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Safety Perception of Pedestrians at Level Crossings in Bangladesh

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Abstract

Rail-pedestrian crashes are a persisting tragedy in Bangladesh with inevitable fatalities. While research regarding road-pedestrian crashes is common, research on railway-pedestrian crashes is still insignificant. Current study explores the safety perception of pedestrians at level crossing by finding the influence of various demographic traits, suicidal ideation, distractions from electronic gadgets and other factors behind pedestrian crashes on railways. A questionnaire with 8 sub-groups namely socioeconomic characteristics, situational case, safety knowledge and perception, awareness etc. was utilized to collect data from 250 rail-road trespassers from 8 different level crossings. Predictor variables were formed utilizing survey responses while respondents' assessed safe distance to cross the railway track in front of an oncoming train was the dependent variable. Due to dependent variable's ordinal nature, ordered probit analysis was conducted to find the significant factors influencing the safety perception of pedestrians. The model concludes by finding the most and least risk-taking cohort. The study reveals the less safety-conscious pedestrian cohort to the policymakers so that necessary measures can be taken by introducing safety education for them and implementing robust monitoring systems near railroads.

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

1 Introduction

Railway-pedestrian collisions are common in nations with a high density of level crossings, such as Bangladesh. Furthermore, because of the socio-demographic features, the rate of such collisions is higher in the developing countries. Statistical analysis of railway network in Finland, a developed nation, shows that it faced 311 railway pedestrian fatalities from 2005-2009 (Silla and Luoma, 2012). The Transportation Safety Board of Canada reports an 11% decrease in railway accidents over a ten-year period from 2010 to 2019 (Government of Canada, Transportation Safety Board of Canada, 2021). According to another study, 2090 train-pedestrian collisions occurred in China between 2011 and 2020, with 1173 people killed and 963 injured (Guo et al., 2022). However, developing nation like Bangladesh breaks all of the aforementioned records, coming in first place with 95% of all railway pedestrian accidents at different level crossings (Rahman, 2022) and 300 fatalities and 250 injuries annually (Jugantor, 2020). According to a report, there were 68 collisions in 44 manned Authorized Level Crossing Gate, 75 crashes in 62 unmanned Authorized Level Crossing Gate, and 20 collisions in crossings where neither the manned nor unmanned status of the gate could be determined (Azzacy, 2012). Headphone usage (Ogwu, 2019), suicidal tendencies (Ferdous and Alam, 2021), presence of vendors (Dhruba, 2014) and slum dwellers (A24 News Agency., 2021) are some of the major causes behind railway pedestrian crashes in Bangladesh. Lack of proper monitoring and penalty imposition also encourage people in unsafe level crossing. Despite extensive research on vehicle pedestrian collisions, current literature still fails to explore railway-pedestrian crashes properly. Therefore, this study addresses this knowledge gap to help authorities reduce the number of fatalities and injuries resulting from pedestrian rail crashes in Bangladesh by evaluating the safety perception of pedestrian at level crossing.

2 Literature Review

The literature review of the relevant studies was broadly divided into several features focusing on the factors affecting rail-pedestrian crashes such as socioeconomic and demographic traits, safety issues, unsafe behaviors, and punishment. Their effects are described below:

2.1 Personal Characteristics:

2.1.1 Age:

In the occurrence of train-pedestrian collision, age is a critical factor. The age range of people involved in train-pedestrian collisions differs across cities and countries. 51.4% of Finnish train-pedestrian fatalities involved people between 10-29 years old (Silla and Luoma, 2012). According to Illinois Commerce Commission (2009), people between 40-49 years old are more accident prone (Ghomi et al., 2016).

2.1.2 Gender:

Gender is sometimes considered as a factor influencing the fatalities and injuries rate in case of railway crossing. Generally, both males and females are equally responsible for the accidents found in a study (Ghomi et al., 2016) but in another study (Silla and Luoma, 2012), it is observed that the male and female accident ratio is 3.4:1.

2.1.3 Education:

It is noticed that educated people remain aware while level crossing. A session continued for 45 minutes regarding railway safety provided in a few schools had an effective result in preventing unsafe crossings (Silla and Kallberg, 2016), although another study found it less effective (Lobb et al., 2003).

2.1.4 Mental illness and suicidal tendencies:

Pedestrians suffering from mental illness frequently don't remain aware of the situation and attempt to stroll through dangerous tracks. A study found that suicide victims had greater mental illness (39.2%) than accident victims (Silla and Luoma, 2012). About 20% to 27% of train crashes are noted as suicides (Gabree et al., 2014).

2.1.5 Pedestrian Distraction

Many pedestrians cross railway lines while being distracted by electronic gadgets. A study (Filtness et al., 2021) observed that 41.9% out of a total of 585 pedestrians were found to talk on mobile or looking at its screen. Such distractions are 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:

People are seen to taking more risks instead of using the over bridge, preferring a shorter or easier way (Silla and Luoma, 2009). Another study stated limited options for the pedestrians to cross the railway safely (Filtness et al., 2018).

2.2.2 Warning signs and devices:

Severe crash occurs when people fail to see the traffic signal indications properly. A sound warning system reduced the number of trespassers in two sites in Finland by 18% and 44% (Kallberg and Silla, 2017). Flashing light is suggested to use as warning while the train is approaching (Filtness et al., 2019).

2.3 Unsafe Behaviors

2.3.1 Risk taking behavior of Young People:

The young people tend to have more curiosity and thrill-seeking tendencies which is a major cause for crashes (Amelia et al., 2012). It was mentioned in a study (Zhang et al., 2018) that 18.88%, 4.1% and 8.2% of rail crashes are taking place due to climbing or jumping, running or walking and crawling respectively.

2.3.2 Use of Narcotics:

Crossing the railway track being intoxicated is one of the reasons for increasing the train-pedestrian fatalities and accidents rate. According to a study conducted by the US FRA (2008) there are 936 fatalities between 2002 and 2004, when the victims being trespassers under the influence of alcohol (Ghomi et al., 2016).

2.4 Punishments:

According to Rail Safety and Standards Board (2007), implementation of punishments is necessary to reduce unsafe crossing (Silla and Luoma, 2012).

Above literature showed that rail-pedestrian studies were rigorously done in developed nations to reduce such incidents. However, in the case of Bangladesh, there are few, if any, studies addressing this issue and more research is needed, specifically pedestrian safety perception on crossing the railway track in front of an oncoming train.

3 Methodology & Data Collection

With the aid of a questionnaire survey, data was collected from 250 respondents via direct interview from 6 different level crossings (Kawranbazar, Moghbazar, Malibagh, Mohakhali and two crossings at Tejgaon) and some people from our surroundings. The questionnaire was prepared based on previous literatures, local context and pilot survey. It consisted of 8 sub-groups namely socioeconomic condition, demographic traits, accident experience, situational case, personal crossing characteristics, knowledge and perception about safety and awareness. Some major questions were regarding age, gender, pedestrians' risk-taking tendency while in a group of people, their knowledge about the rules and regulations, usages of mobile phones while crossing railway lines, and so on.

In case of dependent variable, <10m, 10-20m and >20m distance from a pedestrian to an approaching train were ordered as 3, 2 and 1 respectively. Total of 54 independent variables were formed from the data collected using the questionnaire survey. Ordered probit model was used, since our dependent variable being ordinal in nature and the model was run using Stata 15 software. The general specification used is:

$$y_i^* = x_i\beta + \varepsilon_i \quad (1)$$

Where,
y_i= Latent, unobservable and continuous dependent variables
x_i= Row vector of explanatory variables
β= Column vector of unknown parameters
ε_i= Random Error

4 Result & Discussion

Table 1: 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
3. Safety Knowledge			
i. Any idea or knowledge regarding the rules and regulations to be followed as railway pedestrian	0.385	1.93	0.053
4. 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
5. 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
6. 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
7. 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
8. 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 Observation	Log-Likelihood	Pseudo R^2	Cut-1 (τ_1)	Cut-2 (τ_2)	
250	-170.305	0.343	2.102	3.755	

It is to be noted that, if the order of the dependent variable is higher, according to our model, the safety perception of the pedestrian is lower. Discussion on the results are as follows:

4.1 Situational Case:
Four factors were found to have significant effect: (i) not crossing the track when train is coming in two different tracks from both sides (ii) not crossing the track in presence of safer alternative even if distance is same (iii) being warned while not crossing a railway track safely and (iv) not crossing in between two trains coming at a very short interval. The result in the table indicates a higher safety perception of the pedestrians who don't cross the tracks when trains are approaching from two separate tracks, each on a different side (-1.167, p=0.001). Pedestrians may remain patient and not take risk noticing the first train passing and another approaching from the opposite side. Moreover, people using safer alternatives also fall in this cohort (-0.490, p=0.053), preventing risks, when it may take the same time to cross the level crossing (Zhang et al., 2018). Moreover, safety perceptions of trespassers may gradually increase when people around are warning them which motivates them to follow the rules and regulations (-0.652, p=0.001). Patient pedestrians, having higher safety perception (-0.511, p=0.013), probably don't break safety protocols and don't cross the track when another train is expected to arrive shortly.

4.2 Safety Knowledge:
Positive coefficient (0.385) and p=0.053 denotes lower safety perception of pedestrians lacking in safety knowledge and may not follow rules and regulations properly with awareness. Education regarding railway safety may be effective in reducing unsafe crossings (Silla and Kallberg, 2016).

4.3 Safety Perception:
Frequency of using unsafe crossing, allowing the vendors and slum dwellers around the railway line and maximum duration preferred for the warning bell to ring are the three significant factors associated with safety perception. People using railway tracks often (1.797, p=0.001) or sometimes (1.101, p=0.001) perhaps become habituated with surrounding conditions and don't focus on either side of the track whether a train is coming, resulting in crashes, identifying them as high-risk takers. Pedestrians who are slum dwellers and vendors reside around railway tracks even after knowing accidents are highly probable due to continuous pedestrian movements, are found to be high risk takers (0.454, p=0.057). The maximum duration preferred for the warning bell to ring is divided into 3 categories: 25 seconds, 50 seconds and 75 seconds. Safety perception is the highest in case of 25 seconds (-1.494, p=0.001). Higher waiting time may make people impatient and break the rules. Thus, providing a minimum time period for ringing bells discourages students from violating rules (Yeh and Multer, 2008).

4.4 Personal Crossing Characteristics:
The three significant factors associated with it are frequency and reason for using the railway track and its location. People crossing the track daily (0.673, p=0.007) or weekly (0.792, p=0.004) and going home (0.694, p=0.002) and market (0.707, p=0.002) belong to the high risk-taking cohort. Their higher frequency of using railway tracks may have made them habituated, thus not paying any heed to safety conditions. Moreover, pedestrians using the Mohakhali (1.292), Tejgaon (1.305) and Malibagh (1.256) crossing frequently, all having p=0.001, are also a part of this cohort and can be considered high risk takers for the same reason.

4.5 Surrounding Conditions:
Traffic and light conditions around the railway crossing are the two significant factors related to this subdivision. Pedestrians using crossings congested with small and medium vehicles (0.747, p=0.001) perhaps need to focus more to save themselves from those small vehicles and can't focus on the oncoming train, which decreases their safety perception. On the contrary, good lighting conditions probably makes the vision clear, resulting in higher safety perception of the trespassing group (-0.444, p=0.02).

4.6 Awareness:
Two significant factors of awareness are (i) not supporting punishment and (ii) medium of acquiring knowledge about safety issues. People who discourage punitive measures belong to the high risk-taking group (0.438, p=0.023) as they may break the rules frequently but don't want to be penalized in cases where punishments are suggested (Silla and Luoma, 2012). Old technology like radio is being used by a range of people of different age groups to acquire safety consciousness in crossing a railway line (-0.919, p=0.034), possessing higher safety perception.

4.7 Socioeconomic Characteristics:
Factors significantly affecting socio economic characteristics are age, profession and education. Pedestrians under 25, the youngest from the four age groups (<25, 25 to 45, 46 to 65, >65 years old) perceive least safety perception (0.023, p=0.015), as they may remain more adventurous and have more risk-taking tendency (Wang et al., 2016). Moreover, this survey shows that students (0.650, p=0.023), graduates (0.406, p=0.101) and the teachers (0.604, p=0.051) possess less consciousness because education may not always be an effective measure to lessen such unsafe crossings or over confidence is associated with those cohort of pedestrians to involve in such kind of unsafe act (Metaxatos and Sriraj, 2013).

5 Conclusion:

The objective of this study was to assess the trespassing characteristics of the pedestrians, identifying the significant safety perception factors of the high risk-taking cohort based on a multifarious background. This study finds less risk-taking groups to be those not trespassing even when trains from both sides are approaching within a small interval and during presence of safer alternatives. Better quality lighting conditions and using radio to learn about pedestrian safety issues belong to this group as well. Besides, low risk-taking pedestrians are those who prefer 25 seconds only for the warning bell to ring and be warned. On the contrary, people under 25, students, teachers, graduates, pedestrians not supporting punitive measures and lacking in safety knowledge possess lower sense of safety perception or safety understanding. This cohort also encompasses those 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, high risk-taking groups are the slum dwellers and vendors around the railway track. This study would be helpful for the policy makers to make the afore mentioned high risk-taking cohort more aware about the safety issues associated with level crossing by organizing different safety related programs and implementing robust monitoring systems. Furthermore, it would be helpful for strengthening the existing laws and placement of safety signs around the crossings as required.

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