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Impact Of Social and Technological Distraction on Pedestrian Crossing Behaviour: A Case Study in Enna, Sicily

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Abstract

The safety of pedestrians in the city depends on numerous factors such as crossing habits (traffic behaviour, traffic culture), infrastructural elements and overall traffic conditions. Among the most critical urban areas are those near pedestrian crosswalks with traffic lights. Several studies focus on collecting pedestrian and infrastructure data through a combination of video recording and manual counting and/or the administration of interviews or surveys. Among the factors analysed are pedestrian crossing behaviour, pedestrian volume, waiting time, risk and infrastructure elements and other influential parameters. The literature shows that there are gender and age differences. Although the number of accidents involving pedestrians distracted by their smartphones is certainly rarer when compared to driver-related accidents, it is essential to investigate this kind of distraction and analyze possible strategies for its mitigation. Children are more likely to cross the road in groups and, there are evidence, that group can be a distractor too. There is also evidence of behavioural characteristics, i.e., pedestrians who use a mobile phone while crossing the road have a higher violation rate and are more likely to be late. A comparison of national and international studies shows that cognitive distraction among pedestrians resulting from phone use reduces risk awareness and increases dangerous behaviour. Many actions are generally performed by pedestrians' mobile phones, such as receiving calls, writing and sending e-mails, text messages and instant or voice messages, listening to music, watching videos and podcasts, using social networks and taking photos. All these actions people of all age groups (and in particular the under-15s) are inclined to do wherever there is reception, regardless of environmental circumstances. The age of children approaching the web and social networks is dropping dramatically. The results show that pedestrians who use mobile phones tend to be distracted and disregard signs, and those who use them while crossing the road have a reduced speed that puts them at greater risk of an accident. The analysis of a case study confirmed some of the results already known in the literature and laid the foundations for further investigations such as questionnaires to pedestrians and the analysis of other urban crossings in high density areas such as offices, banks and schools.

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1. Introduction

Mobility has come to a standstill due to the recent COVID-19 pandemic. Some modes of transport have declined, such as public transport, but others have been preferred, such as walking or cycling, which are strongly encouraged by policy strategies on sustainable and resilient mobility. Both regulations and recommendations have been implemented in the various contexts, encouraging short-distance mobility and the spread of the 15 minutes cities Several works in the literature show that the choice of walking modes is optimal for making certain urban contexts more accessible (Campisi et al.,2020) while other studies point to the possibility of creating shared spaces where pedestrians can travel together with bicycles and micro-mobility while avoiding access to motorised vehicles (Nikiforiadis et al.,l2020a,b).The road user has been analysed for decades with regard to both his propensity to walk and his vulnerability in terms of safety. Several psycho-social factors as well as travel habits influence walking. It has been found that the most vulnerable pedestrians are generally the elderly and children because of their cognitive or psychical abilities.

The former due to their reduced speed of movement, the latter due to their physical size and reduced perception of the surrounding space. Smartphone use while walking (i.e. being a smartphone "zombie") has become a prevalent phenomenon in many cities around the world. Previous research shows that many pedestrians choose to interact with their phones while walking in the city, despite being aware that their behaviour could be dangerous. Virtual communication could serve as a compensation for real-world society, thus putting aside the need to cross safely (Appel et al.,2019). A number of environmental factors influence walking, especially infrastructure, signs and surrounding structures. As far as the first two parameters are concerned, it is well known that at crossroads there is a greater propensity for accidents to occur, often due to failure to respect the rules of the road and signs and/or due to distraction. Distraction can be caused by surrounding elements such as the presence of lights or other people or by the use of electronic devices, especially in recent years by the use of smartphones while walking or crossing the street. Additional distractions may include carrying a child or pushing a pushchair (Thompson et al.,2013).Talking on a mobile phone has the greatest effect on unsafe pedestrian behaviour; texting/viewing content on a mobile phone also affects pedestrian behaviour, although less than talking, while listening to music has the least impact (Pešić, et al.2016). Pedestrians gait is slow and they pay no attention to their surroundings because they are focused on their smartphones. Safety risks have been identified due to such distracted pedestrians. While texting, they can trip on pavements, walk in front of cars and hit other pedestrians. It is estimated that the field of vision of a smartphone user is only 5% of that of a normal pedestrian (https://www.neogaf.com). Legislation to fine people who cross the road with their head bent over their mobile phone has been proposed by several countries. The streets of Japan are full of people walking with their eyes glued to the screen of their smartphone, increasing the phenomenon of the "arukisumaho" (smartphone zombie). In Yamato, about 30 km from Tokyo, posters have been put up warning of pedestrians using their phones while walking and crossing the street. In South Korea, for example, a city has installed flickering lights and laser beams at road intersections to warn pedestrians that they are walking while looking at their screens, while in China a pedestrian lane has been opened for people using their phones while walking down the street. Finally, in Honolulu, Hawaii, a law has been introduced against distracted walkers with fines for texting while walking.

This work focused on an analysis of the literature related to the distractions that pedestrians experience when crossing, highlighting the causes of these distractions according to the gender and age of the pedestrian. The recent pandemic has highlighted the need to design and redevelop urban public spaces such as squares and streets, paying more attention to setting safety and comfort standards, increasing accessibility and respecting social distancing. The analysis of a case study highlighted the critical issues related to the excessive use of mobile phones in the street by pedestrians. These distractions should be mitigated by a public awareness campaign and the installation of light and sound devices.

Literature review

Several studies focus on assessing the influences of phone use on pedestrian crossing behaviour at signposted intersections using data acquisition systems such as video recording and manual counting. A study carried out by researchers in China shows that age is a significant factor, while gender is not (Zhou et al., 2019).

In accordance with (Hatfield et al.,2007), pedestrians (female) who crossed while talking on their mobile phone crossed more slowly and were less likely to pay attention to traffic before they started crossing, wait for traffic to stop, or watch traffic during the crossing, compared to appropriate controls. Male pedestrians, crossing while talking on a mobile phone, crossed more slowly at yield intersections.

These effects suggest that talking on a mobile phone is associated with cognitive distraction, which may reduce pedestrian safety. The study conducted by (Sobhani and Farooq, 2018) shows that females have a more dangerous crossing behaviour especially in distracted conditions; however, the presence of a smart LED reduces this negative impact and increases the rate of successful crossings. Studies show that adult performance and efficiency decreases when multi-tasking, especially for older people (Kramer & Madden, 2008). In addition, studies of different adult age groups in this context have indicated that dual-tasking decreases memory encoding and walking speed in general for all, but more considerably for older and middle-aged adults (Neider et al., 2011).

With regard to distraction by electronic devices, the results show that drivers are significantly impaired when using a mobile phone. In addition, the probability of a pedestrian successfully crossing the intersection decreases, which in some cases leads to unsafe crossing attempts. Several studies use observed or simulated environmental data for their analysis. The World Health Organisation on Road Accidents reported that more than half of all road traffic deaths are among vulnerable road users: pedestrians, cyclists, and motorcyclists. About 93% of the world's fatalities on the roads occur in low- and middle-income countries and road traffic injuries are the leading cause of death for children and young adults aged 5-29 years (World Health Organisation, 2020). One of the controversial reasons for this increase is the increase in distracted pedestrians, who are on their phones talking, texting, surfing the web, looking for directions or playing games (Nasar et al.,2008, Nasar et al.,2013, Tapiro et al., 2016). In recent years, violations such as J-walking, crossing during red lights and failure to respect vehicles are combined with smartphone-related distractions to create a high-risk situation resulting in increased pedestrian road injuries and fatalities.

Therefore, some studies have focused on different types of pedestrian crossing structures to address the concerns of unsafe crossing (Anciaes & Jones, 2018). However, this increase in death and injury rates is alarming, given the many studies, policies, educational and safety measures, improvements and implementations that aim to reduce these risks. Unmarked road crossings require an individual's attention and concentration. To successfully select a crossing that allows safe crossing, individuals must accurately judge the spatial and temporal dimensions of the crossing in relation to their ability to cross in time. This process is further complicated when there is more than one traffic lane. (Plumert & Kearney, 2014). When traffic flow increases in both directions, safe crossing spaces become smaller and less frequent (Wang et al., 2012). Since crossing violations are partly due to the pressure added by time constraints, the act of crossing is usually rushed, resulting in more careless crossing. When the cognitive demand for crossing is divided by distractions, pedestrian awareness is reduced resulting in unsafe and risky crossing behaviour (Lin & Huang, 2017). It is therefore essential to analyse the reaction times of the most vulnerable groups of pedestrians, such as children (Campisi et al., 2018) and elderly (Zivotofskyet al.,2012) especially in the area closed to the intersections. As a result of the increase in distracted pedestrians, various measures have been proposed, such as the development of smartphone applications that display warning signals on the distracted pedestrian's phone when he or she starts a road crossing.

The comparison of the literature cases in the period 2001-2021 allowed the construction of synthetic tables highlighting the factors that most generate the social impact and distraction, the dislocation and the strategies adopted so far. Table 1 shows how sociodemographic characteristics (gender and age) according to the analysed area have been addressed by the research.

Table 1. Literature review related to the impact of social and technological distraction on pedestrian

Authors	Period	Age	Area	Authors	Period	Age	Area
Wayne et al	2004	C-Y-A-E	I-R-O	Solah et al	2016	/	I
Bungum et al	2005	C-Y-A-E	I	Sobhani et al	2017	Y	I
Hatfield et al.	2007	C-Y-A-E	I	Horberry et al	2019	C-Y-A-E	I
Stravrinos et al	2009	C	R	Troung et al	2019	C-Y-A-E	O
Nieuwesteeg et al	2010	T-A-E	I	Simmos et al	2020	C-T-A-E	I-R
Neither et al	2010	/	I	Ištoka Otković et al	2021	C	I
Neider et al	2011	E	I	Deluka-Tibljaš et al	2021	C	I
Schwebel et al	2012	Y	R				

where C=children (3-14), Y=youth (15-35) , A=Adults /middle aged (36-60) , E=elderly people (<60)
and also I=intersection; R=road; O=other space

2. Methodology

A survey campaign through the use of video cameras was carried out at urban location of Enna city in the centre of Sicily (Italy) during the period 08March 2021-14 March 2021. The monitored area is characterised a 4arms intersection and by 4 crossings on either side of the intersection, one of which is the most crowded and was the subject of this study with traffic light regulation near offices and schools. It is possible to define 3 observation phases, namely in the area before crossing (Phase A), in the waiting area (Phase B) and during the crossing (Phase C), as shown in Figure 1. is characterised by 4 crossings on either side of the intersection, one of which is the most crowded and was the subject of this study

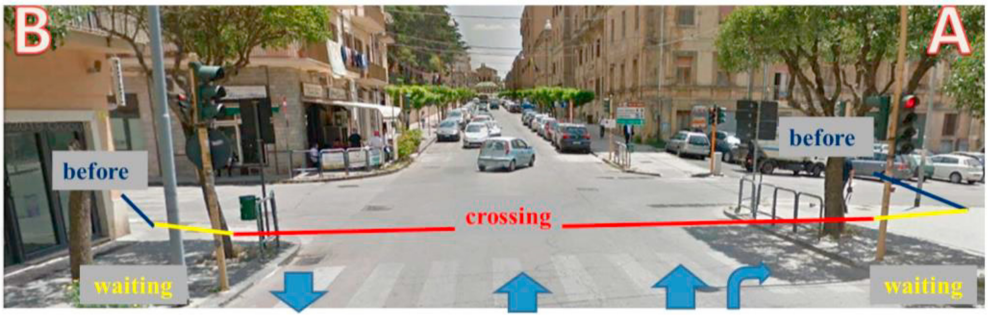

Fig. 1. Monitored pedestrian crossing in Enna (Italy)

The study focused on the most dangerous phase, i.e., Phase C, where the pedestrian may have collisions with different means of motorised vehicles. The peak pedestrian flow was estimated in the hour between 08:30 and 09:30 and on Tuesday as there is also an open market near the intersection. This preliminary investigation allowed the statistical analysis of the pedestrian flow along the A-B and B-A direction considering a crossing of about 12.5 m and a pedestrian cycle marked by 40sec of green-39 sec of red and 5 of yellow. Figure 1 shows the areas marked by the crossing (12.5 m), waiting (1.5 m) and moving before crossing (2.5 m) actions, indicating the vehicle manoeuvring directions

Observing the footage, there are about 5-6 pedestrians per hour in the waiting area (yellow area) in both directions, at least 1 or 2 of whom are holding a mobile phone. the investigated parameters have been summarized in the Table 2. Using video recording and manual counting, a total of 220 ped/h were observed. Participants were divided into four age groups: children (0-14 years), young people (15-35 years), middle-aged (36-60 years), and elderly (over 60 years).

Table 2 Parameters of investigated intersection crossing

Direction	n° lanes (2 directions)	Pedestrian volume (ped/h)	Ped. Red time (s)	Ped. Green time (s)	Land use
A-B	3	117	39	40	Public services area (office-bank)
B-A		103			Administration and public services area (school-office-pharmacy)

According to the use of the traffic signal, pedestrians can be classified into 2 categories: pedestrians crossing the road during the green signal (regular users); pedestrians crossing during the red signal (trainers).

3. Results and discussion

The pedestrian flow was defined by individual movements of the various users and the respect of social distancing due to the recent pandemic. The sample was analysed considering socio-demographic characteristics as summarised in Table 3.

Table 3 Socio demographic details of the monitored pedestrian sample

	Age								Gender			
	Child		Youth		Middle-aged		Elderly		Female		Male	
	n	%	n	%	n	%	n	%	n	%	n	%
A_B	11	36,6	27	44,3	36	62	43	60,5	59	48,4	58	59,2
B_A	19	63,4	34	55,7	22	38	28	39,1	63	51,6	40	40,8
tot	30		61		58		71		122		98	

There is a greater proportion of over-65s, with a prevalence of women. Statistically, the different types of actions carried out during the movement from A to B and vice versa were analysed according to age and respectively crossing without a phone use (W), talking with phone (T), listening (L) and chat (C) obtaining the following results in Table 4-

Table 4 Distractions related to phone use during the green light crossing vs. age

	Direction A-B Phase C									Direction B-A Phase C								
	Child		Youth		Middle-aged		Elderly			Child		Youth		Middle-aged		Elderly		
	n	%	n	%	n	%	n	%		n	%	n	%	n	%	n	%	
W	5	45,4	7	26	11	30,5	27	62,8	50	3	15,8	11	32,3	10	45,5	19	67,8	43
T	3	27,3	6	22,2	9	25	9	20,9	27	5	27,7	4	11,8	6	27,3	6	21,4	21
L	1	9,1	5	18,5	7	19,5	6	13,9	19	6	31,6	8	23,5	4	18,2	2	7,1	20
C	2	18,2	9	33,3	9	25	1	2,4	21	5	26,3	11	32,4	2	9,0	1	3,7	19
tot	11		27		36		43			19		34		22		28		

Similarly, the pedestrians crossing during the red signal were analysed and Table 5 shows under which conditions.

Table 5 Violations (in brackets) and distractions related to phone use during crossing at red light vs. age

	Direction A-B Phase C									Direction B-A Phase C								
	Child		Youth		Middle-aged		Elderly		tot	Child		Youth		Middle-aged		Elderly		tot
	n	%	n	%	n	%	n	%		n	%	n	%	n	%	n	%	
W	1(1)	33,3	2(1)	15,3	6(1)	35,3	5	62,5	14	2	18,2	6 (2)	35,3	4 (1)	26,7	3	60	15
T	1	33.3	3 (2)	23,1	4	23,5	2	25	10	4 (1)	36,4	3	17,6	6 (1)	40	1	20	14

L	1	33.3	3 (1)	23,1	6	35,3	1	12,5	11	3 (1)	27,2	7 (2)	41,2	4	26,7	1	20	15
C	0	0	5	38,5	1	5,9	0	0	6	2	18,2	1	5,9	1	6,6	0	0	4
tot	3		13		17		8		41	11		17		15		5		48

The same was observed for the gender variable, obtaining comparable values for both directions and slightly higher for the female gender like described on Table 6

Table 6 Distractions related to phone use during crossing at green light vs. gender

	Direction A-B Phase C					Direction B-A Phase C				
	Female		Male			Female		Male		
	n	%	n	%	tot	n	%	n	%	tot
W	9	34,6	7	28	16	10	30,3	8	27,6	18
T	6	23,1	6	24	12	9	27,3	9	31,1	18
L	5	19,2	8	32	13	9	27,3	9	31,1	18
C	6	23,1	4	16	10	5	15,1	3	10,2	8
tot	26		25		51	33		29		62

In addition, the following Table 7 summarises the violations during the crossing at red light. In particular, it was found that users violate the pedestrian red light and cross along the traffic signal, even using their mobile phones. In the table below, the values in brackets refer to people violating the traffic signal and the crossing area at the same time. Violation of both the signal and the crossing area occurs mainly among pedestrians who do not have a mobile phone in their hand or among people who are talking or listening on mobile phones in both directions.

Table 7 Violations (in brackets) and distractions related to phone use during crossing at red light vs. gender

	Direction A-B Phase C					Direction B-A Phase C				
	Female		Male			Female		Male		
	n	%	n	%	tot	n	%	n	%	tot
W	8 (1)	38	6 (2)	30	14 (3)	8 (2)	32	7(1)	30,4	15 (3)
T	5 (1)	23,8	5 (1)	25	10 (2)	6 (1)	24	7 (1)	30,4	13 (2)
L	4 (0)	19,1	7 (1)	35	11 (1)	7 (1)	28	8 (1)	34,8	15 (2)
C	4 (0)	19,1	2 (0)	10	6 (0)	4 (0)	16	1(0)	4,3	5 (0)
tot	21		20		41	25		23		48

Observing the table above it can be seen that the most frequent violation is defined crossing during the red light by females in both directions, while for men the most frequent violation is committed while listening with headphones and talking on the phone. Finally, a comparison of crossing speeds was carried out with the results shown in Table 8.

Table 8 Average pedestrian speed variation (m/s) during green pedestrian crossing phase

		Age								Gender			
		Child		Youth		Middle-aged		Elderly		Female		Male	
		n	avg speed	n	avg speed	n	avg speed	n	avg speed	n	avg speed	n	avg speed
W	A_B	11	0.87	27	1.28	36	1.1	43	1.05	9	1,08	7	1,075
	B_A	19	0.88	34	1.31	22	1.2	28	1.06	10	1,1	8	1,09
T	A_B	3	0.85	6	1.23	9	1.01	9	1.1	6	1,1	6	1,04
	B_A	5	0.86	4	1.27	6	1.09	6	1.11	9	1,18	9	1,05
L	A_B	1	0.87	5	1.28	7	1.1	6	1.05	5	1,08	8	1,075
	B_A	6	0.88	8	1.31	4	1.2	2	1.06	9	1,1	9	1,09

C	A_B	2	0.79	9	1.07	9	0.89	1	0.98	6	0.92	4	0.95
	B_A	5	0.80	11	1.09	2	0.93	1	0.97	5	0,93	3	0,93

A reduction in speed of 0.10 m/s from people that cross without mobile phone to chat and a reduction of about 0.05m/s from talking on the phone are observed for all classes. Walking and talking at the same time interrupts people's normal breathing and leaves the spine exposed (Lamberg &Muratori, 2012; Alejalil & Davoodi, 2017). The use of mobile phones, and the habit of talking while walking, would increase the risk of finding our backs 'unprotected'. In addition, mobile phone use distracts attention from seeing signs, people around us and cars, increasing the risk of collisions and therefore accidents.

4. Conclusion

The research is observational in nature and lays the foundations as a preliminary investigation. It was extended to other intersections and supplemented by the administration of a questionnaire to acquire more information on the frequency of movements and the psycho-social aspect of pedestrians walking while talking on the phone.

The data refer to the Italian context and there is a partial analogy with what has been found in other non-European contexts such as China. A limitation is that the results are based on pedestrians in the same intersection in two crossing directions during rush hour. Therefore, more pedestrians at other sites and in other time periods should be studied in the future. The results provide a basis for the evaluation of strategies that can discourage mobile phone use in the vicinity of road intersections, improving the overall safety of the area. The excessive use of smartphones can bring with it pitfalls such as the phenomenon of 'alert addiction', which describes the condition of children who are constantly hunched over their mobile phones. The article focuses on a review of the state of the art and the development of an analysis methodology. The aim of this paper is to provide preliminary recommendations for safer roads for all users. A consequence of crossing the road with a mobile phone in hand may arise in the event of an investment. The insurance company may refuse to pay compensation for distracted pedestrians. It is linked to the pedestrian violations considering the normal rules of caution and becomes such a sudden obstacle for the driver that cannot be avoided. In Italy and in many other countries, there is currently no provision explicitly regulating this situation, as there is in the case of driving a vehicle. The only provision in the Highway Code from which we can derive a ban on crossing the road with a mobile phone stipulates that pedestrian must pay 'the necessary attention to avoid situations of danger to themselves or others'. In such cases, any sanction is left to the assessment of the traffic warden, who will establish whether the distraction caused by the mobile phone was such as to endanger his own safety and that of others. Once this has been established, the Municipal Police officer may impose a fine, which may also be the case if the pedestrian crosses the road outside the crosswalk or diagonally across the two sides.The decision makers are considering a series of measures aimed to increase pedestrian safety in new circumstances from technological solutions for switch attention to legal and restrictive measures.Some educational campaigns should be conducted to make pedestrians (especially young people) aware of the risks of using a mobile phone while crossing the road. An improvement in planning and safety could be provided by the installation of pedestrian signals to avoid long waiting times. In addition, forthcoming studies on telephone technology could help research knowledge to improve pedestrian safety.

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