IS CYCLING SAFE? USING MENTAL MAPPING TO UNPACK PERCEPTIONS OF CYCLING SAFETY

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Abstract

Cycling is the most energy efficient mode of transport and modal shift can bring extensive environmental, health and economic benefits. Despite this, only 2% of the Irish population cycle to work, school or college. Research has highlighted safety concerns as the major barrier, with negative perceptions of safety as well as concrete safety risks impeding the growth of cycling. Overcoming such negative perceptions could increase cyclist numbers and consequently improve cyclist safety. Key steps to achieving this is a) the identification and removal of actual hazards for cyclists and b) targeted work on improving safety perceptions among current and future cyclists.

This study of cycling conditions in Galway City combines mental mapping, road data and a questionnaire survey to identify the determinants of perceived safety and danger among cyclists. Respondents were asked to draw their regular cycling routes, colouring each route segment according to cycling safety. This was followed by a questionnaire survey of preferences for cycling infrastructure and road characteristics among cyclists. Road data including traffic volumes, road widths and locations of collisions complemented the survey and maps.

Mental maps and questionnaires were analysed and correlated with road data to identify the road characteristics that are, or are perceived as, unsafe for cyclists. It was found that the major determinants of cycling safety concerns are related to traffic (number and speed of vehicles passing) and infrastructure (presence of roundabouts, road lane width, adjacent car parking). A ranking system for cycling routes was developed which could be used to allay perceptions of danger and prioritise certain infrastructural improvements for cyclists. The paper concludes that further research is needed on the use of online tools to engage cyclists and the general public on the safety and quality of infrastructure and feed into 'soft' and 'hard' cycling policy responses.

1. Introduction

Ireland is something of latecomer to the promotion of cycling as a sustainable transport option. Key recent developments in the area of sustainable transport include Smarter Travel [1], National Cycle Policy Framework [2] and the Design Manual for Urban Roads and Streets [3]. These documents envisage a new approach to infrastructure planning and design that promotes sustainable travel, in particular cycling and walking. Considerable progress has been made in the area of cyclist safety with fatalities down 40% between 2007 and 2011. Despite this, cyclists comprised 5% of all road fatalities despite representing only 2% of road users (9 deaths in 2011 and 8 in 2012) [4].

According to Swift (2012), cycling policy in Ireland needs to respond to two key challenges. Firstly, to achieve a significant modal share for cycling means to cater for a highly heterogeneous group of road users that includes people with different abilities, levels of expertise, views of cycling (safety) and actual cycling practices. Secondly, a range of design options for cycling infrastructure exists, reflecting rapid developments in this area both in Europe and elsewhere. As a result, different (and sometimes contradictory) models exist which Ireland could learn from and adopt. Cycling safety continues to be a hotly debated subject in Irish transport policy and practice, especially in the context of urban planning and road developments. Cyclists continue to rank below motorists in the hierarchy of road users and it is frequently down to local volunteer cycling lobby groups to fight for the interests of cyclists [5].

Perceptions of road safety continue to play a big role in efforts to encourage walking and cycling. For example, An Taisce's Green Schools Travel Programme which seeks to promote walking and cycling among school children is frequently confronted with safety concerns among parents. To address these concerns, more than 3,700 school children received cycling training during the school year 2010-11 alone [6].

Mirroring increasing societal interest in health, diet and fitness metrics, quantitative data that capture cyclists' experiences are increasingly in demand [7]. A review of the literature to date indicates that there is an urgent need to provide empirical evidence of cyclists' experiences not only to influence user-applications (health and safety) but also to inform transport and environmental policies (e.g. road conditions, cycle path provision). Issues around safety perceptions and actual safety risks constitute key targets for future research.

2. Literature Review

The relationship between environmental perceptions and spatial behaviour has interested social scientists for decades. Research from the 1970s in the area of cognitive psychology assumed that individual variables such as attitudes and perceptions are the dominant drivers of behaviour. (See for example Fishbein and Ajzen's (1975) *Theory of Reasoned Action* (TRA) which was initially developed and manipulated in the US to ascertain public political preferences during elections).

In recent years, these approaches have increasingly been criticised for their almost complete neglect of the role of structural and contextual factors in shaping individuals' behaviour. Nevertheless, a detailed literature review demonstrates that while (safety) perceptions are not the only factor, they do play an important role in influencing behaviour. For example, geographical and sociological studies of crime in cities and perceptions of neighbourhood safety [8,9] have shown that perception is often more important than objective reality in determining people's use of features of the built environments, including transport infrastructure and services.

The influence of perceived safety on cycling behaviour and indeed the accuracy of commonly held perceptions about cycling has also been widely debated in the literature. Parkin (2007) states: "While actual, or objective risk, is relatively high for cycling compared with other modes, the perceived risk, that is the risk that is assumed to exist by existing and would-be mode users, is the important criterion in terms of behavioural response" [10]. Hunt and Abraham (2007) discuss how relative accuracies of perceptions regarding safety vary across differing levels of cycling training and experience. In their review they note that 'some

contend that cycling on 'bike paths' and 'bike lanes' is actually less safe in general than cycling in 'mixed traffic' – at least for cyclists who understand basic driving rules and practice 'effective cycling'' [11].

Recent documents issued by the pro-cycling lobby group Dublin Cycling Campaign (2013) reflect many of the safety concerns raised by its membership, including the quality of road surfaces, motor vehicle speeds, the need for more direct routes for cyclists, including two-way use of one-way streets, improvements in junction design and lane width, better signage and road marking and suitably designed cycle lanes and cycle paths [12]. These concerns apply across all demographics; for example a recent study of Australian University students revealed that route safety was the primary factor in choosing whether to commute by bicycle [13].

The successful use of video and other visual aids to investigate road safety concerns among cyclists deserves particular attention (see also section on mental mapping below). Parkin et al. [10] constructed two perceived risk models and an acceptability model based on responses to video clips of routes and junctions. It was found that cycling facilities at roundabouts did not reduce the perceived hazard. Cycling infrastructure on roads with heavy traffic marginally reduced perceived danger, while completely off-road routes significantly reduced perceived danger.

The design of the built environment also directly affects safety perceptions. Increased perception of cycling crash risk can be found in areas of low density, non-mixed land uses as opposed to compact, mixed-use neighbourhoods. This was even found to be the case when the latter areas experienced greater actual crash risk [14].

Beyond the physical environment, driver and cyclist attitudes also affect safety perception. Lawson et al. (2013), using a fixed-response questionnaire, considered cyclists' compliance with the rules of the road, weather conditions and attitudes of drivers in the Dublin area. It was found that careless and reckless driver behaviour negatively affect the perceived safety of cyclists and that the use of safety accessories (e.g. helmets) does not increase perception of safety among cyclists [15].

Cyclists' safety perceptions also vary according to cycling frequency. Frequent cyclists are more likely to fear more commonly reported actual collisions, while infrequent cyclists are more likely to be affected by near misses. Near misses are of significant concern for cyclists, 70% having experience a near miss [16]. Once near misses and the under-reporting of collisions are considered, one begins to gain an appreciation for the extent of cycling safety concerns.

Mental maps

Maps have always been part and parcel of geographical research. They have the capacity to reveal and link knowledge, learning and power [17]. Arguably, map-making constitutes a creative process that reflects and respond to "the environmental perception and the geographical imagination of humans". All maps can serve as texts for exploring human perceptions of the landscape [18].

Within the research field of environmental perception, the environmental or spatial data stored in an individual's memories is termed a mental map and the process of acquiring this data is called 'mental mapping'.Mental maps are defined in the Dictionary of Human Geography as "an amalgam of information and interpretation reflecting not only what a person knows about places but also how he or she feels about them" [19]. Mental maps have long been associated with the behavioural aspect of cartography that explores human perceptions of landscape. Lynch's (1960) study of images in the city represents an early landmark study in this field [20].

Geographical studies have utilised mental maps to explore a range of subjects including perceived desirability of neighbourhoods, orientation and way-finding, perceptions of crime and migration propensities (see for example [21,22]). More recently, mental maps have become part of a broader movement within 'environmental perception' and have merged with

the growing interest across a range of disciplines in representations and the social construction of places [23].

While the creative process of map-making varies considerably, the process of mental mapping traditionally is considered as comprising four key elements; an actor, an external environment, environmental perceptions – i.e. the set of outputs from environment to actor and environmental response behaviour – a set of outputs from actor to environment [8]. No two people respond to the same environment in exactly the same way but researchers such as Golledge (1999) note that are generalities according to age, gender and regional characteristics [24].

3. Methods

This study combined mental mapping, a questionnaire survey and road data from Galway City to compare perceptions of cycling safety among participating cyclists with actual road conditions and their impacts on cycling safety. While most mental mapping studies ask participants to undertake a freehand drawing, this study provided the respondents with a base map (Figure 2) to draw their regular cycling routes and to colour each route segment according to cycling safety: green for safe, yellow for unsafe, and red for very dangerous. An additional questionnaire was used to record respondents' preferences on cycling infrastructure and road characteristics as well as some basic demographic information. Finally, road data including traffic volumes, road widths and locations of collisions involving cyclists were collected.

Responses were garnered on the NUI Galway campus at various events during the 2012-13 academic year, including Bike Week, Mobility Week, Health Fair. NUI Galway is located approximately 1 km from Galway City Centre. The university has a cycling modal share of 15%. Galway City has a population of 75,000 and a cycling modal share of 5%.

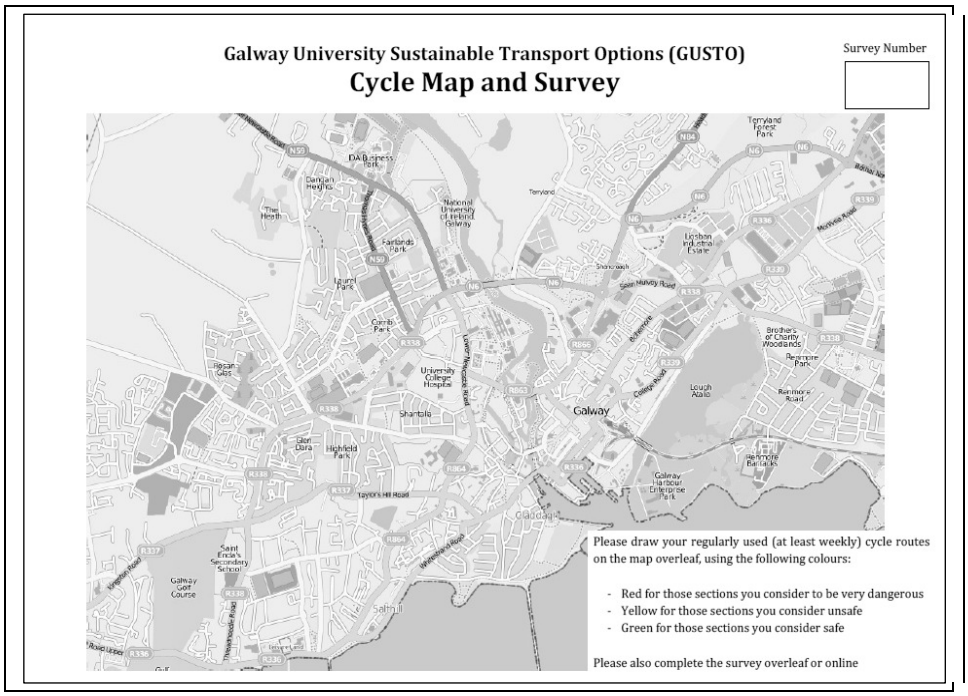

Figure 1 – Mental mapping exercise template

4. Results and Discussion

120 responses to the questionnaire and mental mapping exercise were achieved, of which 104 were usable for data analysis. The demographic and household profile of respondents is presented in Table 1. The largest age grouping of respondents was 25-44 years old and the sample has an average age of 30.8 years. There were no respondents over 64 years of age. The majority of respondents (60.6%) were male, reflecting the national cycling gender gap. The largest occupation categories of respondents were 'at work' and 'undergraduate

student'. This reflected the campus-based data collection. One third of respondents have lived in Galway for less than five years, while one third has lived in Galway for between five and fourteen years and one third for more than fourteen years.

Table 1 – Demographic profile of survey respondents (n=104)

	%		%
Age		*Gender*	
Under 25 years old	36.5	Female	39.4
25 – 44 years old	48.1	Male	60.6
45 – 64 years old	15.4		
Over 64 years old	0		
Occupation		*Time spent living in Galway*	
At work	35.6	Less than 5 years	33.7
Undergraduate student	35.6	5 – 9 years	19.2
Postgraduate student	21.3	10 – 14 years	12.5
Other / not stated	5.8	Over 14 years	34.6

More than half of the respondents cycle everyday (51%), a further 29% cycle several times per week and the remaining fifth cycle less often. 29% of cyclists in the study classified themselves as *highly skilled*, 64% as *competent* and 7% as *inexperienced*. 14% of the sample classified themselves as *very fit*, 51% as *fit*, 29% as of *average fitness* and 6% as *unfit*. The most common motivation for cycling was commuting and two-thirds of respondents always commute by bicycle (Table 2). Cycling is used by 27% of respondents as a means to other modes of transport and by around 20% for health/fitness, shopping and leisure.

Table 2 – Frequency of various cycling trip motivations (percent)

	Always	**Sometimes**	**Never**
Commuting	67.4	28.4	4.2
Means to other transport	26.9	47.8	25.4
Health/Fitness	20.5	67.5	12.0
Shopping	19.5	59.7	20.8
Leisure	17.3	76.5	6.2

Respondents were asked to rank a list of physical factors according to their perceived impact on cycling safety. Responses were weighted and averaged according to rank (1^{st}=1 etc.), the lower the weighted average, the greater the concern for cyclists. The top three factors are related to the speed, volume and composition of traffic: *number of trucks passing*, *speed of traffic* and *number of cars passing* (Table 3). Infrastructure proved to be less of a concern than traffic; however, cyclists consider the presence of a roundabout, the width of the road lane and the presence of an adjacent car parking lane to be concerns for safety.

Table 3 – Physical factors ranked by concern for safety

	Weighted average
Number of trucks passing	3.08
Speed of traffic	3.08
Number of cars passing	3.68
Presence of a roundabout	3.68
Width of road lane	4.23
Presence of a car parking lane	5.39
Number of junctions passed through	5.55
Width of cycle lane	6.16
Maximum gradient	6.60

Following the ranking of safety concerns, respondents were asked whether they felt certain physical factors compromised their safety while cycling (Table 4). Almost 60% expressed concern about the volume of trucks passing 55% feel their safety is compromised by the number of cars passing and 43% feel unsafe passing through a roundabout. The presence of an adjacent car parking lane was considered less of a hazard. When asked what is the maximum speed limit of a road that you would feel comfortable cycling on, 41% responded 30-50 km/h, 26% said 50-60 km/h and 16% said 60-80 km/h. The remainder suggested limits under 30 km/h or above 80 km/h.

Table 4 – Physical factors and the degree to which cyclists feel their safety is compromised (%)

	Yes	Possibly	Indifferent	Probably not	No
Number of trucks passing	59.2	27.2	5.8	5.8	1.9
Number of cars passing	54.5	30.7	4.0	7.9	3.0
Presence of a roundabout	42.6	33.7	7.9	5.0	10.9
Presence of a car parking lane	14.9	26.7	16.8	23.8	17.8

Respondents were also asked to rank their typical and preferred cycling locations (Table 5). These were weighted and averaged according to rank (1^{st}=1 etc.), with a lower average score indicating a greater preference. On comparing typical and preferred uses, the lack of dedicated cycling infrastructure is evident. Cyclists typically ride on-road – either at the kerb or in traffic flow – even though they would prefer to use raised or kerb-side cycle lanes. Many cyclists also ride on the footpath, though they would prefer not to do so. This discrepancy between expressed preference and actual use is likely to affect cyclists' perception of on-road cycling safety as the route type being used for the vast majority of trips is not the preferred route type.

Table 5 – Cycling locations ranked by typical use and preferred use

Typical use		*Preferred use*	
	Weighted average		**Weighted average**
On road (at kerb)	1.72	Raised cycle lane	1.83
On road (in traffic)	1.77	Kerb-side cycle lane	2.05
Kerb-side cycle lane	1.86	Off-road greenway	3.65
Raised cycle lane	1.95	On road (at kerb)	4.00
On the footpath	2.05	Shared bus-cycle lane	4.08
Shared bus-cycle lane	2.28	On the footpath	4.43
Off-road greenway	2.31	On road (in traffic)	4.59

The results of the mental mapping process were used to develop a perceived safety rating, with weights of 1 for safe, 5 for unsafe and 10 for very dangerous being awarded to each road segment. Table 6 presents the most frequently rated road segments, their average safety rating, including number of ratings, n, and the engineering characteristics of each road segment.

To ensure a variety of responses, only the thirty most rated roads and two roundabouts were included in the analysis, all of which were rated by ten or more respondents. The road segments rated as most dangerous were: Browne Roundabout, Bodkin Roundabout, St. Vincent's Avenue, University Road, and Eyre Square. The road segments rated as the safest were: Seamus Quirke Road, Siobhán McKenna Road, and NUI Galway Campus roads. The only segment which was frequently rated and has experienced a collision involving a cyclist was the Browne Roundabout.

Table 6 – Perceived safety rating and engineering characteristics of road segments

Road Segment	Rating	n	LV[1]	HV[2]	Width[3]	Seg.[4]	Parking[5]
Bishop O'Donnell Road (1)	2.6	*20*	8614	288	3	Y	N
Bishop O'Donnell Road (2)	2.2	*14*	5436	204	3	Y	N
Bishop O'Donnell Road (3)	3.3	*12*	5999	149	3	Y	N
Bodkin Roundabout	9.2	*14*	n/a	n/a	n/a	N	N
Browne Roundabout	9.6	*14*	n/a	n/a	n/a	N	N
Canal Towpath	2.1	*13*	n/a	n/a	1.6	Y	N
Eglinton Street	5.5	*11*	n/a	n/a	2.2	N	Y
Eyre Square	7.3	*11*	n/a	n/a	2.2	N	Y
Fr. Griffin Road (1)	5.3	*14*	7680	184	2.8	N	N
Fr. Griffin Road (2)	4.7	*11*	4912	121	3	N	N
Fr. Griffin Road (3)	4.7	*11*	5157	125	2.8	N	N
Headford Road (1)	6.2	*13*	6902	126	3.3	N	N
Headford Road (2)	4.3	*13*	14183	545	3.3	N	N
N6/Seamus Quirke Road	3.0	*11*	11392	439	3.5	Y	N
Newcastle Road Lower (1)	4.3	*24*	5046	94	2.6	N	Y
Newcastle Road Lower (2)	4.6	*30*	5773	107	2.6	N	Y
Newcastle Road Lower (3)	6.5	*26*	6021	109	2.6	N	Y
Newcastle Road Upper	4.3	*21*	5105	159	2.3	N	Y
NUI Galway Roads	1.6	*35*	n/a	n/a	2.5	N	N
Quincentennial Bridge	3.2	*33*	14791	464	3.5	Y	N
Rahoon Road	5.4	*10*	6903	230	3.2	N	N
Salthill Road Lower	3.4	*12*	4151	61	2.1	N	Y
Salthill Road Upper (1)	4.3	*14*	6661	127	3	N	Y
Salthill Road Upper (2)	4.0	*10*	6377	111	3	N	Y
Seamus Quirke Road (1)	1.5	*22*	8449	284	3	Y	N
Seamus Quirke Road (2)	1.3	*22*	7958	274	3	Y	N
Shantalla Road	3.3	*12*	2150	40	2.6	N	Y
Siobhán McKenna Road	1.5	*10*	n/a	n/a	3.2	N	N
St. Mary's Road	5.6	*17*	4381	64	2.8	N	Y
St. Vincent's Avenue	8.8	*14*	5717	106	2.2	N	Y
Thomas Hynes Road	6.3	*12*	7456	220	3.2	N	N
University Road	7.3	*38*	6799	97	2.1	N	Y

Notes:

1. Number of light vehicles, 7am to 7pm (Galway City Council, 2012)
2. Number of heavy vehicles, 7am to 7pm (Galway City Council, 2012)
3. Width of road lane (m), approximate
4. Segregated cycling infrastructure, Y/N
5. Adjacent parking lane, Y/N

We compared perceived safety ratings and actual engineering characteristics, testing for significance using Mann-Whitney tests. The outcome can be summarised as follows:

1. The average perceived safety rating of road segments with segregated cycling infrastructure was 2.5. The average of those without was 5. The provision of segregated cycling infrastructure significantly increases perceived cycling safety.
2. The average perceived safety rating of road segments with a volume of light vehicles in excess of 5,000 vpd was 4.65 and the rating of those segments with volumes below 5,000 vpd was 4.25. Once road segments with segregated cycling infrastructure are excluded, the average perceived safety rating of road segments with a volume of light vehicles in excess of 5,000 vpd is 5.6 and the rating of those segments with volumes below 5,000 vpd was 4.6. The volume of cars passing a cyclist significantly decreases perceived cycling safety.
3. The average perceived safety rating of road segments with a volume of heavy vehicles above 300 vpd was 4.7 and the rating of those segments with volumes below 300 vpd was 4.5. Once road segments with segregated cycling infrastructure are excluded, the average perceived safety rating of road segments with a volume of heavy vehicles in excess of 200 vpd is 5.6 and the rating of those segments with volumes below 200 vpd is 5.4. Interestingly, the number of heavy vehicles was not found to be a significant factor.
4. The average perceived safety rating of road segments with adjacent car parking was 5.2. The average of those without was 3.2. The provision of adjacent car parking along roads significantly increases perceived cycling danger.
5. The average perceived safety rating of road segments with a lane width in excess of 2.8 m was 5 and the rating of those segments less than or equal to 3 m wide was 4.3. Once road segments with segregated cycling infrastructure are excluded, the average perceived safety rating of road segments with a lane width in excess of 3 m is 5.6 and the rating of those segments less than or equal to 3 m wide is 5.3. As the width of the road lane increases, so does the perceived cycling safety.

5. Conclusions

Perceived safety risks in relation to cycling continue to impact significantly on transport debates and practices in Ireland. This paper shows that motorised traffic presents the biggest challenge, with vehicle speed and frequency affecting cyclists' perception of their own safety. Road segments in Galway City that feature segregated cycling facilities tend to fare better than those where motorists and cyclists must share road space. However, previous research has shown that there are issues both of driver attitudes and infrastructure at play here. Efforts to increase cycling such as the Irish government's goal of 10% of all commuting trips to be done by bike by 2020 thus require a serious commitment to improving interactions between motorised vehicles and cyclists.

This paper also reveals that risk perceptions among cyclists frequently coincide with actual physical features that pose a risk such as on-street parking, heavy traffic and high vehicle speeds. While the size and nature of the sample does not allow for conclusions to be drawn about the wider population of cyclists in Ireland, the findings nevertheless confirm many of the observations made in cycling safety documents and contributions to cycling policy by cycling campaigners and lobby groups such as the Dublin Cycling Campaign. Aligning these findings with other survey results and relevant literature, a ranking system for routes that are most or less suitable for cycling can be developed.

Overall, the findings presented in this paper have significant implications for future cycling policy. First and foremost, they reveal that interactions with other road users, most notably motorists, represent a key factor in cyclists' perception of their own safety. This suggests that the current emphasis in national transport policy on cycling infrastructure development needs to be complemented with measures to improve interactions between more vulnerable road users (pedestrians, cyclists) and motorists. As previous research reveals, misconceptions

among different groups of road users continue to negatively affect the safety of these vulnerable groups and remain a source of tension. National policy initiatives could be designed to both dispel prevailing perceptions of risks and raise awareness of the vulnerability of non-motorised road users.

The use of mental mapping represents an innovative contribution to the discussion on cycling safety perceptions. Considering the gap between perceptions and actuality in cycling safety, mental maps allowed 'unpacking' of perceptions and comparison with real data.

Further research should consider developing an online tool to gather data from a grass roots/user's perspective on perceived and actual safety and quality ratings of transport infrastructure, in particular cycling. Such a tool would negate the time issues faced in survey response collection, allow an international dimension and could be connected to community engagement and local authority feedback mechanisms such as FixMyStreet.ie. Further research should also consider linking this work to GPS-based cycling route-choice models which have the potential to reveal areas avoided by cyclists due to safety concerns.

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References
[1] DoTTS (2009a). Smarter Travel. Department of Transport, Tourism and Sport, Dublin.
[2] DoTTS (2009b). National Cycle Policy Framework. DoTTS, Dublin.
[3] DoTTS (2013). Design Manual for Urban Roads and Streets. DoTTS, Dublin.
[4] RSA (2013). Road Collision Fact Book. Road Safety Authority, Ballina, Co. Mayo.
[5] Swift, C. (2012). No room for manoeuvre: An analysis of factors impacting participation of cycling lobby groups in decision making on planning. Dissertation, Political Science & Sociology, NUI Galway.
[6] An Taisce (2011). Green-Schools Travel Programme Annual Report. An Taisce, Dublin.
[7] Eisenman, S.B., Miluzzo, E., Lane, N.D., Peterson, R.A., Ahn, G-S and Campbell, A.T. (2009). *BikeNet: A mobile sensing system for cyclist experience mapping ACM Transactions on Sensor Networks*. ACM Transactions on Sensor Networks, 6, 1-39.
[8] Rengert G.F. and Pelfrey, W.V. (1997). Cognitive Mapping of the City Center: Comparative Perceptions of Dangerous Places IN David Weisburd and Tom McEwen, eds (1997) *Crime Mapping and Crime Prevention*, pp.193-217, Willow Tree Press, New York.
[9] Austin, M.A., Furr, A.L. and Spine, M. (2002). *The effects of neighbourhood conditions on perceptions of safety*. Journal of Criminal Justice, 30, 417-427.
[10] Parkin, J., Wardman, M. and Page, M. (2007). *Models of perceived cycling risk and route acceptability.* Accident Analysis and Prevention, 39, 364-371.
[11] Hunt, J.D. and Abraham, J.E. (2007). *Influences on Bicycle Use*. Transportation, 34, 453-470.
[12] Dublin Cycling Campaign (2013). Infrastructure position document. Available at: http://www.dublincycling.ie/node/152 (accessed 8th August 2013).
[13] Whannel, P., Whannell, R., and White R. (2012). Tertiary student attitudes to bicycle commuting in a regional Australia university. International Journal of Sustainability in Higher Education 13, 34-45.
[14] Cho, G., Rodriguez, D.A. and Khattak, A.J. (2009). *The role of the built environment in explaining relationships between perceived and actual pedestrian and bicyclist safety*. Accident Analysis and Prevention, 41, 692-702.
[15] Lawson, A.R., Pakrashi, V., Ghosh, B. and Szeto, W.Y. (2013). *Perception of safety of cyclists in Dublin City.* Accident Analysis and Prevention, 50, 499-511.
[16] Sanders, R. (2013). *Dissecting perceived traffic risk as a barrier to adult bicycling.* 92nd Annual Meeting of the Transportation Research Board, Washington D.C., January 2013.
[17] Lydon, M. (2003). *Community mapping: the recovery (and discovery) of our common ground*. Geomatica, 57, 131-44.
[18] Soini, K. (2001). *Exploring human dimensions of multifunctional landscapes through mapping and map making.* Landscape and Urban Planning, 57, 225-239
[19] Johnston, R .J., Gregory, D., Pratt, G. and Watts, M. (eds.) (1986). *The Dictionary of Human Geography*. Oxford (Blackwell) 2nd edition
[20] Lynch, K. (1960). *The Image of the City*. Cambridge MA: MIT Press.
[21] Gould, P., & White, R. (1993). *Mental maps* (3rd ed.). Boston ; London: Allen & Unwin.
[22] Fahy, F. and Ó Cinnéide, M. (2009). *Re-Mapping the urban landscape: community mapping – an attractive prospect for sustainability?* Area, 41, 167-175.
[23] Gregory, D. (2009). *The Dictionary of Human Geography Wiley-Blackwell*, Oxford (5th Edition).
[24] Golledge, R. G. (Ed.). (1999). *Wayfinding Behavior: Cognitive Mapping and Other Spatial Processes*. Baltimore, MD: Johns Hopkins University Press.