Analysis of Speed Variations at Different Distances from a Road Crossing Facility

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APPROVAL

The dissertation entitled "***Analysis of Speed Variations at Different Distances from a Road Crossing Facility***", by SK. Redwan Ferdous and Iktier Ahmed Farhad has been approved fulfilling the requirements for the Bachelor of Science Degree in Civil Engineering.

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DECLARATION

We hereby declare that the undergraduate research work reported in this thesis has been performed by us under the supervision of Associate Professor **Dr. Shakil Mohammad Rifaat** and we have taken reasonable care to ensure that this work has not been submitted elsewhere for any purpose

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ABSTRACT

Failure of stable communication and understanding between the drivers and crossing pedestrians leads to severe pedestrian crashes in Bangladesh in most cases. So the behavior as well as mentality of both the drivers and pedestrians should be properly studied and monitored. Various factors have a significant effect on the speed of a vehicle in a highway when pedestrians are seen crossing the road. Considering the factors, speed study has been performed regarding the speed behavior of different types of vehicles at different distances from the crossing when pedestrians are seen crossing that particular road. Interrelations between the crossing pedestrians and the different types of vehicles have been found. Most of the vehicles of different catagories, tend to decelerate 30 meters ahead of the crossing at a speed of 40-45 km/hr when a pedestrian or a group of pedestrians starts crossing the road. There is no significant gradual speed reduction from 40 meters to 30 meters from the crosswalk. Unusual behavior was found for the drivers of buses as they show increase of speed from 40 meters to 30 meters at a speed of 35-40 km/hr and decelerate from 30 meters at a speed of 40-45km/hr. Significant speed differences have been also found between light and heavy vehicles. Regarding the abrupt behavior of the buses such as sudden increasing and decreasing of speed and the overall management and safety of the site some recommendations are suggested. Foot over bridge, speed bump, deployment of traffic police in the starting and ending hours of schools and colleges in that area can be an effective way for controlling the speed of the vehicles ensuring safety.

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CHAPTER ONE: INTRODUCTION

1.1 Background:

Introduction of new innovations in the vehicle industry, speed comes to add a major concern for pedestrian safety. Carelessness of both the driver and pedestrians in a non-signalized road crossing diminish the safety and increase the rate of crashes. From a study on fatal crashes attributable to speeding study it is found that in the period of 2001–2011,the fraction of fatal crashes attributable to high-level speeding (>20 kph over the speed limit) decreased from 25% to 6% and that attributable to medium-level speeding (10–20 kph over the speed limit) decreased from 13% to 9%, whereas that attributable to low-level speeding progressively increased from 7% to 13%.(Viallon and Laumon,2012)

Studies of road accidents revealed that heavy vehicles such as trucks and buses including mini buses are major contributors to road accidents. The group of vehicles is particularly over involved in pedestrians accidents accounting for about 79% (trucks 37%,buses 20% and minibuses 22%) (Hoque et al.,2004). When a pedestrian or a group of pedestrians have a motive to cross a non-signalized road, most of the cases, both driver and pedestrians be in a dilemma zone .This confusion often leads to serious road accidents. So, carelessness of both the driver and pedestrians in a non-signalized road crossing diminish the safety and increase the rate of crashes. Vehicles driving at a high speed on a free highway often refuse to reduce speed when pedestrians cross roads without any traffic control. As we can see that pedestrian injury in most cases fatal, are increasing rapidly day by day, it is high time we understood the mentality of a pedestrian while crossing a road. Again same pedestrian or pedestrian groups can show different mentality at different road crossing situations, even at a different time.

A weak tendency is found for female pedestrians to have more discordance between observed and declared crossing behaviour on residential roads, and the same is the case for young pedestrians in all road and traffic conditions. Overall, while most pedestrians appear to have consistent declared and observed behaviour, there may all deviate from their general "profile" under specific conditions.(Papadimitriou et al.,2016).Some general experiments have been conducted analysing the speed of crossing pedestrians. At locations where the speed limit was 70 km/h, pedestrians' average crossing speed was found to be 1.60 m/s and 1.73 m/s while at locations where the speed limit was 50 km/h, pedestrians' average crossing

speed was found to be 1.04 m/s and 0.97 m/s. This shows that pedestrians feel safer while crossing when the vehicle speed is low.(Demiroz et al.,2015) . Moreover pedestrian crossing through the roads is always discouraged by both the authority and drivers as they create disturbance to the free flow traffic. Pedestrian interference makes the intersection performance worse, resulting in lower transportation efficiency, more energy consumptions and higher safety risk.(Li and Sun, 2016)

At the starting hours of schools and garments factories the density of pedestrian crossing the roads increases rapidly. Besides being hurry for the schools and bindings of time act as the main force for taking risks by the students while crossing a road. The chances of accidents increases when students intend to cross the roads without guidance. Fu and Zou (2005)conducted an experiment that showed that children who crossed the road alone had more violation and adventure crossing behavior than those had companions. Boys were found more likely to run crossing than girls, but there was no significant gender difference in other crossing behaviour. Moreover the students, being less matured often calculate the minimum required gap acceptance wrong and this increases the chances of hit n run situation, for that particular crossing. Pawar and Patil (2016) found that the speed of the conflicting vehicle has significant effect on the spatial gap acceptance, and temporal and spatial critical gaps by different methods vary between 3.6–4.3 s and 60–73 m respectively. Again, the 50th percentile temporal and spatial gaps ranged from 4.1 to 4.8 s and 67 to 79 m respectively, whereas the 85th percentile temporal and spatial gaps ranged from 5 to 5.8 s and 82 to 95 m respectively. These gap values were smaller than that reported in the studies in developed countries. The speed of conflicting vehicle was found to be significant in spatial gap but not in temporal gap acceptance. The gap acceptance decision was also found to be affected by the type of conflicting vehicles. (Pawar and Patil,2014).Some experiment were also conducted determining the dilemma zone of a pedestrian Pawar et al.(2015) determined the dilemma zone by using different methods such as the gap cumulative distribution method, the binary logit method, the support vector machine and the probabilistic method. For the selected midblock sections, dilemma zone started at 49 m and ended at 62 m upstream from the marked pedestrian crossing.

So speed reduction and management of the vehicles at the pedestrian crossing zone is highly needed for their safety and efficient traffic flow reducing economy and energy loss. There are some significant factors that affect the amount of risks and gap taken by the different types of pedestrians while crossing the roads. Young pedestrians shows abrupt behaviour in comparison with the others. As the reference site involve both school and college, the safety of the students should be main concern. Some researches have been done regarding the situation in the 1st world, but in a developing country like Bangladesh where transportation system is far more different and less efficient than others, this kind of researches is highly needed for better pedestrian safety and management. As this study will help to understand the pedestrian driver relationship in terms of speed and distance, the result will give a direct overview of the vulnerability of that pedestrian crossing zone.

1.2 Research Objectives:

The results of the study will give a overview of the general characteristics of the drivers of different vehicles .

- Which type of vehicle have more risky speeding behavior according to the pedestrian crossing.
- Which category drivers are more careful and more careless about reducing speed.
- Difference of various types of vehicle speeds at different distances from the pedestrian crossing area can be evaluated at every intersection.
- Graphical representation of speed profile gives the changes of speed of same category vehicle drivers

1.3 Scope of the Study:

The study will find out the vulnerability of different catagory drivers in terms of speed using difference between two means for both equal and unequal variances. In this study we will measure the speed of the different types of vehicles when a pedestrian or a group of pedestrians starts crossing the road. The measured speeds will be used as sample for determining the speed differences and variances. For this study, College Gate, Gazipur will be used as the site for speed measurement. This experiment will also reveal the factors

associated drivers speeding behavior in the context of pedestrian crossing. It will also find out the speed variances of same category vehicle at different distances from the divider that is used for road crossing. Graphical representations of the vehicle's speed differences at different distances will also be given.

1.3 Significance of the Study:

1. Finding out the vulnerable vehicles and driver in terms of speeding risks at the pedestrian crossing will help the government to take necessary steps to reduce risky speeding behavior enhancing pedestrian's safety.
2. The policy makers might be benefited by graphical speed profile and speed difference of different types of vehicles to improve the road safety condition of that particular intersection.
3. The results of the study will help the government in new road construction cases evaluating the drivers speeding characteristics.
4. Design of safety outcome for the targeted pedestrians and drivers.

Chapter Two: Literature Review:

2.1 Effect of Age:

Age and speed are clearly related when driving skills, collision avoidance etc. are considered. Many studies showed that older drivers are more likely to involve in crashes due to their reduced skill and reaction time. But the young drivers are motivated to increased speed due to some phycological factors as well as risk taking tendency.

2.1.1 Physical Abiliy:

Ability comes to add a direct influence on driving skills. Older drivers are at increased risk of injury due to frailty, at increased risk of crashing due to slower reaction times, and have less agility judging time and distance compared to younger drivers(Chevalier -et al.,2016). With age most of the drivers breaking ability and above all physical ability reduces. This phenomenon directly influence the speeding behaviors of the drivers. The older drivers, especially older female drivers, displayed a conservative driving attitude as a compensation for reduced driving ability, but also showed to be the most vulnerable group for the relatively complex driving manuvers.(Yan et al., 2016)

2.1.2 Peer Pressure:

Though peers are not directly involved in speed behaviour of drivers but have a important influence on drivers. Peers are known to often influence young drivers' risky behaviors through proximal (direct and indirect active pressures) and distal (passive pressure) forms of intervention (Allen & Brown, 2008). It is believed that part of this risk is due to pressure from peer passengers to engage in speeding; which may be active (i.e., verbal encouragement) or passive (i.e., perceived pressure on the part of the driver). Horvath et al. (2011) found that intentions to speed were found to be higher in the "no passenger" than "passenger present" conditions. Moller and Haustein (2013) found that perception of friends' speeding, was the most important predictor of speeding in both age groups. . Other significant factors were: negative attitude towards speed limits, injunctive subjective norm, and the perceived risk of having an accident when speeding. In the older age group it was more

common to drive faster than allowed and their speeding was largely in line with the perceived level of their friends' speeding. In the younger age group a higher discrepancy between own and friends' speeding was found indicating that young male drivers are socialized into increased speeding behaviour based on peer pressure. By contrast for the 28-year-olds peer pressure mainly seems to maintain or justify individual speeding behaviour.

2.1.3 Flexibility and Stability:

Flexibility directly affects the drivers intensions to speed. With age flexibility of shoulders, hands and legs reduces significantly. Dukic and Broberg (2011) showed the clear age effect, with the older drivers showing less neck flexibility. When it comes to visual behaviour data, a difference was also found concerning the area of interest the drivers looked at; while the older drivers looked more at lines and markings on the road to position themselves in the traffic, the younger drivers looked more at dynamic objects such as other cars representing a possible threat. Comparing the elder with the young, the unstable driving behaviors were examined in elderly and they were apt to run fast in approaching the intersection and also stopping rapidly.(Hong et al.,2015)

2.1.4 Attitude and Intentions:

Mind stability and intensions changes with age. Attitude and intensions of the drivers are one of the most important factors while driving, but this does not remain constant, it changes with age. Steg and Brussel (2009) found that aberrant behaviour of moped riders can indeed be classified as errors, lapses, and violations. Accidents involvement appeared not to be significantly related to errors, lapses, and violations. As hypothesised, young moped riders were more likely to speed, and had a stronger intention to disobey speed limits when they have a positive attitude towards speeding, and when they think that others expect them to speed. Perceived control did not affect self-reported speeding and intention to speed. Newnam et al.(2014) hypothesised that younger, less educated drivers will report engaging in more unsafe driving behaviours compared to older, more educated drivers. Contrary to expectations, they found the opposite effect, whereby older, more educated drivers reported engaging in more unsafe driving behaviours than younger, less educated drivers.

2.2 Distraction of the Drivers:

Distraction of the drivers is one of the most severe and important factors of reckless driving or excessive speeding. there are many studies that shows the adverse effects of different type of distractions on excessive speeding as well as reckless driving.

2.2.1 Cell Phones:

Cell phones work as primarily cause of distraction for a driver while driving. Mohammad Saifuzzaman et al. (2015) found an increase of 0.33 s in time headway when a driver is engaged in hands-free phone conversation and a 0.75 s increase for handheld phone conversation. Fitch, et al., (2015) explored that conversing on an Hands Held cell phone was found to significantly decrease drivers' mean percent Total Eyes Off Road Time (TEORT), indicating that drivers looked at the forward roadway more often. No significant differences in percent TEORT were found for drivers conversing using PHF or IHF cell phones. Papadakaki et al. (2016) analysed that "variation of the steering position per second" was significantly affected by "text-message reading. And sum of squared acceleration per second" was significantly decreased during conversation on the phone.

Distracted drivers on average appear to reduce the speed of their vehicle faster and more abruptly than non-distracted drivers, exhibiting excess braking comparatively and revealing perhaps risk compensation. The braking appears to be more aggressive for distracted drivers with provisional licenses compared to drivers with open licenses.(Haque and Washington, 2014). For some cases peer pressure also works as a primary cause of distraction for drivers. Sullman (2012) found that the most frequently observed distraction was talking to a passenger, followed by smoking and using a mobile phone. Younger drivers were significantly more likely to be distracted in general and by talking to passengers, while older drivers were less likely to be distracted by adjusting controls or using a mobile phone.

2.2.2 In Vehicle Music:

Brodsky and Slor (2013) explored the effects of driver-preferred music on driver behavior. 85 young-novice drivers completed six trips in an instrumented Learners Vehicle. The study

found that all participants committed at-least 3 driver deficiencies; 27 needed a verbal warning/command and 17 required a steering or braking intervention to prevent an accident. While there were elevated positive moods and enjoyment for trips with driver-preferred music, this background also produced the most frequent severe driver miscalculations and inaccuracies, violations, and aggressive driving.

2.2.3 Alcohol:

Alcohol is becoming one of the most acute and primary cause of reckless driving of the drivers even in modern countries. Harrison and Fillmore (2011) explored that divided attention had no impairing effect on driving performance in sober drivers. However, under alcohol, divided attention exacerbated the impairing effects of alcohol on driving precession. Bhalla et al.(2013) Roadside interviews suggest that the population of modern cities is already highly sensitized to the risks associated with drink driving and speeding.

Besides consuming alcohol during driving increases the chance of crash or fatal injuries. Bogstrand et al.(2015) found Statistically significant associations were found between impairment by alcohol or amphetamines and driving unbelted or speeding.

Chen et al.(2016) conducted an experiment that suggested drivers may be more heavily influenced by what other drivers do on the road, rather than what they perceive they ought to do, when it comes to engaging in distractions.

2.3 Phycology:

Phycological factors and driver's decision to speed in a different situation in a road is one of the most important factors of speed characteristics of a driver. Wang et al. (2016) found that drivers are more likely to decelerate 30m-37m ahead of crosswalk at a speed of 40-50 km/h, and decelerate 23m-30m ahead of crosswalk at a speed of 30-40 km/h. An average distance is about 25m away from the crosswalk.

Pedestrian behaviour significantly affects the speed choice of a driver. Sun et al. (2015) found that pedestrians have accurate estimation intervals that vary by weather conditions. When the

speed of the oncoming vehicle exceeded the upper bound of the accurate interval, pedestrians were more likely to underestimate the vehicle speed, increasing their risk of incorrectly deciding to cross when it is not safe to do so.

Even a pedestrian's positivity affects the speed choice by the drivers. Lubbe and Davidsson (2015) explored that pedestrian speed was found to have a statistically significant influence on brake onset. For pedestrian speeds of 1 m/s, 90% of drivers braked before 2.6 s Total Time of Collision (TTC). For 2 m/s this value was 2.2 s. A driver can be influenced and react in a positive way even by body language and facial expressions of a pedestrian. It was found that a smile increases the number of drivers who stop. The same effect was observed when the pedestrian tries to cross outside the pedestrian crossing. Finally, this study shows that motorists drive slower after they see a pedestrian smile, suggesting that a smile can induce a positive mood. (Guéguen et al.,2015)

Attitude towards speeding, subjective norm, and perceived behavioral control are significant determinants of self-reported speeding. Self-reported speeding, and subjective norm, but not perceived behavioral control, did then contribute to the prediction of drivers' logged speeding. The fact that perceived behavioral control did not directly contribute to the prediction of drivers' logged speeding may be due to the possibility that drivers with several years of experience already take into account the actual control they have over the target behavior.(Warner and Åberg,2006).

Besides there are many cases, where drivers are influenced by the decisions taken by other drivers while driving. How often other drivers commit the same behaviours measured by the driver behaviour questionnaire (DBQ) in Sweden and Turkey, respectively. The results showed that committing aberrant driving behaviours less frequently than their perception of how often other drivers commit the same behaviours.(Warner and Åberg,2006)

Sometimes marginal speed limits often act reversely in case of reducing speed of the vehicles. Dinh and Kubota (2012) showed that drivers tended to have positive beliefs about complying with the 30 km/h speed limit and understand the negative consequences of speeding; however, a majority of the drivers considered breaking the speed limit as a way to reduce their travel time. This study identified that the drivers who did not support the

30 km/h speed limit were associated with those who had committed traffic-law violations, who had negative beliefs about complying with the speed limit, who did not consider residents' opinions, who believed it is acceptable for them to drive at a high speed, and who felt it difficult to refrain from speeding.

Again speed violations of a driver can be dependent upon his socio-economic conditions . Tseng (2012) revealed that the determinant factors associating with a taxi driver's speeding violation were not related to gender or educational level. However, age, job experience, operating styles, kilometers driven daily, driving late at night, and monthly off duty days were significantly associated with committing the speeding violations .

2.4 Road Environment:

2.4.1 Route Similarity:

Differences in driving behavior due to the presence of users familiar (or unfamiliar) with the road are considered in the road and traffic engineering. However, although considered, the matter is largely unexplored: there is a lack of theoretical foundations and data on determining the impact of route familiarity on accident rates, speed choice and risk perception. On the other hand, some literature studies confirm that route familiarity is influential on driving behaviour. Speed choice seems to be affected by route familiarity. Speed increases with the repetition of travels on the same route.(Colonna et al., 2015)

2.4.2 In Road Obstruction:

Excessive speed is currently one of the primary contributory factors in traffic accidents within roadwork sites around the world. Allpress and Leland Jr.(2009) evaluated two novel interventions designed to control traffic speed within an open road, roadwork site in New Zealand where drivers were required to decrease their speed from 100 to 50 km/h. Two different interventions were placed at the entrance to the work site and required drivers to pass between a certain width of passage of either evenly or decreasingly spaced cones. Both interventions were highly effective at reducing vehicle speed. Although both arrangements are highly effective, the use of unevenly-spaced cones is likely to most markedly reduce the number of speed-related accidents within open road roadwork zones. Paolo and Sar (2012)

analysed the speed of vehicles approaching work zones aiming to understand the drivers' speed behaviour. This work shows that drivers do not obey the temporary speed limit and that they reduce speeds only when the lane width is reduced, resulting in high deceleration rates Davoodi et al. (2011) have conducted two road experiments to obtain empirical values of motorcycle Perception Response Time(PRT) to expected and unexpected objects. In the expected condition, 89 motorcyclists applied brake as quickly as possible following activation of a light beside the road. In the unexpected condition, 16 riders responded by braking in response to an obstacle that appeared suddenly in their lane. The mean PRT to expected and unexpected object is 0.71 s and 1.25 s respectively. The 85th percentile PRT to unexpected object is 2.12 s. This study found that most riders are capable of responding to an unexpected object along the roadway in 2.5 s or less. Therefore, PRT of 2.5 s is an appropriate value for motorcycle lane geometric design

2.4.3 Road Characteristics:

Road characteristics such as road geometry, road side environment has an important effect on speeding of drivers. There is a clear tendency of drivers to "cut" both the right curves as well as the left curves in order to minimize the speed reduction in the tangent–curve–tangent transition.(Bella, 2012).Again variables such as lane width and night hour had an increasing effect on speeding. Conversely, roadside parking had a decreasing effect on speeding. One-way and lane width had an increasing effect on excessive speeding, whereas evening hour had a decreasing effect.(Heydari et al., 2014)[a] . Again, reckless driving is also affected by the road width. The risky driving behavior is associated with the single-lane road under bad light or weather conditions while drivers are more likely to engage in risky behavior on the multi-lane road.(Weng and Meng, 2011)

2.4.4 Road Signs :

Road signs plays an important role in choosing a safe and adaptable speed for the drivers . Kay et al. (2014) presented the results of a controlled field evaluation of bicycle warning sign with a "Share the Road" plaque, which involved an examination of driver behavior while overtaking bicyclists. A series of field studies were conducted concurrently on two segments of a high-speed, rural two-lane highway. These segments were similar in terms of roadway geometry, traffic volumes, and other relevant factors, except that one of the segments

included centerline rumble strips while the other did not. The sign treatment also resulted in a 2.5 miles/h (4.0 km/h) reduction in vehicle speeds. Drivers are more likely to stop at locations where enforcement cameras or flashers are present. Stopping was also more prevalent at intersections with lower speed limits, longer crossing distances, and where pedestrian crosswalks are present.(Savolainen et al.,2015). Wilmots et al. (2015) found the effect during the speed control with advanced warning sign is larger compared to the speed control only (respectively −4.5 km/h and −2.5 km/h in the V85 speed).Again the probability of yellow light running increases with the increase in driving speed at the onset of yellow(Haque et al.,2015). Islam[a,] et al. (2013) found significant reduction in mean free-flow speed and speed variances for all combinations of time-of-day and day-of-week classifications by reducing posted speed limit from 50 to 40 km/h.

For saving travel time, yellow lights in the intersections adversely affect drivers mentality resulting a increased speed for running the yellow lights, The effect of time pressure on yellow-light running is not mediated by approach speed, which showed that drivers in a hurry are likely to run lights intentionally (Palat and Delhomme,2015).

2.5 Visibility:

2.5.1 Fog:

Driver characteristics are adversely affected due to foggy situation in the roads. Yan et al. (2014) explored that the drivers intended to reduce their speeds in order to lower the driving risk in foggy conditions at all three risk levels. However, due to the limited visibility in fog, the drivers can not observe and respond to impending changes in road geometries in a timely way, which resulted in higher operating speeds than in clear weather conditions. At the medium risk level, the drivers' dynamic speed adjustment behavior is degraded in the fog, with both acceleration and deceleration rates lower than in the clear conditions; therefore, more rear-end collisions happens in the foggy conditions than in the clear conditions. At the high risk level, the experiment he conducted showed that drivers' speed compensation in foggy conditions does not sufficiently reduce their crash-involvement risk, but it can effectively lower the crash severity, as indicated by a significantly lower collision speed. For speed differentials based on the 85th percentile for maximum speed reduction (85MSR),predicts that the inverse of the approaching tangent length and of the curve radius

significantly explained the dependent variable in both cases, with a higher dependence of nighttime 85MSR on the curve geometry than on the tangent length. Tangent length had a significant effect on operating speed for independent tangents only for the daytime model, whereas the inverse of the previous radius was confirmed as a predictor for both night and daytime visibility conditions (Bella et al.,2014).

Driver's risky speed choice in foggy condition is more acute in curved roads. Li et al.(2015) conducted an experiment on drivers behaviour in foggy condition on s-curve of a road. The experimental results indicated that drivers tended to drive more cautiously in heavy fog, but the driving risk was still increased, especially in the transition stage from the straight segment to the S-curve. The non-professional (NP) drivers were less sensitive to the impending change in the road geometry, and less skilled in both longitudinal and lateral vehicle control than the professional drivers. The NP female drivers in particular were found to be the most vulnerable group in S-curve driving.

Mueller and Trick (2012) explored that experienced drivers drove faster in clear visibility than novice drivers, yet they reduced their speed more in reduced visibility so that both groups drove at the same speed in simulated fog. Compared to experienced drivers, novice drivers had higher hazard response times, greater speed and steering variability, and were the only drivers to have collisions.

Hassan and Abdel-Aty (2011) revealed that drivers satisfaction with Variable Speed Limit(VSL)/Changeable Massage Signs(CMS) was the most significant factor that positively affected drivers' compliance with advice or warning messages displayed on VSL/CMS under different fog conditions followed by human factors. Moreover, it was found that roadway type affected drivers' compliance to VSL instructions under medium and heavy fog conditions. Furthermore, drivers' familiarity with VSL and human factors were the significant factors affecting drivers' satisfaction with VSL/CMS advice under reduced visibility conditions

2.5.2 Reduced Visibility:

Some experiments were conducted by simulator imposed reduced visibility to analyse the adverse impact on a driver. Daffy (2012) used a goal conflict model that links drivers' conflicting motivations for fast and safe driving with an emotional state of anxiety. It is proposed that this linkage is mediated by a behavioural inhibition system (Gray and McNauohton, 2000) affecting drivers' mood, physiological responses and choice of speed. The model was tested with 24 male participants, each of whom undertook 18 runs of a simple driving simulation. An increase in task difficulty induced by low visibility resulted in an additional speed reduction and increase in self-reported anxiety but did not lead to a increase in self-assessed attention and arousal. Rui-Ni et al.(2012) found that performance decreased when visibility was reduced for both older and younger drivers, with better performance for younger drivers as compared with older drivers. An age-related interaction was also found with deteriorated optical flow information. These results suggest that under reduced visibility conditions, older drivers may have increased accident risks due to decreased ability to successfully steer the vehicle.

2.5.3 Rain:

It was found that poor visibility conditions, especially rain, decrease the effectiveness of drivers' visual search. The lack of interaction between driving experience and visibility suggests that some aspects of visual search are affected by general rather than situation specific driving experience (konstantopoulos et al.,2010).

Chapter Three: Methodology

3.1:Site Selection:

Speed characteristics of a driver can be done more accurately when speed measurement of a same vehicle is taken at successive intersections on a certain highway at different situations. However due to the limitation of resources, we have considered only a single location in a highway assuming same category vehicle driver possesses same mentality of speeding due to the crossing of pedestrians.

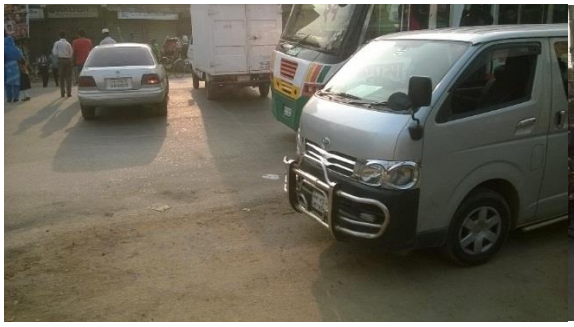

Fig:3.1: Crossing of Vehicles

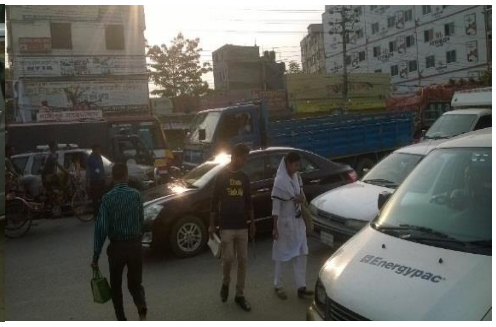

Fig: 3.2: School Student's Crossing

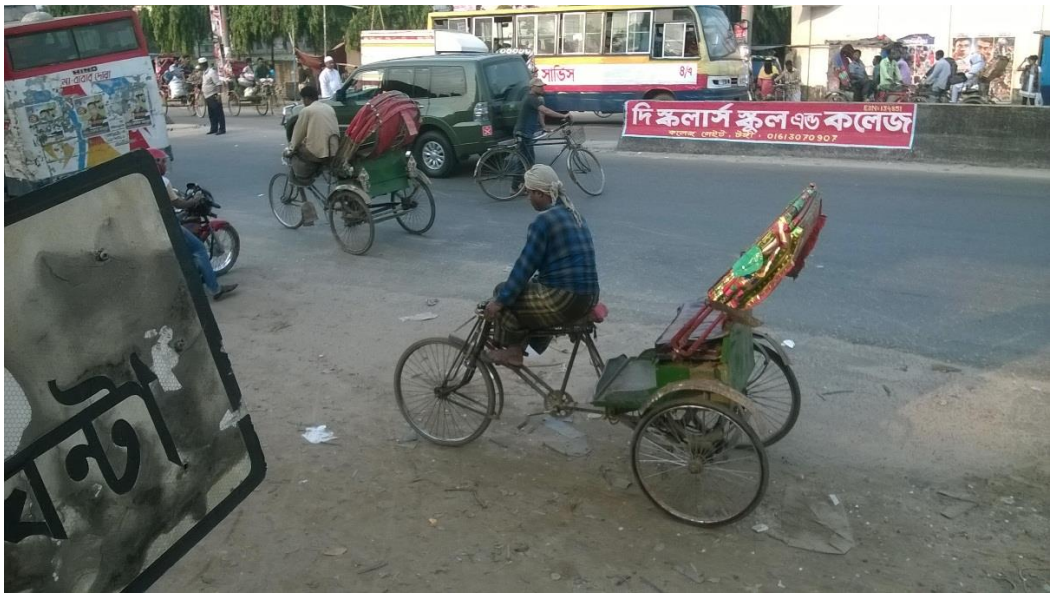

Fig: 3.3: Free Movement of vehicles

This sites has following problems regarding our study:

1.The site that we have chosen is non signalized.

2.And there is no over-bridge.

3.Pedestrians cross the road without any traffic control

4.And the location is on the highway

3.2:Data Collection:

Data has been collected at a particular time of a day and these data has been taken at weekday and weekend.

- Using the speed gun speed of the different vehicles has been measured.
- The work has been carried in 3 different days in a week
- Two weekdays and a weekend have been selected for collecting speed data.

The morning time(6.30-8.00) has been chosen for data collection because this time is the opening hour of schools and colleges in that area, so the density of the pedestrian is high at that time with the addition of garments workers who cross that divider at the morning time.

3.3:Statistical Analysis:

3.3.1:Testing Differences between Two Means: Equal Variance:

The competing hypotheses for a directional test, that one population mean is larger than another, are

$$H_o: \mu_1 - \mu_2 \leq 0$$

$$H_a: \mu_1 - \mu_2 > 0 \qquad 3.1$$

here μ1-μ2 is the value of the difference in sample means

Testing Differences between Two Means: Equal variance:

- A test statistic for a difference between two population means with equal population variances is given by

$$t^* = \frac{(\overline{X_1} - \overline{X_2}) - (\mu_1 - \mu_2)}{\sqrt{s_p{}^2(\frac{1}{n_1} + \frac{1}{n_2})}} \qquad 3.2$$

That has a t distribution with n1+n2—2 degrees of freedom.

Here n1 and n2 are the samples from population 1 and population 2 and X1-X2 is the average sample difference between population 1 and population 2.

And sp^2 is the pooled estimator of variance.

Where variance is given by:

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \qquad 3.3$$

And a (1-@)100% confidence interval for the difference between two population means (µ1-µ2) is given by :

$$(\bar{x}_1 - \bar{x}_2) \pm t_{(1-\alpha/2)} \sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}} \qquad 3.4$$

3.3.2:Testing Difference between Two Means: Unequal Variance:

The most common difference between two population means µ1 and µ2 is the one presented below where the null hypothesis states that the two means are equal.

$$H_o: \mu_1 - \mu_2 \leq 0$$

$$H_a: \mu_1 - \mu_2 > 0$$

3.5

Estimation of test statistics for a difference between means with unequal population variance:

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)_0}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

3.6

And degrees of freedom that has a t distribution is given by:

$$df = \frac{\left[\left(s_1^2/n_1\right) + \left(s_2^2/n_2\right)\right]^2}{\left[\frac{\left(s_1^2/n_1\right)^2}{(n_1 - 1)} + \frac{\left(s_2^2/n_2\right)^2}{(n_2 - 1)}\right]}$$

3.7

Chapter Four: Result Analysis

4.1 Introduction:

In this chapter, the discussion will be limited to describe the variance in speed among different vehicles at different distances from the crosswalk. Reasoning of the difference in speed among vehicles in different scenarios will be given elaborately. These reasons are given based on the overall situation that influenced the speed of the vehicles on that time at the site. Using the "STATA" software significant difference in speed is measured which is shown in the following tables:

Table 4.1 : Comparison of Average Speed between Vehicles 30 meter from the Pedestrian Crossing:

Vehicle 1 vs vehicle 2 (from a particular distance from the pedestrian crossing)	P value* (for equal varience)	Statically Significant=√ Statically Insignificant=×	P value ** (for unequal varience	Statically Significant=√ Statically Insignificant=×
Truck vs pick up	0.0167	×	0.0169	×
Truck vs bus	0.3036	×	0.3036	×
Truck vs car	0.0000	√	0.0000	√
Pick up vs bus	0.0014	√	0.0015	√
Pick up vs car	0.0919	×	0.0920	×
Bus vs car	0.0000	√	0.0000	√

Table 4.2: Comparison of Average Speed between Vehicles 40 meter from the Pedestrian Crossing:

Vehicle 1 vs vehicle 2 (from a particular distance from the pedestrian crossing)	P value* (for equal varience)	Statically Significant=√ Statically Insignificant=×	P value ** (for unequal varience	Statically Significant=√ Statically Insignificant=×
Truck vs pick up	0.1151	×	0.1152	×
Truck vs bus	0.1789	×	0.1789	×
Truck vs car	0.0000	√	0.0000	√
Pick up vs bus	0.8963	×	0.8963	×
Pick up vs car	0.0012	√	0.0012	√
Bus vs car	0.0019	√	0.0019	√

Table 4.3: Comparison of Average Speed between Vehicles 20 meter from the Pedestrian Crossing:

Vehicle 1 vs vehicle 2 (from a particular distance from the pedestrian crossing)	P value (for equal varience)	Statically Significant=√ Statically Insignificant=×	P value (for unequal varience)	Statically Significant=√ Statically Insignificant=×
Truck vs pick up	0.5304	×	0.5304	×
Truck vs bus	0.7070	×	0.7070	×
Truck vs car	0.6328	×	0.6329	×
Pick up vs bus	0.8085	×	0.8085	×
Pick up vs car	0.2868	×	0.2868	×
Bus vs car	0.4107	×	0.4107	×

Table 4.4 :Comparison of Average Speed of Vehicles between 20 meter,30 meter and 40 meter from the Pedestrian Crossing:

Distance 1 vs distance 2 (from the pedestrian crossing)	P value* (for equal variance)	Statically Significant=√ Statically Insignificant=×	P value ** (for unequal variance)	Statically Significant=√ Statically Insignificant=×
20m vs 30m	0.0000	√	0.0000	√
30m vs 40m	0.6024	×	0.6024	×
20m vs 40m	0.0000	√	0.0000	√

Table 4.5 : Comparison of Average Speed of a Particular Vehicle at 20m,30m and 40m from the Pedestrian Crossing:

Distance 1 vs distance 2 (from the pedestrian crossing) for a particular vehicle	P value* (for equal variance)	Statically Significant=√ Statically Insignificant=×	P value ** (for unequal variance)	Statically Significant=√ Statically Insignificant=×
Truck 20m vs truck 30m	0.0000	√	0.0000	√
Truck 30m vs truck 40m	0.6024	×	0.6024	×
Truck 20m vs truck 40m	0.0000	√	0.0000	√
Car 20m vs car 30m	0.0000	√	0.0000	√
Car 30m vs car 40m	0.9483	×	0.9483	×
Car 20m vs car 40m	0.0000	√	0.0000	√
Pick up 20m vs pick up 30m	0.0001	√	0.0001	√
Pick up 30m vs pick up 40m	0.3023	×	0.3023	×
Pick up 20m vs pick up 40m	0.0000	√	0.0000	√
Bus 20m vs bus 30m	0.0009	√	0.0009	√

Bus 30m vs bus 40m	0.0223	√	0.0223	√
Bus 20m vs bus 40m	0.1103	×	0.1103	×

The results are shown in Table 4.1,4.2,4.3,4.4 and 4.5. Based on the *p*-values of the *t*-tests, 15 factors were found to be significant ($p \leq 0.05$).By inputting the data in the 'stata' software the p value for the t tests were found foe both equal and unequal variances. Total number of observation was 30 for each type of vehicle. 'P value' less than 0.05 is taken as significant as the confidence level of the model is 95%. From these significant value, the variations in speed among different types of vehicle is found at the start of pedestrian crossing

4.2 Average speed comparison between vehicles at a particular distance from the pedestrian crossing:

Speed comparison among different types of vehicles at a particular distance from the pedestrian crossing .The comparison between truck, bus,pick up and car from a particular distance from the pedestrian crossing is presented in table 3.

From table 4.1, it is observed that at 20 meter from the pedestrian crossing there is no significant speed difference between different category vehicles. It is because of the common behavior shown by the drivers of different vehicles at 20 meter from the pedestrian crossing. At 20 meter, all the drivers of different vehicles reduced their speed at approximately same level, when pedestrians are seen crossing the road, as a result there is no significant difference in speed among the vehicles. It is because of the common behavior shown by the drivers of different vehicles at 20 meter from the pedestrian crossing. At 20 meter, all the drivers of different vehicles reduce their speed at approximately same level, when pedestrians are seen crossing the road. As a result there is no significant difference in speed among the vehicles. Moreover at the start of the school hour the density of the pedestrians crossing the roads increases rapidly so all the drivers tend to reduce their speed to a certain level for providing safe and unharmed crossing for the pedestrians.

For 30 meter from the pedestrian crossing, significant difference is found between car and other type of vehicles such as pick up, truck and bus. Reasons behind this difference is that for a freeway, drivers of the private car expect that the pedestrians crossing at that time would pass before the car reaches to the collision point. And cars being the lighter vehicle comparing with bus, pick up, truck, it is easy for them to break or reduce rapidly if they feels that a pedestrian fails to cross the collision point before the car approaches there. But it is difficult for the other type of vehicle to break suddenly in the same case because these vehicles are usually very heavy. Moreover these types of vehicles (truck, pick up) carries delicate industry materials. These materials can take damage if all breaks are use suddenly. So they maintain comparatively low speed than cars. As for the buses, they tend to pick the passengers from the pedestrians that cross and many students get down from the buses for school and college. So the buses also maintain lower speed than cars 30 meter from the crossing.

Significant difference in speed is also observed between car and truck, bus for 40 meter from the pedestrian crossing. Also in this case car being the lighter vehicle maintain high speed than truck bus. Difference between pick up and bus in terms of speed is also observed. It is because when a group of passenger is seen by the drivers of pick up and bus, pickup driver expects that they would get enough time to cross the roads, so they maintain higher speed than bus. As for the buses being the heavier vehicle travel at a lower speed than pickups and also expect to pick up some passengers from the crossing pedestrians.

4.3 Average speed comparison of all vehicles for 20m,30m and 40 m from the pedestrian crossing:

While comparing the speed of all vehicles among 20m, 30m and 40m from the crossing, significant difference is noticed between 20m and 30m, 20m and 40m. It can be described by the common behaviour that when pedestrians are seen crossing the roads, at the closer distances drivers travel at a lower speed than the higher distances from the pedestrian crossing for safety.

4.4 Average speed comparison of a particular vehicle for 20m,30m and 40m from the pedestrian crossing:

Same situation is observed while comparing individual category vehicle for different distances from the pedestrian crossing. For car, pick up and truck ,speed at 30 meters and 40 meters from the crossing is higher than speed at 20 meters because of the approaching interruption for crossing pedestrians and some light vehicles. Another possible reason is that even if cars,pick ups and trucks often uses outer lane for uninterrupted flow, some vehicles use U-turn in that place that results in further decrease in speed for the vehicles behind the vehicles that are using U-turn.

But for buses some changed situation is observed. For the case of bus, speed at 30 meters is found to be much higher than 20 meters from the crossing and speed at 40 meters from the crossing is significantly lower than the speed at 30 meters from the crossing. This type of scenario indicates that drivers of buses travel at a significantly higher speed at 30 meters than that of 40 meters and suddenly reduces speed at 20 meters. Some possible reasons for this type of abrupt behavior is that drivers of buses in our country cares less about the law of driving and lack knowledge for pedestrian safety. Moreover most of the drivers of buses are below age and they don't have proper driving skills on the highway road .As a result, they show sudden increase and decrease of speed when they see a pedestrian or a group of pedestrians cross the road and get less decision making time that sometimes causes serious road accidents

Chapter Five : Discussion and Conclusion

5.1 Introduction:

Principal objective of our study was to find the speeding behavior of different types of vehicles regarding the pedestrian crossing. In order to achieve this objective speed measurements of different vehicles had been taken at different distances from a crosswalk. To find significant difference in speeding behavior “t test” had been done with the collected data from the site. This chapter gives an overview of the important findings of this research. The findings are discussed in detail based on their speeding behaviour in the highway. This is followed by suggestions for precautionary measures to be taken to enhance safety as well as suggestions for future research.

5.2 Findings from the Study:

Objective of the study was to monitoring the speed variance of different vehicles at a particular distance from the divider at the start of the pedestrian crossing. Our study found the interrelations between the crossing pedestrians and the different types of vehicles. Most of the vehicles of different catagories, tend to decelerate 30 meters ahead of the crossing at a speed of 40-45 km/hr when a pedestrian or a group of pedestrians starts crossing the road. There is no significant gradual speed reduction from 40 meters to 30 meters from the crosswalk. Unusual behavior was found for the drivers of buses as they show increase of speed from 40 meters to 30 meters at a speed of 35-40 km/hr and decelerate from 30 meters at a speed of 40-45km/hr.

5.3 Limitations of the Study:

However the shortcomings of the study is that the sample side is limited and the speed data has been collected for only few days. The findings of the study would be much more strengthened if there were more observations; however, due to limited manpower and budgetary constraint it was not possible to collect more data.

5.3 Recommendations for Future Improvement:

By analyzing the data and observed results, some recommendation have been drawn for the policy makers. Some general requirements are discussed based on the key findings from our analysis.

Table 4.6: recommendation for the policy makers:

Safety Measures	Justification from the findings of the study
Speed Bump	As in the early morning density of pedestrians increases but traffic volume stays low, there is a possibility of some vehicles that fails to reduce speed at the crossing and leads to serious accidents. Speed bump should be introduced in that place and thus excess speed of the vehicles can be controlled.
Foot Overbridge	Foot overbridge can be a feasible solution for both the crossing pedestrians and uninterrupted flow of all the vehicles because with the help of this structure, problems regarding reducing speed of the vehicles and the frequent and abrupt crossing of the pedestrians can be solved efficiently.
Deploying traffic police in the starting and closing hours of school and college	For the overall management , proper monitoring and safe crossing of the pedestrians traffic police can be deployed.
Providing Proper Signs	Applying public crossing signs or speed limit signs, speed of the upcoming vehicle can be controlled for safe crossing.

So based on the current scenario and observed result some preventive measures should be taken to avoid pedestrian crashes in that place and uninterrupted traffic flow.

5.4 Limitations:

However the shortcomings of the study is that the sample side is limited and the speed data has been collected for only few days. The findings of the study would be much more strengthened if there were more observations; however, due to limited manpower and budgetary constraint it was not possible to collect more data.

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