WALKING AND TALKING: THE EFFECT OF SMARTPHONE USE AND GROUP CONVERSATION ON PEDESTRIAN SPEED

Lexie Reynolds Walsh
The University of Sydney

Tingsen (Tim) Xian
The University of Sydney

David Levinson
The University of Sydney
david.levinson@sydney.edu.au

Word Count: 3285 words + 5 figures× 250 + 7 tables× 250 = 6285 words

Submission Date: July 27, 2018

Abstract

By testing the walking speed of groups of pedestrians and of phone users, followers of groups and of phone users, and of people uninfluenced by phone users and groups, from different sites it could been seen that groups of people and phone users, and often followers of phone users, walk significantly slower than people uninfluenced by phone. In a narrow path people in groups and phone users not only slow themselves down but also slow the people behind. The rise of the smartphone correlates with a reduction in walking speed.

Keywords: Walking speed, Pedestrian behaviour, Phone usage, Distracted Walking, Group behaviour

INTRODUCTION

As smartphones have come to be almost ubiquitous across the world, the issue of smartphone use while walking arises. Recent literature shows that smartphone use while walking causes people to walk more slowly and more carefully, albeit with no more collisions than normal walkers (1, 2). It also reduces a person's ability to follow a set pathway correctly and lowers reaction time to both auditory and visual cues (3). Smartphone use while walking has caused an increase in injury rates (4), causes distraction while walking across all age groups (5) and is most common among young and female pedestrians (6).

Considering this, it may be reasonable to assume that pedestrians using smartphones would have a slowing effect on the flow of pedestrian traffic more generally. However, it is difficult to ascertain whether this is true in practice based on the existing literature. This paper aims to answer this question by testing what effect smartphone use among some pedestrians has on overall pedestrian speed.

An investigation was made as to whether the use of smartphones while walking slows down pedestrian traffic. The research method used was the examination of video footage at several sites.

It was expected that results would show that smartphones do slow down pedestrian traffic in general – that is, even for pedestrians who are not using smartphones. It was thought that the smartphone using pedestrians would become obstacles for the non-smartphone users, and thus slow their walking speed. Further, it was expected that more collisions and safety incidents will occur because of smartphone use by pedestrians.

An alternative hypothesis was that pedestrians without smartphones adapt their behaviour to accommodate the texting pedestrians: they may weave around the texting pedestrians, and increase their walking speed to overtake, and thus allow them to cross the distance in a similar timeframe as if they had not met any texting pedestrians. In this scenario, the use of smartphones would primarily affect the walking speeds of individual pedestrians using the devices but would not actually have any effect on the average speed of other travelers. Further, collisions may be isolated to those pedestrians actively using smartphones: those without the devices may be able to effectively avoid possible collisions by adapting their walking speed and direction.

In addition the behaviour of pedestrians in groups has been studied and shown to have similar effects.

MATERIALS AND METHODS

Description of Datasets

Three sites were examined. They are discussed in turn.

Site 1: City Road Bridge

Site 1 (Figure 1) consists of a pedestrian bridge over City Road on the University of Sydney campus. Video footage was recorded during a school day, just prior to lunchtime to ensure maximum pedestrian traffic. The distance covered in the frame was recorded, and the time taken for each pedestrian to pass through the frame was logged to extract their walking speed. Other information on each pedestrian recorded includes gender and whether they walked alone or in a group, and whether they were using their phone while walking. Each pedestrian was also time stamped to ensure an analysis of the general pedestrian movements at any one time could be made. This data was then analysed to investigate the effects of smartphone use on pedestrian traffic over the bridge.

The footage was taken on April 24, 2018 between 11:24am and 12:34pm. During the

TABLE 1 Descriptive statistics: Bridge Study: Site 1

	Total	Male	Female
Number of Pedestrians	180	92	88
Average Walking Speed (m/s)	1.21	1.24	1.17
Using Phones	17%	17%	17%
Texting (or Reading and Typing)	15%	15%	15%
Calling (or Talking on Phone)	2%	2%	2%
Holding Phone Only	15%	12%	18%
Not Using Phones	83%	83%	83%
In a group	28%	18%	39%

recording period the conditions were clear, with light breeze and approximately 23 deg$C$. The pedestrian movements in the first ten minutes of the video were logged. This data was then analysed in conjunction with a more general observation of the full hour of footage.

The method for logging the data is as follows: the distance covered in the frame was recorded (The footage was at an angle which resulted in a 24m observation for pedestrians on the west side of the Bridge, and 18m on the east), and the time taken for each pedestrian to pass through the frame was logged to extract their walking speed. Other information on each pedestrian was recorded including gender, whether they walked alone or in a group, and whether or not they were using their phone while walking. Each pedestrian was time stamped, and direction of travel was noted to enable an analysis.

This dataset therefore has 180 reference items, each one corresponding to a pedestrian, and includes the relevant information on that pedestrian as outlined above.

The data was broken down for analysis based on gender, people walking in groups, and smartphone usage: the walking speeds of the pedestrians in various categories was then evaluated. Some initial information on the dataset is provided in Table 1.

The information that was extracted from the observation of the footage is more general in nature: it offers insights into trends that the initial data analysis did not pick up. For example, the most obvious trend seen in the video observation is that pedestrians that were texting while walking were careful to keep to the left in their direction of travel. In this way, they caused less of an obstruction for other pedestrians when compared with people walking in groups. Based on this observation, further information was logged from the video: the number of times that pedestrians overtook one another and whether the pedestrians overtaken were using smartphones or not.

Site 2: Bay Street

Three videos were collected at Bay St, Ultimo, NSW. The three videos had been collected from 4:42pm to 4:55pm at 1 May, 2018, from 11:11am to 11:28am at 13 June, 2018 and from 4:22pm to 4:38pm at 13 June, 2018, respectively. The camera was located about halfway on the east sidewalk facing west between Grose St and Broadway (refer to Figure 2(a) and (c)). The camera was placed at the other side of the road in order not to narrow the walkway under observation. The camera faced west.

On sites 2 and 3, a person was considered uninfluenced by phone if the person was not walking with phone and followed a person using a phone by more than 5s.

Table 2 shows the appearance of features at Bay St.

FIGURE 1 Site 1 (a) Camera Layout and (b) Measuring Zone: 24m on the west (far) side of the Bridge, 18m on the east (near)

TABLE 2 Frequency of features at Site 2

Feature	Frequency	Feature	Frequency
Northbound	48.01%	With phone	12.37%
Male	43.40%	Phone user follower	11.95%
High heels	4.19%	Unaffected by phone	75.68%
Slippers	4.40%	Walking alone	66.88%
Backpack	57.44%	Carrying in one hand	33.96%
Obese	3.56%	Carrying in both hands	4.82%
Tall	11.32%	Short	15.09%
Average estimated age	30.6		

Site 3: Martin Place

Another video had been collected at Martin Place, a large pedestrian zone without crowding issues, which aims to control for the walking speed at different locations. The video was collected from 4:55pm to 5:10pm at 16 April. The camera was located at Martin Place (about halfway between Elizabeth St and Philip St). The camera was facing West. Three historical videos were tested for comparison.

For sites two and three, Apple iMovie had been used in order to analyze the data frame by frame. Distances at both Bay St (Figure 2(c)) and Martin Place (Figure 2(d)) were selected and measured physically. The time taken and number of steps taken for the each pedestrian to cross this length had been measured via iMovie. The features of each pedestrian had been collected based on observation of the research team, which are phone use while walking, earphone plugged while walking, gender, wearing high heels, wearing slippers, wearing backpack, carrying a package in hand, obese, estimated age, and estimated height.

$$speed = \frac{distance}{time} \tag{1}$$

FIGURE 2 Sites 2 and 3: (a) Camera layout Bay St (Site 2) (b) Camera layout Martin Place (Site 3) (c) Measuring zone Bay St (Site 2) (d) Measuring zone Martin Place (Site 3)

Methodology for Analysis

For the observations, the method was simple: watch the video and make note of behavioural patterns and interactions between pedestrians. These notes form part of the results of this study and assist in framing the discussion of the research question at hand.

For the logged data, the methodology is more complex. First the pedestrians are broken into gender groups, since it was expected that gender would have an impact on walking speeds. Gender (and other attributes) were ascribed by the research team. This was also done to allow for the study of different behavioural patterns in male and female pedestrians. After capturing some basic statistics (as is presented in Table 1), more in depth analysis was made.

The first step was to identify at what time pedestrians using smartphones pass through the video. Then the pedestrians that also passed through at that time were identified, and their walking speeds logged. The average walking speed of these subgroups was then compared with the average walking speed of the entire data set.

TABLE 3 Effect of Smartphone Users on Surrounding Pedestrians: Site 1

	Avg Walking Speed (m/s)	Std Deviation (m/s)	N
All Pedestrians	1.21	0.32	180
Pedestrian Using Phone	1.16	0.30	31
Texting Pedestrian	1.19	0.22	27
Calling Pedestrian	0.95	0.64	4
Group of Pedestrians	0.97	0.32	51
Three Immediate Followers of a Texter	1.24	0.29	65
Three Immediate Followers of a Caller	0.82	0.38	10
Three Immediate Followers of a Group	1.16	0.33	100

RESULTS

Site 1

Table 1 summarizes some general trends seen in the video: the average walking speed was 1.21 m/s and was slightly higher for males than females. Female and male pedestrians had exactly the same percentage using phones (17%), texting (15%), and calling (2%).

Gender was significant in two other dimensions: female pedestrians were 5% more likely than male counterparts to be holding their phones but not using them. Women were significantly more likely to walk in groups than men: 39% when compared with 18%.

Walking Speed Analysis

Table 3 illustrates the effect that pedestrians using smartphones had on the following 3 pedestrians that passed through the frame in terms of walking speeds.

Although there is a very slight slowing in walking speed for groups following people on the phone and people walking in groups, it was not significant enough to fall outside the standard deviation of the general walking speed. Conversely, groups following texting pedestrians had a slightly above average walking speed – but again this was not significant enough to fall outside the standard deviation of the general walking speed.

Analysis of Overtaking Patterns

Table 4 details information on pedestrians that were overtaken. 18% of pedestrians seen in the video were overtaken. The percentages in the second part of the table are related to the respective subset in the original dataset, i.e. without filtering for overtaking patterns. That is, 19% of all people who were texting were overtaken. No pedestrian was overtaken when using a phone to call. 41% of all people who were holding their phones were overtaken, and 31% of all people walking in groups were overtaken.

The data shows that female pedestrians were more likely to be overtaken than male pedestrians. This is likely to be because most female pedestrians who were overtaken were walking in groups, and of the people who were overtaken, 48% were walking in groups.

Table 5 provides information on the pedestrians that overtook others. 59% of pedestrians that overtook others were male; 41% were female. Overtaking pedestrians were likely to be walking alone (91%), and not using their phones (95%). A group of two people, one male and one female, was the only group to overtake in the footage. One male pedestrian held his phone as he overtook, and one female pedestrian managed to overtake while texting – in fact, she overtook two

TABLE 4 Data on the Overtaken: Site 1

	Male	Female	Overall	Percent of General Data Set
People overtaken	13	20	33	18%
				Percent of Related General Data Subset
Texting	2	3	5	19%
Calling	0	0	0	0%
Holding phone only	1	5	6	41%
In a group	3	13	16	31%
Alone with no phone	7	2	9	45%

TABLE 5 Data on the Overtakers: Site 1

	Male	Female	Number	Percent of Overtakers
Overtook others	13	9	22	-
Alone	12	8	20	91%
Not using phone	13	8	21	95%
In a group	1	1	2	9%
Texting	0	1	1	0.05%
Holding phone only	1	0	1	0.05%

people.

Observation Notes

The following points were noted during observation of the footage:

- Texters kept to the left in their direction of travel – they tended to hug the wall as they passed over the bridge, and most looked up periodically
- People in groups appeared to be less aware of their surroundings and took up more space than texters
- No collisions or near misses were noted
- Pedestrians more easily overtook people using smartphones than people walking in groups

Gender Significance

The significance of gender was thought to be substantial before this study was carried out. Research by (6) found that female pedestrians were more likely to be distracted by smartphones than male pedestrians. However, the results of this investigation show that women are just as likely as men to be using their phones while walking.

A slightly higher number of women (5%) than men carried their phones without using them: this could be explained by the fact that women's clothing has less functional pockets than men's clothing. If a female pedestrian was between texts, she may be less likely to put her phone away in her bag where she would be unlikely to hear or feel notifications, whereas a male pedestrian may be more likely to slip his phone back in his pocket while waiting for a reply. In addition, some women may keep their phone in their hand while listening to music for a similar reason. Without examining all the female pedestrians' pockets or asking them why they were holding their phones without using them, it is hard to make a definitive statement on this.

As noted in Table 5 and discussed in the previous section, female pedestrians were much more likely to be overtaken than male pedestrians. However, females were much more likely to

walk in groups than males, and people walking in groups were most likely to be overtaken. It may be that women are more likely to be overtaken simply because they walked in groups, or there could be another unknown reason for this that has not been captured by this investigation.

Overtaking Patterns

Initially it was thought that pedestrians using smartphones would slow down the other pedestrians around them. However, the results demonstrate that pedestrians using smartphones had no discernible effect on the walking speed of the pedestrians following them. When this result was identified, it was thought that the smartphone using pedestrians were overtaken by the surrounding pedestrians, and that these pedestrians increased their walking speed temporarily during the overtaking, thereby producing no net effect on the general pedestrian speed.

To investigate this hypothesis, further analysis on overtaking patterns was undertaken with the expectation that most pedestrians who were using smartphones would be overtaken. However, results show that the vast majority of people who were texting were not overtaken: just 19% of texters were overtaken. None of the 4 pedestrians talking on the phone were overtaken at all.

These results indicate that smartphone usage among pedestrians has little effect on overall pedestrian speed. However, this seems counter-intuitive given that people using smartphones have been shown to walk more slowly than without a smartphone, and walk with a reduced ability to follow a set pathway correctly (1–3). Increases in injury rates have also been documented (4).

It is thought that the effect of smartphone use would be more significant in areas with heavier pedestrian traffic, at different times of day, and perhaps with a slightly different demographic. Most of the pedestrians seen in the video footage were almost certainly university students, around 18-35 years. At around 11:30am, these students would not yet be late for a 12pm class, and so would not likely be rushing. Further, just before 12pm is about the time friends may meet for lunch, and therefore be more likely to be walking in groups than using their phones.

Another location and time of day may yield different results. At 8am in Sydney CBD for example, a high volume of pedestrians aged 18 years and up would more likely to be walking alone on their way to work. It is possible that under this scenario, smartphone use is more prolific and the effect on general pedestrian speed would be more significant and obvious. Further, a higher number of people walking past one another may mean that smartphone usage among some pedestrians does slow the walking speeds of other people.

The barricades on the sides of the pedestrian bridge may also be affecting pedestrian behaviour. It is noted that most texters kept to the left and stayed very close to the barricade as they walked. However, if the edge of the footpath met a busy road this may not be the case: people using smartphones may be more likely to walk close to the centre of the footpath where they would be more difficult to overtake.

Site 2

Table 6 shows there are slightly more male pedestrians walking with phone than female pedestrians. The appearance of phone user followers and unaffected by phone pedestrians appear to be independent of gender.

In Figure 3, female phone users and female phone user followers have similar walking speed. But female unaffected pedestrians shows a higher walking speed than both female phone users and female phone user followers. Male phone users followers have a slightly higher walking speed than male phone users. Male unaffected pedestrians have even higher walking speed than

	All	Phone user	Phone user follower	Unaffected by phone
All	1.31	1.20	1.25	1.34
		12.37%	11.95%	75.68%
Female	1.29	1.15	1.22	1.32
		11.48%	12.59%	75.93%
Male	1.34	1.25	1.30	1.37
		13.53%	11.11%	75.36%
Walking alone	1.36	1.23	1.32	1.39
		15.36%	10.03%	74.61%
Walking in group	1.22	1.05	1.16	1.25
		6.33%	15.82%	77.85%

TABLE 6 Average walking speed (m/s) by gender and group status: Site 2

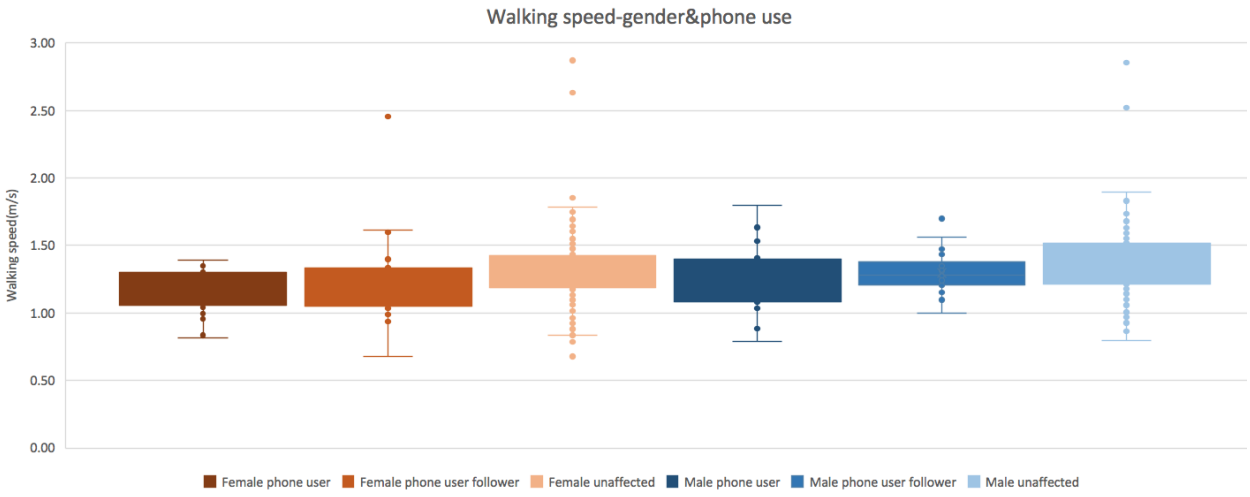

FIGURE 3 Walking speed-gender and phone use: Site 2

male phone user followers. Z-tests generally corroborate the observations, as shown in Table 7.

The table also shows that Site 1 and Site 2 had different average speeds (though within 10%), due both to the different mix of users and difference on the site.

Walking speed and walking in group

In Figure 4, phone user followers have a higher walking speed than phone users in both walking alone and walking in group. Unaffected pedestrians have a higher walking speed than both phone users and phone user followers in both walking alone and walking in group. Those walking alone have a higher walking speed than people walking in groups.

Site 3

Walking speed and time

Figure 5 shows that pedestrians at Site 3: Martin Place have a similar walking speed distribution as Site 2: Bay St. The Z-test (Table 7) between pedestrians at Martin Place and Bay St shows a confidence interval of 66.87%. So there is no significant difference in walking speed at sites 2 and

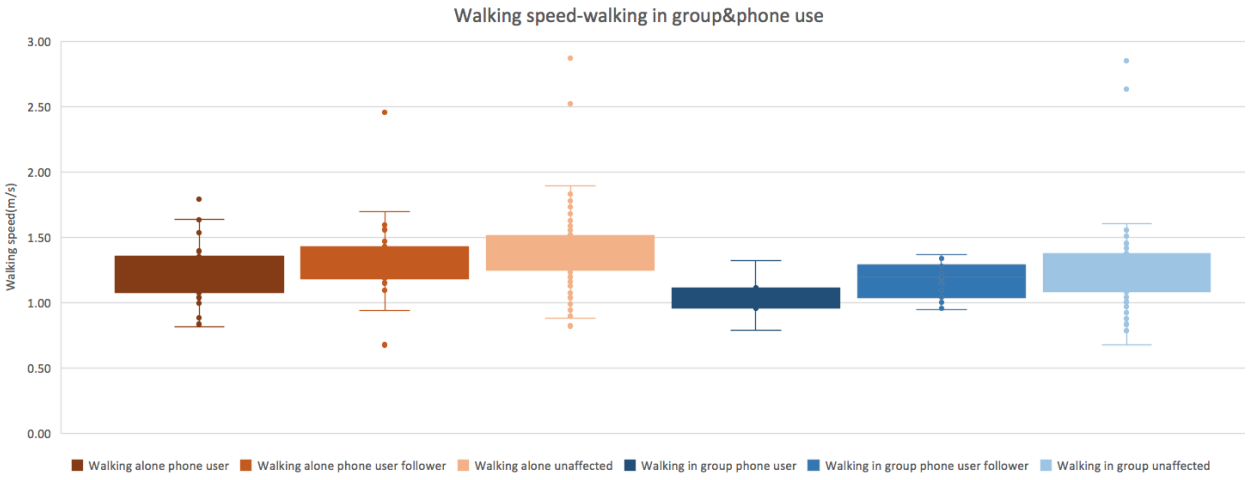

FIGURE 4 Walking speed-walking in group and phone use: Site 2

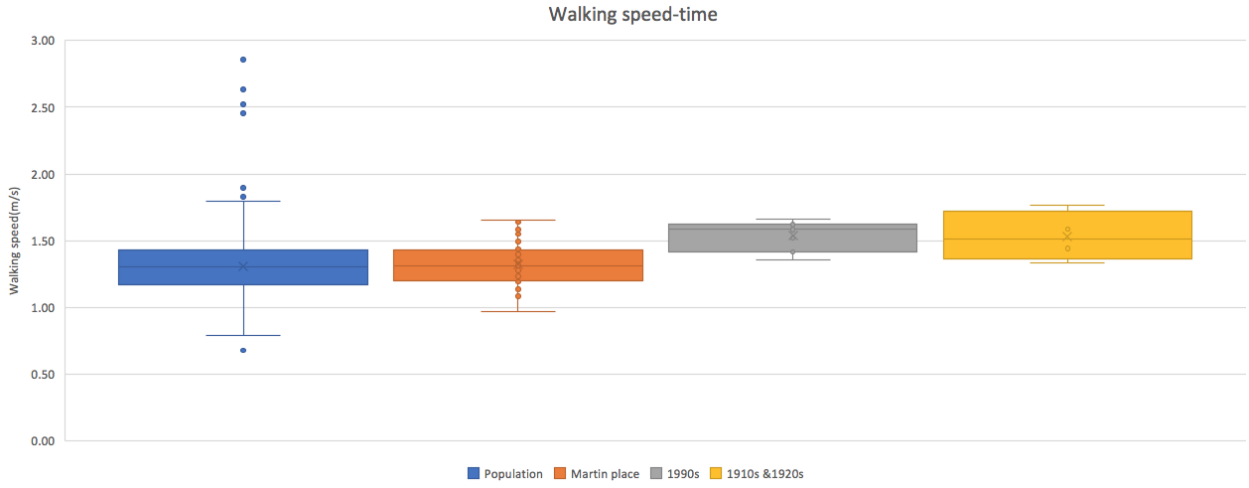

FIGURE 5 Walking speed-time: Site 3

3.

To compare, historical videos from the Martin Place site in the 1910s, 1920s, and 1990s were also compared. (7–9) Historically people in Sydney walked faster than today. This could possibly because of pedestrians have fewer distractions such as smartphones, or perhaps for other reasons.

Group 1	Group 2	Z-Test*
Site 2		
Female pedestrians	Male pedestrians	99.40%
Pedestrians uninfluenced by phone	Phone users	99.99%
Uninfluenced by phone	Phone user followers	99.00%
Phone users	Phone user followers	89.65%
Female phone users	Male phone users	94.87%
Female phone user followers	Male phone user followers	93.52%
Female unaffected pedestrians	Male unaffected pedestrians	96.56%
Female phone users	Female phone users followers	83.50%
Female phone users	Female unaffected pedestrians	99.99%
Female phone user followers	Female unaffected pedestrians	96.14%
Male phone users	Male phone users followers	85.79%
Male phone users	Male unaffected pedestrians	98.74%
Male phone user followers	Male unaffected pedestrians	91.64%
Pedestrians walking alone	General population	99.46%
Pedestrians walking in groups	General population	99.99%
Pedestrians walking alone	Pedestrians walking in groups	99.99%
Walking alone phone users	Walking in group phone users	99.99%
Walking alone phone user followers	Walking in group phone user followers	99.50%
Walking alone unaffected pedestrians	Walking in group unaffected pedestrians	99.99%
Walking alone phone users	Walking alone phone user followers	94.28%
Walking alone phone users	Walking alone unaffected pedestrians	99.99%
Walking alone phone user followers	Walking alone unaffected pedestrians	87.27%
Walking in group phone users	Walking in group phone user followers	99.76%
Walking in group phone users	Walking in group unaffected pedestrians	99.99%
Walking in group phone user followers	Walking in group unaffected pedestrians	97.08%
Site 3		
Walking speed in 1990s	Walking speed in 2018	99.99%
Walking speed in 1910s & 1920s	Walking speed in 2018	99.99%
Site Comparisons		
Site 1	Site 2	99.99%
Site 1 Phone users	Site 2 Phone users	98.65%
Site 1 Phone non-users	Site 2 Phone non-users	99.97%
Site 3	Site 2	66.87%

Note: * Z-Test column indicates confidence with which null hypothesis is rejected.

TABLE 7 Z-test Comparisons of Difference of Walking Speed

CONCLUSION

Observation of walking behaviour reveals or confirms the following: Males walk faster than females, females are more likely to walk in groups, females are more likely to carry a backpack or packages in their hands than males.

Historic film footage from the 1990s and from the 1910s & 1920s indicates pedestrians walked faster than at the time of these measurements (2018). This could possibly because pedestrians had fewer distractions on the road (e.g. smartphones) in the past.

The results of the investigation from Site 1, a wide university bridge, show that pedestrians using smartphones did not have a significant impact on overall pedestrian speed on the pedestrian bridge. Average walking speeds of pedestrians walking near smartphone users were not significantly different from the average speed. Overtaking pattern analysis showed that most people using smartphones were not overtaken either. It was found that people walking in groups were most likely to be overtaken by other pedestrians.

In contrast, Site 2, a more crowded city sidewalk, clearly indicated that pedestrians using smartphones slowed down themselves and others.

On a crowded walkway, administrators may consider discouraging or prohibiting looking at phones, or separating phone users and non-users to increase efficiency. Developing and applying pedestrians rules as customs and mores, such as keeping left (right in right-hand rule countries) unless overtaking and no stopping or turning, could also increase the overall efficiency of walkways. This might be done with reminder signage.

REFERENCES

[1] Lopresti-Goodman, S. M., A. Rivera, and C. Dressel, Practicing safe text: the impact of texting on walking behavior. *Applied Cognitive Psychology*, Vol. 26, No. 4, 2012, pp. 644–648.

[2] Timmis, M. A., H. Bijl, K. Turner, I. Basevitch, M. J. Taylor, and K. N. van Paridon, The impact of mobile phone use on where we look and how we walk when negotiating floor based obstacles. *PLoS One*, Vol. 12, No. 6, 2017, p. e0179802.

[3] Haga, S., A. Sano, Y. Sekine, H. Sato, S. Yamaguchi, and K. Masuda, Effects of using a smart phone on pedestrians' attention and walking. *Procedia Manufacturing*, Vol. 3, 2015, pp. 2574–2580.

[4] Smith, D. C., K. M. Schreiber, A. Saltos, S. B. Lichenstein, and R. Lichenstein, Ambulatory cell phone injuries in the United States: an emerging national concern. *Journal of Safety Research*, Vol. 47, 2013, pp. 19–23.

[5] Laatar, R., H. Kachouri, R. Borji, H. Rebai, and S. Sahli, The effect of cell phone use on postural balance and mobility in older compared to young adults. *Physiology & Behavior*, Vol. 173, 2017, pp. 293–297.

[6] Ortiz, N. C., M. Ramnarayan, and K. Mizenko, Distraction and road user behavior: an observational pilot study across intersections in Washington, DC. *Journal of Transport & Health*, Vol. 7, 2017, pp. 13–22.

[7] Kinolibrary, *1990s Sydney, Australia, Street Scenes*. `https://www.youtube.com/watch?v=Asd08CTWRA4`, 2015.

[8] Tivoli Video, *Sydney As It Was*. `https://www.youtube.com/watch?v=LvYqvYlD9a4`, 2015.

[9] National Film and Sound Archive of Australia (NFSA), *Sydney 1896-1929: Rugby, boxing and landmarks*. `https://www.youtube.com/watch?v=j6DvqIIWAcY`, 2012.