. (2011). Effect of three countermeasures against the illegal crossing of railway tracks. *Accident Analysis & Prevention*, *43*(3), 1089–1094. https://doi.org/10.1016/j.aap.2010.12.017

Silla, A., & Luoma, J. (2012). Main characteristics of train–pedestrian fatalities on Finnish railroads. *Accident Analysis & Prevention*, *45*, 61–66. https://doi.org/10.1016/j.aap.2011.11.008

Siques, J. T. (2002). Effects of Pedestrian Treatments on Risky Pedestrian Behavior. *Transportation Research Record*, *1793*(1), 62–70. https://doi.org/10.3141/1793-09

Stefanova, T. S., Burkhardt, J., Wullems, C., Freeman, J. E., Rakotonirainy, A., & Delhomme, P. (2015). Direct Observations of Pedestrian Unsafe Crossing at Urban Australian Level Crossings. *Urban Rail Transit*, *1*(2), 112–130. https://doi.org/10.1007/s40864-015-0022-9

Symonds, R. L. (1985). Psychiatric aspects of railway fatalities. *Psychological Medicine*, *15*(3), 609–621. https://doi.org/10.1017/s0033291700031469

Symonds, R. L. (1994). Psychiatric and preventative aspects of rail fatalities. *Social Science & Medicine*, *38*(3), 431–435. https://doi.org/10.1016/0277-9536(94)90443-x

Total number of railway fatalities including suicides in Great Britain (UK) from 2013/14 to 2020/21. (2021). In *Statista*. https://www.statista.com/statistics/305441/total-number-of-railway-injuries-in-great-britain-uk-by-level-of-injury/#main-content

Van Houwelingen, C. T. M., & Kerkhof, A. J. F. M. (2008). Mental healthcare status and psychiatric diagnoses of train suicides. *Journal of Affective Disorders*, *107*(1–3), 281–284. https://doi.org/10.1016/j.jad.2007.08.024

Wali, B., Khattak, A. J., & Ahmad, N. (2021). Injury severity analysis of pedestrian and bicyclist trespassing crashes at non-crossings: A hybrid predictive text analytics and heterogeneity-based statistical modeling approach. *National Library of Medicine*, *150*, 105835. https://doi.org/10.1016/j.aap.2020.105835

Wang, X., Liu, J., Khattak, A. J., & Clarke, D. J. (2016). Non-crossing rail-trespassing crashes in the past decade: A spatial approach to analyzing injury severity. *Safety Science*, *82*, 44–55. https://doi.org/10.1016/j.ssci.2015.08.017

Ward, N. D., & Wilde, G. J. S. (1995). Field observation of advance warning/advisory signage for passive railway crossings with restricted lateral sightline visibility: An experimental investigation. *Accident Analysis & Prevention*. https://doi.org/10.1016/0001-4575(94)00057-s

Wigglesworth, E. C. (2001). A human factors commentary on innovations at railroad–highway grade crossings in Australia. *Journal of Safety Research*, *32*(3), 309–321. https://doi.org/10.1016/s0022-4375(01)00053-6

Witte, K., & Donohue, W. A. (2000). Preventing vehicle crashes with trains at grade crossings: the risk seeker challenge. *Accident Analysis & Prevention*, *32*(1), 127–139. https://doi.org/10.1016/s0001-4575(99)00061-5

Yeh, M., & Multer, J. (2008). *Driver behavior at highway-railroad grade crossings : a literature review from 1990-2006*. https://rosap.ntl.bts.gov/view/dot/8929

Yeh, M., Multer, J., & Raslear, T. (2014). An examination of the impact of five grade-crossing safety factors on driver decision making. *Journal of Transportation Safety & Security*. https://doi.org/10.1080/19439962.2014.959584

Zhang, Z., Trivedi, C., & Liu, X. (2018). Automated detection of grade-crossing-trespassing near misses based on computer vision analysis of surveillance video data. *Safety Science, 110,* 276–285. https://doi.org/10.1016/j.ssci.2017.11.023