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Human factors of pedestrian walking and crossing behaviour

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Background

- Human factors related to pedestrians have received less attention in the literature compared to other road users.
- Road and traffic factors alone may explain only a small part of pedestrian behaviour in urban areas.
- Several studies dealing with pedestrian human factors, however outside the context of the road and traffic environment.
- Understanding pedestrian behaviour may assist in the improved design and planning of the road and traffic environment, and consequently to the improvement of pedestrian comfort and safety.

Overview of studies

Author	Year	Problem			Theory		Models				Variables			Data	
		crossing decision	attitudes, perceptions etc.	compliance	Planned behaviour	Other		Linear Regression, GLM	Factor analysis	Other	individual	roadway	traffic	observational data	self-report
Hine	1996	●	●			●				●		●	●		●
Evans and Norman	1998	●	●		●			●			●				●
Yagil	2000	●		●	●			●			●				●
Diaz	2002	●	●		●				●		●				●
Holland and Hill	2007	●			●			●			●				●
Oxley et al.	1997	●	●			●				●	●			●	
Berhhoft and Carstensen	2008	●		●		●		●			●	●			●
Rosenbloom et al.	2008	●		●		●		●			●			●	
Sisiopiku & Akin	2003	●		●		●		●			●	●	●	●	●
Papadimitriou et al.	2013		●	●		●			●		●	●	●		●
Granié et al.	2013		●	●		●			●		●				●

Objectives

- The objective of this research is the in-depth analysis of human factors of pedestrian walking and crossing behaviour in urban areas.

- More specifically, this research aims to:
  - capture and analyse key components affecting pedestrian behaviour, namely the pedestrians attitudes, perceptions, motivations, behaviour and habits
  - identify 'profiles' of pedestrians on the basis of these human factors.

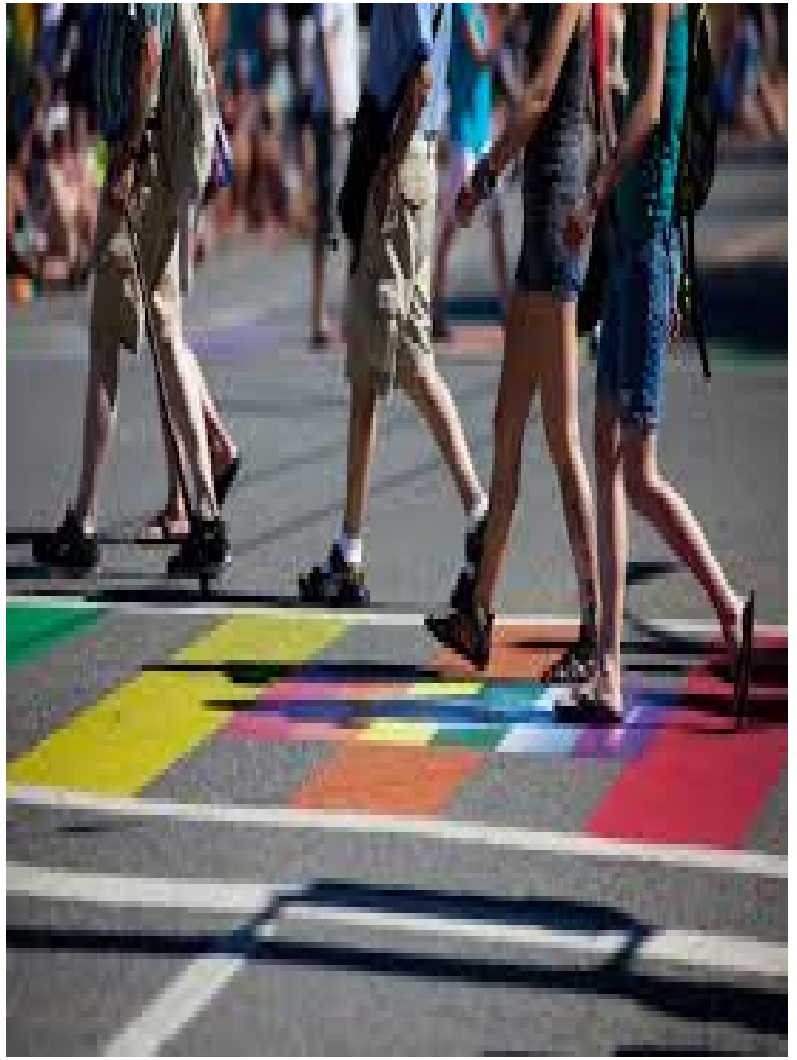
Research hypotheses

- Demographics
  - Age & gender: Younger and male pedestrians are more risk-taking
  - Income: low income, perceived social inequality and the lack of alternatives to walking lead to more aggressive behaviour.
- Travel motivations
  - positive relationship between walking frequency / distance travelled and crossing behaviour
  - Pedestrians walking for health / recreation purposes likely to be less risk-taking and more safety conscious
- Risk perception and value of time
  - The risk minimizer vs. the delay minimiser;
- Interaction with other road users
  - Imitation and leader / follower effects
  - Pedestrians with negative opinion on drivers are more likely to be careful and compliant

Data collection

- A questionnaire was designed with 6 sections (questions with 5-point Likert scales)
  (a) demographics,
  (b) mobility and travel motivations,
  (c) attitudes, perceptions and preferences,
  (d) self-assessment and identity,
  (e) behaviour, compliance and risk taking, and
  (f) opinion on drivers

- Filled by 75 individuals in the period July - December 2013;
  - 53% of the participants were males,
  - 50% of the participants were 18-24 years old, 27% were 25-34, 20% were 35-45 and 3% were >45 years old.
  - The majority were are frequent pedestrians, but also use both private cars and public transport.



Questionnaire

B	How many times per week do you travel by each one of the following modes*:
B1_i	Public transport (metro, bus, trolley bus, tramway)
B1_ii	Pedestrian
B1_iii	Passenger car (driver or passenger)
	Last week, how many kilometers did you travel by each one of the following modes**:
B2_i	Passenger car (driver or passenger)
B2_ii	Pedestrian
B2_iii	Public transport (metro, bus, trolley bus, tramway)
	As a pedestrian, how much would you agree with each one of the following statements***:
B3_i.	I walk for the pleasure of it
B3_ii	I walk because it is healthy
B3_iii	In short trips, I prefer to walk
B3_iv	I prefer taking public transportation (buses, metro, tramway, etc.) than my car
B3_iv	I walk because I have no other choice
C	As a pedestrian, how much would you agree with each one of the following statements***:
C1_i.	Crossing roads is difficult
C1_ii.	Crossing roads outside designated locations increases the risk of accident
C1_iii.	Crossing roads outside designated locations is wrong
C1_iv	Crossing roads outside designated locations saves time
C1_v	Crossing roads outside designated locations is acceptable because other people do it
C2_i	I prefer routes with signalized crosswalks
C2_ii	I try to make as few road crossings as possible
C2_iii	I try to take the most direct route to my destination
C2_iv	I prefer to cross diagonally
C2_v	I try to take the route with least traffic to my destination
C2_vi	I am willing to make a detour to find a protected crossing
C2_vii	I am willing to take any opportunity to cross
C2_viii	I am willing to make dangerous actions as a pedestrian to save time

D	Compared to other pedestrians, how much do you agree that***:
D_i	I am less likely to be involved in a road crash than other pedestrians
D_ii	I am faster than other pedestrians
D_iii	I am more careful than other pedestrians
E	As a pedestrian, how often do you adopt each one of the following behaviors****:
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
E2_iv	I cross while talking on my cell phone or listing to music on my headphones
E2_v	I cross even though obstacles (parked vehicles, buildings, trees, etc.) obstruct visibility
E2_vi	I cross even though there are oncoming vehicles
F	As a pedestrian, how much would you agree with each one of the following statements***:
F1_i	Drivers are not respectful to pedestrians
F1_ii	Drivers drive too fast
F1_iii	Drivers are aggressive and careless
F1_iv	Drivers should always give way to pedestrians
F1_v	When there is an accident, it is the driver's fault most of the times
F1_vi	I let a car go by, even if I have right-of-way

Analysis methods

- Principal Component Analysis (PCA)
  - to identify groups of variables (“components” or “dimensions”),
  - to understand the structure of this set of variables
  - to reduce the dataset to a more manageable size

- Cluster analysis
  - to group individuals (respondents) instead of variables
  - Grouping of the basis of “components” scores

Results - descriptive statistics (1/3)

- Travel motivations
- Self-assessment
- Opinion on drivers

B3	As a pedestrian, how much would you agree with each one of the following statements:	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
B3_i.	I walk for the pleasure of it	6%	4%	29%	43%	18%
B3_ii	I walk because it is healthy	3%	4%	18%	53%	22%
B3_iii	In short trips, I prefer to walk	1%	4%	10%	39%	46%
B3_iv	I prefer taking public transportation (buses, metro, tramway, etc.) than my car	15%	31%	26%	17%	11%
B3_iv	I walk because I have no other choice	19%	21%	24%	18%	18%

D	Compared to other pedestrians, how much do you agree that:	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
D_i	I am less likely to be involved in a road crash than other pedestrians	1%	10%	26%	50%	13%
D_ii	I am faster than other pedestrians	3%	14%	26%	38%	19%
D_iii	I am more careful than other pedestrians	1%	8%	26%	54%	10%

F1	As a pedestrian, how much would you agree with each one of the following statements:	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
F1_i	Drivers are not respectful to pedestrians	0%	13%	19%	49%	19%
F1_ii	Drivers drive too fast	1%	7%	32%	47%	13%
F1_iii	Drivers are aggressive and careless	1%	6%	26%	49%	18%
F1_iv	Drivers should always give way to pedestrians	3%	14%	24%	36%	24%
F1_v	When there is an accident, it is the driver's fault most of the times	1%	31%	44%	21%	3%
F1_vi	I let a car go by, even if I have right-of-way	7%	26%	36%	29%	1%

Results - descriptive statistics (2/3)

- Attitudes and risk perceptions

C1	As a pedestrian, how much would you agree with each one of the following statements:	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
C1_i.	Crossing roads is difficult	10%	33%	25%	29%	3%
C1_ii.	Crossing roads outside designated locations increases the risk of accident	3%	13%	13%	53%	19%
C1_iii.	Crossing roads outside designated locations is wrong	7%	19%	22%	42%	10%
C1_iv	Crossing roads outside designated locations saves time	4%	15%	21%	38%	22%
C1_v	Crossing roads outside designated locations is acceptable because other people do it	19%	43%	24%	7%	7%

C2	As a pedestrian, how much would you agree with each one of the following statements:	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
C2_i	I prefer routes with singalised crosswalks	1%	8%	32%	50%	8%
C2_ii	I try to make as few road crossings as possible	3%	17%	26%	42%	13%
C2_iii	I try to take the most direct route to my destination	0%	1%	19%	44%	35%
C2_iv	I prefer to cross diagonally	6%	35%	29%	25%	6%
C2_v	I try to take the route with least traffic to my destination	1%	6%	25%	44%	24%
C2_vi	I am willing to make a detour to find a protected crossing	8%	24%	38%	25%	6%
C2_vii	I am willing to take any opportunity to cross	0%	22%	39%	28%	11%
C2_viii	I am willing to make dangerous actions as a pedestrian to save time	18%	38%	21%	21%	3%

Results - descriptive statistics (3/3)

- Behaviour, compliance and risk-taking

E1	As a pedestrian, how often do you adopt each one of the following behaviours:	Never	Rarely	Sometimes	Often	Always
E1_i.	I cross diagonally	10%	33%	33%	21%	3%
E1_ii	I cross at midblock at major urban arterials	43%	29%	18%	10%	0%
E1_iii	I cross at midblock at urban roads	11%	28%	36%	22%	3%
E1_iv	I cross at midblock in residential areas	1%	11%	24%	47%	17%
E1_v	I cross at midblock when I am in a hurry	3%	11%	25%	46%	15%
E1_vi	I cross at midblock when there is no oncoming traffic	3%	7%	17%	39%	35%
E1_vii	I cross at midblock when I see other people do it	21%	33%	35%	10%	1%
E1_viii	I cross at midblock when my company prompts me to do it	20%	28%	24%	23%	6%
E1_ix	I prompt my company to cross at midblock	21%	37%	24%	14%	4%
E1_x	I cross at midblock when there is a shop I like on the other side	11%	37%	24%	15%	13%
E1_xi	I cross even though the pedestrian light is red	13%	28%	31%	28%	1%
E1_xii	I walk on the pavement rather than on the sidewalk	4%	19%	32%	29%	15%

E2	As a pedestrian, how often do you adopt each one of the following behaviours:	Never	Rarely	Sometimes	Often	Always
E2_i	I cross between vehicles stopped on the roadway in traffic jams	1%	15%	25%	47%	11%
E2_ii	I cross without paying attention to traffic	63%	31%	7%	0%	0%
E2_iii	I am absent-minded while walking	21%	39%	28%	8%	4%
E2_iv	I cross while talking on my cell phone or listing to music on my headphones	7%	18%	42%	26%	7%
E2_v	I cross even though obstacles (parked vehicles, buildings, trees, etc.) obstruct visibility	21%	26%	32%	18%	3%
E2_vi	I cross even though there are oncoming vehicles	19%	42%	29%	8%	1%

Results - Principal Component Analysis

- Grouping variables: 3 components explaining 65% of the total variance from the 51 questionnaire variables are extracted (eigenvalue>1 criterion).

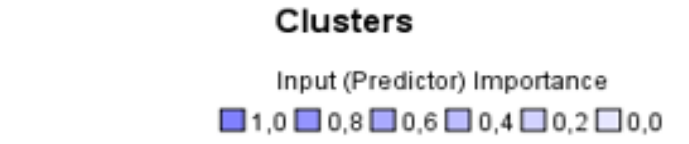
Component 1: Risk taker & optimizer	Loadings
Crossing roads outside designated locations increases the risk of accident	-0.568
Crossing roads outside designated locations is wrong	-0.509
Crossing roads outside designated locations is acceptable because other people do it	0.418
I prefer to cross diagonally	0.633
I am willing to make a detour to find a protected crossing	-0.564
I am willing to take any opportunity to cross	0.636
I am willing to make dangerous actions as a pedestrian to save time	0.526
I am faster than other pedestrians	0.473
I cross diagonally	0.674
I cross at midblock at major urban arterials	0.579
I cross at midblock at urban roads	0.739
I cross at midblock in residential areas	0.723
I cross at midblock when I am in a hurry	0.825
I cross at midblock when there is no oncoming traffic	0.602
I cross at midblock when I see other people do it	0.467
I cross at midblock when my company prompts me to do it	0.575
I prompt my company to cross at midblock	0.746
I cross even though the pedestrian light is red	0.593
I cross between vehicles stopped on the roadway in traffic jams	0.658
I cross even though obstacles (parked vehicles, buildings, trees, etc.) obstruct visibility	0.548
I cross even though there are oncoming vehicles	0.683

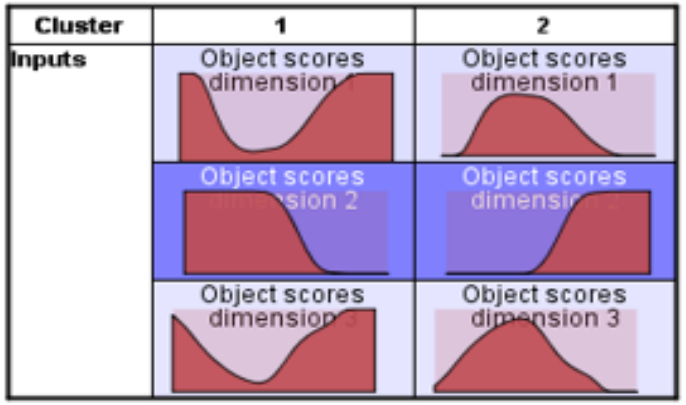
Component 2: Conservative & public transport user	Loadings
Weekly travel by Public transport	0.698
Weekly travel by Pedestrian	0.470
Weekly travel by Passenger car	-0.534
Weekly Km of travel by Passenger car	-0.475
Weekly Km of travel by Public transport	0.724
I prefer taking public transportation than my car	0.493
Crossing roads is difficult	0.558
I try to make as few road crossings as possible	-.463
I prefer to cross diagonally	-.503
I am less likely to be involved in a road crash than other pedestrians	-.452

Component 3: Pedestrian for pleasure	Loadings
Weekly travel by Pedestrian	0.570
Weekly travel by Passenger car (driver or passenger)	-0.593
WeeklyKm of travel by Passenger car (driver or passenger)	-0.534
WeeklyKm of travel by Pedestrian	0.583
I walk for the pleasure of it	0.562
I walk because it is healthy	0.628
I prefer routes with singalised crosswalks	0.419
I am willing to make a detour to find a protected crossing	.417
I cross at midblock when there is a shop I like on the other side	.425
When there is an accident, it is the driver's fault most of the times	.478

Results - Cluster Analysis

- Two clusters of respondents are formed (distribution of almost 40%-60%).
- Component 2 is strong predictor of cluster membership.





- Group 1 "Negative attitudes and behavior / weak walking motivations":
  - high scores on risk-taking and low delay acceptance
  - low scores on illegal crossing perceived as dangerous
  - rarely use public transport and do not walk for pleasure or health

- Group 2 "Positive attitudes and behavior / strong walking motivations":
  - low scores on risk-taking behaviour
  - high scores on risk perception
  - frequently use public transport and walk for pleasure or health

Final Cluster Centers

	Cluster	
	1	2
Object scores dimension 1	,23	-1,11
Object scores dimension 2	,16	-,77
Object scores dimension 3	-,22	1,09

Discussion 1/2

- 3 meaningful dimensions / components in the data, the two first strongly related to pedestrian risk-taking attitudes and perceptions, and the third one strongly related to pedestrians walking motivations.

- Clustering of pedestrians in two groups: on the one hand "positive" (i.e. non risk taking, compliant, motivated) pedestrians, and on the other hand "negative" (risk-taking, impatient, unmotivated) pedestrians.

- The research hypotheses on human factors of pedestrian behaviour were not confirmed by the above results.
  - 5 components were assumed as the structure of the questionnaire, but only 3 emerged.

"The Anonymous Pedestrians", Wroclaw, Poland

Discussion 2/2

- Limitations of the research:
  - Survey sample was rather small
  - older pedestrians are not included, and middle-aged pedestrians are under-represented.

- The present research confirms that human factors are important determinants of pedestrian behaviour
  - diversity in attitudes, perceptions and declared behaviours
  - strong “contrast” between pedestrian profiles identified
  - effect on pedestrian walking and crossing behaviour.

- Next steps:
  - Larger and more representative sample may reveal additional dimensions
  - Combined effect of road, traffic and human factors on pedestrian behaviour

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