A multidisciplinary examination of walkability: Its concept, assessment and applicability

by

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A1 Appendix A

Review of behaviour models and their role in walkability research

While reviewing walkability and environment related behaviour research from diverse disciplines it was noted that the behavioural models and theories underpinning the research varied. This review briefly explores the role of theories and models adopted by public health researchers, transport planners and environmental psychologists (including urban designers and geographers) in the study of individuals' interactions with, and behaviours within, built environments. The abilities of current theories to predict physical activities such as active transportation are quite limited and research on physical activity would benefit from including variables from other behavioural theories (de Bruijn, Kremers, Singh, van den Putte, & van Mechelen, 2009). The converse is also true. Therefore, understanding the theoretical backgrounds underpinning the research fields gives context and perspective to their approaches. This is the purpose of this section of the review. This will potentially inform (i) the information that should be collected in a walkability study and (ii) how to better interpret, integrate and disseminate research findings by making results applicable to the different research interests.

A1.1.1 Ecological model

The socio- ecological model has been considered appropriate for analysing the link between the built environment and physical activity (King, Stokols, Talen, Brassington, & Killingsworth, 2002; Pikora, Giles-Corti, Bull, Jamrozik, & Donovan, 2003; Sallis, Bauman, & Pratt, 1998) as it emphasises the role of both the intra (personal, behaviour) and extra-individual (social, physical, contextual) variables on behaviour outcomes (Humpel, Owen, & Leslie, 2002; King, Satariano, Marti, & Zhu, 2008; Pikora et al., 2002; Sallis et al., 1998; Stokols, 1992; TRB, 2005). Figure A-1 illustrates a basic ecological model which outlines the hierarchy of individual, social, environmental and natural factors influencing physical activity in communities from Edwards and Tsouros (2006). Other variations of ecological models include the influence of living and working conditions, institutional structures such as churches and schools and the influence of policy on these environments and the physical structure of the built

environment. Ecological models not only assume that multiple levels of influence exist but also that these levels are interactive and reinforcing and may have different effects on individual people depending on their unique beliefs and practice. This in turn conceptualises behaviours, and outcomes such as health and mobility patterns, as determined by an interplay of environment and individual factors (Golden & Earp, 2012).

Figure A-Error! No text of specified style in document.**-1: Factors influencing physical activity in communities (Edwards and Tsouros, 2006)**

Figure A-2 is a proposed ecological model by Saelens, Sallis and Frank (2003b) which was constructed following a review of transportation, planning and urban design literature. According to this model, the influences on walking and cycling for recreation include influences from psychosocial correlates of physical activity such as self-efficacy yet these correlates are excluded from the transportation activity pathway. It is likely that this discrepancy was based on theoretical differences in the literature between disciplines reflecting the different bases of understanding rather than active travel not being influenced by psychosocial correlates. Typically psychologists and public health researchers address more individually based items, such as psychosocial correlates, with less emphasis placed on wider environmental and policy environments (Biddle & Mutrie, 2008). The converse appears to be true for the transport profession where the network design remit has kept the focus on the environments and not the individual's behaviour. This model (Figure A-2) does not incorporate multi-purpose trips, such as the scenario where an individual elects to

walk for transport to meet their daily exercise requirements. To better understand transport behaviours it is important to also consider psychosocial correlates when investigating trip behaviours.

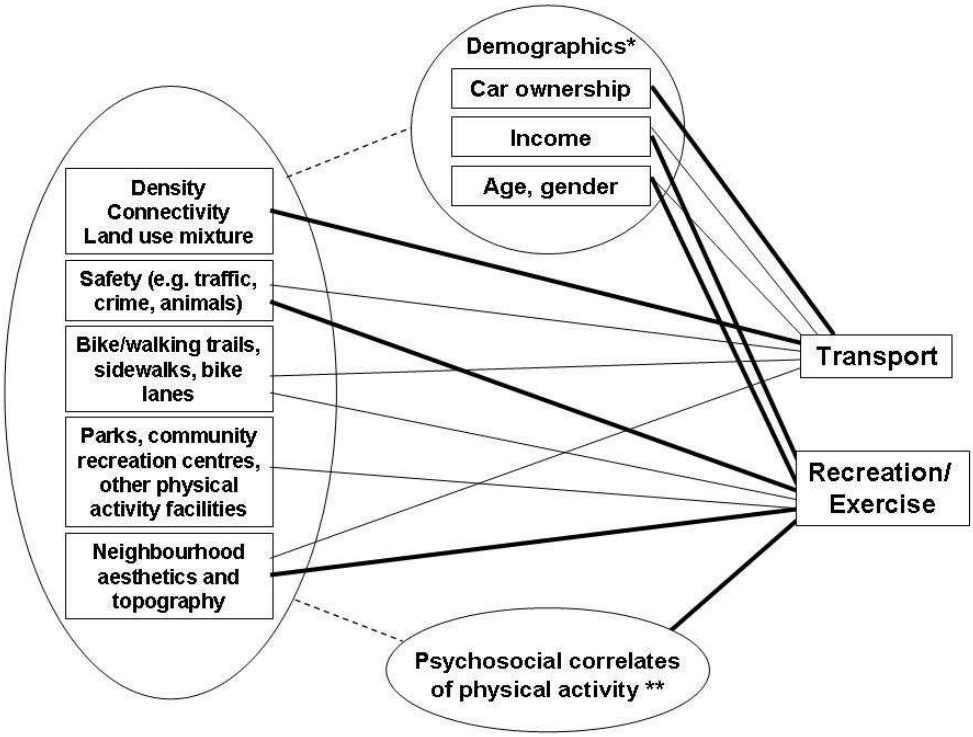

Figure A-Error! No text of specified style in document.-2: A proposed ecological model of neighbourhood environment influence on walking and cycling presented by Saelens, Sallis and Frank (2003)

*Some examples of demographic variables are provided, but should not be considered comprehensive. **Psychosocial correlates of physical activity would include, but are not limited to, such variables as self-efficacy, perceived benefits, perceived barriers, social support, and enjoyment of physical activity.

A1.1.2 Transport demand theory

For many years transportation research focused primarily on a transport demand model based on an economic model of supply and demand, where infrastructure was provided to facilitate trips between origins and destinations (trip generators) (Coogan & Coogan, 2004; Moudon & Lee, 2003; TRB, 2005). Transport planners provide for the movement of all people, including the design, routing and provision of roads, public transport, footpaths and bicycle lanes. They measure and project the demand for transport modes and design systems to suit (Amekudzi & Meyer, 2006). Until recently in Ireland, and many other countries, this model was primarily applied to motorised transport followed by public transport feasibility and rarely to active travel modes

(Owen, Humpel, Leslie, Bauman, & Sallis, 2004; TRB, 2005). The built environment factors which planners and transport planners often focus on to encourage walking trips are density, land use mix and the formation of the street network (Cervero & Kockelman, 1997; Frank, Kerr, Sallis, Miles, & Chapman, 2008). Transport for London's commissioned walkability index (Stonor, Campos, Chiaradia, Takamatsu, & Smith, 2003) treats walkability solely as a framework for walking and outlines factors and instructions for the provision of pedestrian infrastructure in a format similar to motorised transport design manuals. In this index, pedestrians are considered in a manner similar to motorised vehicles, using a volume/ capacity ratio to determine the level of service of a footpath (Lo, 2009). The publication of the Irish Department for Transport's Smarter Travel policy document (2009) is indicative of recent efforts to move away from an auto-centric demand model approach and towards a focus on sustainable transport behaviours which include increased active travel and public transport usage. In the transport profession walking is measured in terms of 'trips taken'. While transport demand is relevant to determine capacity planning it should be considered in conjunction with other behaviour theories.

A1.1.3 Behavioural model of environment

Lee and Moudon (Lee, Moudon, & Courbois, 2006; Lee & Moudon, 2006; Moudon & Lee, 2003) base their studies on the socio- ecological model (SEM) but identified a shortcoming of the model which is that it does not provide sufficient guidance towards conceptualising physical environment attributes. The SEM simply says that the environment influences physical activity but does not specify contexts. Moudon and Lee (2003) incorporate a behavioural model of environment into their research which considers the attributes of all sections of the trip and not just the origin (e.g. home neighbourhood). This model encompasses elements of the transport demand model and considers the origin (O) and destination (D) (trip generators) of the active travel trip, the characteristics of the route (R) taken for these trips and the characteristics of the area (A) in which the trip takes place (Figure A-3). This is a positive move towards the functional and contextual requirements and level of desirability required for both transport and recreational walking and thus merging research fields. There is an example of where consideration was given of the influence of the contextual environment in the pedestrian quality needs (PQN) project. Czogalla (2010, pp.184-

185) considers the trip purpose in their pedestrian model; 'the impatient traveller' is on a commuter trip with time constraints and 'the patient traveller' is on a leisure walk without time constraints. On the latter trip an increased weighting is given to the quality of the route within the model. Other individual considerations noted by the PQN study included gender, age and personal abilities, consistent with the SEM. Collecting the level of data required to analyse all these environments within their trip contexts while considering individual demographic and psychosocial correlates poses complexity issues for data collection and analysis.

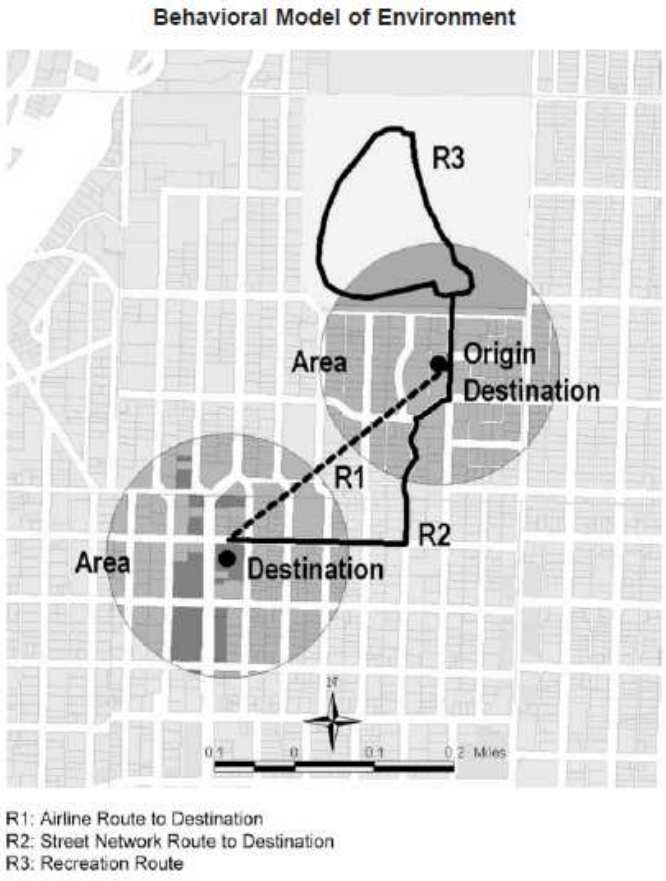

Figure A-Error! No text of specified style in document.**-3: Behavioural Model of the Environment from Moudon and Lee (2003)**

A1.1.4 Social cognitive theory

In a review of socio ecological approaches to health education and promotion interventions by Golden and Earp (2012), social cognitive theory (SCT) was the most prevalent theory informing the interventions. SCT explains the decision making

process behind behaviours (Godin, 1994). Bandura's (1977) social cognitive theory, which has had a particular influence on physical activity research (Owen et al., 2004; TRB, 2005), explains behaviour as the interplay among the person, the behaviour, and the environment in which the behaviour is performed (Figure A-4). According to the SCT, all changes in behaviour or actions in unfamiliar environments (therefore not habitual) are mediated by a cognitive mechanism called self-efficacy, a belief that one can successfully perform a desired behaviour (Bandura, 1977; Godin, 1994). Individual self-efficacy is learned from personal experience (good or bad) and the example provided by others (modelling), persuasion (social or verbal) from others and emotional responses to stimuli or events (Biddle & Mutrie, 2008). This theory, like other theories reviewed in this section, needs to be considered when collecting information for a walkability study. SCT has particular relevance in the investigation of the role of the built environment on physical activity and active travel behaviours.

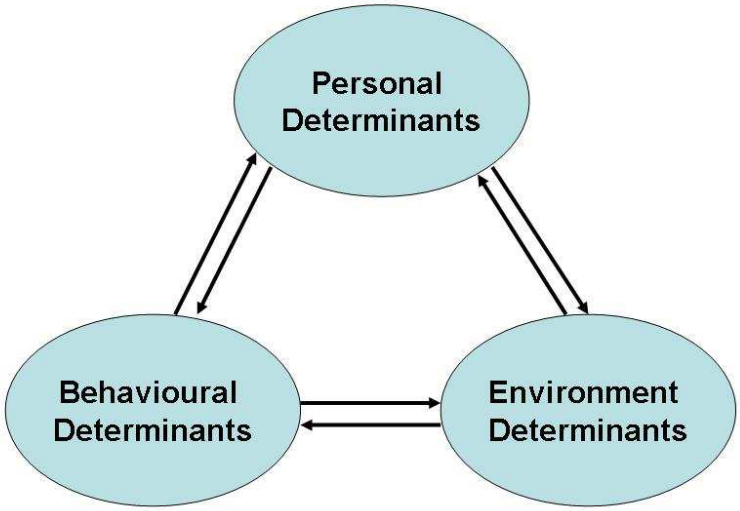

Figure A-Error! No text of specified style in document.**-4: Social Cognitive Theory**

A1.1.5 Theory of planned behaviour

The theory of planned behaviour (TPB) is a popular social cognition model used to understand physical activity (Rhodes, Brown, & McIntyre, 2006) and has been applied

to walking/cycling behaviour (de Bruijn et al., 2009; Giles-Corti & Donovan, 2002; Rhodes et al., 2006). TPB suggests that determinants of behaviour are: (i) intention to engage in that behaviour and (ii) perceived behavioural control (PBC) (Rhodes *et al.*, 2006; Bell *et al.*, 2001, p.33) where the behaviour may or may not be in control of the individual because of 'a requirement for opportunities, resources or skills' (Godin, 1994, p.126), Figure A-5. The intention to perform a given behaviour is assumed to capture the motivational factors that influence behaviour (Ajzen, 1991). PBC reflects beliefs about the resources and opportunities an environment presents to an individual (Godin, 1994) similar to Mehta's 'usefulness', the ability of the environment to serve basic needs and create place attachment (Mehta, 2008, p.217), and Alfonzo's 'feasibility' and 'accessibility', the affordance an environment and an individual's personal circumstances present for a walking trip (Bell *et al.*, 2001, p.66; Alfonzo, 2005). Therefore consideration should be given to intentions and perceived barriers, both physical and social, when considering how walkable an individual perceives their environment.

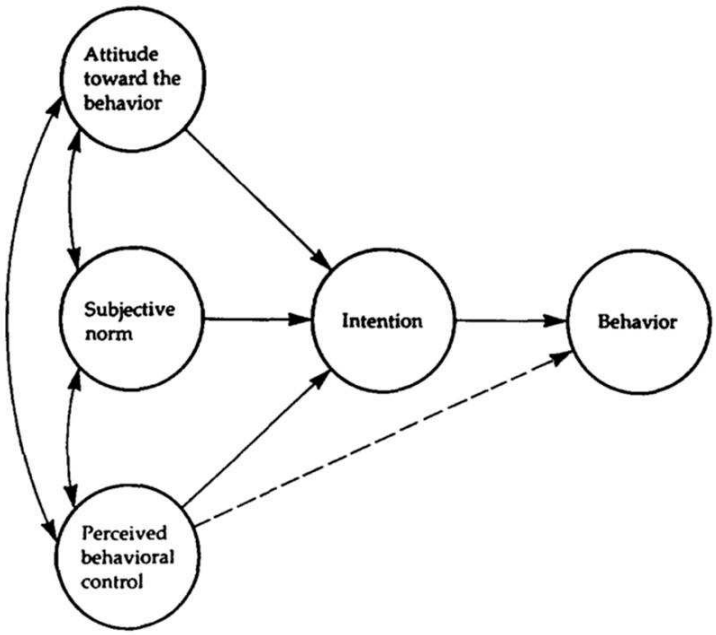

Figure A-Error! No text of specified style in document.**-5: Theory of Planned Behaviour (Ajzen, 1991)**

A1.1.6 Habit theory

In their study on cycling behaviour De Bruijn and collegues (2009) considered habit theory variables alongside variables for the theory of planned behaviour in a cross sectional study. Habit strength was found to be the strongest correlate to bicycle use and when habit strength was high, intention to use was weak and when habit strength was low intention to use was high. This finding was consistent with the belief that when a behaviour is a habit, intentions are less relevant predictors of behaviours and therefore put a boundary limitation on the application of reasoned action models such as the theory of planned behaviour.

The purposeful nature, and associated frequency, of many transportation based trips can result in the usual mode choice becoming a habit. Hence the relevance of habit theory, and its bearing on the TPB and SCT, means that all three theories play important roles in walkability research as a means to understanding how an individual responds to their environment and to the choices they perceive to be feasible for them. The relationship between exercise adherence theories such as self-efficacy theory and TPB may relate well to recreational behaviours (Biddle & Mutrie, 2008), however these theories may require additional theoretical considerations for transportation walking trips which have a more functional outcome. For example, health outcomes may be a factor in modal choice decisions but is not necessarily the primary motivation for undertaking the trip. This limitation of current models, alongside the need to encompass environment models and theories, may warrant the construction of a new model.

Another consideration for a walking specific behavioural model of the environment is the individual's response to environmental stimuli, or perceptions of the environment. Feedback from an emotional arousal can be a source of self-efficacy information. While Biddle and Mutrie (2008) note that this theory is hardly studied in exercise research, it is the foundation stone of environmental psychology, the theory behind urban design (Carmona, Heath, Oc, & Tiesdell, 2003). A greater emphasis on perceptions, thus embracing urban design theory, could potentially strengthen (physical) environment - behaviour research and the application of SCT. An individual's

reaction or response to an environment would in-turn inform the SCT and TPB's intention to participate.

A1.1.7 Models of the physical environment

When considering the neighbourhood or street level environment, there is a difference between the models for measurement presented for consideration between professions. Space Syntax's (transportation) walkability index developed for Transport for London shows the environmental variables which were identified as most important for walkability (Stonor *et al.*, 2003) Table A-1. The schematic model outlining the physical environment factors which should be considered in research linking physical activity and the physical environment presented in Pikora and colleagues (2003) public health research paper is shown in Figure A-6. An example of the built environment characteristics considered by urban designers who focus on the responses they evoke in an individual is shown in Figure A-7 (Van Deurs, Gehl Architects 2009). While many items are similar or complementary the transportation list deals exclusively with the functionality of the environment (except references to weather and day of the week) (Table A.1), the public health list deals with a mix of functionality, land uses and aesthetics alongside individual factors (Figure A-6) and the urban design list deals with perceptual responses as well as functional purposes (Figure A-7). To insure relevance and comprehensive understanding of how the environment is perceived by an individual a behavioural model of the environment should encompass as many elements of the environment as feasible and with contextual reference where possible.

Table A-1: Space Syntax table (Stonor *et al.*, 2003) **walkability factors in terms of their importance**

First Order	Second Order	Third Order
Footway Accessibility	Lighting	Footway Quality
Ground Level Activity	'Type' of Pedestrian	Proximity to Road Traffic
Pedestrian Crossing Design	Footway Width	
Traffic Signal Phasing	Footway Gradient	
Time of Day	Movement Generators – Proximity to Transport Facilities	
	Signage	
	Weather	
	Day of the Week	

Presence or Absence of other Moving People
Presence or Absence of other Stationary People

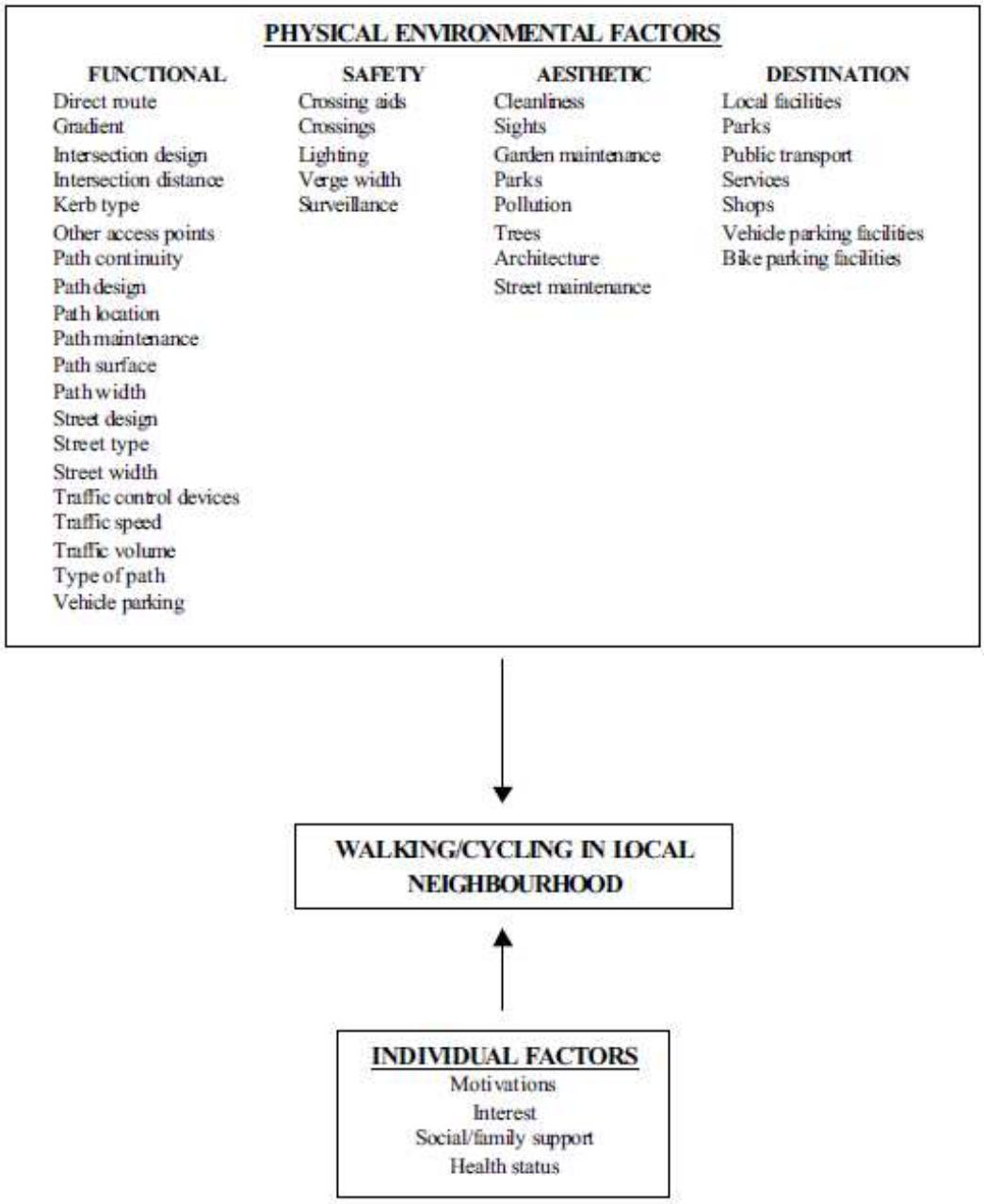

Figure A-Error! No text of specified style in document.**-6: Schema of the physical environmental factors that may influence walking/cycling in the local neighbourhood** (Pikora *et al.*, 2003)

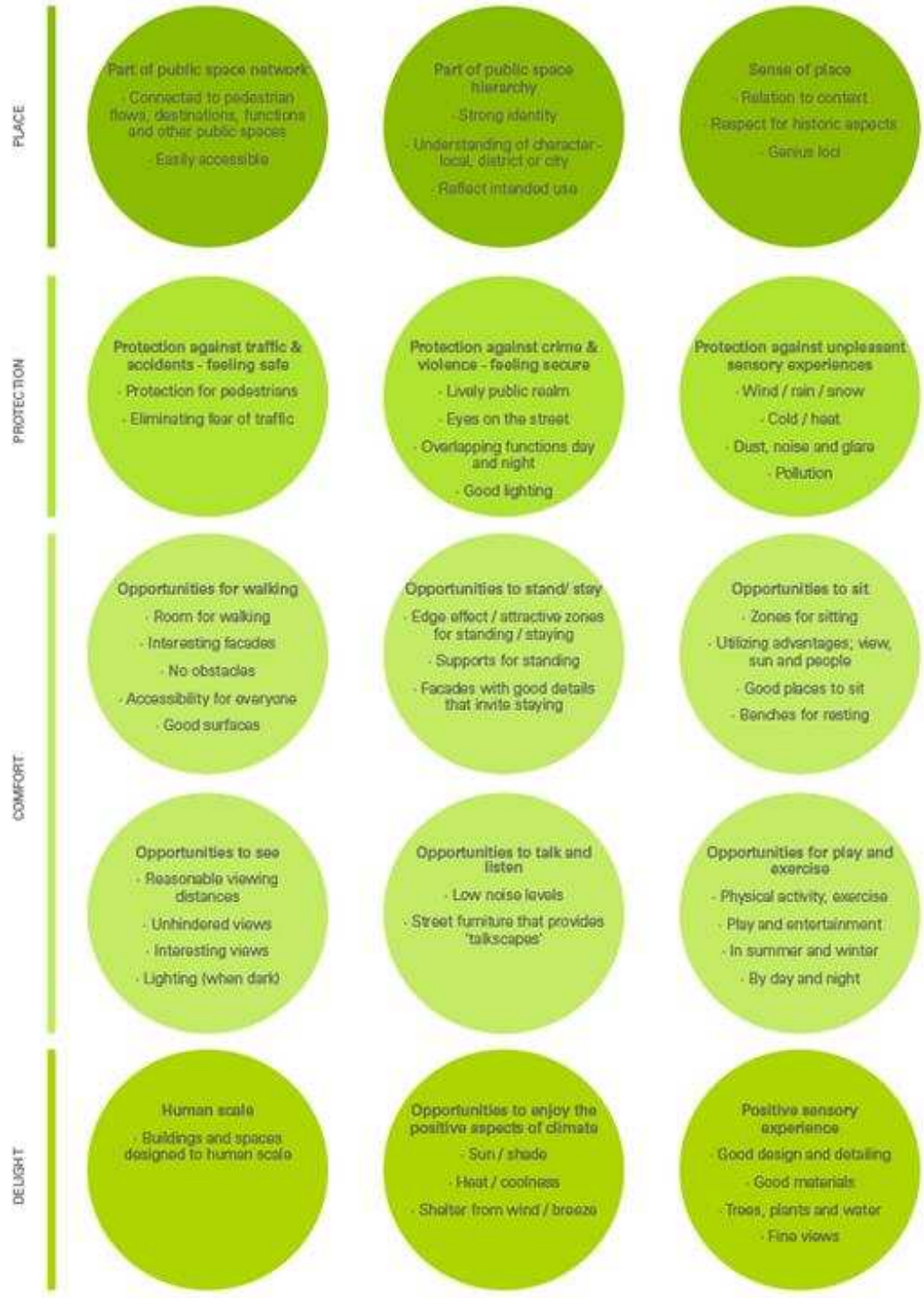

Figure A-Error! No text of specified style in document.**-7: What urban designers look at, not a complete list (Van Deurs and Gehl Architects, 2009)**

Mehta (2008) combines the perceptual element of Ewing and Handy's (2009) conceptual model with an ecological model of walking behaviour, which incorporates Alfonzo's (2005) hierarchy of walking needs, to create a comprehensive model for a main street setting, Figure A-8. This model includes the accessibility and feasibility affordances of a trip consistent with the perceived behavioural control as a determinant of behaviour. The physical and land use characteristics correspond to the physical environment factors on Pikora and colleagues' model (Figure A-6) and the street characteristics corresponds to Gehl Architects' considerations of place, protection, comfort and delight (Figure A-7). The purpose of the walking trip outcome is not included in this model as it relates to a specific environment, the main street, but the model does encompass the self-efficacy, perceived behaviour control and individual demographic considerations discussed in this section of the literature review and is therefore a good foundation for further ecological models of walking behaviours. Also missing from the model is a pathway by which an individual's emotional response to an area triggers a coping response (Bell *et al.*, 2001, p.122) whereby the pedestrian adapts by taking an alternative route rather than abandoning the trip which still results in walking behaviour despite the negative perceptual response to the environment.

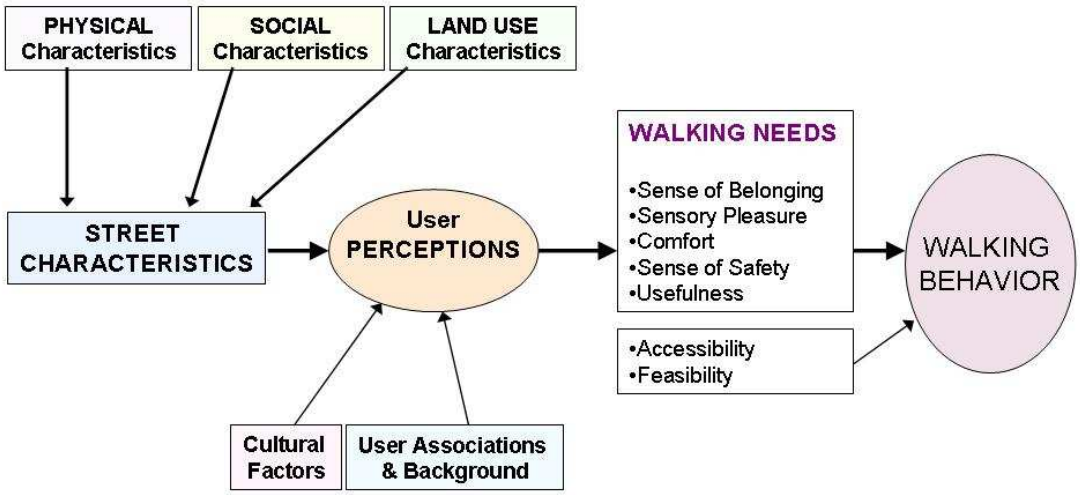

Figure A-Error! No text of specified style in document.-8: Conceptual framework of walking needs on Main Street Adapted from Mehta (2008)

When constructing ecological models of behaviour it is also important to recognise that environment – behaviour relationships are transactional in nature, characterised by 'reoccurring cycles of reciprocal/mutual influence between people and their surroundings rather than by linear (or unidirectional) effects of environmental conditions on behaviour' and should be represented as such (King *et al.*, 2002, p.7). Litter and graffiti are products of human behaviour which can influence an individual's perception of their environment. The land use and social characteristics of an area act as attractors for particular populations engaging in or utilising land uses. Adult shops, methadone clinics or night club areas are all known attractors of social groups who may be perceived as a threat to some people.

Due to the complexity of the environment that a pedestrian walks through, for any and all purposes, there is a considerable list of environment features to consider. The preliminary findings of the pedestrian quality needs (PQN) study (Sauter & Wedderburn, 2008) list ten relevant dimensions of walking which should to be measured, objectively and subjectively, to generate a complete picture of the walking environment Table A-2. This list includes behaviour data, accident and incident data, measures of the built environment and subjective satisfaction (perceptions and comfort). Each source has its merits so when exploring the concept of walkability, the relevance of each data source and the influence of each parameter on the walking environment should be considered.

Table A-2: Preliminary approach towards relevant dimensions of measuring walking (Sauter & Wedderburn 2008)

A	Transport and travel behaviour data
B	Pedestrian counts (user counts), behaviour analysis (observation, interaction/conflict analysis) and pedestrian flows (models)
C	Activity and time spent in public spaces (sojourn without mobility, stationary activities)
D	Road danger/safety: traffic accidents with pedestrians (involving at least one vehicle) & single pedestrian accidents (falling, stumbling etc.)
E	Security: threats, attacks, harassments
F	Competences (disabilities), physical activity (walking), health and health outcomes
G	Walking environment, accessibility, public space quality and infrastructure provisions ("walkability")
H	Ecological footprint, land-use
I	Perceptions, attitudes and images: personal satisfaction and subjective perception: "measuring the smiles"
J	Investments, personnel and research: Data on institutional aspects

In order to draw associations between the built environment and behaviours many facets of the environment need to be considered and not just the physical environment but also its context (including social context), individual emotional responses and the purpose of the area (e.g residential area, nightclub strip, park or historic area). Habitual behaviours and occasional trips should both be considered, also in context, where possible. An individual's personal characteristics are also important. Individual, family, community and city level social considerations may all influence perceptions and behaviours. To truly understand walkability and to communicate effectively between disciplines we need to collect as much of this information as feasible to generate a comprehensive picture of an individual's environment. This is an extensive list and consideration must be given to feasibility and expense.

References

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179–211.

Alfonzo, M. (2005). To Walk or Not to Walk? The Hierarchy of Walking Needs. *Environment and Behavior*, *37*(6), 808–836

Amekudzi, A., & Meyer, M. D. (2006). Considering the Environment in Transportation Planning: Review of Emerging Paradigms and Practice in the United States. *Journal of Urban Planning & Development*, *132*(1), 42–53.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215.

Bell, P. A., Greene, T. C., Fisher, J. D., & Baum, A. (2001). *Environmental Psychology*. (P. Howell & M. Tomiak, Eds.) (5th ed.). Orlando, FL., USA: Harcourt College Publishers.

Biddle, S. J. H., & Mutrie, N. (2008). *Psychology of Physical Activity; Determinants, Well-Being and Interventions* (2nd ed.). London: Routledge.

Carmona, M., Heath, T., Oc, T., & Tiesdell, S. (2003). *Public Places, Urban Spaces: The Dimensions of Urban Design* (1st ed.). Kent, UK: Architectural Press.

Cervero, R., & Kockelman, K. (1997). Travel Demand and the 3 D's: Density, Diversity and Design. *Transportation Research Part D: Transport and Environment*, *2*(3), 199–219.

Coogan, P. F., & Coogan, M. A. (2004). When Worlds Collide: Observations on the Integration of Epidemiology and Transportation Behavioral Analysis in the Study of Walking. Commentary on Health Promoting Community Design. *American Journal of Health Promotion*, *19*(1), 39–45.

Czogalla, O. (2010). *Parameters determining route choice of pedestrians in walkable networks. PQN Final Report B. 1. 10* (pp. 171–190). London, UK. Retrieved from http://www.walkeurope.org/uploads/File/publications/PQN Final Report part B1.pdf

De Bruijn, G.-J., Kremers, S. P. J., Singh, A., van den Putte, B., & van Mechelen, W. (2009). Adult active transportation: adding habit strength to the theory of planned behavior. *American Journal of Preventive Medicine*, *36*(3), 189–94.

Department of Transport. (2009). Smarter Travel. A Sustainable Transport Future. A New Transport Policy for Ireland 2009-2020. Dublin, Ireland: Department of Transport.

Edwards, P., & Tsouros, A. (2006). *Promoting physical activity and active living in urban environments. The role of local governments*. Copenhagen, Denmark: WHO (World Health Organisation) Regional Office for Europe.

Ewing, R., & Handy, S. L. (2009). Measuring the Unmeasurable: Urban Design Qualities Related to Walkability. *Journal of Urban Design*, *14*(1), 65–84.

Frank, L. D., Kerr, J., Sallis, J. F., Miles, R., & Chapman, J. (2008). A hierarchy of sociodemographic and environmental correlates of walking and obesity. *Preventive Medicine*, *47*(2), 172–8.

Giles-Corti, B., & Donovan, R. J. (2002). The relative influence of individual, social and physical environment determinants of physical activity. *Social Science & Medicine*, *54*(12), 1793–812.

Godin, G. (1994). Theories of Reasoned Action and Planned Behaviour: Usefulness for Excercise Promotion. *Medicine and science in sports and exercise*, *26*(11), 1391–4.

Golden, S. D., & Earp, J. A. L. (2012). Social ecological approaches to individuals and their contexts: twenty years of health education & behavior health promotion interventions. *Health Education & Behavior: The official publication of the Society for Public Health Education*, *39*(3), 364–72.

Humpel, N., Owen, N., & Leslie, E. (2002). Environmental Factors Associated with Adults ' Participation in Physical Activity: A Review. *American Journal of Preventive Medicine*, *22*(3), 188–199.

King, A. C., Satariano, W. a, Marti, J., & Zhu, W. (2008). Multilevel modeling of walking behavior: advances in understanding the interactions of people, place, and time. *Medicine and Science in Sports and Exercise*, *40*(7 Suppl), S584–93. doi:10.1249/MSS.0b013e31817c66b7

King, A. C., Stokols, D., Talen, E., Brassington, G. S., & Killingsworth, R. (2002). Theoritical Approaches to the Promotion of Physical Activity Forging a Transdisciplinary Paradigm. *American Journal of Preventive Medicine*, *23*(2S), 15–25.

Lee, C., & Moudon, A. V. (2006). Correlates of Walking for Transportation or Recreation Purposes. *Journal of Physical Activiy and Health*, *3*(Suppl 1), S77–S98.

Lee, C., Moudon, A. V., & Courbois, J.-Y. P. (2006). Built environment and behavior: spatial sampling using parcel data. *Annals of Epidemiology*, *16*(5), 387–94.

Lo, R. H. (2009). Walkability: What is it? *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, *2*(2), 145–166.

Mehta, V. (2008). Walkable streets: pedestrian behavior, perceptions and attitudes. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, *1*(3), 217–245.

Moudon, A. V., & Lee, C. (2003). Walking and bicycling: an evaluation of environmental audit instruments. *American Journal of Health Promotion*, *18*(1), 21–37.

Owen, N., Humpel, N., Leslie, E., Bauman, A., & Sallis, J. F. (2004). Understanding environmental influences on walking; Review and research agenda. *American Journal of Preventive Medicine*, *27*(1), 67–76.

Pikora, T. J., Bull, F. C. L., Jamrozik, K., Knuiman, M., Giles-Corti, B., & Donovan, R. J. (2002). Developing a reliable audit instrument to measure the physical environment for physical activity. *American Journal of Preventive Medicine*, *23*(3), 187–94.

Pikora, T. J., Giles-Corti, B., Bull, F. C. L., Jamrozik, K., & Donovan, R. J. (2003). Developing a framework for assessment of the environmental determinants of walking and cycling. *Social Science & Medicine*, *56*(8), 1693–1703.

Rhodes, R. E., Brown, S. G., & McIntyre, C. a. (2006). Integrating the perceived neighborhood environment and the theory of planned behavior when predicting walking in a Canadian adult sample. *American Journal of Health Promotion*, *21*(2), 110–8.

Saelens, B. E., Sallis, J. F., & Frank, L. D. (2003). Environmental Correlates of Walking and Cycling: Findings From the Transportation, Urban Design, and Planning Literatures. *Annals of Behavioral Medicine: a publication of the Society of Behavioral Medicine*, *25*(2), 80–91.

Sallis, J. F., Bauman, A., & Pratt, M. (1998). Environmental and Policy Interventions to Promote Physical Activity. *American Journal of Preventive Medicine*, *15*(4), 379–397.

Sauter, D., & Wedderburn, M. (2008). Measuring Walking. Towards Internationally Standardised Monitoring Methods of Walking and Public Space. In *8th International Conference on Survey Methods in Transport*. Annecy, France.

Stokols, D. (1992). Establishing and Maintaining Healthy Environments Toward a Social Ecology of Health Promotion. *American Psychologist*, *47*(1), 6–22.

Stonor, T., Campos, M. B. de A., Chiaradia, A., Takamatsu, S., & Smith, A. (2003). Towards a "Walkability Index." In *European Transport Conference 2003 (8th -10th Oct)*. London, UK: Association for European Transport.

TRB. (2005). *Does the Built Environment Influence Physical Activity? Examining the Evidence TRB Special Report 282 Committee on Physical Activity, Health, Transportation and Land use.* Washington, D.C.: Transportation Research Board. Retrieved from www.TRB.org

Van Deurs, C. R. (2009). Key Quality Indicators. In *Walk 21, More Footsteps, Less Carbon*. New York, USA.

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A1 Appendix A

Review of behaviour models and their role in walkability research

While reviewing walkability and environment related behaviour research from diverse disciplines it was noted that the behavioural models and theories underpinning the research varied. This review briefly explores the role of theories and models adopted by public health researchers, transport planners and environmental psychologists (including urban designers and geographers) in the study of individuals' interactions with, and behaviours within, built environments. The abilities of current theories to predict physical activities such as active transportation are quite limited and research on physical activity would benefit from including variables from other behavioural theories (de Bruijn, Kremers, Singh, van den Putte, & van Mechelen, 2009). The converse is also true. Therefore, understanding the theoretical backgrounds underpinning the research fields gives context and perspective to their approaches. This is the purpose of this section of the review. This will potentially inform (i) the information that should be collected in a walkability study and (ii) how to better interpret, integrate and disseminate research findings by making results applicable to the different research interests.

A1.1.1 Ecological model

The socio- ecological model has been considered appropriate for analysing the link between the built environment and physical activity (King, Stokols, Talen, Brassington, & Killingsworth, 2002; Pikora, Giles-Corti, Bull, Jamrozik, & Donovan, 2003; Sallis, Bauman, & Pratt, 1998) as it emphasises the role of both the intra (personal, behaviour) and extra-individual (social, physical, contextual) variables on behaviour outcomes (Humpel, Owen, & Leslie, 2002; King, Satariano, Marti, & Zhu, 2008; Pikora et al., 2002; Sallis et al., 1998; Stokols, 1992; TRB, 2005). Figure A-1 illustrates a basic ecological model which outlines the hierarchy of individual, social, environmental and natural factors influencing physical activity in communities from Edwards and Tsouros (2006). Other variations of ecological models include the influence of living and working conditions, institutional structures such as churches and schools and the influence of policy on these environments and the physical structure of the built

environment. Ecological models not only assume that multiple levels of influence exist but also that these levels are interactive and reinforcing and may have different effects on individual people depending on their unique beliefs and practice. This in turn conceptualises behaviours, and outcomes such as health and mobility patterns, as determined by an interplay of environment and individual factors (Golden & Earp, 2012).

Figure A-Error! No text of specified style in document.**-1: Factors influencing physical activity in communities (Edwards and Tsouros, 2006)**

Figure A-2 is a proposed ecological model by Saelens, Sallis and Frank (2003b) which was constructed following a review of transportation, planning and urban design literature. According to this model, the influences on walking and cycling for recreation include influences from psychosocial correlates of physical activity such as self-efficacy yet these correlates are excluded from the transportation activity pathway. It is likely that this discrepancy was based on theoretical differences in the literature between disciplines reflecting the different bases of understanding rather than active travel not being influenced by psychosocial correlates. Typically psychologists and public health researchers address more individually based items, such as psychosocial correlates, with less emphasis placed on wider environmental and policy environments (Biddle & Mutrie, 2008). The converse appears to be true for the transport profession where the network design remit has kept the focus on the environments and not the individual's behaviour. This model (Figure A-2) does not incorporate multi-purpose trips, such as the scenario where an individual elects to

walk for transport to meet their daily exercise requirements. To better understand transport behaviours it is important to also consider psychosocial correlates when investigating trip behaviours.

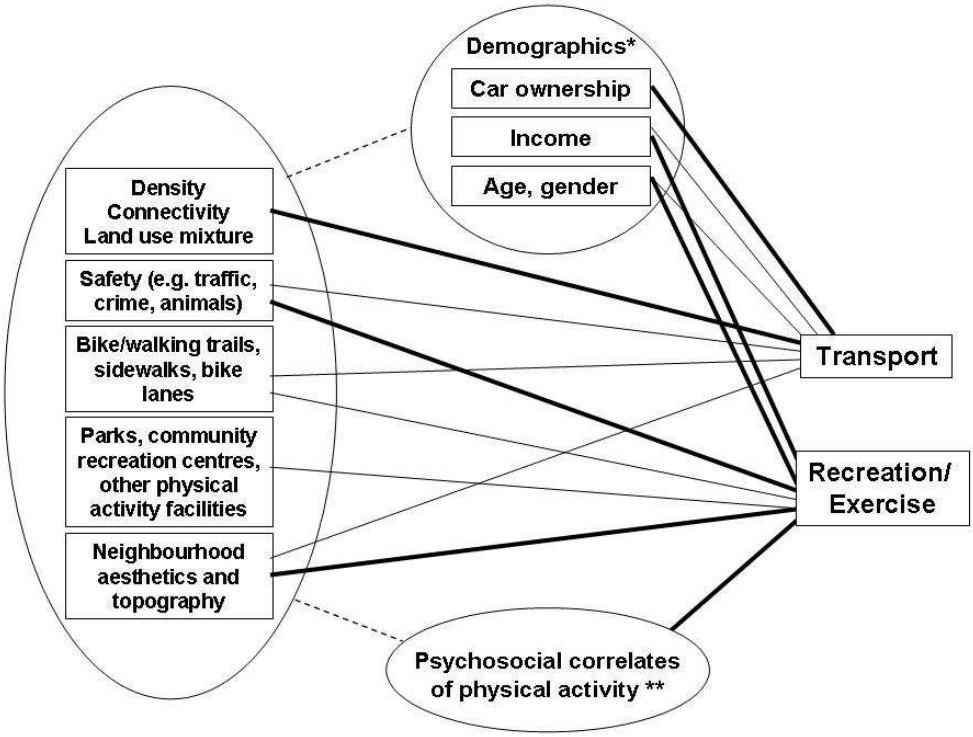

Figure A-Error! No text of specified style in document.-2: A proposed ecological model of neighbourhood environment influence on walking and cycling presented by Saelens, Sallis and Frank (2003)

*Some examples of demographic variables are provided, but should not be considered comprehensive. **Psychosocial correlates of physical activity would include, but are not limited to, such variables as self-efficacy, perceived benefits, perceived barriers, social support, and enjoyment of physical activity.

A1.1.2 Transport demand theory

For many years transportation research focused primarily on a transport demand model based on an economic model of supply and demand, where infrastructure was provided to facilitate trips between origins and destinations (trip generators) (Coogan & Coogan, 2004; Moudon & Lee, 2003; TRB, 2005). Transport planners provide for the movement of all people, including the design, routing and provision of roads, public transport, footpaths and bicycle lanes. They measure and project the demand for transport modes and design systems to suit (Amekudzi & Meyer, 2006). Until recently in Ireland, and many other countries, this model was primarily applied to motorised transport followed by public transport feasibility and rarely to active travel modes

(Owen, Humpel, Leslie, Bauman, & Sallis, 2004; TRB, 2005). The built environment factors which planners and transport planners often focus on to encourage walking trips are density, land use mix and the formation of the street network (Cervero & Kockelman, 1997; Frank, Kerr, Sallis, Miles, & Chapman, 2008). Transport for London's commissioned walkability index (Stonor, Campos, Chiaradia, Takamatsu, & Smith, 2003) treats walkability solely as a framework for walking and outlines factors and instructions for the provision of pedestrian infrastructure in a format similar to motorised transport design manuals. In this index, pedestrians are considered in a manner similar to motorised vehicles, using a volume/ capacity ratio to determine the level of service of a footpath (Lo, 2009). The publication of the Irish Department for Transport's Smarter Travel policy document (2009) is indicative of recent efforts to move away from an auto-centric demand model approach and towards a focus on sustainable transport behaviours which include increased active travel and public transport usage. In the transport profession walking is measured in terms of 'trips taken'. While transport demand is relevant to determine capacity planning it should be considered in conjunction with other behaviour theories.

A1.1.3 Behavioural model of environment

Lee and Moudon (Lee, Moudon, & Courbois, 2006; Lee & Moudon, 2006; Moudon & Lee, 2003) base their studies on the socio- ecological model (SEM) but identified a shortcoming of the model which is that it does not provide sufficient guidance towards conceptualising physical environment attributes. The SEM simply says that the environment influences physical activity but does not specify contexts. Moudon and Lee (2003) incorporate a behavioural model of environment into their research which considers the attributes of all sections of the trip and not just the origin (e.g. home neighbourhood). This model encompasses elements of the transport demand model and considers the origin (O) and destination (D) (trip generators) of the active travel trip, the characteristics of the route (R) taken for these trips and the characteristics of the area (A) in which the trip takes place (Figure A-3). This is a positive move towards the functional and contextual requirements and level of desirability required for both transport and recreational walking and thus merging research fields. There is an example of where consideration was given of the influence of the contextual environment in the pedestrian quality needs (PQN) project. Czogalla (2010, pp.184-

185) considers the trip purpose in their pedestrian model; 'the impatient traveller' is on a commuter trip with time constraints and 'the patient traveller' is on a leisure walk without time constraints. On the latter trip an increased weighting is given to the quality of the route within the model. Other individual considerations noted by the PQN study included gender, age and personal abilities, consistent with the SEM. Collecting the level of data required to analyse all these environments within their trip contexts while considering individual demographic and psychosocial correlates poses complexity issues for data collection and analysis.

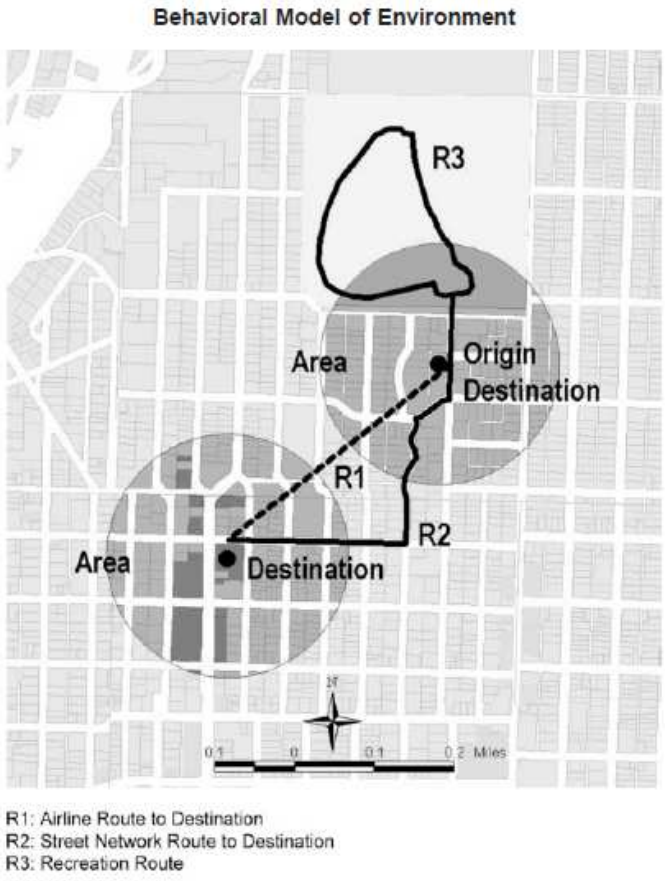

Figure A-Error! No text of specified style in document.**-3: Behavioural Model of the Environment from Moudon and Lee (2003)**

A1.1.4 Social cognitive theory

In a review of socio ecological approaches to health education and promotion interventions by Golden and Earp (2012), social cognitive theory (SCT) was the most prevalent theory informing the interventions. SCT explains the decision making

process behind behaviours (Godin, 1994). Bandura's (1977) social cognitive theory, which has had a particular influence on physical activity research (Owen et al., 2004; TRB, 2005), explains behaviour as the interplay among the person, the behaviour, and the environment in which the behaviour is performed (Figure A-4). According to the SCT, all changes in behaviour or actions in unfamiliar environments (therefore not habitual) are mediated by a cognitive mechanism called self-efficacy, a belief that one can successfully perform a desired behaviour (Bandura, 1977; Godin, 1994). Individual self-efficacy is learned from personal experience (good or bad) and the example provided by others (modelling), persuasion (social or verbal) from others and emotional responses to stimuli or events (Biddle & Mutrie, 2008). This theory, like other theories reviewed in this section, needs to be considered when collecting information for a walkability study. SCT has particular relevance in the investigation of the role of the built environment on physical activity and active travel behaviours.

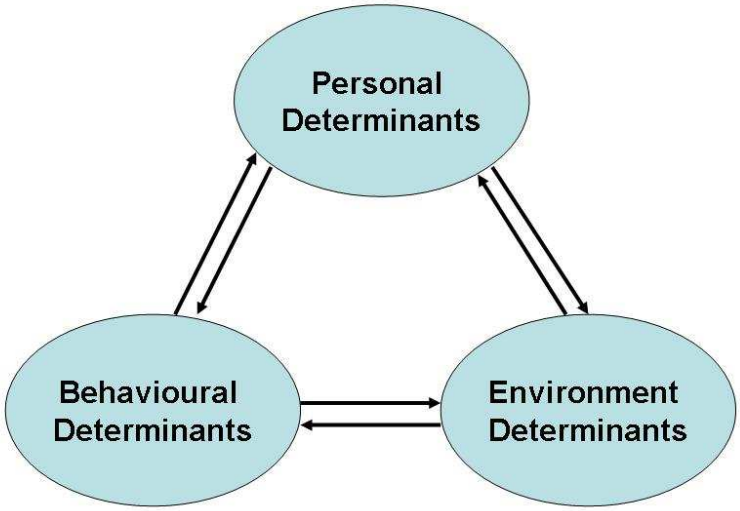

Figure A-Error! No text of specified style in document.**-4: Social Cognitive Theory**

A1.1.5 Theory of planned behaviour

The theory of planned behaviour (TPB) is a popular social cognition model used to understand physical activity (Rhodes, Brown, & McIntyre, 2006) and has been applied

to walking/cycling behaviour (de Bruijn et al., 2009; Giles-Corti & Donovan, 2002; Rhodes et al., 2006). TPB suggests that determinants of behaviour are: (i) intention to engage in that behaviour and (ii) perceived behavioural control (PBC) (Rhodes *et al.*, 2006; Bell *et al.*, 2001, p.33) where the behaviour may or may not be in control of the individual because of 'a requirement for opportunities, resources or skills' (Godin, 1994, p.126), Figure A-5. The intention to perform a given behaviour is assumed to capture the motivational factors that influence behaviour (Ajzen, 1991). PBC reflects beliefs about the resources and opportunities an environment presents to an individual (Godin, 1994) similar to Mehta's 'usefulness', the ability of the environment to serve basic needs and create place attachment (Mehta, 2008, p.217), and Alfonzo's 'feasibility' and 'accessibility', the affordance an environment and an individual's personal circumstances present for a walking trip (Bell *et al.*, 2001, p.66; Alfonzo, 2005). Therefore consideration should be given to intentions and perceived barriers, both physical and social, when considering how walkable an individual perceives their environment.

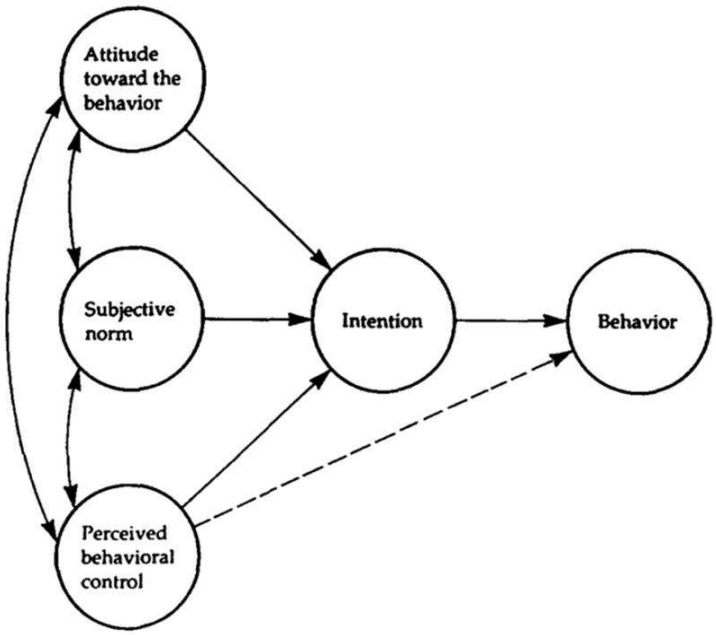

Figure A-Error! No text of specified style in document.**-5: Theory of Planned Behaviour (Ajzen, 1991)**

A1.1.6 Habit theory

In their study on cycling behaviour De Bruijn and collegues (2009) considered habit theory variables alongside variables for the theory of planned behaviour in a cross sectional study. Habit strength was found to be the strongest correlate to bicycle use and when habit strength was high, intention to use was weak and when habit strength was low intention to use was high. This finding was consistent with the belief that when a behaviour is a habit, intentions are less relevant predictors of behaviours and therefore put a boundary limitation on the application of reasoned action models such as the theory of planned behaviour.

The purposeful nature, and associated frequency, of many transportation based trips can result in the usual mode choice becoming a habit. Hence the relevance of habit theory, and its bearing on the TPB and SCT, means that all three theories play important roles in walkability research as a means to understanding how an individual responds to their environment and to the choices they perceive to be feasible for them. The relationship between exercise adherence theories such as self-efficacy theory and TPB may relate well to recreational behaviours (Biddle & Mutrie, 2008), however these theories may require additional theoretical considerations for transportation walking trips which have a more functional outcome. For example, health outcomes may be a factor in modal choice decisions but is not necessarily the primary motivation for undertaking the trip. This limitation of current models, alongside the need to encompass environment models and theories, may warrant the construction of a new model.

Another consideration for a walking specific behavioural model of the environment is the individual's response to environmental stimuli, or perceptions of the environment. Feedback from an emotional arousal can be a source of self-efficacy information. While Biddle and Mutrie (2008) note that this theory is hardly studied in exercise research, it is the foundation stone of environmental psychology, the theory behind urban design (Carmona, Heath, Oc, & Tiesdell, 2003). A greater emphasis on perceptions, thus embracing urban design theory, could potentially strengthen (physical) environment - behaviour research and the application of SCT. An individual's

reaction or response to an environment would in-turn inform the SCT and TPB's intention to participate.

A1.1.7 Models of the physical environment

When considering the neighbourhood or street level environment, there is a difference between the models for measurement presented for consideration between professions. Space Syntax's (transportation) walkability index developed for Transport for London shows the environmental variables which were identified as most important for walkability (Stonor *et al.*, 2003) Table A-1. The schematic model outlining the physical environment factors which should be considered in research linking physical activity and the physical environment presented in Pikora and colleagues (2003) public health research paper is shown in Figure A-6. An example of the built environment characteristics considered by urban designers who focus on the responses they evoke in an individual is shown in Figure A-7 (Van Deurs, Gehl Architects 2009). While many items are similar or complementary the transportation list deals exclusively with the functionality of the environment (except references to weather and day of the week) (Table A.1), the public health list deals with a mix of functionality, land uses and aesthetics alongside individual factors (Figure A-6) and the urban design list deals with perceptual responses as well as functional purposes (Figure A-7). To insure relevance and comprehensive understanding of how the environment is perceived by an individual a behavioural model of the environment should encompass as many elements of the environment as feasible and with contextual reference where possible.

Table A-1: Space Syntax table (Stonor *et al.*, 2003) **walkability factors in terms of their importance**

First Order	Second Order	Third Order
Footway Accessibility	Lighting	Footway Quality
Ground Level Activity	'Type' of Pedestrian	Proximity to Road Traffic
Pedestrian Crossing Design	Footway Width	
Traffic Signal Phasing	Footway Gradient	
Time of Day	Movement Generators – Proximity to Transport Facilities	
	Signage	
	Weather	
	Day of the Week	

Presence or Absence of other Moving People
Presence or Absence of other Stationary People

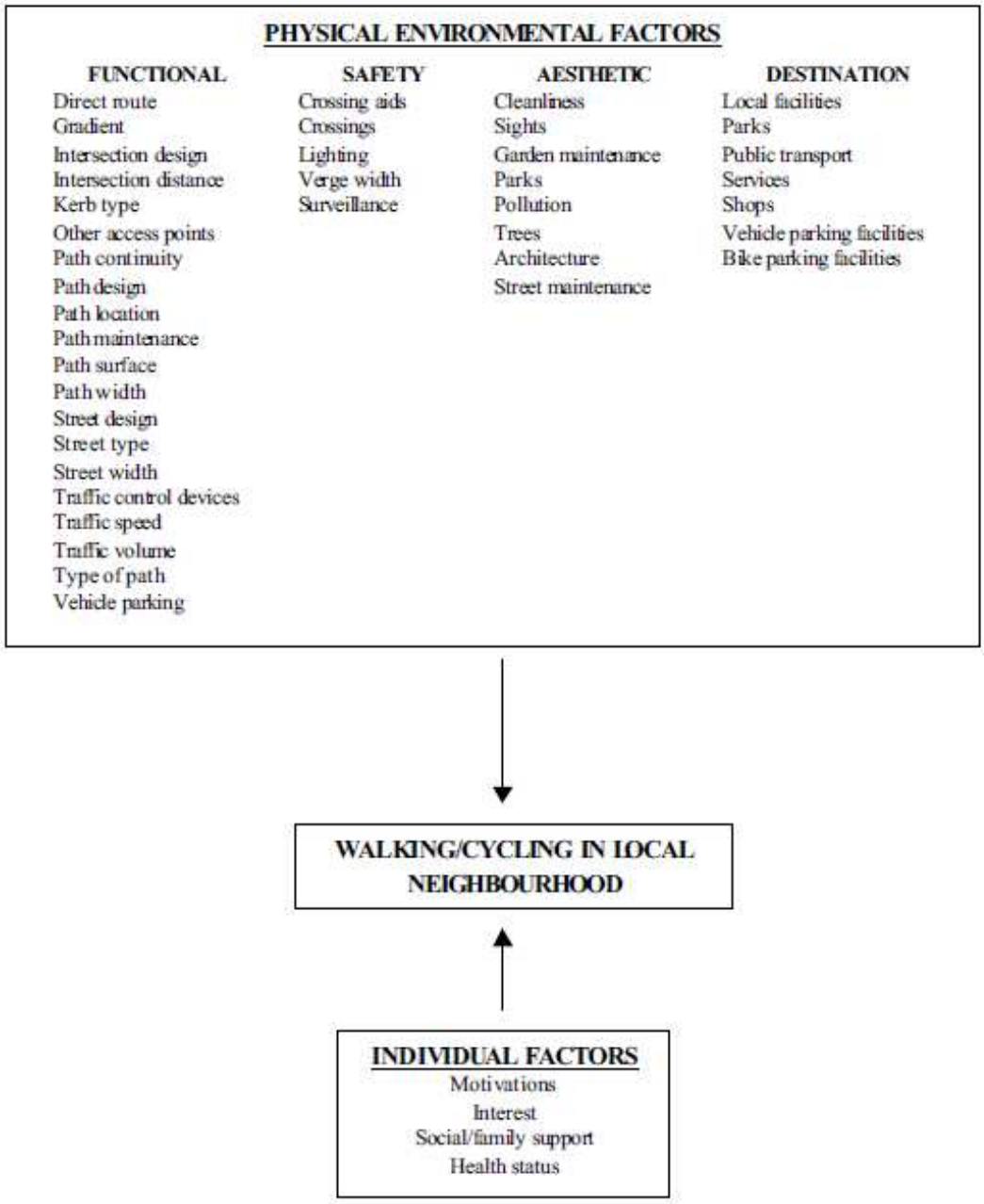

Figure A-Error! No text of specified style in document.**-6: Schema of the physical environmental factors that may influence walking/cycling in the local neighbourhood** (Pikora *et al.*, 2003)

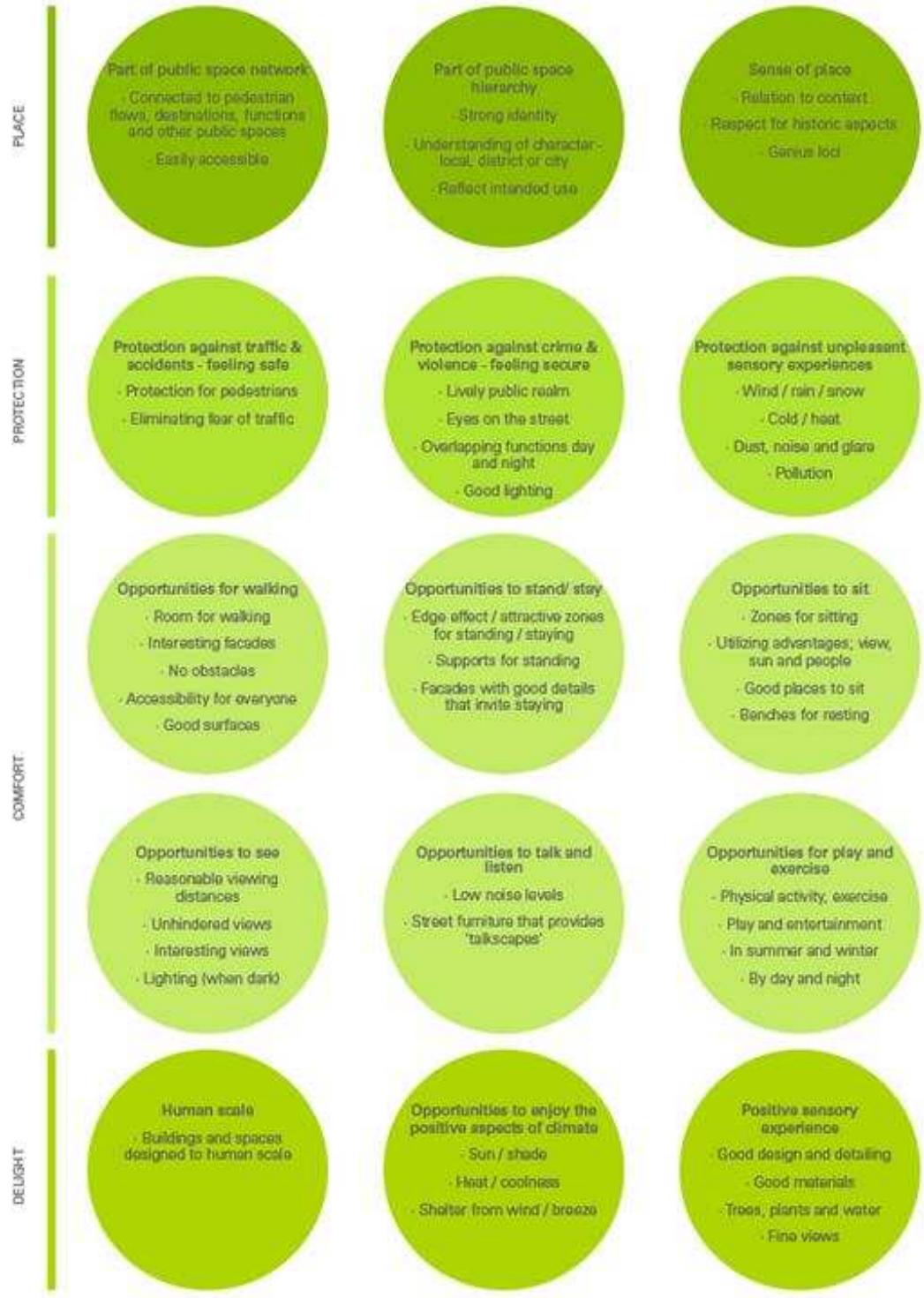

Figure A-Error! No text of specified style in document.**-7: What urban designers look at, not a complete list (Van Deurs and Gehl Architects, 2009)**

Mehta (2008) combines the perceptual element of Ewing and Handy's (2009) conceptual model with an ecological model of walking behaviour, which incorporates Alfonzo's (2005) hierarchy of walking needs, to create a comprehensive model for a main street setting, Figure A-8. This model includes the accessibility and feasibility affordances of a trip consistent with the perceived behavioural control as a determinant of behaviour. The physical and land use characteristics correspond to the physical environment factors on Pikora and colleagues' model (Figure A-6) and the street characteristics corresponds to Gehl Architects' considerations of place, protection, comfort and delight (Figure A-7). The purpose of the walking trip outcome is not included in this model as it relates to a specific environment, the main street, but the model does encompass the self-efficacy, perceived behaviour control and individual demographic considerations discussed in this section of the literature review and is therefore a good foundation for further ecological models of walking behaviours. Also missing from the model is a pathway by which an individual's emotional response to an area triggers a coping response (Bell *et al.*, 2001, p.122) whereby the pedestrian adapts by taking an alternative route rather than abandoning the trip which still results in walking behaviour despite the negative perceptual response to the environment.

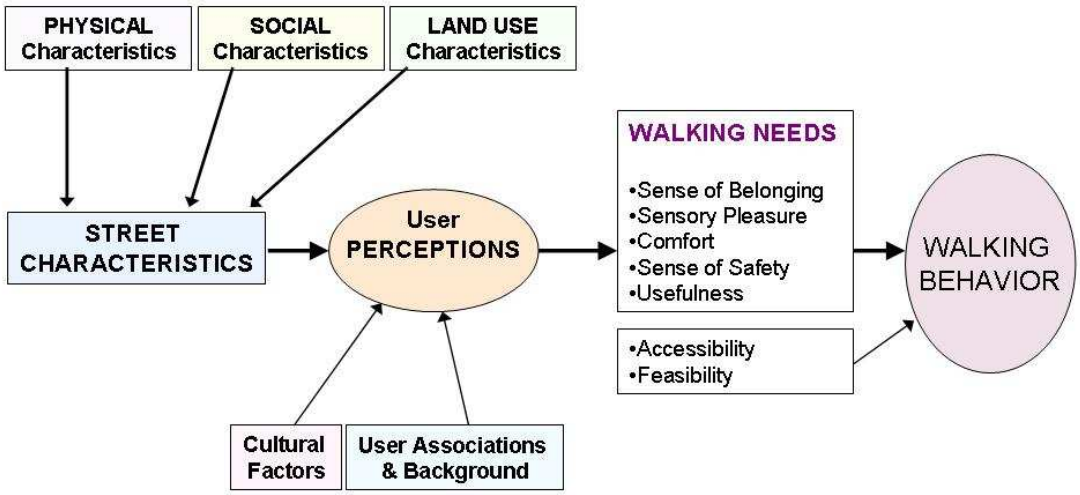

Figure A-Error! No text of specified style in document.-8: Conceptual framework of walking needs on Main Street Adapted from Mehta (2008)

When constructing ecological models of behaviour it is also important to recognise that environment – behaviour relationships are transactional in nature, characterised by 'reoccurring cycles of reciprocal/mutual influence between people and their surroundings rather than by linear (or unidirectional) effects of environmental conditions on behaviour' and should be represented as such (King *et al.*, 2002, p.7). Litter and graffiti are products of human behaviour which can influence an individual's perception of their environment. The land use and social characteristics of an area act as attractors for particular populations engaging in or utilising land uses. Adult shops, methadone clinics or night club areas are all known attractors of social groups who may be perceived as a threat to some people.

Due to the complexity of the environment that a pedestrian walks through, for any and all purposes, there is a considerable list of environment features to consider. The preliminary findings of the pedestrian quality needs (PQN) study (Sauter & Wedderburn, 2008) list ten relevant dimensions of walking which should to be measured, objectively and subjectively, to generate a complete picture of the walking environment Table A-2. This list includes behaviour data, accident and incident data, measures of the built environment and subjective satisfaction (perceptions and comfort). Each source has its merits so when exploring the concept of walkability, the relevance of each data source and the influence of each parameter on the walking environment should be considered.

Table A-2: Preliminary approach towards relevant dimensions of measuring walking (Sauter & Wedderburn 2008)

A	Transport and travel behaviour data
B	Pedestrian counts (user counts), behaviour analysis (observation, interaction/conflict analysis) and pedestrian flows (models)
C	Activity and time spent in public spaces (sojourn without mobility, stationary activities)
D	Road danger/safety: traffic accidents with pedestrians (involving at least one vehicle) & single pedestrian accidents (falling, stumbling etc.)
E	Security: threats, attacks, harassments
F	Competences (disabilities), physical activity (walking), health and health outcomes
G	Walking environment, accessibility, public space quality and infrastructure provisions ("walkability")
H	Ecological footprint, land-use
I	Perceptions, attitudes and images: personal satisfaction and subjective perception: "measuring the smiles"
J	Investments, personnel and research: Data on institutional aspects

In order to draw associations between the built environment and behaviours many facets of the environment need to be considered and not just the physical environment but also its context (including social context), individual emotional responses and the purpose of the area (e.g residential area, nightclub strip, park or historic area). Habitual behaviours and occasional trips should both be considered, also in context, where possible. An individual's personal characteristics are also important. Individual, family, community and city level social considerations may all influence perceptions and behaviours. To truly understand walkability and to communicate effectively between disciplines we need to collect as much of this information as feasible to generate a comprehensive picture of an individual's environment. This is an extensive list and consideration must be given to feasibility and expense.

References

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179–211.

Alfonzo, M. (2005). To Walk or Not to Walk? The Hierarchy of Walking Needs. *Environment and Behavior*, *37*(6), 808–836

Amekudzi, A., & Meyer, M. D. (2006). Considering the Environment in Transportation Planning: Review of Emerging Paradigms and Practice in the United States. *Journal of Urban Planning & Development*, *132*(1), 42–53.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215.

Bell, P. A., Greene, T. C., Fisher, J. D., & Baum, A. (2001). *Environmental Psychology*. (P. Howell & M. Tomiak, Eds.) (5th ed.). Orlando, FL., USA: Harcourt College Publishers.

Biddle, S. J. H., & Mutrie, N. (2008). *Psychology of Physical Activity; Determinants, Well-Being and Interventions* (2nd ed.). London: Routledge.

Carmona, M., Heath, T., Oc, T., & Tiesdell, S. (2003). *Public Places, Urban Spaces: The Dimensions of Urban Design* (1st ed.). Kent, UK: Architectural Press.

Cervero, R., & Kockelman, K. (1997). Travel Demand and the 3 D's: Density, Diversity and Design. *Transportation Research Part D: Transport and Environment*, *2*(3), 199–219.

Coogan, P. F., & Coogan, M. A. (2004). When Worlds Collide: Observations on the Integration of Epidemiology and Transportation Behavioral Analysis in the Study of Walking. Commentary on Health Promoting Community Design. *American Journal of Health Promotion*, *19*(1), 39–45.

Czogalla, O. (2010). *Parameters determining route choice of pedestrians in walkable networks. PQN Final Report B. 1. 10* (pp. 171–190). London, UK. Retrieved from http://www.walkeurope.org/uploads/File/publications/PQN Final Report part B1.pdf

De Bruijn, G.-J., Kremers, S. P. J., Singh, A., van den Putte, B., & van Mechelen, W. (2009). Adult active transportation: adding habit strength to the theory of planned behavior. *American Journal of Preventive Medicine*, *36*(3), 189–94.

Department of Transport. (2009). Smarter Travel. A Sustainable Transport Future. A New Transport Policy for Ireland 2009-2020. Dublin, Ireland: Department of Transport.

Edwards, P., & Tsouros, A. (2006). *Promoting physical activity and active living in urban environments. The role of local governments*. Copenhagen, Denmark: WHO (World Health Organisation) Regional Office for Europe.

Ewing, R., & Handy, S. L. (2009). Measuring the Unmeasurable: Urban Design Qualities Related to Walkability. *Journal of Urban Design*, *14*(1), 65–84.

Frank, L. D., Kerr, J., Sallis, J. F., Miles, R., & Chapman, J. (2008). A hierarchy of sociodemographic and environmental correlates of walking and obesity. *Preventive Medicine*, *47*(2), 172–8.

Giles-Corti, B., & Donovan, R. J. (2002). The relative influence of individual, social and physical environment determinants of physical activity. *Social Science & Medicine*, *54*(12), 1793–812.

Godin, G. (1994). Theories of Reasoned Action and Planned Behaviour: Usefulness for Excercise Promotion. *Medicine and science in sports and exercise*, *26*(11), 1391–4.

Golden, S. D., & Earp, J. A. L. (2012). Social ecological approaches to individuals and their contexts: twenty years of health education & behavior health promotion interventions. *Health Education & Behavior: The official publication of the Society for Public Health Education*, *39*(3), 364–72.

Humpel, N., Owen, N., & Leslie, E. (2002). Environmental Factors Associated with Adults ' Participation in Physical Activity: A Review. *American Journal of Preventive Medicine*, *22*(3), 188–199.

King, A. C., Satariano, W. a, Marti, J., & Zhu, W. (2008). Multilevel modeling of walking behavior: advances in understanding the interactions of people, place, and time. *Medicine and Science in Sports and Exercise*, *40*(7 Suppl), S584–93. doi:10.1249/MSS.0b013e31817c66b7

King, A. C., Stokols, D., Talen, E., Brassington, G. S., & Killingsworth, R. (2002). Theoritical Approaches to the Promotion of Physical Activity Forging a Transdisciplinary Paradigm. *American Journal of Preventive Medicine*, *23*(2S), 15–25.

Lee, C., & Moudon, A. V. (2006). Correlates of Walking for Transportation or Recreation Purposes. *Journal of Physical Activiy and Health*, *3*(Suppl 1), S77–S98.

Lee, C., Moudon, A. V., & Courbois, J.-Y. P. (2006). Built environment and behavior: spatial sampling using parcel data. *Annals of Epidemiology*, *16*(5), 387–94.

Lo, R. H. (2009). Walkability: What is it? *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, *2*(2), 145–166.

Mehta, V. (2008). Walkable streets: pedestrian behavior, perceptions and attitudes. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, *1*(3), 217–245.

Moudon, A. V., & Lee, C. (2003). Walking and bicycling: an evaluation of environmental audit instruments. *American Journal of Health Promotion*, *18*(1), 21–37.

Owen, N., Humpel, N., Leslie, E., Bauman, A., & Sallis, J. F. (2004). Understanding environmental influences on walking; Review and research agenda. *American Journal of Preventive Medicine*, *27*(1), 67–76.

Pikora, T. J., Bull, F. C. L., Jamrozik, K., Knuiman, M., Giles-Corti, B., & Donovan, R. J. (2002). Developing a reliable audit instrument to measure the physical environment for physical activity. *American Journal of Preventive Medicine*, *23*(3), 187–94.

Pikora, T. J., Giles-Corti, B., Bull, F. C. L., Jamrozik, K., & Donovan, R. J. (2003). Developing a framework for assessment of the environmental determinants of walking and cycling. *Social Science & Medicine*, *56*(8), 1693–1703.

Rhodes, R. E., Brown, S. G., & McIntyre, C. a. (2006). Integrating the perceived neighborhood environment and the theory of planned behavior when predicting walking in a Canadian adult sample. *American Journal of Health Promotion*, *21*(2), 110–8.

Saelens, B. E., Sallis, J. F., & Frank, L. D. (2003). Environmental Correlates of Walking and Cycling: Findings From the Transportation, Urban Design, and Planning Literatures. *Annals of Behavioral Medicine: a publication of the Society of Behavioral Medicine*, *25*(2), 80–91.

Sallis, J. F., Bauman, A., & Pratt, M. (1998). Environmental and Policy Interventions to Promote Physical Activity. *American Journal of Preventive Medicine*, *15*(4), 379–397.

Sauter, D., & Wedderburn, M. (2008). Measuring Walking. Towards Internationally Standardised Monitoring Methods of Walking and Public Space. In *8th International Conference on Survey Methods in Transport*. Annecy, France.

Stokols, D. (1992). Establishing and Maintaining Healthy Environments Toward a Social Ecology of Health Promotion. *American Psychologist*, *47*(1), 6–22.

Stonor, T., Campos, M. B. de A., Chiaradia, A., Takamatsu, S., & Smith, A. (2003). Towards a "Walkability Index." In *European Transport Conference 2003 (8th -10th Oct)*. London, UK: Association for European Transport.

TRB. (2005). *Does the Built Environment Influence Physical Activity? Examining the Evidence TRB Special Report 282 Committee on Physical Activity, Health, Transportation and Land use.* Washington, D.C.: Transportation Research Board. Retrieved from www.TRB.org

Van Deurs, C. R. (2009). Key Quality Indicators. In *Walk 21, More Footsteps, Less Carbon*. New York, USA.

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Appendix B1: Neighbourhood Creators Walkability Questionnaire Development Tables

Table B.1: NCWQ Question development: Area of work and demographic profile.

#	Item (draft 1)	Post Pre-Pilot (2 doc)	Post Validation (reliability: crosstabs % agreement)	Post Reliability/ Final
Demographics				
Final Question 1 & 2: Area of work and Place of Work				
1.1	**Main Area of Expertise? (tick box)** Advocacy Architecture Engineering Planning Public Health Transport Planning Urban Design Other, Please Specify_____	**What is your Main Area of Expertise? (please tick a maximum of two)** Academia Architecture Elected Government Office (Local or National) Engineering Planning Public Health Landscape Architecture Local Government (Employed) Transport Planning Urban Design Advocacy Other (please specify)	**Which of the following options best describes your area of work?** Architecture Engineering Landscape Architecture Planning Public Health Public Representative Transport Planning Urban Design Advocacy Other (please specify) (91%)	**Which of the following options best describes your area of work?** Architecture Engineering Landscape Architecture Planning Public Health Public Representative Transport Planning Urban Design Advocacy Other (please specify)
1.2			**Which of these best describes your place of work?** Civil Service, Local Civil Service, National Consultancy/ Private Sector NGO, Charitable Organisation, Community Organisation etc. Public Representative, Local Public Representative, National University Other (please specify) (99%)	**Which of these best describes your place of work?** Civil Service, Local Civil Service, National Consultancy/ Private Sector NGO, Charitable Organisation, Community Organisation etc. Public Representative, Local Public Representative, National University Other (please specify)

Table B.1 cont.

#	Item (draft 1)	Post Pre-Pilot (2 doc)	Post Validation (reliability: crosstabs % agreement)	Post Reliability/ Final
1.3		**Which age bracket do you fit into?**[3] Under 25 years 25 – 35 years 36 – 45 years 46 – 55 years 56 – 65 years 65 years plus I'd rather not say	**What year were you born?**	**What year were you born?**
1.4			**Are you...?** Male Female	**Are you...?** Male Female
1.5			**Are you a parent with a child of 17yrs or younger living at home?** Yes No	**Are you a parent with a child of 17yrs or younger living at home?** Yes No

Table B.2: NCWQ Question Development: Beliefs, Attitudes and Opinions

#	Item (draft 1)	Post Pre-Pilot (2 doc)	Post Validation (reliability crosstabs % agreement)	Post Reliability/ Final
Final Question 3 & 4: Agreement with hypothesis				
2.1	**Do you agree with the statement that Walkability influences Physical Activity?** 1 Strongly Disagree 2 Somewhat Disagree 3 Somewhat Agree 4 Strongly Agree	**Do you agree with the following statement[4]:** '*the way that we plan and design our communities and transport systems matters for human health*' 1 Strongly Disagree 2 Somewhat Disagree 3 Neither Agree nor Disagree[5] 4 Somewhat Agree 5 Strongly Agree	**To what extent do you agree or disagree with the following statement?** 'Human health is affected by the way we plan and design our communities and transport systems' 1 Strongly Agree 2 Somewhat Agree 3 Neither Agree nor Disagree 4 Somewhat Disagree 5 Strongly Disagree (74%)	**To what extent do you agree or disagree with the following statement?** 'Human health is affected by the way we plan and design our communities and transport systems' 1 Strongly Agree 2 Somewhat Agree 3 Neither Agree nor Disagree 4 Somewhat Disagree 5 Strongly Disagree
2.2			**To what extent do you agree or disagree with the following statement?** 'Climate Change is affected by the way we plan and design our communities and transport systems' 1 Strongly Agree 2 Somewhat Agree 3 Neither Agree nor Disagree 4 Somewhat Disagree 5 Strongly Disagree (64%)	**To what extent do you agree or disagree with the following statement?** 'Carbon emissions are affected by the way we plan and design our communities and transport systems' 1 Strongly Agree 2 Somewhat Agree 3 Neither Agree nor Disagree 4 Somewhat Disagree 5 Strongly Disagree

Table B.2 cont.

2.3	**How would you describe a walkable area?** In the following questions the term walkable area is interchangeable with these terms: (1) area conducive to walking, (2) walking friendly environment, (3) walk promoting area & (4) facilitative walking environment	**Think about the neighbourhoods and areas in the Greater Dublin Area (Dublin City and its Suburbs). Some of these areas are more walkable than others. How would you describe a walkable area?**		
2.4	**Please list the potential benefits of living in a walkable area?**	**What are the benefits of living in a walkable area?** *Please list up to three, if there are none please write 'none'.*		

Table B.3: NCWQ Environmental items and their influence on walkability

#	Item (draft 1)	Post Pre-Pilot (2 doc)	Post Validation (reliability: crosstabs % agreement)	Post Reliability/ Final
Perceptions				
3.1	Please list three factors that positively influence the walkability of an area? Are there any other factors that you would like to add to this list?	A lot of factors influence the walkability of an area. Please list the three factors that you think most **increase** the walkability of an area?		
3.2	Now think of three factors that negatively influence the walkability of an area? Please list. 1. 2. 3. Are there any other factors that you would like to add to this list?	Q7: List the three factors that you think most **decrease** the walkability of an area? 1. 2. 3.		

Table B.4: NCWQ Environment Correlates - Functional

#	Draft 1: Initial Proposed Instrument	Draft 2 for Pre-Pilot	Draft 3: Post Validation (reliability: crosstabs % agreement)	Draft 4: Post Reliability/ Final
3.3	**Using the following list of factors please rate your top 10 positive factors**	**Below is a list of factors that might be associated with walkability.** **Please indicate how important you think they are** Please rate each of the following factors on a scale of 1 to 9, 1 being the lowest level of importance and 9 the highest.	**Below is a list of factors that might be associated with walkability (pedestrian friendliness)** Please select a response that ranges from 1 - very good for walkability to 5 - very bad for walkability. 1 - Very good for walkability 2 – Good for walkability 3 – Neither good nor bad for walkability 4 – Bad for walkability 5 – Very bad for walkability 6 – Don't know	**Below is a list of factors that might be associated with walkability (pedestrian friendliness)** Please select a response that ranges from 1 - very good for walkability to 5 - very bad for walkability. 1 - Very good for walkability 2 – Good for walkability 3 – Neither good nor bad for walkability 4 – Bad for walkability 5 – Very bad for walkability 6 – Don't know
	Functional			
3.3.1	Well Maintained footpaths and street lighting[1]	Well maintained footpaths	Well maintained footpaths (74%)	Well maintained footpaths
3.3.2	Safe pedestrian crossings[2]	Many well designed pedestrian crossings	Many well designed pedestrian crossings (62%)	Many well designed pedestrian crossings
3.3.3	Even Slope/ Gradient along the route	Even Slope/ Gradient along the route	Even slope/ gradient along the route (not hilly)[3] (63%)	Even slope/ gradient along the route (not hilly)

[1]Factor divided to separate footpaths and lighting (3.3.34)
[2]well designed pedestrian crossings incorporates fit for purpose and in a suitable location. This was an important aspect of this item as the presence of a crossing does not mean that it follows the pedestrian desire line or has a relevant design for the purpose of the crossing.
[3]The explanation not hilly was added following validity testing as the terms 'slope' and 'gradient' may not be familiar to all respondents

Table B.5: NCWQ Environment Correlates - Connectivity

#	Draft 1: Initial Proposed Instrument	Draft 2 for Pre-Pilot	Draft 3: Post Validation (reliability: crosstabs % agreement)	Draft 4: Post Reliability/ Final
	Connectivity			
3.3.4	A continuous route	A continuous route[4]		
3.3.5	Connectivity of the street network	Connectivity of the street and path network	Cul-de-sacs (66%)	Cul-de-sacs
3.3.6			Pedestrian shortcuts (65%)	Pedestrian shortcuts
3.3.7			Pedestrian bridges over roads (64%)	Pedestrian bridges over roads
3.3.8			Long waiting time for pedestrians at traffic lights (65%)	Long waiting time for pedestrians at traffic lights

[4]On reflection it was noted that for a route to be continuous a number of items need to be working in conjunction with each other. A continuous route described as an uninterrupted route could suggest no barriers such as traffic lights at junctions and describing the route as a direct route may suggest only having footpaths along certain roads which to get from A to B rather than a variety of route options. This item developed into a series of items (3.3.5 to 3.3.8) which along with the functional factors 3.3.1 to 3.3.3 contribute to a continuous route.

Table B.6: NCWQ Environment Correlates – Destinations and Land Planning

#	Draft 1: Initial Proposed Instrument	Draft 2 for Pre-Pilot	Draft 3: Post Validation (reliability: crosstabs % agreement)	Draft 4: Post Reliability/ Final
	Destinations and Land Planning			
3.3.10	Access to recreation facilities[5]	Access to recreation facilities	Access to parks and other green spaces (61%)	Access to parks and other green spaces
3.3.11			Proximity to the sea, river or canal (62%)	Proximity to the sea, river or canal
3.3.12			Public spaces where people can gather (55%)	Public spaces where people can gather
3.3.13	Proximity to destinations Schools/ shops/ other local services/ public transport stops[6]	Schools, shops and other services within walking distance	Schools, shops, transport stops, recreation facilities and other services within walking distance from people's homes[7] (57%)	Schools, shops, transport stops, recreation facilities and other services within walking distance from people's homes
3.3.15		Mixed Land Use	Mixed land use (variety of shops, residences, amenities and other uses) [8] (55%)	Mixed land use (variety of shops, residences, amenities and other uses)
3.3.16			Inviting local shops (57%)	Inviting local shops
3.3.17	Proximity to friends/ family's homes	Friends/ family's homes within walking distance[9]	Friends/ family's homes within walking distance (68%)	Friends/ family's homes within walking distance
3.3.18	Residential Density	Residential Density[10]	Low residential density (40%)	Low residential density
3.3.19			Tall buildings (48%)	Tall buildings
3.3.20		Car parking spaces in front of shops	Large flat car parks[11] (67%)	Large flat car parks

[5]previous research from public health focused on destinations being only places that an individual would go to exercise. In a neighbourhood planning context relating to walking the ease of making the journey to the destination on foot is as important as having the recreational destination. When considering neighbourhood walking the presence of many destinations is important. Recreational facilities was also expanded to both outdoor areas 'to go for a walk' and destinations for physical activity such as community centres and fitness centres. [6]Access to public transport is an important item as it is what potentially makes a greater city area and beyond accessible without having to resort to using private motorised transport. This item was listed within the items in 3.3.13 as it is a service. [7]For clarity, item 3.3.13 included 'within walking distance from peoples homes' to provide context. [8]Following the validation an explanation for 'mixed land use' was added to encompass the sense of a variety. [9]'Proximity to' replaced with 'within walking distance' to emphasise context. [10]direction was added to this item. [11]This item was amended following validation to put clearer context on the question

Table B.7: NCWQ Environment Correlates - Personal Safety

#	Draft 1: Initial Proposed Instrument	Draft 2 for Pre-Pilot	Draft 3: Post Validation (reliability: crosstabs % agreement)	Draft 4: Post Reliability/ Final
	Personal Safety			
3.3.27	Safety from Crime	Low Crime	Above average crime rate (61%)[13]	Above average crime rate
3.3.28	Social Policing from Passing Traffic	Social Policing by Passing Traffic[14]		
3.3.29	Other People Walking	Other People Walking	Other people walking (62%)	Other people walking
3.3.30			Shops and businesses with closed shutters at night (69%)	Shops and businesses with closed shutters at night
3.3.31	Route Overlooked by buildings	Route Overlooked by occupied buildings[15]	Route overlooked by occupied buildings, shops and residences (55%)	Route overlooked by occupied buildings, shops and residences
3.3.32			High walls surrounding properties (70%)	High walls surrounding properties
3.3.33			Overlapping day and night functions in an area (58%)	Overlapping day and night functions in an area
3.3.34		Good street and path lighting	Good street and footpath lighting (72%)	Good street and footpath lighting
3.3.35		Children playing on the street[16]	Young children playing (58%)	Young children playing

[13]Direction and relativity were given to the item 'crime level' to put it into a context in order for it to be measured. [14]Social policing by passing traffic was removed post validation as it caused confusion. [15]Item expanded to include types of buildings for clarity. [16]Children playing on the street amended post validation to young children playing to remove confusion as to whether or not the children are on the footpaths or on the road.

Table B.8: NCWQ Environment Correlates - Safety from Traffic

#	Draft 1: Initial Proposed Instrument	Draft 2 for Pre-Pilot	Draft 3: Post Validation (reliability: crosstabs % agreement)	Draft 4: Post Reliability/ Final
	Safety from Traffic			
3.3.36	Safety from Traffic (i.e. presence of a buffer between pedestrian and road)	Presence of a buffer between pedestrian and road (for example: grass verge/ parked cars/ barriers)[17]	Presence of a buffer between pedestrian and road (for example: grass verge/ parked cars/ barriers) (62%)	Presence of a buffer between pedestrian and road (for example: grass verge/ parked cars/ barriers)
3.3.37			Pedestrianised streets (no motorised vehicles) (71%)	Pedestrianised streets (no motorised vehicles)
3.3.38		Low speed of passing traffic	Low speed of passing traffic (66%)	Low speed of passing traffic
3.3.39		Wide roads	Wide roads with multiple lanes of traffic[18] (52%)	Wide roads with multiple lanes of traffic

[17]Explination added of what constitutes a 'buffer'. [18]Context given to explain what constitutes a 'wide road'

Table B.9: NCWQ Environment Correlates - Personal Comfort

#	Draft 1: Initial Proposed Instrument	Draft 2 for Pre-Pilot	Draft 3: Post Validation (reliability: crosstabs % agreement)	Draft 4: Post Reliability/ Final
	Personal Comfort			
3.3.40	Familiar faces	Familiar faces		
3.3.41		Friendly Faces[19]	Friendly faces (57%)	Friendly faces
3.3.42			Congestion on footpaths (68%)	Congestion on footpaths
3.3.43	Street furniture to stop and rest	Street furniture to stop and rest[20]	Benches to stop and rest (69%)	Benches to stop and rest
3.3.44		Bad weather	Bad weather (58%)	Bad weather
3.3.45		Good Weather[21]		
3.3.46		Sheltered routes[22]	Sheltered routes from wind and rain (59%)	Sheltered routes from wind and rain
3.3.47		Mixed age profile of people living in the area	Mixed age profile of people living in the area (64%)	Mixed age profile of people living in the area
3.3.48		Age of the area	Older area of the city[23] (55%)	Older area of the city
3.3.49			Poor air quality/ presence of air pollution (42%)	Poor air quality/ presence of air pollution
3.3.50			Buildings and spaces designed to human scale (49%)	Buildings and spaces designed to human scale
3.3.51			Loud noise (66%)	Loud noise
3.3.52			Street entertainment or buskers (58%)	Street entertainment or buskers
3.3.53			People begging (68%)	People begging
3.3.54			**If you think that we have forgotten a factor that is good for walkability please feel free to list more below.[24]** **This question is optional**	**If you think that we have forgotten a factor that is good for walkability please feel free to list more below.** **This question is optional**

[19]A decision was made to use just one of the factors 'friendly faces' and 'familiar faces' following the validity as while it was appreciated that they reflected different things the similar items within the long list felt like repetition. [20]Discription given as to what constitutes 'street furniture' following validity as street furniture can apply to lampposts and signal boxes in commonly used engineering terminology. [21]Good weather removed as it was decided there was repetition with the inclusion of Bad Weather also. [22]Further explanation of what is meant by sheltered routes with the inclusion of 'from wind and rain'. [23]Direction added to item. [24]opportunity was given to include any factors the respondent thinks has been overlooked

Table B.10: NCWQ Social and Demographic Correlates

#	Draft 1: Initial Proposed Instrument	Draft 2 for Pre-Pilot	Draft 3: Post Validation (reliability: crosstabs % agreement)	Draft 4: Post Reliability/ Final
3.4		**A lot of factors influence how likely a person is to walk in their local area or neighbourhood. To what extent do you think each of these factors influences how likely a person is to walk in their local area or neighbourhood?** *Much more likely* *Somewhat more likely* *No influence* *Somewhat less likely* *Far less likely* *Don't understand what is being asked*	**Personal factors can influence how likely people are to walk in their local area or neighbourhood. How would you rate the influence of the following factors?** Much more likely to walk Somewhat more likely to walk No Influence Somewhat less likely to walk Far less likely to walk Not sure/ don't know[25] (α = .8)	**Personal factors can influence how likely people are to walk in their local area or neighbourhood. How would you rate the influence of the following factors?** Much more likely to walk Somewhat more likely to walk No Influence Somewhat less likely to walk Far less likely to walk Not sure/ don't know
3.4.1		Social class[26]		
3.4.2		Education level	Low education level (77%)	Low education level
3.4.3		Number of children	Having lots of children (45%)	Having 4 or more children
3.4.4			Having a young child (55%)	Having a child under 4 years old
3.4.5			Being a single parent (70%)	Being a single parent
3.4.6		Body weight	Being overweight/ obese (66%)	Being overweight/ obese
3.4.7		Fitness level	Being fit (63%)	Being fit
3.4.8			Enjoying exercise (82%)	Enjoying exercise
3.4.9		Income	Having a low income (58%)	Having a low income
3.4.10			Having a middle income (72%)	Having a middle income
3.4.11			Having a high income (60%)	Having a high income
3.4.12		Age	Being old (69%)	Being old
3.4.13			Being a child (58%)	Being a child
3.4.14		Gender	Being female (65%)	Being female

Table B.10 cont.

3.4.15		Perception of Social Cohesion – (maybe 'sense of belonging in a neighbourhood')	Feeling part of the community (65%)	Feeling part of the community
3.4.16		Number of cars per household	Having a car (71%)	Having a car
3.4.17		Having a physical disability	Having a physical disability (52%)	Having a physical disability
3.4.18			Having a sensory impairment (e.g. blindness or deafness) (61%)	Having a sensory impairment (e.g. blindness or deafness)
3.4.19		Having a mental illness	Having a mental illness (e.g. depression) (60%)	Having a mental illness (e.g. depression)
3.4.20		Having an intellectual disability	Having an intellectual disability (e.g. autism or downs syndrome) (62%)	Having an intellectual disability (e.g. autism or downs syndrome)
3.4.21		Mixed socio-economic status in the area[28]		
3.4.22			Not having much time (63%)	Not having much time
3.4.23			Interest in fashion or make-up[27](52%)	Wanting to look smart/ Having an interest in fashion or make-up
3.4.24			Owning a dog (83%)	Owning a dog
3.4.25			Being a social person (67%)	Being a social person

[25]'Don't understand' has been replaced with 'Not sure/ Don't know' after pre-pilot consultation. The wording of the question was also amended. [26]Soical class and mixed socio-economic status in the area were removed and replaced with factors which can be attributed to social class or socio economic status such as income, single parenthood and education level. [27]Artulicating what was intended for exploratory item 3.4.23 was difficult to do in one short line to fit in the questionnaire. The situation being explored is if an individual (male or female) is required to present themselves neatly for work or if a woman has a preference for coiffed hair, lots of make up and high shoes, does this influence their decision to walk, particularly in an unpredictable climate such as in Dublin. [28]This item was removed.

Appendix B2: NCWQ distribution email

Email 1 – Cold call (individuals):

Dear Sir/Madam

Because of your professional expertise we would like to invite you to participate in an international interdisciplinary research project currently being undertaken by Dublin City University, Trinity College Dublin, West Virginia University and University of Strathclyde, Glasgow. This project is funded under the Environmental Protection Agency STRIVE programme.

This questionnaire is aimed at planners, urban designers, transport planners, civil engineers, architects, politicians, public health officials, local government officials, advocacy professionals, academics and others working in related fields.

While every effort has been made to avoid multiple emails we would like to apologise if you do receive this email more than once.

The purpose of the study is to better understand the factors that influence people's decision to walk. We are specifically interested in your professional perspective. To participate all we ask is that you take approximately 15 minutes to fill out the questionnaire attached.

The questionnaire can be exited and returned to at a later time provided the same computer is used.

This study focuses on the Greater Dublin Area but is not restricted to people currently working in Dublin. The study is open to people who have previously worked on or are currently working on projects in the Dublin Region.

This is a completely voluntary survey. Responses will remain completely confidential; none of your answers will be connected with your contact details. By clicking the questionnaire link you are giving consent that your answers can be used and summarised as part of our study.

While every effort has been made to avoid multiple emails we would like to apologise if you do receive this email more than once.

We would be very grateful it if you could respond to our survey within the next week or so, your response will be very much appreciated. If you have any questions or queries please do not hesitate to contact us.

Survey link: http://www.surveymonkey.com/s/KZBY8RB (no longer available)

Kindest Regards

Lorraine Fitzsimons - School of Health and Human Performance, Dublin City University (086-8654707)

Professor Kevin Leyden – West Virginia University

Dr Norah Nelson – University of Strathclyde, Glasgow

Professor James Wickham –Trinity College Dublin

Dr Catherine Woods - Dublin City University

If participants have concerns about this study and wish to contact an independent person, please contact: The Secretary, Dublin City University Research Ethics Committee, c/o Office of the Vice-President for Research, Dublin City University, Dublin 9. Tel 01-7008000

Email 2 – Cold call (companies and professional institutions):

Alternative introduction paragraph:

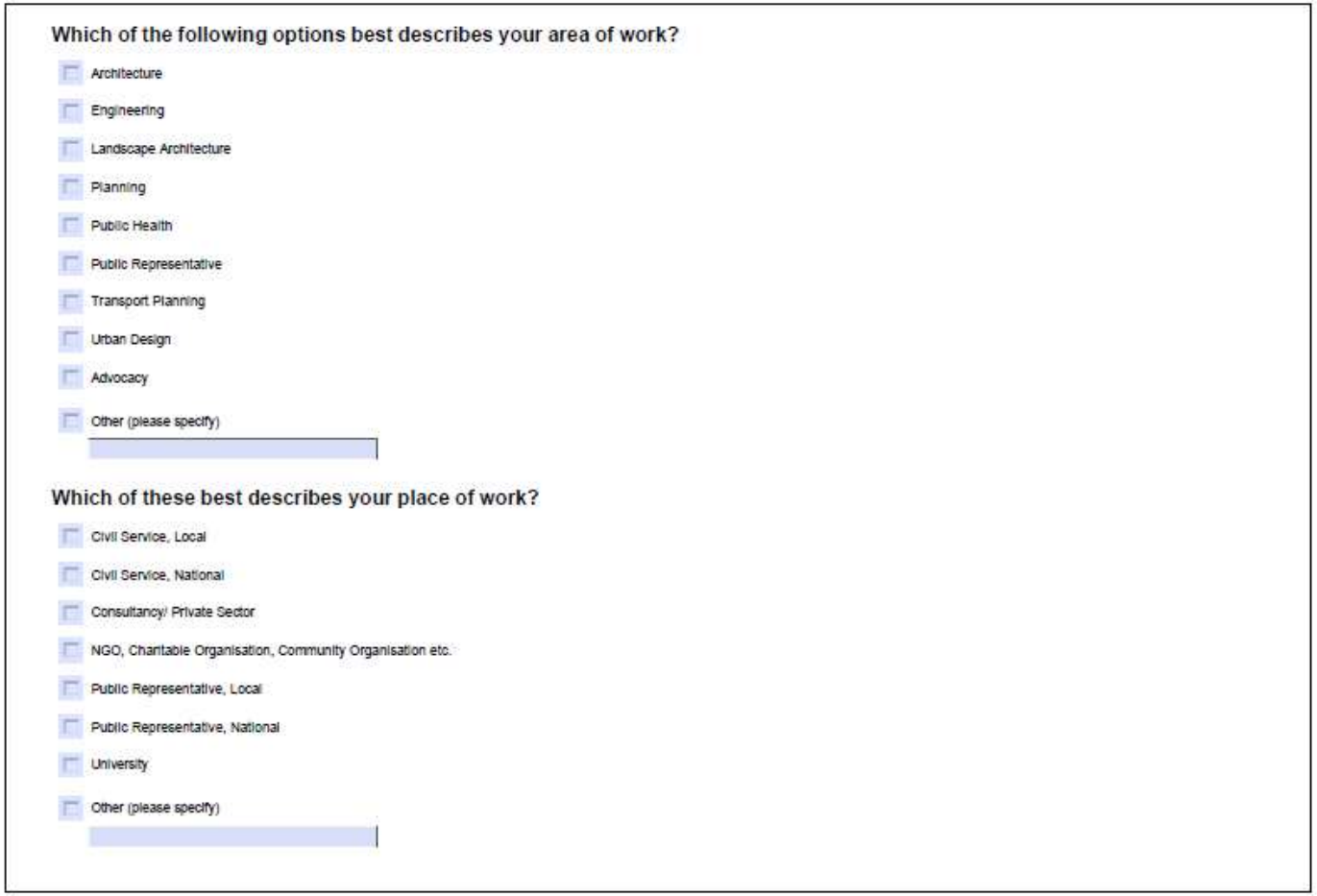
Because of your professional institution's [company's professional/ department's] expertise we would like to invite your members [staff] to participate in an international interdisciplinary research project currently being undertaken by Dublin City University, Trinity College Dublin, West Virginia University and University of Strathclyde, Glasgow. The project is funded by the Environmental Protection Agency.

This questionnaire is aimed at planners, urban designers, transport planners, civil engineers, architects, public health officials, local government officials, politicians, advocacy professionals, academics and others working in related fields.

It would be greatly appreciated if you could forward this email to your members, colleagues and friends that work within the professions listed above.

(Alternative weblink accompanied this email)

Appendix B3: NCWQ web-host template

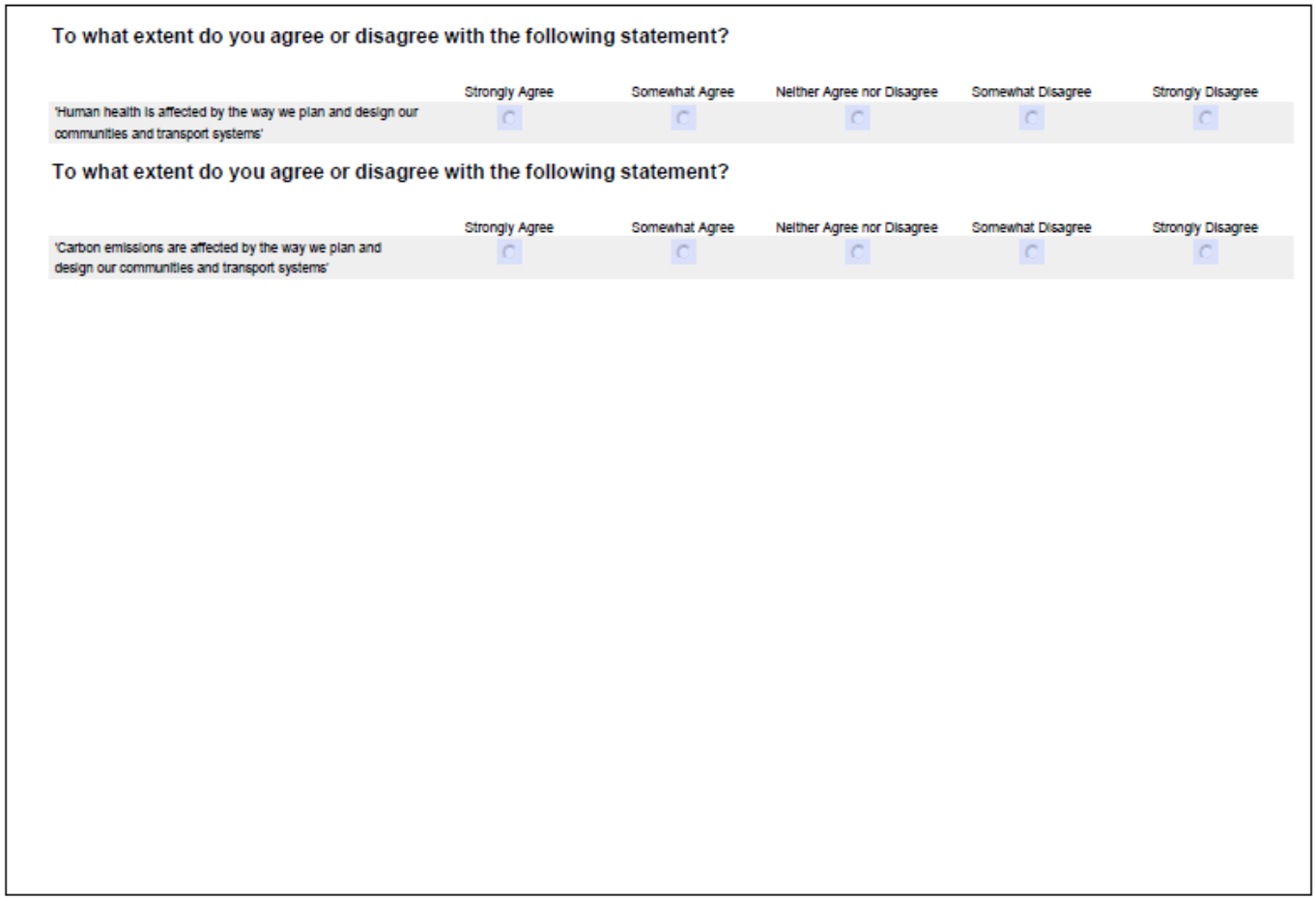


Which of the following options best describes your area of work?

- [ ] Architecture
- [ ] Engineering
- [ ] Landscape Architecture
- [ ] Planning
- [ ] Public Health
- [ ] Public Representative
- [ ] Transport Planning
- [ ] Urban Design
- [ ] Advocacy
- [ ] Other (please specify)

Which of these best describes your place of work?

- [ ] Civil Service, Local
- [ ] Civil Service, National
- [ ] Consultancy/ Private Sector
- [ ] NGO, Charitable Organisation, Community Organisation etc.
- [ ] Public Representative, Local
- [ ] Public Representative, National
- [ ] University
- [ ] Other (please specify)



To what extent do you agree or disagree with the following statement?

	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
'Human health is affected by the way we plan and design our communities and transport systems'					

To what extent do you agree or disagree with the following statement?

	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
'Carbon emissions are affected by the way we plan and design our communities and transport systems'					

Similar to Page 3, below is a list of other factors that might be associated with walkability (pedestrian friendliness)
Please select a response that ranges from 1 - very good for walkability to 5 - very bad for walkability.

	1 - Very good for walkability	2 - Good for walkability	3 - Neither good nor bad for walkability	4 - Bad for walkability	5 - Very bad for walkability	Don't know
Shops and businesses with closed shutters at night	○	○	○	○	○	○
Presence of a buffer between pedestrian and road (for example: grass verge/ parked cars/ barriers)	○	○	○	○	○	○
Young children playing	○	○	○	○	○	○
Mixed land use (variety of shops, residences, amenities and other uses)	○	○	○	○	○	○
Friends/ family's homes within walking distance	○	○	○	○	○	○
Unique areas with personality and character	○	○	○	○	○	○
Route overlooked by occupied buildings, shops and residences	○	○	○	○	○	○
Benches to stop and rest	○	○	○	○	○	○
Friendly faces	○	○	○	○	○	○
High walls surrounding properties	○	○	○	○	○	○
Large flat car parks	○	○	○	○	○	○
Tall buildings	○	○	○	○	○	○
Low residential density	○	○	○	○	○	○
Buildings and spaces designed to human scale	○	○	○	○	○	○

Similar to Pages 3 and 4, below is a list of other factors that might be associated with walkability (pedestrian friendliness)
Please select a response that ranges from 1 - very good for walkability to 5 - very bad for walkability.

	1 - Very good for walkability	2 - Good for walkability	3 - Neither good nor bad for walkability	4 - Bad for walkability	5 - Very bad for walkability	Don't know
Many well designed pedestrian crossings	○	○	○	○	○	○
Loud noise	○	○	○	○	○	○
Above average crime rate	○	○	○	○	○	○
Congestion on footpaths	○	○	○	○	○	○
Pedestrianised streets (no motorised vehicles)	○	○	○	○	○	○
Mixed age profile of people living in the area	○	○	○	○	○	○
Dirty, unkempt local area	○	○	○	○	○	○
Street art	○	○	○	○	○	○
Pedestrian bridges over roads	○	○	○	○	○	○
Low speed of passing traffic	○	○	○	○	○	○
Street entertainment or buskers	○	○	○	○	○	○
Good street and footpath lighting	○	○	○	○	○	○
Overlapping day and night functions in an area	○	○	○	○	○	○
People begging	○	○	○	○	○	○
Long waiting time for pedestrians at traffic lights	○	○	○	○	○	○
Public spaces where people can gather	○	○	○	○	○	○

Personal factors can influence how likely people are to walk in their local area or neighbourhood. How would you rate the following factors?

	Much more likely to walk	Somewhat more likely to walk	No influence	Somewhat less likely to walk	Far less likely to walk	Not sure/ don't know
Being fit	○	○	○	○	○	○
Having 4 or more children	○	○	○	○	○	○
Having a child under 4 years old	○	○	○	○	○	○
Being female	○	○	○	○	○	○
Not having much time	○	○	○	○	○	○
Being overweight/ obese	○	○	○	○	○	○
Low education level	○	○	○	○	○	○
Having a low income	○	○	○	○	○	○
Having a middle income	○	○	○	○	○	○
Having a high income	○	○	○	○	○	○
Wanting to look smart/ Having an interest in fashion or make-up	○	○	○	○	○	○
Being old	○	○	○	○	○	○
Being a child	○	○	○	○	○	○

We would like to thank you for your time, we appreciate your input.

Would you be interested in getting further information on this project?

- ○ yes
- ○ no

If yes, please fill in your details below

Name	
Email address	
Telephone number	
Student number	

your personal details will not be used in connection to the collected data

You are now finished the survey, please press the 'done' button below to submit your response

Thank You very much for your time

Appendix B4: NCWQ Environment sub component tables

Table B.11: NCWQ Sub-component 1: Destinations (n=9)

Item	Reliability (test-retest % agreement)
Schools, shops, transport stops, recreation facilities and other services within walking distance from people's homes	57%
Mixed land use (variety of shops, residences, amenities and other uses)	55%
Proximity to the sea, river or canal	62%
Access to parks and other green spaces	61%
Public spaces where people can gather	55%
Inviting local shops	57%
Friends/ family's homes within walking distance	68%
Large flat car parks	67%
Overlapping day and night functions in an area[1]	58%
Scale: average reliability = 67%, α = .8, intraclass correlation coefficient (ICC)= .6***	

[1]Day and night functions in an area moved from personal safety heading to destinations as it is a better fit and results in a higher alpha score, **ρ<0.01, ***ρ<0.001

Table B.12: NCWQ Sub component 2: Path Context (n=6)

Item	Reliability (test-retest % agreement)
Attractive gardens & trees along route	70%
Interesting architecture	67%
Little or no graffiti	64%
Dirty, unkempt local area	63%
Street art	55%
Unique areas with personality and character	64%
Scale: average reliability = 64%, α = .7, intraclass correlation coefficient (ICC)= .6***	

**ρ<0.01, ***ρ<0.001

Table B.13: NCWQ Sub component 3: Personal Safety (n=7)

Item	Reliability (test-retest % agreement)
Above average crime rate[1]	61%
Other people walking	62%
Shops and businesses with closed shutters at night	69%
Route overlooked by occupied buildings, shops and residences	55%
High walls surrounding properties	70%
Good street and footpath lighting	72%
Young children playing	58%
Scale: average reliability = 64%, α = .6, intraclass correlation coefficient (ICC)= .4***	

[1]reverse phrased items reversed for analysis . [2]higher but strong theoretical basis for inclusion

**ρ<0.01, ***ρ<0.001

Table B.14: NCWQ Sub component 4: Personal Comfort (n=11)

Item	Reliability (test-retest % agreement)
Friendly faces	57%
Congestion on footpaths	68%
Benches to stop and rest	69%
Bad weather	58%
Sheltered routes from wind and rain	64%
Mixed age profile of people living in the area	59%
Older area of the city	55%
Buildings and spaces designed to human scale	49%
Loud noise	66%
Street entertainment or buskers	68%
People begging	58%
Scale: average reliability = 61%, α = .6, intraclass correlation coefficient (ICC)= .5***	

**ρ<0.01, ***ρ<0.001

Table B.15: NCWQ Sub component 5: Road and path network (n=12)

Item	Reliability (test-retest % agreement)
Well maintained footpaths	74%
Many well designed pedestrian crossings	62%
Low residential density	40%
Even slope/ gradient along the route (not hilly)	63%
Cul-de-sacs	66%
Pedestrian shortcuts	65%
Pedestrian bridges over roads	64%
Long waiting time for pedestrians at traffic lights	65%
Poor air quality/ presence of air pollution	42%
Wide roads with multiple lanes of traffic	52%
Pedestrianised streets (no motorised vehicles)	71%
Low speed of passing traffic	66%
Scale: average reliability = 61%, α = .7, intraclass correlation coefficient (ICC)= .6***	

**ρ<0.01, ***ρ<0.001

Appendix C: Focus Group Procedure

The procedure was:

1) Participants were welcomed, offered refreshments and asked to fill out an informed consent form.
2) Participants sat at a desk with two maps and a set of 6 blue removable stickers per person.
3) Before starting the moderator informed the group that an audio recording would be made of the session and outlined confidentiality protocol. Participants were given an opportunity to raise any concerns that they might have. The conversational tone of the moderator was light hearted so participants would feel at ease and not feel like they are being examined.
4) The audio recorder was started and participants were asked to introduce themselves, their profession and the relevance walking has to their line of work.
5) The moderator then gave the instruction to the group to select two areas in each of the inner city, the outer city and the suburbs (outside the M50 orbital motorway) which from personal experience they consider to be highly walkable. The moderator emphasised that there are no right or wrong answers just different opinions. If a group member asked for clarification to what was meant by walkable they were told to go with what they think is walkable and the understandings of walkability would be discussed after.
6) After five minutes each participant was given six pink removable stickers and asked to repeat the exercise for low walkable areas.
7) After five minutes the moderator asked each participant for their selections which were written on a flip chart by the assistant moderator.
8) The discussion was started when the moderator asked a randomly selected participant for the reasons for their selections. Each area was discussed in turn and other group members were asked for their views on the area. Discussion started in the inner city and worked out towards the suburbs.

9) Following this exercise the assistant moderator gave a summary of what was discussed and participants were asked if they agree or if there is anything that they think we missed for participant verification.

10) Then, if relevant, the assistant moderator raised items which were identified by the research team that were not discussed. The assistant moderator kept a checklist during the focus group discussion.

11) At the end of the focus group participants were thanked for their participation.

12) Maps and flipcharts were photographed.

13) Peer debriefing took place between the moderator and the assistant moderator

Focus groups were repeated until data saturation was reached. This was when no new topics were being raised in the focus groups or no uniquely different areas were being selected by participants.

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Appendix D1: Example of Area Tables for Site Selection

Table D.1: Sample of Qualitative Area information from Study 2, Portobello Area

Area – Only residential included in this analysis		Selected by (FG, Gender, Discipline, personal experience)	Reason for inclusion
Inner City			
Area 1 – Portobello SCR (8 Selections HW Inner)			
Portobello & SCR	HW- I	**P, F, UD,Y** **3, M, SP, Y** **4, M, SP,Y** **P, M , LA,Y**	residential area, interesting **mix of cul-de-sacs and permeable roads** – people like both to live on an quiet cul-de-sac and be able to move through the area. Roads are not always at right angles which give for an **interesting mix of gardens and spaces**. **High connectivity**, short distances to **destinations**. very **vibrant** part of town, it's alive and really you feel like you could walk around there **anytime**, night or, and there is a lot going on and that's a good thing. different mixes of people, **social mix** in that sort of area is very strong and it really adds to the **character** and makes it a **pleasant place** to sort of walk through. very **close to everywhere else** a **lot of facilities** within a very easy striking distance - a very **successful interfac**e sort of between the two (business centre and residential)- it's almost **boutique-y type shops** and things like that and residential community and it's fairly **seamless** and I think it is a pleasant experience too pass through all of those
Wexford Camden St Area	HW- I	**P, M, TP, Y** **2, M, Arch,Y** *P, F, UD, Y* *P, M, Arch, Y* **4, M, UD,Y** **2, F, SP, Y**	**varied activity** on the main area and on the kinda **draws leading** into it and it's **very permeable** you can kinda come in and out of it from almost anywhere. permeability on it's own isn't enough it has to be **of interest as well. It** is **nice** and makes it **easy to remember** it it has a **length of life** in it actually from early in the day to quite late at night Wexford street absolutely full of life, full of vitality but it's also quite, a little bit of a **closterphobic street**. The **footpaths aren't wide quite wide enough** for the number for pedestrians. And a **lot of shutters** and bars at night. I absolutely hate the bottom end of Wexford Street by the way. I just don't like walking there at all Every part of the street had something going on or there was something to do that was interesting, **continuous active frontage**, a continuous line of it they have **a kind of charm**… there is activity around… **diversity of activity**… **connectivity… busy roads but alternative route** through quiet area.
Summary: Alternative connected routes with variety of uses (day and night), character and shape. Vibrant yet quiet in areas. Diverse population. Proximity to destinations but also to other areas. An area with an ease of movement. While footpaths are narrow and streets busy it has a charm.			

Appendix D2: Area Selection Information

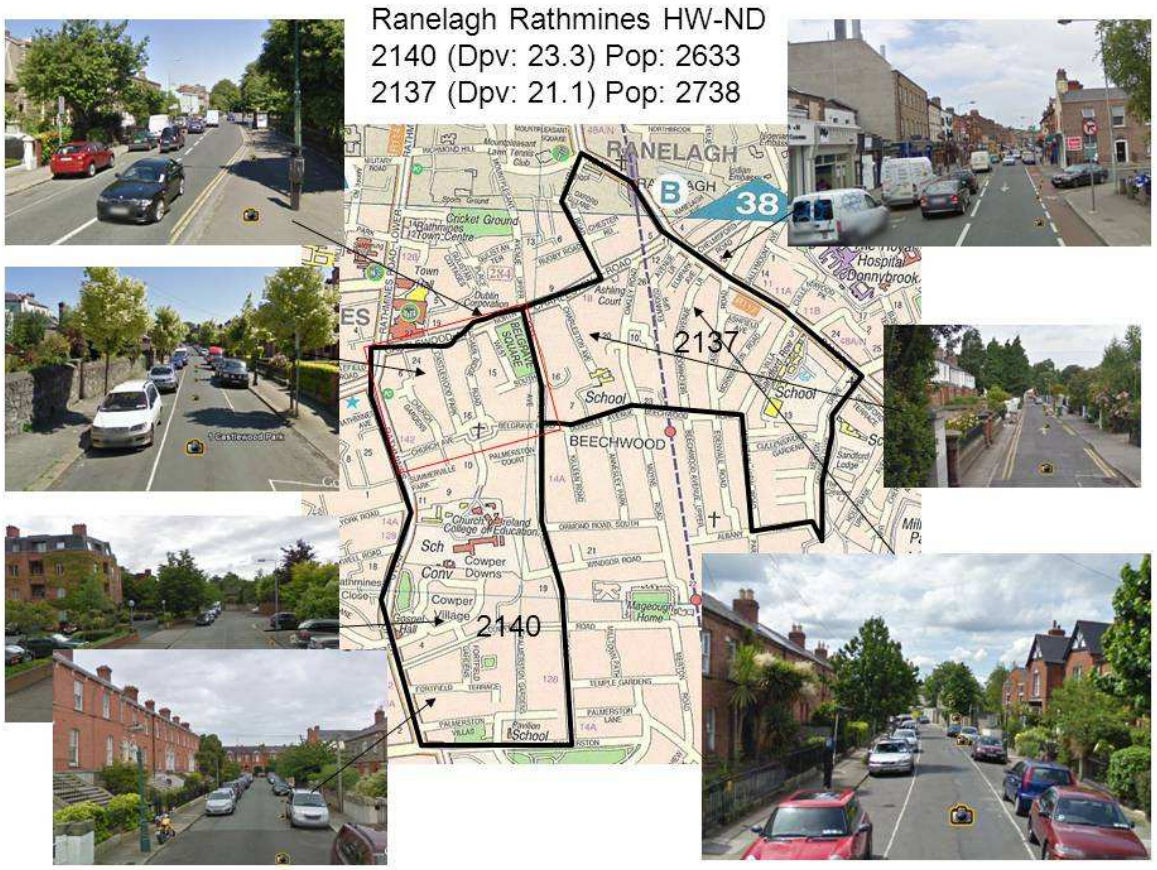


Figure D -1: Ranelagh - Rathmines Slide

Swords suburbs LW-ND
4026 (Dpv: 15.1) Pop: 5526

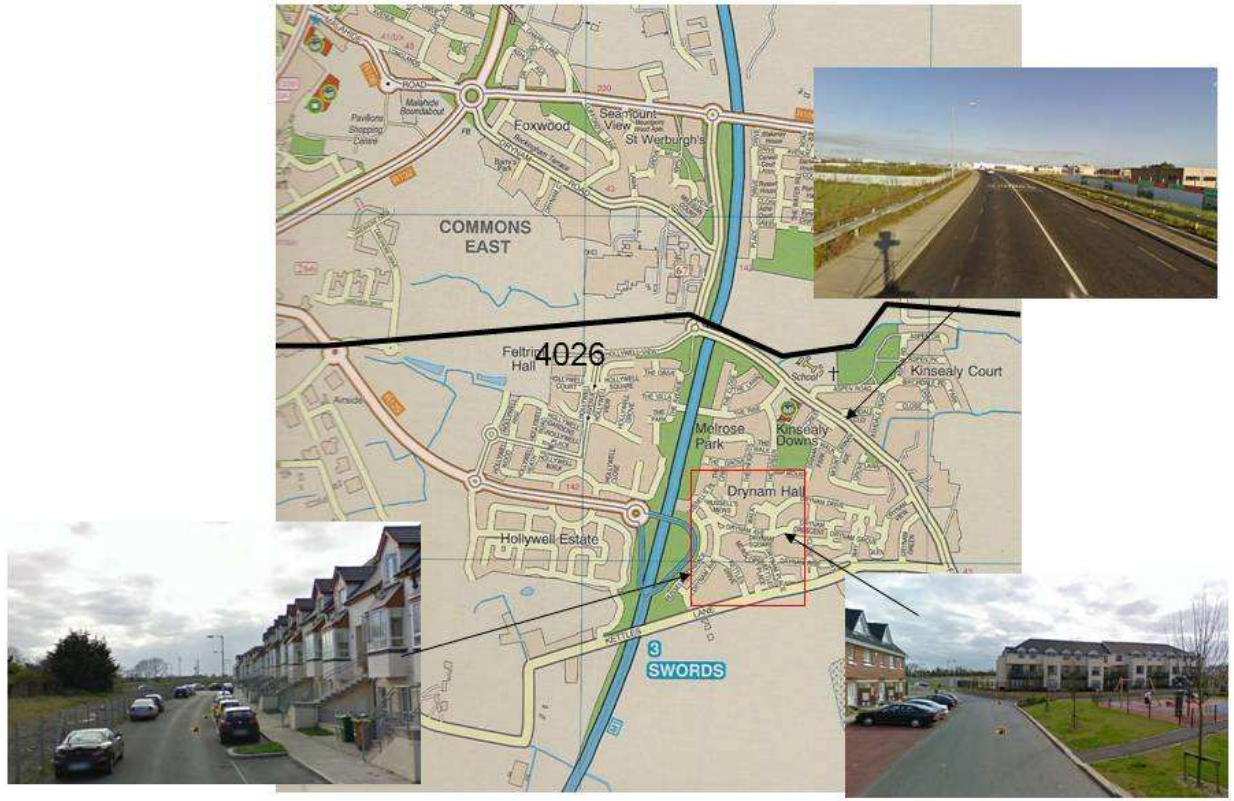
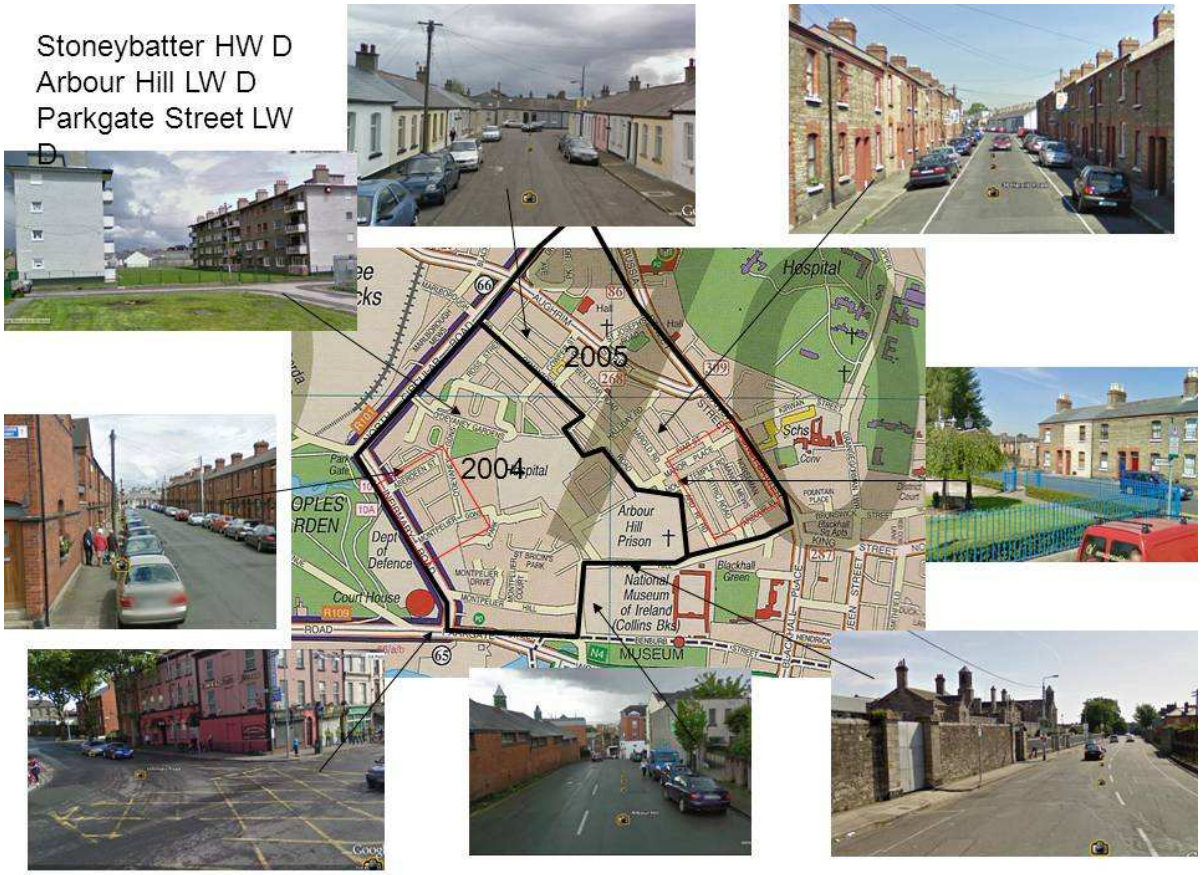


Figure D -2: Swords Suburbs Slide



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Appendix E1: Cleaner, Leaner, Greener Questionnaire and Cover Letter

Dear Resident:

Your household has been selected for an international study on health and travel activity in Dublin. Please fill out our survey; it should take no longer than **15 to 20 minutes** of your time.

You are under no obligation to answer every question; your participation is valued but completely voluntary. Your answers to the questionnaire will be reported as a group response, and individual answers will remain confidential. Only include your name and address on the survey if you wish to be included in a raffle for a €50 voucher for a local shop.

This research is being conducted by Dublin City University, Trinity College Dublin and West Virginia University, USA. It is funded by the Environmental Protection Agency and has been ethically approved by DCU.

Please complete and return the survey within a week or so. Your cooperation with this research is extremely important and hopefully beneficial for communities, including yours, across the nation.

Yours Sincerely,

Dr. Catherine Woods
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Faculty of Science and Health
Dublin City University
Tel: 01-7008008
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DCU

West Virginia University

TRINITY COLLEGE DUBLIN
COLÁISTE NA TRÍONÓIDE, BAILE ÁTHA CLIATH
THE UNIVERSITY OF DUBLIN

epa
Environmental Protection Agency

We would like to ask you questions relating to your neighbourhood, how you travel and your health. We need your help to make our study a success.

Your honest answers to the items in this survey are very important to us. Remember….

- We want to know what you think,
- There are no right or wrong answers, and
- We apologise if some of the questions may seem repetitive, we appreciate your patience.

Please

- answer all questions

Everything you tell us will be kept strictly confidential (secret).

You can complete this survey:

1) On your doorstep with trained researchers

OR

2) At your leisure and it will be collected by the research team at an arranged time or you can post it back using the envelope provided. The postage has already been paid.

OR

3) Online at www.surveymonkey.com/s/dcuneighbourhoods

If you would like to contact us

please email walkable@dcu.ie

or call Lorraine on 01-7008847

Office use only

No. Area____ Hand/Post P D C O T

A: General Questions

For the purpose of this survey your **Neighbourhood** is defined as the area within **approx a kilometre / half a mile** of your home, or about a **10 - minute walk**

(Please ✔ one box only)

A1. In general, would you say that your health is?

❑1	❑2	❑3	❑4	❑5
Poor	Fair	Good	Very good	Excellent

A2. All things considered, how satisfied are you with life as a whole?

❑1	❑2	❑3	❑4	❑5
Very dissatisfied	Moderately dissatisfied	No feelings either way	Moderately satisfied	Very satisfied

A3. How easy, or difficult, is it to use public transport near your home?

Think about…

- getting to the bus, train or LUAS stop,
- how often it comes and
- where you can go to.

❑1	❑2	❑3	❑4	❑5
Very easy	Somewhat easy	Neither easy nor difficult	Difficult	Very difficult

A4. In general, how well do you know your neighbours?

❑1	❑2	❑3	❑4
Not at all	Just a little	Moderately well	Extremely well

A5. Do you have a chronic illness (including mental illness) or physical, learning or sensory disability which affects your capacity to participate in certain physical activities?

Yes ❑1 No ❑0

(If yes, please specify or describe_____)

A6. Do you have a chronic illness (including mental illness) or physical, learning or sensory disability which affects your capacity to drive?

Yes ❑1 No ❑0

(If yes, please specify or describe_____)

B: Travel

We are interested in learning about

- how YOU travel to the following places and
- how often you make the trip and
- how long it takes.

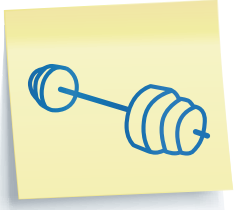
If you do not travel to the places listed, please tick the 'journey not applicable' box.

How do you USUALLY travel to the following?
For mixed trips, please select the method of travel for the longest part, by distance, of the trip

(Please ✔ one box only on each row)

B1	On foot	Bicycle	Bus, Train, Dart or LUAS	By car	Motorcycle or scooter	Taxi	Other means
A corner shop/ newsagent 	❑1	❑2	❑3	❑4	❑5	❑6	❑7

Journey not applicable						
❑	**B2 How often do you make this trip?**	Almost everyday ❑1	3 – 5 times a week ❑2	1-2 times a week ❑3	1 -3 times a month ❑4	Less than once a month ❑5
	B3 How long does the trip take? (one way)	Less than 5 mins ❑1	5- 10 mins ❑2	10-15 mins ❑3	15-20 mins ❑4	20mins + ❑5

B4	On foot	Bicycle	Bus, Train, Dart or LUAS	By car	Motorcycle or scooter	Taxi	Other means
The place you go to exercise (e.g. a gym or the park) 	❑1	❑2	❑3	❑4	❑5	❑6	❑7

Journey not applicable						
❑	**B5 How often do you make this trip?**	Almost everyday ❑1	3 – 5 times a week ❑2	1-2 times a week ❑3	1 -3 times a month ❑4	Less than once a month ❑5
	B6 How long does the trip take? (one way)	Less than 5 mins ❑1	5- 10 mins ❑2	10-15 mins ❑3	15-20 mins ❑4	20mins + ❑5

B7	On foot	Bicycle	Bus, Train, Dart or LUAS	By car	Motorcycle or scooter	Taxi	Other means
A local school 	❑1	❑2	❑3	❑4	❑5	❑6	❑7

Journey not applicable ❑	B8 How often do you make this trip?	Almost everyday ❑1	3 – 5 times a week ❑2	1-2 times a week ❑3	1 -3 times a month ❑4	Less than once a month ❑5
	B9 How long does the trip take? (one way)	Less than 5 mins ❑1	5- 10 mins ❑2	10-15 mins ❑3	15-20 mins ❑4	20mins + ❑5

B10	On foot	Bicycle	Bus, Train, Dart or LUAS	By car	Motorcycle or scooter	Taxi	Other means
The place you go to socialise (eg a pub or community centre) 	❑1	❑2	❑3	❑4	❑5	❑6	❑7

Journey not applicable ❑	B11 How often do you make this trip?	Almost everyday ❑1	3 – 5 times a week ❑2	1-2 times a week ❑3	1 -3 times a month ❑4	Less than once a month ❑5
	B12 How long does the trip take? (one way)	Less than 5 mins ❑1	5- 10 mins ❑2	10-15 mins ❑3	15-20 mins ❑4	20mins + ❑5

B13	On foot	Bicycle	Bus, Train, Dart or LUAS	By car	Motorcycle or scooter	Taxi	Other means
A crèche or childcare facility 	❑1	❑2	❑3	❑4	❑5	❑6	❑7

Journey not applicable ❑	B14 How often do you make this trip?	Almost everyday ❑1	3 – 5 times a week ❑2	1-2 times a week ❑3	1 -3 times a month ❑4	Less than once a month ❑5
	B15 How long does the trip take? (one way)	Less than 5 mins ❑1	5- 10 mins ❑2	10-15 mins ❑3	15-20 mins ❑4	20mins + ❑5

B16	On foot	Bicycle	Bus, Train, Dart or LUAS	By car	Motorcycle or scooter	Taxi	Other means
A public transport stop 	❑1	❑2	❑3	❑4	❑5	❑6	❑7

Journey not applicable ❑						
B17 How often do you make this trip?	Almost everyday ❑1	3 – 5 times a week ❑2	1-2 times a week ❑3	1 -3 times a month ❑4	Less than once a month ❑5
B18 How long does the trip take? (one way)	Less than 5 mins ❑1	5- 10 mins ❑2	10-15 mins ❑3	15-20 mins ❑4	20mins + ❑5

B19	On foot	Bicycle	Bus, Train, Dart or LUAS	By car	Motorcycle or scooter	Taxi	Other means
A supermarket 	❑1	❑2	❑3	❑4	❑5	❑6	❑7

Journey not applicable ❑						
B20 How often do you make this trip?	Almost everyday ❑1	3 – 5 times a week ❑2	1-2 times a week ❑3	1 -3 times a month ❑4	Less than once a month ❑5
B21 How long does the trip take? (one way)	Less than 5 mins ❑1	5- 10 mins ❑2	10-15 mins ❑3	15-20 mins ❑4	20mins + ❑5

B22	On foot	Bicycle	Bus, Train, Dart or LUAS	By car	Motorcycle or scooter	Taxi	Other means
A post office, bank or credit union 	❑1	❑2	❑3	❑4	❑5	❑6	❑7

Journey not applicable ❑						
B23 How often do you make this trip?	Almost everyday ❑1	3 – 5 times a week ❑2	1-2 times a week ❑3	1 -3 times a month ❑4	Less than once a month ❑5
B24 How long does the trip take? (one way)	Less than 5 mins ❑1	5- 10 mins ❑2	10-15 mins ❑3	15-20 mins ❑4	20mins + ❑5

B25	On foot	Bicycle	Bus, Train, Dart or LUAS	By car	Motorcycle or scooter	Taxi	Other means
The friend/ family member you visit most often 	❑1	❑2	❑3	❑4	❑5	❑6	❑7

Journey not applicable ❑	B26 How often do you make this trip?	Almost everyday ❑1	3 – 5 times a week ❑2	1-2 times a week ❑3	1 -3 times a month ❑4	Less than once a month ❑5
	B27 How long does the trip take? (one way)	Less than 5 mins ❑1	5- 10 mins ❑2	10-15 mins ❑3	15-20 mins ❑4	20mins + ❑5

B28	On foot	Bicycle	Bus, Train, Dart or LUAS	By car	Motorcycle or scooter	Taxi	Other means
A church or place of worship 	❑1	❑2	❑3	❑4	❑5	❑6	❑7

Journey not applicable ❑	B29 How often do you make this trip?	Almost everyday ❑1	3 – 5 times a week ❑2	1-2 times a week ❑3	1 -3 times a month ❑4	Less than once a month ❑5
	B30 How long does the trip take? (one way)	Less than 5 mins ❑1	5- 10 mins ❑2	10-15 mins ❑3	15-20 mins ❑4	20mins + ❑5

C: Work

C1. Is your current job status...?

(Please ✔ one only)

(a) Employed or self-employed ..... ❑1
(b) Looking after home/family ..... ❑2
(c) Looking for first regular job ..... ❑3
(d) Unemployed ..... ❑4
(e) Student ..... ❑5
(f) Retired from employment ..... ❑6
(g) Unable to work due to permanent sickness or disability ..... ❑7
(h) Other ..... ❑8

If you do not work or study outside the home please go to question D1

C2	On foot	Bicycle	Bus, Train, Dart or LUAS	By car	Motorcycle or scooter	Taxi	Other means
How do you USUALLY travel to the place that you work or study? (Please tick one only) For mixed trips, please select the method of travel for the longest part, by distance, of the trip	 ❑1	 ❑2	 ❑3	 ❑4	 ❑5	 ❑6	 ❑7

C3 How long does the trip take? (one way)	Less than 5 mins ❑1	5- 10 mins ❑2	10-15 mins ❑3	15-20 mins ❑4	20mins + ❑5

D: Vehicles

For the next few questions we are trying to understand how much you spend on motor fuel (petrol, diesel, etc) for private use.

D1. **How many cars, motorbikes, SUV's or vans are owned or are available for use by one or more members of your household?**
Include any company car or van if available for private use:
0 ❑ 1 ❑ 2 ❑ 3 ❑ 4 or more ❑

D2. **How much money do YOU spend on motor fuel per week?** €_____

D3. **How much money is spent by your household on motor fuel per week?** €_____

D4 **What are the makes, models and engine size's (if known) of the cars, van's, motorbikes or SUV's owned or available for use by one or more members of your household?** Please list your vehicle first

	Make (i.e. Opel)	Model (i.e. Astra)	Engine size (i.e. 1.4 litre or 1399 cc)	Registration Year	Fuel type (i.e. petrol)
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____
5.	_____	_____	_____	_____	_____
6.	_____	_____	_____	_____	_____

E: Neighbourhood Description

Please tick the answer that best applies to you and your neighbourhood.

In my neighbourhood there are…	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Sufficiently wide, good quality footpaths	❑1	❑2	❑3	❑4	❑5
Pedestrian crossings/ pedestrian lights to help walkers cross busy roads	❑1	❑2	❑3	❑4	❑5
Many different routes for walking from place to place so I don't have to go the same way every time	❑1	❑2	❑3	❑4	❑5
Many attractive sights (such as gardens, trees, green spaces, attractive buildings and views)	❑1	❑2	❑3	❑4	❑5
Nice places, within walking distance of my home, to go for a walk for recreation (such as a park or even just around the neighbourhood itself)	❑1	❑2	❑3	❑4	❑5
Large car parks in front of shops and businesses	❑1	❑2	❑3	❑4	❑5
Wide roads with multiple lanes of traffic	❑1	❑2	❑3	❑4	❑5

In my neighbourhood…	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Streets are hilly, making it difficult to walk	❑1	❑2	❑3	❑4	❑5
Many of my family and friends live within walking distance	❑1	❑2	❑3	❑4	❑5
There are many friendly or familiar faces	❑1	❑2	❑3	❑4	❑5
While walking in bad weather I can find shelter from the wind and rain	❑1	❑2	❑3	❑4	❑5
There are a many other people walking	❑1	❑2	❑3	❑4	❑5
Shops and businesses close shutters over their shop fronts when closed	❑1	❑2	❑3	❑4	❑5
The crime rate in my neighbourhood makes it unsafe to walk to places during the day	❑1	❑2	❑3	❑4	❑5
The crime rate in my neighbourhood makes unsafe to walk to places at night	❑1	❑2	❑3	❑4	❑5
Footpaths are separated from the road by a buffer (for example: grass verge, parked cars or other barrier)	❑1	❑2	❑3	❑4	❑5
The speed of traffic on the street I live and most nearby streets is usually slow (Prompt: 30kph or less)	❑1	❑2	❑3	❑4	❑5
People walking on the street can be easily seen by people in their homes, shops and other occupied buildings	❑1	❑2	❑3	❑4	❑5

Your **Neighbourhood** is defined as the area within **approx a kilometre/** half a mile of your home, or about a **10 - minute walk**

In my neighbourhood there are…	**Strongly disagree**	**Somewhat disagree**	**Neither agree nor disagree**	**Somewhat agree**	**Strongly agree**
Badly maintained, unoccupied or unattractive buildings or houses	❑1	❑2	❑3	❑4	❑5
Many inviting, locally owned shops	❑1	❑2	❑3	❑4	❑5
Places to stop for a rest while walking	❑1	❑2	❑3	❑4	❑5
Children playing in the neighbourhood	❑1	❑2	❑3	❑4	❑5
Homeless people and/or beggars	❑1	❑2	❑3	❑4	❑5
Many high walls alongside footpaths	❑1	❑2	❑3	❑4	❑5
People around all day and in the evening shopping or visiting restaurants and pubs nearby	❑1	❑2	❑3	❑4	❑5

In my neighbourhood there is…	**Strongly disagree**	**Somewhat disagree**	**Neither agree nor disagree**	**Somewhat agree**	**Strongly agree**
A variety of shops/ homes/ businesses and amenities	❑1	❑2	❑3	❑4	❑5
A mix of age groups ,young and old people, as well as a mix of family types	❑1	❑2	❑3	❑4	❑5
A lot of air pollution (from all sources including traffic fumes)	❑1	❑2	❑3	❑4	❑5
A lot of noise	❑1	❑2	❑3	❑4	❑5

My neighbourhood…	**Strongly disagree**	**Somewhat disagree**	**Neither agree nor disagree**	**Somewhat agree**	**Strongly agree**
Has little or no graffiti	❑1	❑2	❑3	❑4	❑5
Has a high crime rate	❑1	❑2	❑3	❑4	❑5
Is an unique area with personality and character	❑1	❑2	❑3	❑4	❑5
Is generally free from rubbish/ litter	❑1	❑2	❑3	❑4	❑5
Is safe enough that I would let a 10 year child walk around my neighbourhood alone in daytime	❑1	❑2	❑3	❑4	❑5
Is well lit at night	❑1	❑2	❑3	❑4	❑5

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
While walking in my neighbourhood I often have to wait a long time for a pedestrian light	❑1	❑2	❑3	❑4	❑5
I can do most of my shopping at local shops	❑1	❑2	❑3	❑4	❑5
I feel connected to people that live in my Neighbourhood	❑1	❑2	❑3	❑4	❑5
My local neighbourhood has a village feel to it	❑1	❑2	❑3	❑4	❑5
I can easily travel to the majority of places I want to go in Dublin using public transport	❑1	❑2	❑3	❑4	❑5
While walking in my neighbourhood there are places that I avoid	❑1	❑2	❑3	❑4	❑5

E2. **Overall, how would you rate your neighbourhood as a place to walk?**
Walkable means pedestrian friendly

Very walkable	Somewhat walkable	Neither walkable nor unwalkable	Not very walkable	Not at all walkable
❑1	❑2	❑3	❑4	❑5

E3. **Would you say that most of the time people try to be helpful or that they are mostly just looking out for themselves?** Please tick one.

try to be helpful ❑1

looking out for themselve ❑2

E4. **All things considered, how happy are you right now? (Please ✔ one box)**

Not happy at all	Not very happy	Neither happy nor unhappy	Somewhat happy	Very happy
❑1	❑2	❑3	❑4	❑5

F: Neighbourhood Satisfaction

Thinking about your neighbourhood (or local area), HOW SATISFIED are you with the following?
(Please ✔ one box)

	Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
Living in your neighbourhood	❑1	❑2	❑3	❑4	❑5
Appearance of your neighbourhood	❑1	❑2	❑3	❑4	❑5
Feeling of safety from crime	❑1	❑2	❑3	❑4	❑5
Noise level	❑1	❑2	❑3	❑4	❑5
The amount of motorised traffic (cars, vans and other vehicles)	❑1	❑2	❑3	❑4	❑5
Air quality	❑1	❑2	❑3	❑4	❑5
Ease of getting to and from work or the place I study	❑1	❑2	❑3	❑4	❑5
Ease of getting to and from convenience stores or other shops	❑1	❑2	❑3	❑4	❑5
Places to socialise nearby	❑1	❑2	❑3	❑4	❑5
Ease of getting home late at night	❑1	❑2	❑3	❑4	❑5
Access to basic services nearby (shops, medical services, banking, schools etc)	❑1	❑2	❑3	❑4	❑5
Access to public transport	❑1	❑2	❑3	❑4	❑5

F2. **If money was no object, where in Dublin would you live?**
(Please ✔ one only)

(a) Where I live now ❑1

(b) Other ❑2 Please Specify _____

G: Your Physical Activity

We are interested in finding out about the kinds of physical activities that people do **as part of their everyday lives.**
Please answer each question even if you do not consider yourself to be an active person.

Vigorous physical activities refer to activities that take hard physical effort and make you breathe **much harder than normal**. Activities like strenuous manual labour, aerobics, or fast cycling

Moderate activities refer to activities that take moderate physical effort and make you breathe **somewhat harder than normal**. Activities like carrying light loads, hovering or other active housework

Think about the vigorous and moderate activities you do

- at work,
- at home,
- as part of your house and yard work,
- to get from place to place, and
- in your spare time for recreation, exercise or sport

Think about ALL the **vigorous** activities that you do for at least 10 minutes at a time.

G1. During the **last 7 days**, how many days did you do **vigorous** physical activity?

_____ days per week ❑ No vigorous physical activities ⇨ Skip to question G3

G2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

____ hours and _____ minutes per day ❑ Don't know/Not sure

Think about ALL the **moderate** activities that you do for at least 10 minutes at a time.

G3. **During the last 7 days, how many days did you do moderate physical activities?** Do not include walking or cycling for recreation or to get from place to place.

_____ days per week ❑ No moderate physical activities ⇨ Skip to question G5

G4. **How much time did you usually spend doing moderate physical activities on one of those days?**

____ hours and _____ minutes per day ❑ Don't know/Not sure

Think about the time you spent walking or cycling to get to places, including walking or cycling to places as part of your work day

G5. In the **last 7 days**, how many days did you **walk or cycle to get from place to place** for at least 10 minutes at a time?

_____ days per week ❑ No walking for transport ⇨ Skip to question G7

G6. How much time did you usually spend **walking or cycling to get from place to place** on one of those days?

____ hours and _____ minutes per day ❑ Don't know/Not sure

Think about the time you spent **walking for recreation (leisure)**. This includes walking that you do solely for recreation, exercise, or leisure.

G7. In the last 7 days, how many days did you walk for recreation for at least 10 minutes at a time?

_____ days per week ❑ No walking for recreation ⇨ Skip to question G9

G8. How much time did you usually spend **walking for recreation** on one of those days?

____ hours and _____ minutes per day ❑ Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, time driving, visiting friends, reading, or sitting or lying down to watch television.

G9. During the **last 7 days**, how much time did you spend **sitting** on a **week day?**

____ hours and _____ minutes per day ❑ Don't know/Not sure

You are making great progress.

Please continue as your responses are really important to us.

H: You and your household

H1. Are you? Male ❑1 Female ❑0

H2. What year were you born? _____

H3. What is your weight?

_____Stone and/or _____Ibs or _____Kilos

H4. What is your height without shoes?

_____Feet and Inches or _____Centimetres

H5. Do you happen to know what your waist circumference measurement is?

_____ inches or _____ cm

To measure your waist circumference, use a tape measure. Start at the top of the hip bone, then bring it all the way around -- level with your navel. Make sure it's not too tight and that it is parallel with the floor. Don't hold your breath while measuring it!

H6. How long have you lived at your current address? (Approximate) _____ Years _____ Months

H7. How many people live at this household, including yourself? _____

H8. What are the ages of children (under 18 years) living in your household (if any)?

No Children Child 1___ Child 2___, 3___, 4___, 5___, 6___, 7___, 8___

We understand that people do not like to talk about income. For the purpose of this study we would appreciate it if you would answer this question. We assure you that your answer will be kept confidential.

H9. What was your approximate ANNUAL income before tax in 2010 (including social welfare payments)?
€_____

H10. What was your approximate ANNUAL household income before tax in 2010 (including social welfare payments)? €_____

H11. Does your household have a dog? Yes ❑1 No ❑0

H12. Are you? (Please ✔ one only)

(a) Single ❑1
(b) Married ❑2
(c) Living with partner ❑3
(d) Widowed ❑4
(e) Separated/ Divorced ❑5

H13. What is your highest level of education completed to date? (Please ✔ one only)

(a) Some primarily or no schooling ❑1
(b) Primary education only ❑2
(c) Some secondary education ❑3
(d) Completed secondary education ❑4
(e) Some third level education at college, university, RTC/IT ❑5
(f) Complete third level education at college, university, RTC/IT ❑6
(g) Postgraduate qualification ❑7

H14. Are you? (Please ✔ one only) (a) Irish ❑1 (b) Other ❑2 Please Specify _____

H15. Do you?

(a) Own your home outright (with no mortgage) ❑1
(b) Own your home (with a mortgage/ loan on it) ❑2
(c) Rent privately ❑3
(d) Rent from local authority (including tenant purchase scheme) ❑4
(e) Other ❑5

I: Destinations'

A lot of people are very dependent on a car these days to get where they want to go. If you or another person in your household wanted to, which of the following COULD YOU WALK TO, WITHOUT TOO MUCH TROUBLE? (Please ✔ all that apply)	Yes	No
1. A corner shop/ newsagent	❑1	❑0
2. A church or place of worship	❑1	❑0
3. A park (or pitch) 0	❑1	❑0
4. A local school	❑1	❑0
5. A community centre or recreation centre	❑1	❑0
6. A crèche or childcare facility	❑1	❑0
7. A chemist (or pharmacy)	❑1	❑0
8. A pub	❑1	❑0
9. A public transport stop	❑1	❑0
10. The place that I work/study	❑1	❑0
11. The sea, a river, a canal or a lake	❑1	❑0
12. A supermarket	❑1	❑0
13. A bank or credit union	❑1	❑0
14. A post office	❑1	❑0
15. A coffee shop	❑1	❑0
16. A fast food restaurant	❑1	❑0
17. A non-fast food restaurant (including pub grub)	❑1	❑0

J: Prevent You Walking

J1. How often do the following prevent you from walking in your neighbourhood?

	Never	Rarely	Sometimes	Often	Very often
A disability or poor health	❑1	❑2	❑3	❑4	❑5
Lack of time	❑1	❑2	❑3	❑4	❑5
Bad weather	❑1	❑2	❑3	❑4	❑5
Being self conscious about your appearance	❑1	❑2	❑3	❑4	❑5
Not being in the right mood	❑1	❑2	❑3	❑4	❑5
Lack of company or others to walk with	❑1	❑2	❑3	❑4	❑5
Lack of energy	❑1	❑2	❑3	❑4	❑5
Not enjoying exercise	❑1	❑2	❑3	❑4	❑5
Ruining my hair or make –up	❑1	❑2	❑3	❑4	❑5
Wanting to wear fashionable shoes unsuitable for walking distances	❑1	❑2	❑3	❑4	❑5
Fear of falling/ getting injured	❑1	❑2	❑3	❑4	❑5
Feeling unsafe from crime	❑1	❑2	❑3	❑4	❑5
Feeling unsafe from traffic	❑1	❑2	❑3	❑4	❑5
Not feeling part of the community	❑1	❑2	❑3	❑4	❑5
Easier to drive even short journeys	❑1	❑2	❑3	❑4	❑5

J2. Is there any other comment you would like to make about walking/ living in your neighbourhood?

_____

_____

_____

_____

_____

_____

_____

THE QUESTIONNAIRE IS NOW COMPLETE,
THANK YOU VERY MUCH FOR YOUR TIME.

To be entered into our draw for a €50 voucher for a local supermarket please enter your name and address below.

Your individual responses will remain confidential and you will not be identifiable from the data produced. This page will be removed and stored separately from your survey responses.

Name:_____

Address:_____

_____

_____

_____

_____

Help us map your area, instructions overleaf

www.openstreetmap.org

is a website which allows users map areas using a wiki-style approach.

If you have a smart phone or are interested in GIS//GPS mapping please check it out.


DCU


WestVirginiaUniversity.


TRINITY COLLEGE DUBLIN
COLÁISTE NA TRÍONÓIDE, BAILE ÁTHA CLIATH
THE UNIVERSITY OF DUBLIN


epa
Environmental Protection Agency

Appendix E3: CGL Reliability Test Results

Table E-2: Test-retest reliability of built environment items

	Item	*N*	*ICC*	*95% CI*
	In my neighbourhood there are…			
Ea1	Sufficiently wide good quality footpaths	22	.93	.83 - .97
Ea2	Pedestrian crossings/ pedestrian lights to help walkers cross busy roads	22	.92	.80 - .96
Ea3	Many different routes for walking from place to place so I don't have to go the same way every time	22	.80	.52 - .92
Ea4	Many attractive sights (such as gardens, trees, green spaces, attractive buildings and views)	22	.76	.43 - .90
Ea5	Nice places within walking distance of my home, to go for a walk for recreation (such as a park or even just around the neighbourhood itself)	22	.91	.78 - .96
Ea6	Large car parks in front of shops and businesses	11	.86	.48 - .96
Ea7	Wide roads with multiple lanes of traffic	22	.84	.61 - .93
	In my neighbourhood…			
Eb1	Streets are hilly, making it difficult to walk	21	.86	.65 - .94
Eb2	Many of my friends and family live within walking distance	21	.90	.75 - .96
Eb3	There are many friendly or familiar faces	21	.71	.28 - .88
Eb4	While walking in bad weather I can find shelter from the wind and rain	21	.78	.46 - .91
Eb5	There are many other people walking	21	.84	.62 - .94
Eb6	Shops and businesses close shutters over the shop fronts when closed	21	.61	.03 - .84
Eb7	The crime rate in my neighbourhood makes it unsafe to walk to places during the day	21	.63	.09 - .85
Eb8	The crime rate in my neighbourhood makes it unsafe to walk to places at night	21	.45	-.35 - .78
Eb9	Footpaths are separated from the road by a buffer (for example: grass verge, parked cars or other barrier)	21	.64	.10 - .85
Eb10	The speed of traffic on the street I live and most nearby streets is usually slow (Prompt: 30kph or less)	11	.90	.61 - .97
Eb11	People walking on the street can be easily seen by people in their homes, shops and other occupied buildings	21	.85	.63 - .94
	In my neighbourhood there are…			
Ec1	Badly maintained, unoccupied or unattractive buildings and houses	21	.81	.53 - .92
Ec2	May inviting, locally owned shops	21	.58	-.04 - .83
Ec3	Places to stop for a rest while walking	21	.69	.23 - .87
Ec4	Children playing in the neighbourhood	21	.83	.59 - .93
Ec5	Homeless people and/or beggars	21	.95	.88 - .98
Ec6	Many high walls along footpaths	21	.86	.65 - .94
Ec7	People about all day and in the evening shopping and visiting restaurants and pubs nearby	21	.70	.27 - .88
	In my neighbourhood there is…			
Ed1	A variety of shops/ homes / businesses and amenities	21	.91	.78 - .96
Ed2	A mix of age groups, young and old people, as well as a mix of family types	21	.89	.73 - .96
Ed3	A lot of air pollution (from all sources including traffic fumes)	21	.87	.68 - .95
Ed4	A lot of noise	21	.90	.75 - .96
	My neighbourhood…			
Ee1	Has little or no graffiti	21	.68	.20 - .87
Ee2	Has a high crime rate	21	.82	.54 - .93
Ee3	Is an unique area with personality and character	21	.89	.72 - .95
Ee4	Is generally free from rubbish and litter	21	.64	.11 - .85
Ee5	Is safe enough that I would let a 10 year old child walk around my neighbourhood alone in the daytime	21	.81	.54 - .92
Ee6	Is well lit at night	21	.82	.55 - .93

Ef1	While walking in my neighbourhood I often have to wait a long time for a pedestrian light	21	.75	.37 - .90
Ef2	I can do most of my shopping at local shops	21	.86	.66 - .94
Ef3	I feel connected to the people that live in my neighbourhood	21	.83	.59 - .93
Ef4	My local neighbourhood has a village feel to it	20	.82	.55 - .93
Ef5	I can easily travel to the majority of places I want to go to in Dublin using public transport	21	.87	.67 - .95
Ef6	While walking in my neighbourhood there are places I avoid	11	.93	.75 - .98

Note: ICC: Intra-class correlation coefficient

TableE-3: Test re-test reliability of General Questions

	Item		*N*	*ICC*	*95% CI*
A1	In general, would you say that your health is?	5 point likert scale: (1) Poor to (5) Excellent	22	.95	.87 - .98
A2	All things considered, how satisfied are you with life as a whole?	5 point Likert scale (1) very dissatisfied to (5) very satisfied	22	.97	.92 - .99
A3	How easy, or difficult, is it to use public transport near your home? (with prompt)	5 point Likert scale (1) very easy to (5) very difficult	22	.79	.49 - .91
A4	In general, how well do you know your neighbours?	4 point Likert scale (1) not at all to (4) extremely well	11	.98	.93 - .99
A5	Not included as it was a Y/N and had 100% agreement so analysis didn't work…				
A6					
E2	Overall, how would you rate your neighbourhood as a place to walk?	5 point Likert scale (1) very walkable to (5) not at all walkable	22	.90	.75 - .96
E3	Would you say that most of the time people try to be helpful or look out for themselves	Binary	10	.89	.55 - .97
E4	All things considered, how happy are you right now?	5 point Likert scale (1) not happy at all to (5) very happy	11	.72	-.03 - .93

Table E-4: Test - retest reliability of Neighbourhood satisfaction question

	Item	*N*	*ICC*	*95% CI*
F1a	Living in your neighbourhood	22	.90	.75 - .96
F1b	Appearance of your neighbourhood	22	.87	.69 - .95
F1c	Feeling of safety from crime	22	.84	.62 - .93
F1d	Noise level	22	.85	.63 - .94
F1e	The amount of motorised traffic (cars, vans and other vehicles)	22	.78	.47 - .91
F1f	Air quality	11	.72	-.03 - .93
F1g	Ease of getting to and from work or the place I study	22	.96	.90 - .98
F1h	Ease of getting to and from convenience stores or other shops	11	.95	.81 - .99
F1i	Places to socialise nearby	22	.62	.09 - .84
F1j	Ease of getting home late at night	22	.89	.73 - .95
F1k	Access to basic services nearby (shops, medical services, banking, schools etc)	11	.76	.09 - .93
F1l	Access to public transport	11	.89	.60 - .97
F2	If money was no object, where in Dublin would you live?	19	.97	.92 - .99

Table E-5: Test - retest reliability of Prevent you from walking question

	Item	*N*	*ICC*	*95% CI*
J1a	A disability or poor health	11	.89	.59 - .97
J1b	Lack of time	11	.63	-.39 - .90
J1c	Bad weather	22	.79	.49 - .91
J1d	Being self conscious about your appearance	22	.80	.53 - .92
J1e	Not being in the right mood	21	.56	-.09 - .82
J1f	Lack of company or others to walk with	22	.70	.28 - .88
J1g	Lack of energy	22	.53	-.13 - .81
J1h	Not enjoying exercise	22	.83	.59 - .83
J1i	Ruining my hair or make-up	22	.62	.09 - .84
J1j	Wanting to wear fashionable shoes unsuitable for walking distances	22	.45	-.32 - .77
J1k	Fear of falling/ getting injured	22	.69	.25 - .87
J1l	Feeling unsafe from crime	20	.83	.56 - .93
J1m	Feeling unsafe from traffic	22	.85	.64 - .94
J1n	Not feeling part of the community	21	.49	-.23 - .79
J1o	Easier to drive even short journeys	22	.91	.78 - .96

Table E-6: Test - retest reliability travel behaviours (mode) question

	Item	*N*	*ICC*	*95% CI*
B1	A corner shop/ newsagent	22	.62	.09 - .84
B4	The place you go to exercise (e.g. a gym or the park)	22	.94	.85 - .97
B7	A local school	21	.82	..55 - .93
B10	The place you go to socialise (eg a pub or community centre)	11	.71	-.01 - .92
B13	A crèche or childcare facility	19	.88	.68 - .95
B16	A public transport stop	22	1.0	1.0 – 1.0
B19	A supermarket	21	.93	.83 - .97
B22	A post office, bank or credit union	11	.50	.-.84 - .87
B25	The friend/ family member you visit most often	11	.89	.60 - .97
B28	A church or place of worship	22	1.0	1.0 – 1.0
C2	Place of work or study	22	.98	.94 - .99

Table E-7: Test - retest reliability travel behaviours (frequency) question

	Item	*N*	*ICC*	*95% CI*
B2	A corner shop/ newsagent	20	.92	.80 - .97
B5	The place you go to exercise (e.g. a gym or the park)	20	.74	.34 - .90
B8	A local school	20	.81	.52 - .93
B11	The place you go to socialise (eg a pub or community centre)	11	1.0	1.0 – 1.0
B14	A crèche or childcare facility	17	.87	.63 - .95
B17	A public transport stop	17	1.0	1.0 – 1.0
B20	A supermarket	18	.84	.57 - .94
B23	A post office, bank or credit union	11	1.0	1.0 – 1.0
B26	The friend/ family member you visit most often	11	.91	.65 - .98
B29	A church or place of worship	19	1.0	1.0 – 1.0

Table E-8: Test - retest reliability travel behaviours (trip time) question

	Item	*N*	*ICC*	*95% CI*
B3	A corner shop/ newsagent	10	.59	-.67 - .90
B6	The place you go to exercise (e.g. a gym or the park)	11	.97	.89 - .99
B9	A local school	11	.55	-.65 - .88
B12	The place you go to socialise (eg a pub or community centre)	9	.91	.59 - .98
B15e	A crèche or childcare facility	11	.70	.-.11 - .92
B18	A public transport stop	10	1.0	1.0 – 1.0
B21	A supermarket	9	.81	.16 - .96
B24	A post office, bank or credit union	10	1.0	1.0 – 1.0
B27	The friend/ family member you visit most often	10	.98	.91 - .99
B30	A church or place of worship	11	1.0	1.0 – 1.0
C3	Place of work or study	11	.85	.43 - .96

Table E-9: Test - retest reliability vehicles and demographics questions

	Item	*N*	*ICC*	*95% CI*
D1	Number of cars	20	1.0	
D3	Household fuel	3	.89	-3.3 – 1.0

KL question, totals
N = 22, ICC = .99, 95% CI: .97 to 1.0

Table E-10: Test - retest reliability amended IPAQ - SF question

	Item	*N*	*ICC*	*95% CI*
G1	Vigorous last 7 days	11	.83	.36 - .95
G2	Vigorous time	11	-.28	-3.74 - .66
G3	Moderate last 7 days	11	.02	-2.7 - .74
G4	Moderate time	11	.39	-1.3 - .84
G5	Walk or cycle transport last 7 days	11	.54	-.72 - .88
G6	Walk or cycle transport time	11	.55	-.67 - .88
G7	Walk for recreation last 7 days	11	.03	-2.64 - .74
G8	Walk for recreation time	11	.02	-2.7 - .73
G9	Sedentary time	22	.85	.65 - .94

Appendix E4: NEWS Survey

ID # _____ Version 12/2002 Date _____

Neighborhood Environment Walkability Scale (NEWS)

We would like to find out more information about the way that you perceive or think about your neighborhood. Please answer the following questions about your neighborhood and yourself. Please answer as honestly and completely as possible and provide only one answer for each item. There are no right or wrong answers and your information is kept confidential.

A. Types of residences in your neighborhood

Among the residences in your neighborhood…

1. How common are <u>detached single-family residences</u> in your immediate neighborhood?

1	2	3	4	5
None	A few	Some	Most	All

2. How common are <u>townhouses or row houses of 1-3 stories</u> in your immediate neighborhood?

1	2	3	4	5
None	A few	Some	Most	All

3. How common are <u>apartments or condos 1-3 stories</u> in your immediate neighborhood?

1	2	3	4	5
None	A few	Some	Most	All

4. How common are <u>apartments or condos 4-6 stories</u> in your immediate neighborhood?

1	2	3	4	5
None	A few	Some	Most	All

5. How common are <u>apartments or condos 7-12 stories</u> in your immediate neighborhood?

1	2	3	4	5
None	A few	Some	Most	All

6. How common are <u>apartments or condos more than 13 stories</u> in your immediate neighborhood?

1	2	3	4	5
None	A few	Some	Most	All

B. Stores, facilities, and other things in your neighborhood

About how long would it take to get from your home to the <u>nearest</u> businesses or facilities listed below if you <u>walked</u> to them? Please put only <u>one</u> check mark (√) for each business or facility.

	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
example: gas station	1. ____	2. ____	3. √	4. ____	5. ____	8. ____
1. convenience/small grocery store	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
2. supermarket	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
3. hardware store	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
4. fruit/vegetable market	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____

	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
5. laundry/dry cleaners	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
6. clothing store	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
7. post office	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
8. library	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
9. elementary school	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
10. other schools	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
11. book store	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
12. fast food restaurant	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
13. coffee place	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
14. bank/credit union	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
15. non-fast food restaurant	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
16. video store	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
17. pharmacy/drug store	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
18. salon/barber shop	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
19. your job or school	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
[check here _____ if do not have work away from home or do not attend school]						
20. bus or trolley stop	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
21. park	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
22. recreation center	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____
23. gym or fitness facility	1. ____	2. ____	3. ____	4. ____	5. ____	8. ____

C. Access to services

Please circle the answer that best applies to you and your neighborhood. Both <u>local</u> and <u>within walking distance</u> mean within a 10-15 minute walk from your home.

1. I can do most of my shopping at local stores.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. Stores are within easy walking distance of my home.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. Parking is difficult in local shopping areas.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. There are many places to go within easy walking distance of my home.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. It is easy to walk to a transit stop (bus, train) from my home.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

6. The streets in my neighborhood are hilly, making my neighborhood difficult to walk in.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

7. There are many canyons/hillsides in my neighborhood that limit the number of routes for getting from place to place.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

D. Streets in my neighborhood

Please circle the answer that best applies to you and your neighborhood.

1. The streets in my neighborhood do not have many, or any, cul-de-sacs (dead-end streets).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. There are walkways in my neighborhood that connect cul-de-sacs to streets, trails, or other cul-de-sacs.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. The distance between intersections in my neighborhood is usually short (100 yards or less; the length of a football field or less).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. There are many four-way intersections in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. There are many alternative routes for getting from place to place in my neighborhood. (I don't have to go the same way every time.)

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

E. Places for walking and cycling

Please circle the answer that best applies to you and your neighborhood.

1. There are sidewalks on most of the streets in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. The sidewalks in my neighborhood are well maintained (paved, even, and not a lot of cracks).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. There are bicycle or pedestrian trails in or near my neighborhood that are easy to get to.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. Sidewalks are separated from the road/traffic in my neighborhood by parked cars.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. There is a grass/dirt strip that separates the streets from the sidewalks in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

F. Neighborhood surroundings

Please circle the answer that best applies to you and your neighborhood

1. There are trees along the streets in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. Trees give shade for the sidewalks in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. There are many interesting things to look at while walking in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. My neighborhood is generally free from litter.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. There are many attractive natural sights in my neighborhood (such as landscaping, views).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

6. There are attractive buildings/homes in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

G. Safety from traffic

Please circle the answer that best applies to you and your neighborhood.

1. There is so much traffic along the street I live on that it makes it difficult or unpleasant to walk in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. The speed of traffic on the street I live on is usually slow (30 mph or less).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. The speed of traffic on most nearby streets is usually slow (30 mph or less).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. Most drivers exceed the posted speed limits while driving in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

6. There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

7. The crosswalks in my neighborhood help walkers feel safe crossing busy streets.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

8. When walking in my neighborhood, there are a lot of exhaust fumes (such as from cars, buses).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

H. Safety from crime

Please circle the answer that best applies to you and your neighborhood.

1. My neighborhood streets are well lit at night.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. Walkers and bikers on the streets in my neighborhood can be easily seen by people in their homes.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. I see and speak to other people when I am walking in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. There is a high crime rate in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. The crime rate in my neighborhood makes it unsafe to go on walks <u>during the day</u>.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

6. The crime rate in my neighborhood makes it unsafe to go on walks <u>at night</u>.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

I. Neighborhood satisfaction

Below are things about your neighborhood with which you may or may not be satisfied. Using the 1-5 scale below, indicate your satisfaction with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding. The 5-point scale is as follows:

1 = strongly dissatisfied
2 = somewhat dissatisfied
3 = neither satisfied nor dissatisfied
4 = somewhat satisfied
5 = strongly satisfied

How satisfied are you with…

(example) __3_the number of pedestrian cross-walks in your neighborhood ?

a. ____the highway access from your home?
b. ____the access to public transportation in your neighborhood?
c. ____your commuting time to work/school?
d. ____the access to shopping in your neighborhood?
e. ____how many friends you have in your neighborhood?
f. ____the number of people you know in your neighborhood?
g. ____how easy and pleasant it is to walk in your neighborhood?
h. ____how easy and pleasant it is to bicycle in your neighborhood?
i. ____the quality of schools in your neighborhood?
j. ____access to entertainment in your neighborhood (restaurants, movies, clubs, etc.)?
k. ____the safety from threat of crime in your neighborhood?
l. ____the amount and speed of traffic in your neighborhood?
m. ____the noise from traffic in my neighborhood?
n. ____the number and quality of food stores in your neighborhood?
o. ____the number and quality of restaurants in your neighborhood?
p. ____your neighborhood as a good place to raise children?
q. ____your neighborhood as a good place to live?

Appendix E5: Data input, checking and preparation

Data Input

- Data was inputted by members of the data collection team who were supplied with a SPSS template and a coded survey. The file was emailed to the researcher at the end of each inputting session who incorporated the new datasets into the master dataset.

- Inputting rules included:

    - '999' was imputed for missing data

    - '888' was imputed for don't know responses

    - '777' was inputted for double answers

    - Height (H4) was inputted as cm, weight (H3) as kg, years at address (H6) was inputted as years and waist circumference (H5) in cm.

    - Respondents age was calculated by subtracting the year born (H2) from the current year.

    - IPAQ measures G2, G4, G6, G8 and G9 were all imputed as minutes

- For the first 100 surveys (approximately) team members worked in pairs with one member reading out response codes and the other inputting the scores into the dataset

- Due to personnel limitations the data imputing team worked individually and random checks were carried out on the imputed surveys by another member of the team.

-

Data Checking

- Random checking of 10% of the inputted surveys was conducted by two of the research team calling out responses and the other referring to the dataset.

- The researcher systematically checked the dataset for outliers by running frequencies for all question variables and check that data lies within expected boundaries, e.g. if scale is from 1 -5. The survey ID numbers for identified irregularities were noted and questionnaires were checked manually.

Data Preparation

- Individuals were identified who did not complete more than 25% of section E (environment items) of the questionnaire and/or 25% of the complete survey.

- Travel mode questions (B1, B4, B7, B10, B13, B16, B19, B22, B25, B28 and C2) were recoded into a reduced scale of 'active travel mode' (on foot and bicycle, 'public transport' (item 3 unchanged) or 'motorised transport' (by car, motorcycle or scooter or taxi). 'Other means' was recoded to a missing value.

- An 'average mode score' was calculated by applying the following formula:
  *Average mode score = [∑(relevant trips*mode score)]/ # relevant trips.*

  The relevant trips were determined using the 'journey not applicable' filter. The resulting score rang was 1 to 3 were 1 denoted all motorised trips and 3 denoted all active trips.

- The percentage of the identified destinations which are travelled to by active modes and the percentage of these trips taken on public transport were determined by dividing the number of active mode (or public transport mode) destinations by the total number of relevant destinations.

- The job status measure (C1) was reduced to three categories (1) Employed/ self employed or a student, (2) retired or looking after home/family and (3) Looking for first regular job, unemployed or unable to work due to permanent sickness or disability. 'Other' selections were re-coded as missing values.

- The number of cars per household was determined by diving the number of cars by the number of people in the household minus the number of children under 18.

- Environmental items were cleaned by carrying out a principal component analysis on all 41 environmental items. Correlations between items were also checked. Items Ee2, Eb7 and Eb8, all related to crime rate, were highly correlated (>.7). For these items an average score of the other two items was used to replace missing items. Items Ed3 (air pollution) and Ed4 (noise) were also highly correlated. For all other missing items, items were substituted with an average score of the other items loaded to the same component provided there were three or more items loaded to that component with a loading of greater than .3. Where there were insufficient replies to create an average score from component items were left as missing ('999').

- IPAQ data was processed according to IPAQ guidelines for data processing and analysis (http://www.ipaq.ki.se/scoring.pdf 2005). As the walking for transport and cycling for transport items of the IPAQ –LF were combined the amended IPAQ –SF used in this study the Active Travel MET- minutes per week were calculated by determining a ratio of walking trips to cycling trips from the travel behaviours question (using mode, duration and frequency) in Section B of the questionnaire. The following equation was used to calculate the Active Travel Met-mins per week: (cycle ratio*6.0*active mins*days per week) + (walking

ratio*3.3*active minutes*days per week). This ratio did not influence the calculation of total physical activity as cycling is categorised as moderate physical activity (4.0 but walking is separate at 3.3).

- A summation score was calculated for question I, the Leyden Instrument, without item I10, the place I work or study'. This was because a work place, school or college are not relevant for almost 40% of the surveyed sample.

- Principal component analysis was carried out on environmental items, items which prevent walking and neighbourhood satisfaction to produce components.

Appendix E6: CGL Component Analysis Tables

Table E-11: Environment **Component 1: Crime and Disorder (n=8)**

Item	Reliability ICC	*α if deleted*
A lot of air pollution (from all sources including traffic fumes)	.87	.76
Homeless people and/or beggers	.95	.78
Badly maintained, unoccupied or unattractive buildings or houses	.81	.75
Has a high crime rate	.82	.74
Has little or no graffiti	.68	.76
Is safe enough that I would let a 10 year child walk around my neighbourhood alone in daytime	.81	.76
While walking in my neighbourhood there are places I avoid	.93	.74
Shops and businesses close shutters over their shop fronts when closed	.61	.78
Scale: α = .8, intraclass correlation coefficient (ICC)= .31***		

**ρ<0.01, ***ρ<0.001

Table E-12: Environment Component 2: Village (n=7)

Item	Reliability ICC	*α if deleted*
A variety of shops/ homes/ businesses and amenities	.91	.75
Many inviting, locally owned shops	.58	.77
People about all day and in the evening shopping or visiting restaurants and pubs nearby	.70	.77
A mix of age groups ,young and old people, as well as a mix of family type	.89	.79
I can do most of my shopping at local shops	.86	.78
Is an unique area with personality and character	.89	.77
Nice places, within walking distance of my home, to go for a walk for recreation (such as a park or even just around the neighbourhood itself)	.91	.78
Scale: α = .8, intraclass correlation coefficient (ICC)= .36***		

**ρ<0.01, ***ρ<0.001

Table E-13: Environment Component 3: Social (n=3)

Item	Reliability ICC	*α if deleted*
There are many friendly or familiar faces	.71	.40
I feel connected to people that live in my Neighbourhood	.83	.54
Many of my family and friends live within walking distance	.90	.73
Scale: α = .7, intraclass correlation coefficient (ICC)= .38***		

**ρ<0.01, ***ρ<0.001

Table E-14: Environment Component 4: Scale (n=3)

Item	Reliability ICC	*α if deleted*
Wide roads with multiple lanes of traffic	.84	.39
Large car parks in front of shops and businesses	.86	.38
footpaths are separated from the road by a buffer (for example: grass verge, parked cars or other barrier)	.64	.56
Scale: α = .6, intraclass correlation coefficient (ICC)= .29***		

**ρ<0.01, ***ρ<0.001

Table E-15: Environment Component 5: Comfort (n=2)

Item	Reliability ICC	*α if deleted*
While walking in bad weather I can find shelter from the wind and rain	.78	-
Places to stop for a rest while walking	.69	-
Scale: α = .5, intraclass correlation coefficient (ICC)= .35***		

**ρ<0.01, ***ρ<0.001

Table E-16: Environment Component 6: Overlooking (n=3)

Item	Reliability ICC	*α if deleted*
Eb11 People walking on the street can be easily seen by people in their homes, shops and other occupied buildings	.85	.18
Ec4 Children playing in the neighbourhood	.83	.38
Eb10 The speed of traffic on the street I live on is usually slow (Prompt: 30kph or less)	.90	.30
Scale: α = .4, intraclass correlation coefficient (ICC)= .17***		

**ρ<0.01, ***ρ<0.001

Table E-17: Prevent Component 1: Psychosocial correlates (n=7)

Item	Reliability ICC	*α if deleted*
Not being in the right mood	.56	.75
Lack of time	.63	.77
Lack of energy	.53	.75
Bad weather	.79	.78
Easier to drive even short journeys	.91	.78
Lack of company or others to walk with	.70	.78
Not enjoying exercise	.83	.77
Scale: α = .8, intraclass correlation coefficient (ICC)= .35***		

**ρ<0.01, ***ρ<0.001

Table E-18: Prevent Component 2: Comfort and Inclusion (n=3)

Item	Reliability ICC	*α if deleted*
Feeling unsafe from traffic	.85	.58
Feeling unsafe from crime	.83	.60
Not feeling part of the community	.49	.72
Scale: α = .7, intraclass correlation coefficient (ICC)= .47***		

**ρ<0.01, ***ρ<0.001

Table E-19: Prevent Component 3: Vulnerability due to age or disability (n=2)

Item	Reliability ICC	*α if deleted*
Disability or poor health	.89	na
Fear of falling/ getting injured	.69	na
Scale: α = .7, intraclass correlation coefficient (ICC)= .49***		

**ρ<0.01, ***ρ<0.001, na = not applicable

Table E-20: Prevent Component 4: Fashion (n=2)

Item	Reliability ICC	*α if deleted*
Ruining my hair or make-up	.62	na
Wanting to wear fashionable shoes unsuitable for walking distances	.45	na
Scale: α = .7, intraclass correlation coefficient (ICC)= .57***		

**ρ<0.01, ***ρ<0.001, na = not applicable

Table E-21: Satisfaction Component 1: Access (n=6)

Item	Reliability ICC	*α if deleted*
Ease of getting to and from work or the place I study	.96	.86
Ease of getting to and from convenience stores and other shops	.95	.85
Places to socialise nearby	.62	.86
Ease of getting home late at night	.89	.84
Access to basic services nearby (shops, medical services, banking, schools etc)	.76	.85
Access to public transport	.89	.85
Scale: α = .9, intraclass correlation coefficient (ICC)= .53***		

**ρ<0.01, ***ρ<0.001

Table E-22: Satisfaction Component 2: Comfort (n=6)

Item	Reliability ICC	*α if deleted*
Living in your neighbourhood	.90	.84
Appearance of your neighbourhood	.87	.83
Feeling of safety from crime	.84	.83
Noise level	.85	.83
The amount of motorised traffic	.78	.85
Air quality	.72	.85
Scale: α = .7, intraclass correlation coefficient (ICC)= .51***		

**ρ<0.01, ***ρ<0.001