Impact of Mobile Phone Use on Safety of Pedestrians at Walkways

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Abstract: The number of people who use mobile phones has been increasing and therefore, mobile phone usage-related crashes has been increased in past years. The purposes of this study were to determine the effects of mobile phone use on the safety of pedestrians at walkways and to determine the average walking speed of pedestrians at walkways. Information on different types of mobile phone usage (i.e., texting, calling, or reading), walking alone or in a group, and carrying weight were collected at walkways. Using linear regression analyses, the relationships between speed and type of mobile phone use, and safety and the type of mobile phone use were found. Average pedestrians walking speed at walkways was 1.188 m/s and it varies with type of mobile phone usage other than a conversation on mobile phones. The study showed varying effects of mobile phone usage type on the safety of the pedestrians other than reading texts.

Keywords: Effects of mobile phones; Pedestrians' walkways; Conflicts; Road safety; Vulnerable Road users

1. INTRODUCTION

Road crashes had been increased in India and Sri Lanka in the past couple of years. Traffic crashes increased from 61.2 per 100 000 population in 1938 to 183.6 per 100 000 in 2013 (Dharmaratne *et al*., 2015). In 2017, more than 40,000 people died in motor vehicle crashes; the three biggest causes of fatalities on the road are alcohol, speeding, and distracted driving. (Wagner, 2018). According to WHO, in December 2018, the number of annual road traffic fatalities has reached 1.35 million (UN, 2021).

Pedestrians are rarely more vulnerable when walking in the urban area, crossing busy streets, and negotiating traffic. Safety at the walkways is a major consideration to ensure the safety of the pedestrians. Pedestrians' safety must be ensured to make urban streets more sustainable with almost zero crashes and deaths. Unfortunately, pedestrian fatalities remain high. In the United States of America (USA), there was a more than 3% increase in the number of pedestrians killed in traffic crashes in 2018 with a total of 6283 deaths (NHTSA, 2019). Nearly 6,000 pedestrians were struck and killed by motor vehicles in 2017, with an estimated 7,450 pedestrian deaths (traffic and non-traffic) in the USA (NHTSA, 2019). Distracted walking incidents are on the rise, and everyone walking while using a cell phone is at risk. Therefore, it is required to stop using mobile phones not only while walking in crosswalks or crossing intersections but also when a person is walking in the streets.

Within the last 30 years, there had been a drastic increase in the number of people who own a mobile phone. People engage with their mobile phones in various ways; conversation on a mobile phone, reading and writing texts or emails, online shopping, web browsing, social networking, viewing videos, and many more. Previous research had been found that 2.1 trillion text messages delivered, 2.2 trillion minutes for calling, and 897 million emails sent which is expected to be 1.78 billion in 2017 through mobile phones (VSHSO, 2021).

Most of the time pedestrians engage with mobile phones while walking (Timmis *et a1*, 2017). Through the investigation of the National Injury Surveillance System between 2000-2011 in the USA, 5754 cases were identified based on the emergency section admissions connected to mobile phone usage, where 310 were injuries due to mobile phones, and 78% of the injuries due to mobile phones as the results of falls (Timmis *et a1*, 2017). In 2010, more than 1500 pedestrians were hospitalized due to tripping, falling, or walking over something while using the mobile phones (Timmis *et a1*, 2017). Due to the increase in crashes, while using mobile phones, various research was done to examine the effect of mobile phone used on the safety of pedestrians. Walking while using a mobile phone had resulted in slower walking speed, deviation from moving in a straight line, and a decrease in situational awareness (Timmis *et a1*, 2017). As it takes time to get adapted to the visual information as soon after taking the eyes out of the mobile phones, there is a higher potential in getting involved in crashes.

Pedestrians, much like drivers, have always engaged in multi-tasking like using hand-held devices, listening to music, snacking, or reading that draw their attention while walking. The effects of distracted walking are similar to those experienced in distracted driving (Sarkar *et al*., 2011, Nasar *et al*., 2008, Hyman *et al*., 2009). People who use their smartphones to text or browse while they walk are at a considerable risk of having an accident or a "near-miss" than pedestrians who talk on their phones (Perry and Gustavo, 2021). Through a thorough search, the state of information on unfocused walking and the hazards involved through different distraction types by pedestrians as well as the motorists were found.

Various studies based on risks involved in different distraction types were done in the past few years (Young *et al*., 2003; Neyens and Boyle 2007). The previous studies most of the time are based on driver distractions than the pedestrian distraction. A number of studies which based on the distracted pedestrian and driver interactions is currently in the world (Egodawatta and Amarasingha, 2019; Stavrinos *et al*, 2017; Mwakalonge *et al*, 2015). A few studies have also been conducted on the conflict analysis to regulate the protection of walkers due to distractions between motorists and pedestrians (Schwebel *et al*, 2012; Catalan Traffic Service, 2016). Through this study the effects of mobile phone use on the safety of pedestrians' safety while using mobile phones at walkways and the average walking speed of pedestrians at walkways is determined.

2. LITERATURE REVIEW

Many types of research had been done by the past researchers base on conflicts of pedestrians on mainly in crossings. Most of the research is based on stimulation studies while there are some observational studies are available. Loeb and Clarke (2009) examined the result of mobile phone usage on the safety of pedestrians in the USA utilizing econometric models and specification error tests. Time series data within the years of 1975-2002 were considered when developing and estimating the econometric model. Compared to the accident models this econometric model uses a polynomial function to address turning points and controls for old-style factors. The data and the models were determined by ordinary least squares. For the analyzing process, the models that were not omitted from the specification error test were considered. From the model, it was found that mobile phones have a non-linear relationship with pedestrian deaths. It was also found that the deaths increase at a decreasing rate. The mobile phones had a weighty adverse result on the safety of the pedestrians and the initial increase in the death rate was due to the availability of mobile phones but after the critical number of mobile phones was reached, the death rate was dropped.

Neider *et al*. (2010) conducted a study involving 36 participants from the University of Illinois in a virtual environment. The participants were asked to cross the road under three circumstances: no interference, hearing music through headphones, and conversing on mobile phone in a hand free. A number of 96 experimental trials were done where the conditions were blocked and counterbalanced, and 10 trials were given to each participant to make them familiarize themselves with the event. If the participants get hit by a car or do not cross the road on time were noted as failed. Successful crossing rate, time-out rate, amount of direction turns was measured during the observations. Success rate investigation displayed that the distractions particularly when talking on the mobile phone, lowered the proportion of successful crossings. The accident rate analysis showed that listening to music nor using a mobile phone increased the probability of being engaged in a vehicle accident. The conversations through the mobile phone also led to longer crossing times compared to the other conditions. The average amount of direction turned while starting to cross a road or at the time of crossing the road did not show a significant difference.

Thompson *et al*. (2012) observed pedestrian crossing behavior at 20 intersections in Washington. A sample size of 1,102 pedestrians was considered. Information for the first person accomplishing the limit after one-minute time goes were recorded. An affixed-interval selection criterion was used. Listening to music, hand-held mobile phones, earpiece mobile phones, text on mobile phones, conversing with another individual, etc. were considered distractions. The pedestrian walking direction, whether the pedestrians crossing the crosswalk, looked either side, and whether they obeyed the traffic signal were recorded. The time taken to cross the street was also obtained. It was found that walkers who were involved in texting took half a second in addition to cross each track and the ones who were hearing music crossed quicker than unfocused walkers at 0.16s per lane. It was found through the research that some disturbances were related to dangerous pedestrian behavior, where text messaging was the most critical. The pedestrians involved in texting crossed the road without looking both ways before crossing. A significant effect was observed in text messaging and gender when examining the interferences, crossing actions by watching, either way, crossing at crosswalks, and obeying the traffic signals. When compared to males and females, the females were double as likely to show at least one unsafe behavior while crossing the street. Out of the pedestrians who were involved in text messaging, it was observed that the females exhibit more unsafe crossing behavior compared to males.

Haga *et al*. (2015) done lab experiments on selected participants while the participants were walking while engaging in the mobile phone. The tasks assigned to the participants while walking were texting messages, watching videos, playing games, and just keeping the mobile phone in hand while at the same time performed visual and auditory detection tasks. The walking path was a 3m by 3m square and 4 video displays were placed outside the 3m-by-3m square. The stimuli were presented in the displays while the participants walked clockwise on the square. Noise signals were provided once every second for 500m. The screen color was also changed suddenly from blue to red. Four trials were conducted. It was found out that when using the mobile phone, the footsteps from the right leg were out of the marked line compared to walking in the control conditions while the worst being gaming on the mobile phone. The reaction time for visual and noise detection was longer while using mobile phones. The missed visual targets were higher at the gaming conditions than the rest of the conditions. The results also showed that there was a higher accident rate among the pedestrians who use mobile phones while walking, and the most critical circumstance was when the pedestrians were involved in gaming on mobile phones while walking.

Bungum *et al*. (2005) observed the behavior of 866 pedestrians walking on a wide street. The observed area includes an intersection with a proper traffic lighting system along with a separate traffic system for the pedestrians which will beep when pedestrians enter illegally. The observed pedestrians were wearing headphones, conversations on mobile phones, and doing several works without using mobile phones. The pedestrian behavior was observed including looking left and right, walking on the correct path on the crosswalk, staying on the curb till the green light pops, and entering at the yellow light. Distractions while walking demonstrated less cautionary behavior at the time of pedestrians crossing the street. A 1.6% variance of the pedestrians showed a cautionary behavior. The results further showed that the distractions were the sole significant predictor of whether the pedestrians showed a cautionary behavior or not.

Hatfield and Murphy (2007) conducted an observational study with 270 females and 276 males at intersections to observe and compare the safety of pedestrians while crossing with and without using mobile phones. One of the observers recorded mobile phone users' crossing behaviours and what they were using mobile phones for. Two controlled observations were done to get an idea of the behavior while not using mobile phones. The two controlled methods were the time-matched method, and the demographic-matched method. In the time-matched method, the behavior of the second pedestrian to pass the same point in the same direction without a mobile phone as the first pedestrian was recorded. In the demographic-matched method, the pedestrians of the same gender and age without using the mobile phone like the first pedestrian were observed. The observers classified the pedestrians under starting, near, and not at marked crossings. The pedestrians who were more than 10m away from the crossing were excluded. The speed of the females crossing the road using mobile phones was slower compared to the time and demographic controls but for males, there was no effect. The same pattern was observed when the two factors of age and walking with or without a companion were introduced. At un-signalized intersections along with the new factors, the male crossing speed was affected while that of females remained the same.

Byington and Schwebel (2013) investigated the performance of 92 pedestrians crossing a road in a simulated atmosphere. Individuals were obtained after a psychology lecture at the University of Alabama. Participants were asked to cross the intersection 10 times each under distracted and undistracted conditions. Distraction was done using an email-based "scavenger hunt" which contains a set of texts with commands, which needed the internet to hunt the answer for the questions asked through the mail. Six situations were observed: close call or a hit, start delay, wait time, opportunities missed, observe traffic, and eyes out of the road. The main effect in distraction conditions for the six situations was exposed by repeated-measures the Analysis of Variance (ANOVA) with conditions as the independent parameter and participant scores was dependent parameter. Using the internet simultaneously and crossing the street showed risky behavior in pedestrians compared to crossing without distraction. Through the analysis, it was found that the key results for the unfocused condition were engaged across all pedestrian parameters. Walking and using the internet at the same time had caused dangerous actions compared to the unfocused conditions unrelatedly of the command, gender, background, or age. The pedestrian road crossing ways and usage of the internet while walking had not caused the differential danger due to interruption.

Another experiment on the effect of certain types of disturbance on pedestrian injury risk among university students was done in Alabama, USA. Stavrinos *et al*. (2011) observed the result of a realistic mobile phone discussion on university pupil pedestrians' injury risk and different individual factors which might predict risky behavior. A number 108 people were recruited at an age range from 17-41 which includes 63 females and 45 males for first experiment. Mean walking speed for the virtual atmosphere was measured by instructing to walk a 15 feet hallway 4 times and taking the average value. Participants completed 12 stimulate crossings in the virtual atmosphere, 6 participants been unfocused by a mobile phone conversation with the research assistants, and 6 without being distracted. Familiarization of how these two to stimulate crossings was done and the task involved was done before entering the virtual environment. The participants were videotaped through the process to identify the reactions. In second experiment, 59 college students were recruited at the age range of 18-35 which include 32 females and 27 males. Participants were familiarized with the virtual environment as in the first experiment. Another virtual reality session with 12 virtual crossings consists of 2 people while undistracted, 1 person while answering the mobile phone, 9 people while distracted by realistic mobile phone discussion, spatial task, and arithmetic task. From both the trials it is revealed that the mobile phone discussions distract university pedestrians to a level of negotiated protection which was influenced by distraction where the content was not a factor.

Nasar *et al*. (2008) determined the interference while using mobile phone. The first 60 arbitrarily chosen participants entering a large, urban, campus were asked to walk along a prearranged course. Half of the participants were in conversation on the mobile phone while the rest were waiting for a call which never came. Before the study was done five “out-of-place” items were placed on the route which the participants are asked to walk. In the end, the participants were asked how many “out-of-place” objects they have noticed. It was found out that the ones who were waiting for a phone call noticed more objects compared to the ones who were in conversation over the phone. They examined whether the pedestrians who used hand-held mobile phones display unsafe behaviors than the pedestrians who used other devices like iPods and ones who did not use any device. Three spectators selected a pedestrian reaching the crosswalk by himself/herself in a condition where the pedestrian might involve in a possible conflict with a vehicle that was approaching. The three observers self-sufficiently recorded the pedestrian’s demographic features and actions as they crossed the street. From the observed 127 pedestrians, 28% were noticed as unsafe by the observers. The pedestrians who used mobile phones had a higher probability for unsafe behaviors compared to iPod users and the ones who did not use any device.

Lin and Huang (2017) investigated the effects of smartphone usage on the awareness of roadside events related to the security of pedestrians. The study was done involving 24 healthy participants at the age of 22 to 26 who were selected randomly from local universities. All the participants had possessed a smartphone for more than a year. A virtual environment was constructed with LCD televisions and the participants were asked to monitor different positions within the screen for a variety of roadside actions while walking on the treadmill and respond to designated hand signals. Six types of visual stimuli representing critical road events on pedestrian security were included in the simulation displayed on the display. At one test session only on-road event took place. The normal walking speed was reduced by 33% for the test. The reaction times and response errors had been recorded by the mobile applications which were installed before the test was done. Participants displayed decreased situational awareness at a high rate of road events. From the overall analysis under the six test conditions, 93% of the time the participants were engaging on the smartphone and 7% of the time was allocated for looking on to the LCD display. Participants situational awareness decreased greatly while using an application with a huge workload. It had been found that longer road event detection degraded situational awareness and increased the workload.

Pizzamiglio *et al*. (2017) studied an approach to measure the different levels of distraction encountered by pedestrians while walking. The study aimed to distinguish between the distractions within the brain the proposed work analyses data collected from mobile sensors. The distraction of the pedestrians was recognized through a multimodal approach based on modeling walking behavior: extraction of gait measurements, brain activity modeling: EEG (electroencephalography) signal extraction, and analysis: correlation phase and working memory. In modeling the walking behavior, various gait parameters through Force Sensing Resistor Sensors (FSRs), accelerometers, and gyroscope were recorded. A Samsung Galaxy S4 mini smartphone was fixed at the subject's lower back with an elastic belt and data from its internal accelerometers and gyroscope were recorded. The modeling was done assuming that if the pedestrian is distracted then the most reliable indicator could be the change in the walking behavior. For brain activity modeling EEG signal extraction was used which is an electrophysiological recording technique that able to non-invasively record the electrical activity of the brain. For the study, several participants were involved in two scenarios which were Single Task (ST): Natural Walking and Dual-Task (DT): Walking & Texting. In the ST scenario, the subjects completed a round of walks without engaging with any secondary task. And in the DT scenario, the subjects a round of walk while using a smartphone to reply to an email. The t-tests were performed to assess statistically significant changes in walking behavior, EMG, and EEG activities across the two experimental conditions. It was found that texting while walking has a considerable impact on the gait. Through the results of the conducted experiments, it was found that the proposed approach has considerable potential for recognizing distractions while pedestrians are walking from different perspectives, both behavioral and neurophysiological. From the study, it was proposed to use the suggested work to provide pedestrians with notifications as they approach potential hazards while they walk on the street conducting multiple tasks such as using a smartphone.

Through the previous research it was found most research are being conducted based on pedestrian conflicts in crossings, situational awareness of the pedestrians, and experiments on pedestrians. There is few research conducted by observing the natural walking behavior of pedestrians and the observational data are collected at the observation point itself. This study focuses on observing the natural walking behavior of the pedestrians on the walkways while using the mobile phone and without using the mobile phones and the data collection methodology to gather the pedestrian data would be through videotape recordings.

3. METHODOLOGY

In Sri Lanka urban roadways, it is possible to observe some pedestrians use carriageways instead of using sidewalks creating life threats and disturbing the smooth traffic flow. It could be also observed that the pedestrians tend to use mobile phones while walking on the sidewalks and when crossing the roads which may lead to crashes. Urban roadways in Gampaha and Colombo were selected to collect data for the research. Observations of the pedestrians on walkways at the selected study areas were done to determine the effects of mobile phone use on the safety of the pedestrians at walkways.

3.1. Data Collection

Close observations were done under four conditions: without mobile phones use, in a conversation on the mobile phone, reading a text message, or typing and sending a text message on the mobile phone. Further the observations on pedestrian walking characteristics of whether the pedestrians were walking alone or in a group, whether they were carrying weight and whether the pedestrians were walking out of walkways were collected. The sample size was calculated using Equation 1 (Thakur, 2021).

$$n = \frac{Z^2 pq}{e^2} \tag{1}$$

where:

n	: Sample size,
z	: Confidence level,
p	: Expected prevalence or proportion,
q	: 1- p, and
e	: Precision level.

Sample Size Calculation was done with a precision level of ± 4%, a confidence level of 95%, and a p -value of 0.5. The sample size obtained was 600 pedestrians.

The pedestrian mobile phone usage data were collected through videotape recordings at walkways in Gampaha and Colombo. The video data were collected based on the real situations and none of the pedestrians were forced to do tasks. The speed data were collected by observing the time taken by the pedestrians to travel within the distance visible to the video camera. The data related to the conflicts were obtained using the same video tape recordings used to extract the speed data. The conflicts were categorized under four categories namely, pedestrian involved in a conflict with another pedestrian, pedestrian involved in a conflict with fixed object, pedestrian involved in a conflict with vehicle, and pedestrian without being involved in a conflict.

3.2. Data Analysis

The data were collected by close observations of four conditions: without mobile phones use, in a conversation on the mobile phone, reading a text message, or typing and sending a text message on the mobile phone. The observations were recorded manually and the instances where there was a chance for an accident to take place were to be noted down separately. The data was further categorized after identifying that there is a significant effect on mobile phone use on pedestrian safety. Data were categorized under type of conflicts, type of pedestrians, speed of the pedestrians, etc.

Through the collected data pedestrians' walking speeds were calculated. The specific length of the road segment where the pedestrians are walking was measured and through the time-lapse of the video recordings, the pedestrian walking speed was found. The cumulative speed curves were drawn under the four conditions to determine the 15% and 50% speed of the pedestrians in walkways. The chi-squared tests were conducted to find whether there is a significant effect of conflict types while using mobile phones. The Spearmen correlation was done to determine the relationship between the possibility of being in conflicts and the type of mobile phone use. The Spearmen correlation was also done to determine the relationship between the speed and type of mobile phone use. Linear regression analysis and logistics regression analyses were done to obtain relationship for the speed where independent variables were the waking carrying weight, conflict types, etc.

3.2.1 Correlation analysis

Correlation is a bivariate analysis that is used to measure the strength of association between two variables and the direction of the relationship (Baker, 2018). Basically, through the correlation, a value of + or – is obtained. The + value indicates that there is a perfect degree of association between the variables and the – value indicates that there is a weaker relationship between the two variables. There are different types of correlations in statistics namely Spearman correlation, Pearson correlation, Kendall Rank correlation. The Spearman correlation is done in the research. Spearman correlation is a non-parametric test that is used to measure the degree of association between two variables. Assumptions on Spearman correlation are the data analyzed should be at least ordinal and the scores on one variable must be monotonically related to the other variable.

3.2.2 Linear regression analysis

Linear regression is a technique used for predictive analysis (Montgomery *et al*., 2012). Some of the main uses of the regression are to determine the strength of the predictors, forecasting an effect, and trend of forecasting. Linear regression has different types such as simple linear, multilinear, etc. In regression analysis, it is examined whether the predictor variables do a good job in predicting the outcome and which outcome is significant and what is their magnitude. Linear regression expresses relationships between one dependent variable and one or more independent variables. A basic linear regression equation gives in Equation (2) (Montgomery *et al*., 2012).

$$y = b_i x_i + c \tag{2}$$

where:

y	: dependent variable,
x	: independent variable,
b	: regression coefficient, and
c	: constant

The ten assumptions of the liner regression model are the regression model is linear in parameters, the mean of residuals is zero, homoscedasticity of residuals or equal variance, no autocorrelation of residuals, the x variables and residuals are uncorrelated, the number of observations must be greater than number of xs, the variability in x values is positive, the regression model is correctly specified, no perfect multicollinearity and normality of residuals (Prabhakaran, 2021).

3.2.3 Logistic regression analysis

Logistic regression analysis was also used to finding the relationship between the conflicts and different type of mobile phone use in this research. Logistic regression is used when the dependent variable is binary (Montgomery *et al*., 2012). Logistic regression is also used for the predictive analysis. Logistic regression analysis expresses the relationship between one dependent variable which is a binary and one or more nominal, ordinal, interval independent variables. Some of the logistic regression types are binary logistic regression and multinominal logistic regression. A basic logistic regression equation gives in Equation (3) (Montgomery *et al.*, 2012).

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots \ldots \ldots \ldots .. + \beta_i X_i \quad (3)$$

where:

Y : dependent variable,
β : Coefficients of variables,
X : independent variables, and
β_0 : Constant.

The four assumptions of the logistic regression model are, the binary logistic regression requires the dependent variable to be binary and ordinal logistic regression requires the dependent variable to be ordinal, logistic regression requires the observations to be independent of each other, logistic regression requires there to be little or no multicollinearity among the independent variables and logistic regression assumes linearity of independent variables and log odds (Statistics Solutions, 2021).

4. RESULTS

Cumulative speed curves were developed for the types of pedestrians such as conversation on mobile phones, reading text on mobile phones, sending a text on mobile phones, without using mobile phones separately for those who walk alone and the ones who walk in a group as shown in Figure 1. The cumulative speed curves help to clearly understand the overall variations of the speed among the different type of mobile phone users. When investigating the pedestrians' speeds, it could be noticed that mobile phone users' speed is lower than that of non-users'. The lowest speed had the pedestrian who were in reading a text message on the mobile phone and followed by typing and sending a text message on the mobile and a conversation on the mobile phone. The cumulative speed curves for walking while conversation on mobile phones, walking while sending text on mobile phones, walking while reading text on mobile phone use showed a slight variation between the cumulative speed curves when the pedestrians are walking alone and as a group. But the cumulative speed curves drawn for walking alone without using mobile phones and walking in a group were approximately equal.

The 15% and 50% speed were estimated from cumulative speed curves and the 50% was considered for comparing the walking speed of pedestrians under each condition as it is the average value of the data obtained for the speed. From the obtained 15% and 50% speeds the results are tabulated in Table 1. It was observed that in each and every type of mobile phone user's the 15% speed was higher for the pedestrians walking alone compared to that of the walking in a group. When investigating the 50% speed, it was observed that the conversation on mobile phones and sending a text on mobile phones were higher while walking alone rather than walking in a group. The 50% speeds were lower for reading text on mobile phones and without mobile phones while walking alone compared to walking in groups.

By observing the walking speeds obtained, it was found that the pedestrians' average walking speed on walkways without using mobile phones was 1.188 m/s that was 99.00 % of the average pedestrian walking speed (1.2 m/s) based on past research (Laplante and Kaeser, 2004).

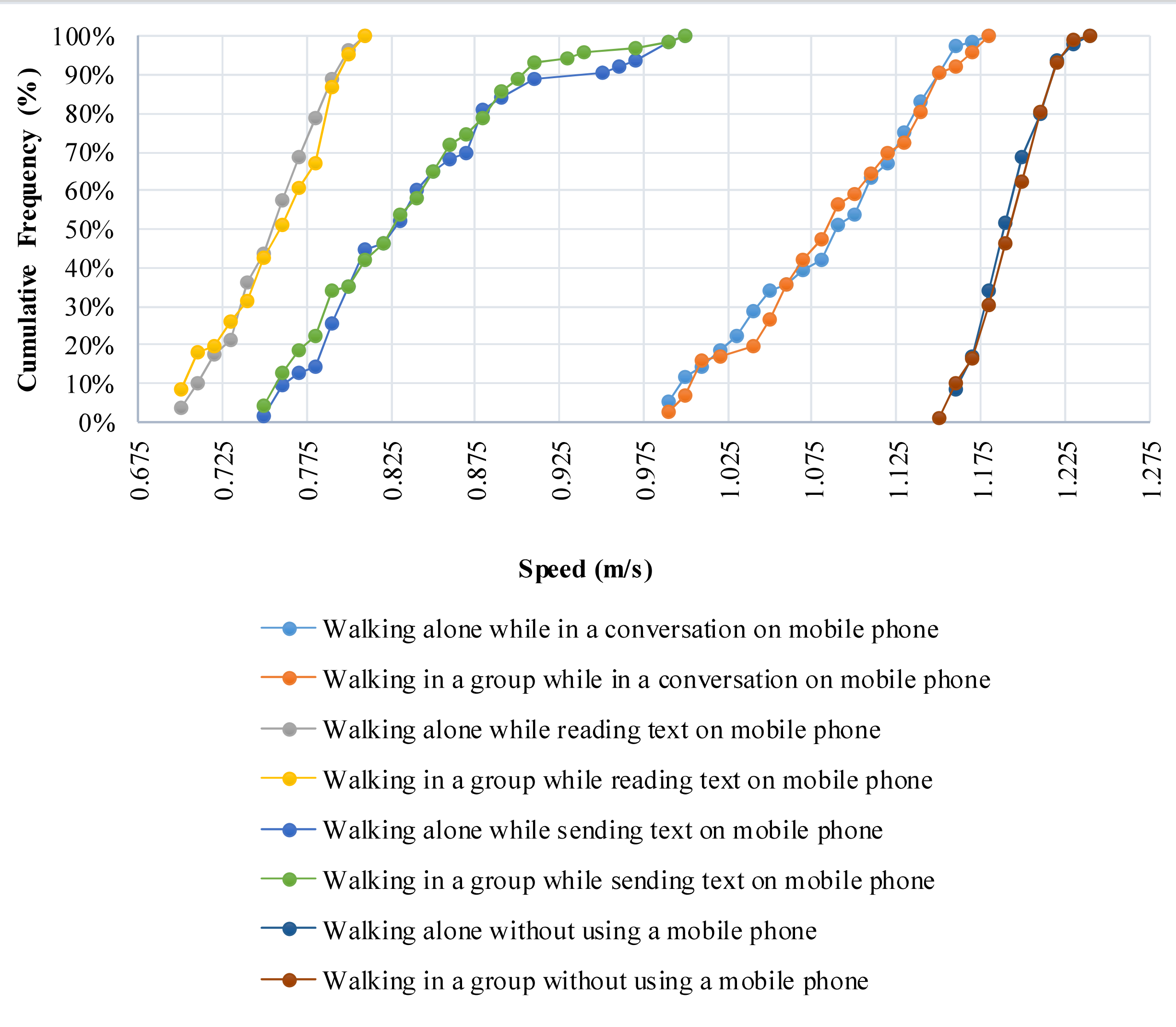

Figure 1: Cumulative Speed Curves for different types of mobile phone users

Table 1: Pedestrians' 15% and 50% walking speeds on walkways by different type of mobile phone use

Type of Mobile Phone Use	Group or Alone	Speed 15% (m/s)	Speed 50% (m/s)	Min Time (s)	Mean Time (s)	Max Time (s)
Conversation on Mobile Phones	Alone	1.011	1.088	17	18	**20**
	Group	1.007	1.081	17	18	**20**
Reading Text on Mobile Phones	Alone	0.718	0.755	25	26	**29**
	Group	0.707	0.758	25	26	**29**
Sending Text on Mobile Phones	Alone	0.781	0.827	20	24	**27**
	Group	0.765	0.826	20	24	**27**
Without Mobile Phones	Alone	1.167	1.188	16	17	**17**
	Group	**1.167**	**1.191**	**16**	**17**	**17**

In comparison to the research done by Egodawatta and Amarasingha (2019) in Sri Lanka recently, which had been found that the average crossing speed of non-mobile phone users was 1.17m/s, whereas in the current study the pedestrian walking speed on walkways was found to be 1.188m/s. The pedestrian crossing speed while text messaging/application usage was 1.08 m/s as per Egodawatta and Amarasingha (2019) and in the current study it was found that pedestrians walking speed while text messaging was 0.827 m/s.

To further classify the data, it was required to determine whether there is an effect on mobile phones on the safety of pedestrians. The data were categorized into two categories as conflicts with mobile phones and without mobile phones such that it could be found whether there is a significant effect due to the mobile phone on safety of pedestrians as shown in Table 2.

Table 2: Conflicts of pedestrians while walking on walkways with and without Mobile phones.

Variable	**Total Observations**	**Conflict Observations**			**Percentage**
		Pedestrians	Fixed Objects	Vehicles	
Pedestrian walking with Mobile Phones	429	148	103	85	**78.32%**
Pedestrian walking without Mobile Phones	271	39	32	43	**42.07%**
Total	**700**	**187**	**135**	**128**	**64.29%**

Using chi-squared tests conducted, it was found that there is a significant effect of conflicts while using mobile phones. Through the analysis, it was found that the most critical condition which leads to conflicts while using mobile phones is due to the conversations on mobile phones (122 conflicts). The highest conflict percentage of 41.56% of the conflicts with pedestrians was observed. And the vehicle conflicts percentage was 68.44% of the conflicts with the pedestrians. The percentage of conflicts with the fixed objects was 72.18% of the conflicts with the pedestrians.

4.1. Spearman Correlation

The relationship between the speed and pedestrian characteristics, the possibility to get into a conflict, and pedestrian characteristics were determined by observing the Spearman Correlation Factors. The Spearman correlation was done for determining the relationship between speed and type of mobile phone use and the relationship between the possibility to involve in conflicts and the pedestrians' characteristics. As shown in Table 3, it was found that there is a positive relationship between walking speed and the people walking without using mobile phones and people who are on a conversation on mobile phones. Considering the people who walked sending and reading text on mobile phones had a negative relationship with the walking speed. Also walking alone or group, carrying weight, and walking out of walkways had negative relationships with the speed.

Table 3: Spearman correlation of speed and possibility of involving in conflicts with the pedestrian characteristics while walking.

Characteristics of pedestrians while walking	Number of pedestrians	Percentage of pedestrians	Significance of speed	Significance of conflicts
Mobile phone use type				
Without using mobile phones	271	38.72 %	0.765**	-0.361**
Conversation on mobile phones	152	21.71 %	0.212**	0.166**
Reading text on mobile phones	141	20.14 %	-0.688**	0.171**
Sending text on mobile phones	136	19.43 %	-0.467**	0.097**
Alone	363	51.86%	-0.050	-0.050
Carrying weight	372	53.14%	-0.170	-0.170
Walking out of walkways	363	51.86%	-0.035	-0.035

** Correlation is significant at the 0.01 interval.
* Correlation is significant at the 0.05 interval.

It was found that there are negative relationships between the possibility to get involved in a conflict and the people walking without using mobile phones and walking out of walkways. As there is a negative relationship, it means an increase in people without using mobile phones and walking out of walkways will decrease the possibility of conflict. Considering the people who walked sending and reading text and on a conversation on mobile phones had a positive relationship with the possibility of involving in a conflict. Here a positive relationship means an increase in the people who walked sending and reading text or a conversation on mobile phones will also increase the possibility of conflict.

The Spearman correlation was done to determine the relationships between the pedestrian characteristics as shown in Table 4. All the correlation coefficient values were less than 0.5, therefore all the variables could use for model developments.

Table 4. Spearman correlation to determine the relationship between the pedestrian characteristics.

Type of mobile phone use	Without using mobile phone	Conversation on mobile phones	Sending text on mobile phones	Reading text on mobile phones	Alone or group	Carrying weight	Walking out of walkways
Without using mobile phone	1.000	-0.420**	-0.390**	-0.395**	0.210	-0.017	-0.009
Conversation on mobile phones	-0.420**	1.000	-0.262**	-0.266**	-0.027	0.029	-0.027
Sending text on mobile phones	-0.390**	-0.262**	1.000	-0.247**	-0.044	0.009	-0.036
Reading text on mobile phones	-0.395**	-0.266**	-0.247**	1.000	0.046	-0.017	0.074*
Alone or group	0.021	-0.027	-0.044	0.046	1.000	0.092*	0.067
Carrying weight	-0.170	0.029	0.009	-0.017	0.092*	1.000	-0.051
Walking out of walkways	-0.009	-0.027	-0.036	0.074*	0.067	-0.051	1.000

** Correlation is significant at the 0.01 interval.
* Correlation is significant at the 0.05 interval.

It was found that all the different types of mobile phone use are significant. Without using mobile phones, conversation on mobile phones, sending text on mobile and reading text on mobile phones have negative relationships between each other. There is a positive relationship between reading text on mobile phones and walking out of walkways. Between walking alone or in group and carrying weight has a positive relationship.

4.2.Linear Regression Model

A linear regression model was developed and obtained the relationship between the speed and the type of pedestrian walking characteristics. The dependent variable of this linear regression model was the speed of the pedestrians which was a continuous variable, and the independent variables are walking without using mobile phones, sending a text on mobile phones, reading text on mobile phones, conversation on mobile phones, walking alone, carrying weight, and walking out of the walkways which are nominal type variables. Table 5 shows the coefficient estimates of the linear regression model. The F-statistic of the linear fit versus the constant model 2196.843 with a p-value of 0.000. That means the model is significant at the 5% significance level. The model fit of the linear regression model could be verified by the R^2 value, as the R^2 value is 0.95 which close to 1. Therefore, the developed model explains about 95% of the variability in the response. The expected and explainable results were identified from the linear regression model.

Table 5. Linear Regression Coefficients for the relationship between the speed and the pedestrian characteristics

Model R	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	
0.975[a]	0.95	0.95	0.0419	
Coefficients[a]				
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	1.093	0.004		250.962	0.000
Without mobile phone use	0.106	0.004	0.276	24.967	0.000
Sending text on mobile phones	-0.251	0.005	-0.535	-51.074	0.000
Reading text on mobile phones	-0.332	0.005	-0.711	-67.525	0.000
Walking alone or group	0.000	0.003	0.001	0.064	0.949
Carrying weight	-0.007	0.003	-0.02	-2.306	0.021
Walking out of walkways	-0.000	0.003	0	-0.027	0.978
a. Dependent Variable: Speed					

Through the linear regression, it was found that the significant variables are walking without using mobile phones, sending a text on mobile phones, and reading text on mobile phones as they have a significance value less than 0.05. As walking alone, carrying weight, walking out of walkways have a higher significance value than 0.05, these variables are not significant. Generally, in linear regression models the uncorrelated variables are no included in the model, however it is important to see which of variables has an effect and which of the variables that does not effect on the pedestrians. Therefore, both significant and unsignificant variables were kept in Table 5. It is possible to observe that the speed of the pedestrians is more while walking without using mobile phones as the coefficient is positive whereas the speed can be reduced if the pedestrians are reading or sending a text on mobile phones as their coefficients are negative. When the pedestrians are sending text or reading text while walking the pedestrians gets distracted as their focus is on their mobile phone, which will lead to a reduction in the walking speed. As they get distracted, they are more likely to get involved in conflicts as they have lower situational awareness due to the usage of the mobile phones (Bungum *et al*. 2005; Nasar *et al*. 2008). Whereas the pedestrians who are walking without using the mobile phone shows more safety behavior while walking in the walkways as they have a higher situational awareness, and they have a higher walking speed compared to the pedestrians who use mobile phones.

4.3.Logistic Regression Model

A logistic regression model was developed and obtained the relationship between the conflicts and the pedestrian characteristics. The dependent variable of this logistic regression model is the conflicts which is a nominal variable, and the independent variables are walking without using mobile phones, sending a text on mobile phones, reading text on mobile phones, conversation on mobile phones, walking alone, carrying weight, and walking out of the walkways which are also nominal variables. The F-statistic of the model fit versus the constant model 4377.116 with a p-value of 0.000. That means the model is significant at the 5% significance level. Table 6 shows the coefficient estimates of the logistic regression analysis.

Table 6. Logistic Regression Model for the relationship between the conflicts and the pedestrian characteristics.

Model Summary			
Step	-2 Log Likelihood	Cox & Snell R Square	Nagelkerke R Square
1	814.851[a]	0.13	0.179

Coefficient Estimates	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
Constant	0.886	0.55	2.569	1	0.109	2.426
Without mobile phone use	-1.77	0.25	50.589	1	0	0.170
Conversation on mobile phones	-0.12	0.29	0.67	1	0.683	0.887
Sending text on mobile phones	-0.43	0.29	2.153	1	0.142	0.653
Walking alone or group	0.137	0.17	0.638	1	0.514	1.147
Carrying weight	0.112	0.17	0.425	1	0.078	1.118
Walking out of walkways	-0.3	0.17	3.115	1	0.109	0.739

Through the logistic regression, it was found there is no any significant effect on the possibility to get involved in a conflict and the type of mobile phone use as the significance values are more than 0.05. Even though there is no significant effect found in this study, it does not suggest that the pedestrians are not involving in conflicts due to the mobile phone use. These results may be due to errors in the video tape method of conflict data collection. Therefore, for future studies, it is recommended to gather the conflict data through observations at the selected location itself with a help of few people in the data collection rather than using a video camera as it may help in occasions where the video camera gets covered during the data collection and the future researchers must pay attention to these errors during the data collection stage. Therefore, there should be a solution to minimize the pedestrian conflicts while using the mobile phones. As the usage of mobile phones increases daily, to increase the pedestrians' safety decreasing mobile phone usage is inevitable. It is not possible to stop people from buying or using mobile phones as they have the right to do so. Therefore, another method must be used to handle the safety of pedestrians while walking on the streets. One of the solutions are to put up a fine against the pedestrians who tend to use their mobile phone while walking, to make it an illegal act to use the mobile phones while walking. If the pedestrians are caught using the mobile phones while walking, they will be directly charged with a fine.

5. CONCLUSIONS AND RECCOMENDATIONS

Through the research, it was found out that there is no significant effect of mobile phone use on the safety of the pedestrians at the walkways and there is an effect of mobile phone use on the pedestrians' walking speed. The model for the speed of the pedestrians at walkways was developed using linear regression analysis. It was found that the pedestrians walking speed on walkways were 99.00% of the walking speed of pedestrians from the previous research done which is 1.2 m/s. And it was found that the conversation on mobile phones does not affect the pedestrians walking speed. Through logistic regression modeling, the model for the conflicts and the type of mobile phone usage was developed. Here it was found that the reading text on mobile phones was not a factor for the possibility of involving in a conflict.

It is recommended to use a much more compatible technique to obtain the required data such as fixing a camera or observing the walkways daily. As carrying weight and walking alone or in a group affects the speed of pedestrians were not significant variables. When doing a conflict study of pedestrians using mobile phones it is recommended to consider the conversation, sending text, reading text on mobile phones, walking alone or group, and carrying weight. It is almost impossible to minimize the usage of mobile phones because mobile phone usage increases daily. Therefore, to minimize the conflicts due to the usage of mobile phones the possible solutions are to put up a fine against the pedestrians who tend to use their mobile phone while walking, to make it an illegal act to use the mobile phones while walking or to do an awareness program to make people critically think on the consequences of using mobile phones while walking on the streets.

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