# Estimation of Pedestrian walking speeds at controlled cross walks in Sri Lanka - a pilot study

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***Abstract:*** *This study aims to develop and test a methodology to extract pedestrian speed data from video footage and to find the pedestrian walking speed Sri Lankans. This study was done in the premises of the Faculty of Engineering, University of Ruhuna. Pedestrians were walking across a measured length was videotaped and the resulting footage was analysed after breaking the footage into frames. For each pedestrian walking event sex of the subject and the starting and ending clock times were recorded. Results showed that sex of the pedestrian did not have a significant effect on the walking speed of the pedestrians. Further, results showed that test subjects walked with a 15$^{th}$ percentile speed of 1.20 m/s. This walking speed is as par with the USA walking speed and faster than the Singaporeans' walking speed when compared with the speeds reported in the previous studies. However it is noted that this walking speed may go down if we include more test subjects from elderly age category.*

***Keywords:*** *Pedestrians Walking speed, Pedestrian crossing, Speed data from*

## 1. INTRODUCTION

Pedestrian walking speed at a cross walk is an important and essential parameter in intersection traffic design. Pedestrian walking speed determines the pedestrian crossing time. 15$^{th}$ percentile of the pedestrian walking speed distribution is used in the signal designs as the design pedestrian walking speed. For a safe crossing, the "Walk" phase in a signal cycle must be at least equal to the pedestrian crossing time based on the design pedestrian walking speed. In related literature design pedestrian walking speeds are suggested.

Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways (Federal Highway Administration 2009) published by the Federal Highway Administration USA, suggest a speed of 1.2 m/s (4 ft/s) as the appropriate pedestrian speed at cross walks. This speed of 1.2 m/s (4 ft/s) was first introduced in the 1961 version of MUTCD for streets and highways. According to LaPlante and Kaeser (LaPlante & Kaeser 2007) the speed of 1.2 m/s is based on an unpublished study by Exnicios in 1952 (Exnicios 1952). However, many studies have questioned this suitability of this speed and different pedestrian walking speeds have been found. A 1996 study by Knoblauch (Knoblauch et al. 1996) found that a 1.19 m/s speed is appropriate for younger pedestrians while 0.91 m/s was suggested for older pedestrians. A 1999 study by Young has found pedestrian walking speed to have a mean of 263.26 m/min with a standard deviation 52.49 m/min. A 2001 study by Tarawneh (Tarawneh 2001) showed that the 15th percentile pedestrian walking speed for general public in Jordan is 1.11 m/s and 0.97 m/s for old age people. A 2005 study by Gates et al. (Gates et al. 2006) using 1,947 pedestrian crossing events measured at eleven intersections in Madison and Milwaukee, Wisconsin, recommended pedestrian walking speed values base on percentage of old age pedestrians. According to Gates et al. when the

proportion of pedestrians over the age of 65 exceeds 20, 30, 40, and 50 percent of the total pedestrians at a location, walking speeds of 3.6, 3.5, 3.4, and 3.3 ft/s, respectively, are recommended as design pedestrian walking speed. A 2006 study by Fitzpatrick et.al (Fitzpatrick et al. 2006) showed that for the general public; a pedestrian walking speed of 3.5 ft/s and for older pedestrians walking speed of 3.0 ft/s is suitable. In 2011, the Public Rights-of-Way Access Advisory Committee of USA (Public Rights-of-Way Access Advisory Committee 2011) has released draft guidelines for public comment. For pedestrian signal phase timing, maximum pedestrian walking speed of 1.1 m/s (3.5 ft/s) was recommended.

In Sri Lanka, there is no clear national guideline on pedestrian walking speeds. Instead, signal designs in Sri Lanka depend on foreign guidelines originated from USA or UK. Being a developing country in tropics, Sri Lankan road environment is very different from USA or UK. Further, Sri Lankan pedestrians' ergonomics and reason for crossing might be different from those of USA and UK. Therefore, suitability of guidelines originated in USA or UK to Sir Lankan conditions is questionable. For example a study by Tanaboriboon et al (1986) has found the Singaporeans walk slower than the Americans or UK citizens.

Need for a national guideline on pedestrian walking speed was not felt in the past because of very limited installations of traffic signals in Sri Lanka. At present, with the economic growth, the number of traffic signal installation in Sri Lanka is in the rise. Therefore, the need for a national guideline on pedestrian walking speed is also increases. This intern derives the need to find the pedestrian walking speeds for Sri Lankan pedestrians under prevailing conditions. Further we need to study other related pedestrian behaviors in the Sri Lankan context. Therefore we need a comprehensive study on pedestrian behavior. This paper presents a part of such a study. There are two objectives for this part of the study they are: (1) to determine pedestrian crossing speed in Sri Lanka; and (2) to find the effect of gender on pedestrian walking speed. The following text is organized into three chapters; chapter 2 gives the methodology followed by results and conclusions.

## 2. METHODOLOGY

A 5 meter level stretch of a road inside the faculty of engineering was selected for the study as the test stretch. 5 meter represents the typical width of the roads in Sri Lanka. Start and the end points of the test stretch were marked with temporary markers. It was made sure that the marks are clearly visible in the final video. Student of the Faculty of Engineering leaving the lecture rooms were chosen as the test subjects. Test subjects were not informed of the test so that they will not behave differently in front of the camera. For the same reason above, camera was placed so that it is not prominently visible to the test subjects.

Students were videotaped using a digital camcorder with PAL video system. PAL video system will yield a video with 25 frames per second. This will give a 1/25 s accuracy in the time measurement. Video was kept at an angle to the test stretch. Keeping at an angle will induce some parallax error; it is believed that parallax error can be eliminated using legs of the test subjects as the reference point. Audio Video Interleaved format produced by Microsoft Inc was used as the video format. Multiple pedestrian crossing events were videotaped at single stretch. Maximum time for a single stretch was limited to 10min so that the resulting video file will be easy to handle.

**Table 1 Sample data collected for this Study**

| Initial Time | Final Time | Time Duration (s) | Speed (m/s) | Gender |
|---|---|---|---|---|
| 00.01.06 | 00.04.14 | 3.13 | 1.597 | F |
| 00.10.08 | 00.15.05 | 4.95 | 1.010 | M |
| 00.11.21 | 00.15.13 | 3.87 | 1.292 | F |
| 00.15.16 | 00.20.10 | 4.9 | 1.020 | M |
| 00.17.04 | 00.21.06 | 4.03 | 1.241 | M |
| 00.24.19 | 00.28.25 | 4.1 | 1.220 | F |
| 00.34.11 | 00.38.05 | 3.9 | 1.282 | F |
| 00.38.00 | 00.42.16 | 4.27 | 1.171 | M |
| 00.38.00 | 00.41.28 | 3.47 | 1.441 | M |

The resulting video was analyzed using Ulead© video editing software. This software breaks the video in to 1/100 s, thereby increasing the accuracy of the time measurements. For each pedestrian crossing event time of start, time of end will be collected in addition sex of the test subject was also recorded. A Sample data collected for this study is shown in Table 1. Here the third column speed is calculated as the distance (5m) divided by the time duration (s).

## 2.1. Data Analysis

Data was analyzed using a non parametric approach. A non parametric model was developed for the data. SPSS package called Clementine was used to develop the model. All statistical significance will be evaluated at a P value of 0.05. Non parametric model called HTBRM was used to model the speed sex relationship. At this stage data for 50 pedestrian crossings were collected. 'Sex' was the only independent variable. There were 34 male and 16 female pedestrian crossing events. Basic statistic of the data used for the analysis is shown in Table 2.

**Table 2 Basic statistic of the data used for the analysis**

| | Speed (m/s) | | | | Number |
|---|---|---|---|---|---|
| | Average | Std.Dev | Max | Min | |
| Female | 1.31658 | 0.179166 | 1.59744 | 1.07991 | 16 |
| Male | 1.32960 | 0.187716 | 1.67785 | 0.95785 | 34 |
| All | 1.32543 | 0.183291 | 1.67785 | 0.95785 | 50 |

## 3. RESULTS

Results of this study showed that pedestrians in Sri Lanka walked with a mean speed of 1.3m m/s having standard deviation of 0.183 m/s. From this the $15^{th}$ percentile data was calculated to be 1.20 m/s.

Several HTBRM models such as CART, CHAID were tried on the models. However the HTBRM models did not show any significant relationship between the sex and speed.

## 4. DISCUSSION AND CONCLUSIONS

According to the T-test (p=0.40) and HTBRM model results, test data showed that males and females walked at a similar speed. However it must be pointed that test subjects in this study were university students with in the age of 22-26, this may have some effect on the walking speed. To get the real situation we have to include all other age groups as well. In future study it is intended to include more explanatory variables such as dress type, shoe type, weather, presence of police officer, walking with a peer, age, sex, carrying stuff etc. it is believed all of this data can be obtained from the videotape itself without disturbing the pedestrians.

Study showed that 15h percentile speed of Sri Lankan test subjects to be 1.20 m/s. This value is equal to the speeds recommended by MUTCD and a 1999 study by Milazzo et al (1999) recommended a same value. Mean walking speed of Sri Lankans is greater than that of reported in a 1986 study by Tanaboriboon and & Chor.

Using the digital video camcorder and Ulead© software we were able to obtain the speed of the pedestrians to a 1/100s high accuracy. No major difficulties were encountered in the process. Extracting speed data manually from video is time consuming however it can be done with hi precision required for this study. It is expected that the presence of zebra crossings will ease the distance measurement. With the experience gained from this pilot study it is believed that we can use the same procedure to get real life data from the field.

This study has produced walking speeds of pedestrians in Sri Lanka. However, it is very much premature to recommend any guideline from this study; main reason is being the limited number of test subjects used in this study. It is believed that inclusion of a larger data set will improve the reliability of the results obtained from this study.

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