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Pedestrian risk taking while road crossing: a comparison of observed and declared behaviour

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Abstract

The objective of this research is the comparative analysis of observed and declared behaviour of pedestrians as regards road crossing in urban areas. A field survey was carried out, in which a panel of 75 young and middle-aged pedestrians (out of which 40 males) were asked to take 8 short walking trips (each one corresponding to a different walking and crossing scenario and involving one road crossing) in the Athens city centre in Greece. This allowed to record their crossing behaviour in different road and traffic conditions, including residential roads, main urban roads and major urban arterials. The same individuals were asked to fill in a questionnaire on their crossing behaviour and preferences at different road and traffic environments, as well as other related questions concerning their travel motivations, their mobility characteristics, their risk perceptions and preferences etc. A comparative analysis of their declared and observed crossing behaviour was carried out. More specifically, for each pedestrian, the rate of mid-block crossing and diagonal crossing during the walking tasks was calculated for the different road and traffic conditions. These were compared to their questionnaire responses on their crossing behaviour in different road and traffic conditions. The results suggest that, overall, pedestrians observed behaviour is in accordance with their declared behaviour. However, there is a non-negligible share of pedestrians, whose observed and declared behaviour were discordant, either at specific road and traffic conditions or overall. For instance, there were pedestrians who declared that they never cross at mid-block on major urban road but did so during the survey. Moreover, there were pedestrians who declared high frequency of mid-block crossing, but did not implement these crossing practices during the survey. The degree of discordance between pedestrian observed and declared behaviour was further analysed in relation to pedestrian demographics. A weak tendency was identified for female pedestrians to have more discordance between observed and declared crossing behaviour on residential roads, and the same was the case for

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young pedestrians in all road and traffic conditions. Overall, the results suggest that, while most pedestrians appear to have consistent declared and observed behaviour, there may all deviate from their general “profile” under specific conditions.

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1. Background and objectives

Although signalized junctions provide pedestrians a protected crossing phase, most pedestrians tend to prefer using the available traffic gaps for crossing (Hamed, 2001). In fact, mid-block crossing and diagonal crossing are common practice among pedestrians aiming to save travel time or distance (Chu et al., 2003). Existing research on pedestrian crossing behaviour in urban areas has contributed very useful insight on the role of road, traffic and pedestrian characteristics on pedestrian crossing decisions, their compliance with traffic rules and the related safety implications - for complete reviews see Ishaque & Noland (2009), Papadimitriou et al. (2009), Papadimitriou et al., (2014). A distinct part of existing research on pedestrian crossing behaviour is devoted to analyses of psychological, attitudinal, perceptual and motivational factors (Evans & Norman, 1998; Diaz, 2002; Bernhoft & Carstensen, 2008; Granié et al. 2013).

The methods for the analysis pedestrian behaviour can be broadly classified in two groups:

(i) methods based on field observations, including video recordings (e.g. at a junction area, on a train station, etc.) (Himanen & Kulmala, 1988; Das et al., 2005; Antonini et al., 2006), following and tracking pedestrians by means of an appropriate data collection form (Lassarre et al. 2013) or a GPS or similar device (Li and Tsukaguchi, 2005; Pulugurtha et al. 2007), or - more recently - experiments in a virtual environment (Simpson et al., 2003; Dommes & Cavallo, 2012); and,

(ii) methods based on questionnaire surveys, in which pedestrians may be presented with various scenarios and asked to indicate their crossing intentions (Chu et al., 2003), or may be interviewed on their preferences, attitudes and behaviours as regards road crossing (e.g. Hine, 1996; Granié et al., 2013).

Both methods have their own advantages and limitations. Field observations are more cumbersome and often require a degree of interpretation of the observed behaviour by the researcher. On the other hand, questionnaire surveys benefit from more control over the design of the experiment and easier recruitment of the participants, however they suffer from the known limitations of self-reported data.

In only a few studies (e.g. Granié, 2007; Sisiopiku & Akin, 2010), local level behaviour observations are combined with questionnaire survey in order to validate the two approaches. The results suggest that pedestrian observed and declared behaviour may differ in several occasions, and consequently it is crucial to further investigate the degree to which pedestrian observed and declared behaviour are in accordance.

The objective of this research is the comparative analysis of observed and declared behaviour of pedestrians as regards road crossing in urban areas. The analysis is based on a field survey in Athens, Greece, combining declared behaviour data through a questionnaire with actual observations of pedestrian crossing behaviour. The data were cross-tabulated allowing to identify cases where observed and declared behaviour are concordant or discordant, for two key crossing behaviours, namely diagonal crossing and mid-block crossing. The results are further analysed for different road types: major urban arterials, main urban roads or minor / residential roads. Age and gender effects on the concordance of declared and observed crossing behaviour are also explored.

2. Methodology and data collection

2.1. Field observations

A field survey was carried out, in which a panel of 75 young and middle-aged pedestrians (out of which 40 males) were asked to take 8 short walking trips (each one corresponding to a different walking and crossing scenario and

involving one road crossing) in the Athens city centre in Greece. This allowed to record their crossing behaviour in different road and traffic conditions, including residential roads, secondary urban roads and major urban arterials.

The field survey design consists of three walking conditions and eight crossing scenarios (see Figure 1):

- Crossing a main urban road with signal controlled and uncontrolled crosswalks: scenarios 1 and 8;
- Crossing a minor (residential) road with or without marked crosswalks: scenarios 2, 5, 6 and 7;
- Crossing a major urban arterial with signal controlled crosswalks: scenarios 3 and 4.

The selected field survey site is located at the Athens central area, from the Evangelismos metro station to the Kolonaki square. The area (see Figure 1) includes all three road types examined in the present research: a major urban arterial (Vas.Sofias Ave.), its parallel two way main urban road (Patriarchou Ioakeim str.), with numerous commercial and recreation uses, as well as a grid network of minor / residential roads with mainly offices and residential uses, between the major arterial and the main urban road. The major urban arterial and the main urban road may demonstrate all types of traffic conditions during the day, from free flow to congestion, while the minor / residential roads have mainly low to moderate traffic throughout the day.

The data were recorded by a trained researcher who followed the pedestrians - with their consent - and filled in a dedicated data collection form, with data on their crossing choice in each scenario, as well as the prevailing road and traffic conditions during the trip.



Fig. 1. Field survey scenarios on study area map.

2.2. Questionnaire survey

The same 75 individuals were asked to fill in a questionnaire on their crossing behaviour and preferences at different road and traffic environments, as well as other related questions concerning their travel motivations, their mobility characteristics, their risk perceptions and preferences, their self-assessment, their opinion on drivers etc. Half of the participants first filled the questionnaire and then carried out the actual walking tasks, and half of the participants did the opposite. The questionnaire was created as a list of items to be rated on the basis of Likert scales expressing always/never or agree/disagree scales. The questionnaire includes 6 sections, as follows:

- Section A: Demographics
- Section B: Mobility and travel motivations
- Section C: Attitudes, perceptions and preferences
- Section D: Self-assessment and identity
- Section E: Behaviour, compliance and risk taking
- Section F: Opinion on drivers

The full questionnaire is not provided here, for the economy of space, and the reader is referred to Papadimitriou et al. (2015). In this research, of particular interest is section E, in which pedestrians were asked to indicate the frequency of crossing at mid-block or diagonally in different road and traffic conditions (see Table 1).

The specific questions to start from are E1_i, E1_ii, E1_iii and E1_iv, concerning the total frequency of diagonal or mid-block crossing per road type. It is underlined that diagonal crossing mainly refers to crossing style (i.e. pedestrian crossing at any location - junction or mid-block - diagonally so as to ‘save’ travel time and distance), while mid-block crossing refers to crossing location (i.e. choice between protected crossing at junction or unprotected crossing at mid-block).

Table 1. Pedestrian behaviour questionnaire items.

E	As a pedestrian, how often do you adopt each one of the following behaviours:	Never	Rarely	Sometimes	Often	Always
E1_i	I cross diagonally					
E1_ii	I cross at midblock at major urban arterials					
E1_iii	I cross at midblock at urban roads					
E1_iv	I cross at midblock in residential areas					
E1_v	I cross at midblock when I am in a hurry					
E1_vi	I cross at midblock when there is no oncoming traffic					
E1_vii	I cross at midblock when I see other people do it					
E1_viii	I cross at midblock when my company prompts me to do it					
E1_ix	I prompt my company to cross at midblock					
E1_x	I cross at midblock when there is a shop I like on the other side					
E1_xi	I cross even though the pedestrian light is red					
E1_xii	I walk on the pavement rather than on the sidewalk					
E2_i	I cross between vehicles stopped on the roadway in traffic jams					
E2_ii	I cross without paying attention to traffic					
E2_iii	I am absent-minded while walking I cross while talking on my cell phone or listening to music on my headphones					
E2_iv	I cross even though obstacles (parked vehicles, buildings, trees, etc.) obstruct visibility					
E2_v	I cross even though there are oncoming vehicles					

2.3. Analysis methods

The main methodological challenge of this research was the processing of observed and declared data in order to obtain similar, meaningful and comparable scales. On the one hand, questionnaire responses concern the declared overall frequency of adopting specific behaviours on a 5-point scale (1: never, 2: rarely, 3: sometimes, 4: often, 5: always); these responses are therefore bound to include the total walking frequency or distance travelled by the individuals in a given period (e.g. “rarely” may reflect a different absolute frequency for a pedestrian who walks only a few times a week, compared to a pedestrian who walks considerable distances on a daily basis). On the other hand, field observations concerned 8 specific crossing choices in 3 different road environments (from 2 to 4 choices in each

environment), and these observations may or may not be representative of an individual's walking and crossing patterns.

In order to transform the two responses to comparable scales as much as possible, it was opted to use a common 3-point scale for mid-block crossing: 1-never, 2-sometimes, 3-always. Through this scale, the two 'extreme' values can be easily and clearly defined on the basis of both the observed and declared observations, while the intermediate category 'sometimes' brings together the major part of the uncertainty in one group. As regards diagonal crossing, this is not examined for different road types, as it is assumed to be more dependent on the pedestrian's tendency to optimise the trajectory and save time, rather than the road and traffic conditions. In this case, there were 8 crossing choices, and it was attempted to transform these in a 5-point scale, same as the one of the questionnaire item E1_i.

For the coding of the field observations, the following steps were taken.

- the 'observed frequency' was defined as the number of mid-block or diagonal crossings per the total number of crossings;
- more specifically, there were: 2 on major urban arterials (scenarios 3 & 4), 4 on main urban roads (scenarios 1, 2, 5 & 8) and 2 on minor / residential roads (scenarios 6 & 7).
- if a pedestrian did not cross at mid-block in any of the crossings made, the observed frequency was coded as 1: never, if a pedestrian crossed at mid-block in all the crossings made the observed frequency was coded as 3: always, and if a pedestrian crossed at mid-block in some (but not all) of the crossings made, the observed frequency was coded as 2: sometimes;
- if a pedestrian did not cross diagonally in any of the 8 crossings the observed frequency was coded as 1: never, if a pedestrian crossed diagonally in 7 or 8 of the crossings the observed frequency was coded as 5: always, if a pedestrian crossed diagonally in 1 or 2 of the crossings the observed frequency was coded as 2: rarely, if a pedestrian crossed diagonally in 3 or 4 of the crossings the observed frequency was coded as 3: sometimes, if a pedestrian crossed diagonally in 5 or 6 of the crossings the observed frequency was coded as 4: often.

Subsequently, the declared and observed frequencies of non-typical crossing behaviours were cross-tabulated, in order to identify cases where observed and declared behaviour is discordant.

3. Results

3.1. Diagonal crossing

In Figure 2, observed and declared frequencies of diagonal crossing are presented, as absolute figures (top panel) and as percentages of the total number of pedestrians (bottom panel). It is reminded that, in this case, there were 8 crossings in total for each individual. It is shown that only 2 of the participants declared to always cross diagonally, and very few to do so often. Moreover, very few participants declared never doing so, which is reasonable given that most pedestrians will cross diagonally under certain conditions.

However, it is noted that observed and declared frequency of diagonal crossing are fully concordant for only 30% of the participants. The highest discordance is noted for pedestrians who declared to rarely cross diagonally, but never did so in the field observations (15.3%), as well as for pedestrians who declared to often cross diagonally, but did so often in the field observations (12.5%). These higher discordances are nevertheless among 'neighbouring' categories, and may even be attributed to the coding of the data. All other discordances are notably small and located 'around' the diagonal of the Figure, indicating that overall pedestrians actually behaved very close to their declarations as regards diagonal crossing.

		Observed					
Declared	Never	Rarely	Sometimes	Often	Always	Total	
Never	2	4	1			7	
Rarely	11	11	2			24	
Sometimes	5	8	10	1		24	
Often	2	4	9			15	
Always			1	1		2	
Total	20	27	23	2		72	

		Observed					
Declared	Never	Rarely	Sometimes	Often	Always	Total	
Never	2,8%	5,6%	1,4%			9,7%	
Rarely	15,3%	15,3%	2,8%			33,3%	
Sometimes	6,9%	11,1%	13,9%	1,4%		33,3%	
Often	2,8%	5,6%	12,5%	0,0%		20,8%	
Always			1,4%	1,4%	0,0%	2,8%	
Total	27,8%	37,5%	31,9%	2,8%	0,0%	100,0%	

Fig. 2. Pedestrian observed vs. declared behaviour as regards diagonal crossing.

3.2. Mid-block crossing per road type

A more in-depth analysis is devoted to mid-block crossing, which was examined in different road types, namely major roads, main / secondary roads and minor / residential roads. The results are shown in Figure 3. Overall, it is interesting to note that the share of concordant declared and observed behaviour decreases when the complexity of the road environment decreases. More specifically, on major roads (top panel) 55% of the participants had fully concordant declared and observed behaviour, and the deviations, while significant, concerned ‘neighbouring’ categories. In fact, there are pedestrians who declared never crossing at mid-block on major roads but who did so sometimes (15,5%) or even always (1,4%), as well as pedestrians who declared sometimes crossing at mid-block on major roads but never actually did so (26,8%). While none of the participants declared always crossing at mid-block on major roads, there were few ones (7%) who did so in all crossing opportunities.

Major roads					
		Observed			
Declared	Never	Sometimes	Always	Total	
Never	19	11	1	31	
Sometimes	16	20	4	40	
Always				0	
Total	35	31	5	71	

		Observed			
Declared	Never	Sometimes	Always	Total	
Never	26,8%	15,5%	1,4%	43,7%	
Sometimes	22,5%	28,2%	5,6%	56,3%	
Always				0,0%	
Total	49,3%	43,7%	7,0%	100,0%	

Main / secondary roads					
		Observed			
Declared	Never	Sometimes	Always	Total	
Never	6	2		8	
Sometimes	21	44	1	66	
Always		2		2	
Total	27	48	1	76	

		Observed			
Declared	Never	Sometimes	Always	Total	
Never	7,9%	2,6%		10,5%	
Sometimes	27,6%	57,9%	1,3%	86,8%	
Always		2,6%		2,6%	
Total	35,5%	63,2%	1,3%	100,0%	

Minor / residential roads					
		Observed			
Declared	Never	Sometimes	Always	Total	
Never		1		1	
Sometimes	32	20	5	57	
Always	3	5	3	11	
Total	35	26	8	69	

		Observed			
Declared	Never	Sometimes	Always	Total	
Never			1,4%	1,4%	
Sometimes	46,4%	29,0%	7,2%	82,6%	
Always	4,3%	7,2%	4,3%	15,9%	
Total	50,7%	37,7%	11,6%	100,0%	

Fig. 3. Pedestrian observed vs. declared behaviour as regards mid-block crossing per road type.

The overall concordance of observed and declared behaviour is also very high on main / secondary roads. In this case, very few participants declared that they always cross at mid-block, but these individuals did not always do so in their actual walking tasks. The only significant discordance is noted for those participants who declared to sometimes cross at mid-block, but never actually did so (27.6%). It is possible that participants tend to declare their intentions to

cross at mid-block, rather than the actual frequency, as it appears that in practice there are constraints that do not allow them to do so as frequently.

The same is the case as regards minor / residential roads. Although more than 98% of participants declared that they sometimes or even always cross at mid-block under these conditions, 50.7% of them never actually did so. In this case, however, the interpretation may be slightly different: the discordance may be due to the lack of constraints (e.g. low or no traffic), making junctions undistinguishable from mid-block locations, and the related choice less meaningful. It may be also interesting to note that the responses are somewhat more dispersed; only 33.3% of behaviours are fully concordant, and discordant behaviours are somewhat more widespread.

3.3. Effects of pedestrian age and gender

The effect of gender and age on the concordance between declared and observed crossing behaviour is examined, by means of the comparison of the respective shares of survey participants. Figure 4 presents the results for male and female pedestrians. These are compared to the right panel of Figure 3, in which the mean shares for all pedestrians are presented. There appear to be no significant differences between males and females on major (top panel) or main roads (middle panel). It may be noticed that there is an increased share of male pedestrians who declared ‘sometimes’ crossing at mid-block on major roads but did so ‘always’ in their actual trips, but the sample is very small to draw any conclusions.

On the other hand, there are some notable differences as regards minor / residential roads (bottom panel). More specifically, female pedestrians appear to have more discordant declared and observed crossing behaviour, and those who declared ‘sometimes’ crossing at mid-block ‘never’ did so to a larger extent compared to the average. On the other hand, male pedestrians who declared ‘sometimes’ crossing at mid-block did so ‘always’ to a larger extent than the average. Additional small differences are visible in other categories, but due to the very small samples in these categories they cannot be considered as systematic differences.

The effect of age on the concordance between declared and observed crossing behaviour is examined in Figure 5, to be compared to the right panel of Figure 3, in which the mean shares for all pedestrians are presented. It is noted that the age groups examined are young pedestrians (i.e. <25 years old) and middle aged pedestrians (i.e. 25-45 years old). The results indicate that young pedestrians have lower shares of concordance in their declared and observed behaviour compared to the average, especially on main / secondary and minor / residential roads.

Male pedestrians					Female pedestrians				
Major roads					Major roads				
Observed					Observed				
Declared	Never	Sometimes	Always	Total	Declared	Never	Sometimes	Always	Total
Never	15,8%	15,8%		31,6%	Never	39,4%	15,2%	3,0%	57,6%
Sometimes	26,3%	31,6%	10,5%	68,4%	Sometimes	18,2%	24,2%		42,4%
Always					Always				0,0%
Total	42,1%	47,4%	10,5%	100,0%	Total	57,6%	39,4%	3,0%	100,0%
Main / secondary roads					Main / secondary roads				
Observed					Observed				
Declared	Never	Sometimes	Always	Total	Declared	Never	Sometimes	Always	Total
Never	5,1%	2,6%		7,7%	Never	10,8%	2,7%		13,5%
Sometimes	20,5%	64,1%	2,6%	87,2%	Sometimes	35,1%	51,4%		86,5%
Always		5,1%		5,1%	Always				0,0%
Total	25,6%	71,8%	2,6%	100,0%	Total	45,9%	54,1%	0,0%	100,0%
Minor / residential roads					Minor / residential roads				
Observed					Observed				
Declared	Never	Sometimes	Always	Total	Declared	Never	Sometimes	Always	Total
Never					Never		3,1%		3,1%
Sometimes	27,0%	35,1%	13,5%	75,7%	Sometimes	68,8%	21,9%		90,6%
Always	5,4%	13,5%	5,4%	24,3%	Always	3,1%		3,1%	6,3%
Total	32,4%	48,6%	18,9%	100,0%	Total	71,9%	25,0%	3,1%	100,0%

Fig. 4. Pedestrian observed vs. declared behaviour as regards mid-block crossing per road type - Males vs. females.

However, it is interesting to note that the most striking increase in discordant behaviour concerns the case where they declared ‘sometimes’ crossing at mid-block but ‘never’ doing so in the actual trips; this may be attributed to an increased tendency of young individuals to declare less compliant and more risky behaviour, which however they were not able to actually demonstrate due to the road and traffic constraints in actual trips.

On the contrary, middle-aged pedestrians appear to largely confirm the overall trend shown in the right panel of Figure 3, according to which there is overall concordance of declared and observed behaviour as regards mid-block crossing, with more variability as road and traffic conditions become less demanding.

Young pedestrians (<25 years old)					Middle-aged pedestrians (25-45 years old)				
Major roads					Major roads				
Observed					Observed				
Declared	Never	Sometimes	Always	Total	Declared	Never	Sometimes	Always	Total
Never	32,4%	13,5%		45,9%	Never	20,6%	17,6%	2,9%	41,2%
Sometimes	18,9%	29,7%	5,4%	54,1%	Sometimes	26,5%	26,5%	5,9%	58,8%
Always					Always				
Total	51,4%	43,2%	5,4%	100,0%	Total	47,1%	44,1%	8,8%	100,0%
Main / secondary roads					Main / secondary roads				
Observed					Observed				
Declared	Never	Sometimes	Always	Total	Declared	Never	Sometimes	Always	Total
Never	12,8%	2,6%		15,4%	Never	2,7%	2,7%		5,4%
Sometimes	33,3%	46,2%		79,5%	Sometimes	21,6%	70,3%	2,7%	94,6%
Always		5,1%		5,1%	Always				0,0%
Total	46,2%	53,8%	0,0%	100,0%	Total	24,3%	73,0%	2,7%	100,0%
Minor / residential roads					Minor / residential roads				
Observed					Observed				
Declared	Never	Sometimes	Always	Total	Declared	Never	Sometimes	Always	Total
Never		2,9%		2,9%	Never				
Sometimes	54,3%	22,9%	5,7%	82,9%	Sometimes	38,2%	35,3%	8,8%	82,4%
Always	5,7%	8,6%		14,3%	Always	2,9%	5,9%	8,8%	17,6%
Total	60,0%	34,3%	5,7%	100,0%	Total	41,2%	41,2%	17,6%	100,0%

Fig. 5. Pedestrian observed vs. declared behaviour as regards mid-block crossing per road type - Young vs. middle-aged.

4. Conclusions

In this paper, a first attempt to compare pedestrian crossing behaviour declared and observed data was presented, on the basis of a dedicated survey in Athens, Greece. The findings suggest that, overall, pedestrians observed behaviour is in accordance with their declared behaviour, especially as regards diagonal crossing, which is confirmed to be a common practice by most pedestrian and under different circumstances (e.g. crossing at junction or at mid-block, in more or less complex road environments etc.).

As regards mid-block crossing, however, there is a non-negligible share of pedestrians, whose observed and declared behaviour were discordant, which was more visible at specific road and traffic condition, namely minor / residential roads. An important finding is that a non-negligible proportion of pedestrians may cross at mid-block even at major roads. More specifically, there were pedestrians who declared that they never cross at mid-block on major urban road but did so during the survey. Moreover, there were pedestrians who declared high frequency of mid-block crossing, but did not implement these crossing practices during the survey.

The analysis of the effects of basic demographics of pedestrians (i.e. age and gender) did not reveal major effects. A weak tendency of females to overestimate their declared behaviour compared to the observed one was identified on minor / residential roads, while the opposite was the case for male pedestrians on major roads. A tendency of young pedestrians to declare more frequently crossing at mid-block than they actually did was identified.

It is noted that the effect of answering the questionnaire before or after the actual walking task was not thoroughly examined in this research. A preliminary inspection of the data did not reveal any systematic differences, nevertheless this is a field for further analysis.

Further analysis will be devoted to more detailed comparison of observed and declared behaviours. In particular, the questionnaire comprises several other questions that concern mid-block crossing under specific circumstances, e.g. when another pedestrian is doing so, when there is no oncoming traffic, when there is a shop on the other side etc. This in-depth analysis may need to focus on a distinct part of the sample, namely the part of the sample where variations exist. In this framework, the coding of the observed and declared behaviour variables may need to be reconsidered to be more efficient.

Especially as regards the coding, the results of this research suggest that - unlike our initial hypothesis - the largest part of the variability is not within the 'intermediate' categories of behaviour ('sometimes'), but there is also significant variability in the other responses. Of course, the coding adopted in this research is only an approximation of the shares of declared and observed behaviour. For example, the declared frequencies ('never', 'sometimes' etc.) should be weighted to the total exposure or overall walking activity of pedestrians (e.g. walking frequency, mean distances walked etc.). Similarly, the observed crossing frequencies should be coded in a more detailed way, by taking into account not only the number but also the length of walking trips. All this information is available through the survey data, and the next steps of the present research will aim at the exploitation of this data for the further analysis of pedestrian declared and observed crossing behaviour.

Consequently, the results of the present research can not be directly exploited by planners or practitioners, due to the small size of the sample and the fact that only one city was studied. The main contribution of the present research is towards the better understanding of pedestrians behaviour and their interaction with the urban road environment. However, the proposed methodology (i.e. combining declared and observed behaviour data) may be useful in the identification of cases where specific design practices may strengthen pedestrians intentions for non compliant behaviour, and the extent to which these intentions may be in fact practiced (e.g. poor traffic control at junctions may lead to increased intentions to cross diagonally, but in practice most pedestrians will actually cross diagonally only when traffic is low). Moreover, the proposed methodology may shed some light on cases where even a rigorous design may not prevent risk-taking behaviour under some circumstances (e.g. some pedestrians may cross at mid-block on major roads, even though this is not a common practice for them). The implementation of similar studies in different cities and traffic conditions may eventually reveal patterns of declared and observed behaviours that may assist planners or practitioners in more targeted design of pedestrian facilities.

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References

- Antonini G., Bierlaire M., and Weber, M. (2006). Discrete choice models of pedestrian walking behaviour. *Transportation Research Part B* 40, pp. 667–687.
- Bernhoft I.M., Carstensen G. (2008). Preferences and behaviour of pedestrians and cyclists by age and gender. *Transportation Research Part F* 11, pp. 83-95.
- Chu X., Guttenplan, M., and Baltés M. (2004). Why People Cross Where They Do - The Role of the Street Environment. *Transportation Research Record* No 1878, pp. 3-10.
- Das S., Manski C.F., Manuszak M. (2005). Walk or Wait? An Empirical Analysis of Street Crossing Decisions. *Journal of Applied Econometrics* 20 (4), pp. 445-577.
- Diaz, E.M. (2002). Theory of planned behaviour and pedestrians' intentions to violate traffic regulations. *Transportation Research Part F* 5, 169–175.
- Dommes A., Cavallo V. (2012). Can simulator-based training improve street-crossing safety for elderly pedestrians? *Transportation Research Part F* 15 (2), pp. 206–218.
- Evans D., Norman P. (1998). Understanding pedestrians' road crossing decisions: an application of the theory of planned behaviour. *Health Education Research* 13 (4), pp. 481-489.

- Granié M.A. (2007) Gender differences in preschool children's declared and behavioral compliance with pedestrian rules. *Transportation Research Part F: Traffic Psychology and Behaviour* 10 (5), pp. 371-381.
- Granié M.A., Pannetier M., Guého L. (2013). Developing a self-reporting method to measure pedestrian behaviors at all ages. *Accident Analysis and Prevention* 50 (2013) 830– 839.
- Hamed M.M. (2001). Analysis of pedestrians' behaviour at pedestrian crossings. *Safety Science* 38, pp. 63-82.
- Himanen, V. and Kulmala, R. (1988). An application of logit models in analysing the behaviour of pedestrians and car drivers on pedestrian crossings. *Accident Analysis & Prevention* 20 (3), pp. 187-197.
- Hine J. (1996). Pedestrian travel experiences: Assessing the impact of traffic on behaviour and perceptions of safety using an in-depth interview technique. *Journal of Transport Geography* 4 (3), 179-199.
- Ishaque M.M., and Noland R.B. (2008). Behavioural Issues in Pedestrian Speed Choice and Street Crossing Behaviour: A Review. *Transport Reviews*, pp. 1-25.
- Lassarre S., Bonnet E., Bodin F., Papadimitriou E., Yannis G., Golias J. (2011). A GIS-based methodology for identifying pedestrians crossing patterns. *Computers, Environment & Urban Systems* 36 (4), pp. 321-330.
- Li, Y., and Tsukaguchi, H. (2005). Relationships between network topology and pedestrian route choice behaviour. *Journal of the Eastern Asia Society for Transportation Studies* 6, pp. 241 - 248.
- Papadimitriou E., Auberlet J-M., Yannis G., Lassarre S., (2014). Simulation of Pedestrians and Motorised Traffic: existing research and future challenges. *International Journal of Interdisciplinary Telecommunications and Networking* 6(1), pp. 57-73.
- Papadimitriou E., Lassarre S., Yannis G., "Introducing human factors in pedestrian crossing behaviour models", Proceedings of the 94th Annual meeting of the Transportation Research Board, Washington, January 2015.
- Papadimitriou E., Yannis G., Golias J. (2009). A critical assessment of pedestrian behaviour models. *Transportation Research Part F* 12 (3), pp. 242-255.
- Pulugurtha S.S., Krishnakumar V.K., Nambisan S.S, (2007). New methods to identify and rank high pedestrian crash zones: An illustration. *Accident Analysis and Prevention* 39, pp. 800–811.
- Simpson G., Johnston L., Richardson M. (2003). An investigation of road crossing in a virtual environment. *Accident Analysis and Prevention* 35, pp. 787–796.
- Sisiopiku, V.P., Akin, D., 2003. Pedestrian behaviors at and perceptions towards various pedestrian facilities: an examination based on observation and survey data. *Transportation Research Part F: Traffic Psychology and Behaviour* 6, 249– 274.