The influence of the built environment on neighbourhood-level walking behaviour and experience: A case study of Shenzhen

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Abstract

The built environment, defined as the man-made environment that provides the setting for human activity, plays a significant role in shaping people's walking behaviour and experiences. A more walkable environment can have multiple benefits to both society and individuals, including creating safer, more livable and connected neighbourhoods, reducing traffic congestion, noise and air pollution through coordination with other public transport modes, and increasing individual health and well-being. Therefore, policies that aim at improving the built environment have attracted increasing attention from both researchers and practitioners. An upsurge of studies has revealed that neighbourhood built environmental features, such as population density, land-use mix, proximity to parks and public spaces, footpath condition and aesthetic qualities, may all influence individual's walking intentions, frequencies and durations.

However, despite the cumulating evidence on the effects of the built environment characteristics on people's walking behaviour, the role of other person-related factors, such as attitudes, perceptions, meanings and place attachment has received much less attention and their connections with the built environment and walking have not been explored in sufficient detail. These factors may significantly shape people's responses to the built environment. Neglecting the role of these person-related factors in the built environment – walking connections may result in biased results and reveal an incomplete picture of this relationship. In addition, most studies on walking and walkability are based on western contexts and grounded in Euro-American theories and worldviews, and it is timely to incorporate findings and insights derived from non-western settings to consider more cultural- and person-specific factors which may be significant in other socio-cultural contexts.

In this thesis, I have employed a mixed-method approach to explore in what ways the built environment and person-related factors influence Chinese urban pedestrians' walking behaviour and experience, using the case of Shenzhen, a rapidly developing city in China. The thesis presents results and implications

from three empirical studies. First, a qualitative study was conducted to explore how pedestrians articulated their daily walking experience using semi-structured interviews. The results demonstrated that the participants' walking experience and behaviour was a result of complex interactions between the built environment and a range of person-related factors that are embedded in the local socio-cultural context. Based on the findings from the qualitative inquiry, a subsequent quantitative study was conducted to investigate the effects of objective neighbourhood characteristics, perceived built environment, and walking attitudes on people's walking behaviour. Using logistic regression analyses, significant interaction effects between the objective neighbourhood characteristics, perceived environment, and walking attitudes on the frequency of walking for specific purposes were identified. The findings showed that pedestrians' walking attitudes could offset the negative effects of the objective neighbourhood environment, and these attitudes contributed positively to people's walking frequency. Finally, in the third study, it is argued that walkability needs to be understood in a more relational way as emerging from current and past interactions between pedestrians and the environment. Based on this relational understanding of walkability, a multiple-scenario approach was proposed as a means to consider the heterogeneity of pedestrians and account for different situations in walkability assessment. The empirical analyses in the case of Shenzhen revealed that the level of walkability varies significantly between different walkability scenarios. It suggests that the use of multi-scenario approach could offer a multifaceted perspective in walkability assessment. Using a pedestrian-centred perspective, this thesis advances our understanding of the environmental influence on walking in a developing-city context and provides insights to future studies to consider other person-related factors in the built environment – walking relationships.

Keywords: walking behaviour; walking experience; walkability assessment; built environment; person-related factors; walking attitudes; physical activity; Shenzhen; neighbourhood-level

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Publications

The papers presented in Chapter Five to Chapter Seven have been submitted for publications in the following peer-reviewed journals:

Chapter Five:

Chan, E. T. H., Li, E. T. T., Schwanen, T., & Banister, D. (under revision). People and their walking environments: An exploratory study of meanings, place and times. Submitted to *International Journal of Sustainable Transportation*.

Chapter Six:

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Chapter Seven:

Chan, E. T. H., Schwanen, T., & Banister, D. (under review). Rethinking walkability relationally: A multiple-scenario approach for walkability assessment. Submitted to *Landscape and Urban Planning.*

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1 Chapter One – Introduction

1.1 Background and rationale of study

As the most sustainable mode of transportation, walking has been widely recognised for its potential benefits for health and well-being. At the individual level, walking is beneficial for improving physical and psychological health conditions (Cerin, Leslie, du Toit, Owen, & Frank, 2007; Giles-Corti et al., 2016; Manaugh & El-Geneidy, 2011; Stronegger, Titze, & Oja, 2010), strengthening social connections and social capital (Josey & Moore, 2018; Leyden, 2003; Rogers, Halstead, Gardner, & Carlson, 2011), and improving overall life satisfaction (Bize, Johnson, & Plotnikoff, 2007; Cao, 2016; Jaśkiewicz & Besta, 2016). At the societal level, improving the walkability of the built environment can help to create safer and more livable neighbourhoods and connected communities (Litman, 2017), facilitate tourism and the night-time economy (Hall & Ram, 2019), improve coordination with other public transport modes (Schlossberg & Brown, 2004; Wibowo & Olszewski, 2005), and consequently reduce congestion, noise, and air pollution (European Commission, 2007; Sælensminde, 2004). Neighbourhood-level walking represents a vital form of people's daily mobility, and the scale of the neighbourhood has drawn much attention as an important spatial and social unit for studying people's travel behaviour and interrelationships with their environments. The neighbourhoods consist of many features that are important to people's daily activities and walking behaviour, such as building types, infrastructure, environmental characteristics, accessibility to jobs and services, social-interactive aspects, and sentimental characteristics (Galster, 2001). To a different extent, residents usually need to conduct walking trips from their home to nearby destinations for daily activities (SUTPC, 2012; Yang & Diez-Roux, 2012). This makes neighbourhood-level walking an essential form of daily travel mode, especially for the residents in urban China.

The benefits of walking and the importance of creating walkable environments have attracted a large body of research in investigating the potential correlates and determinants of walking behaviour. Recent years have seen an upsurge in studies that have examined the correlations between certain built environmental

factors and people's walking behaviour e.g. walking frequency (Khattak & Rodriguez, 2005; Krizek & Johnson, 2006; Larrañaga, Rizzi, Arellana, Strambi, & Cybis, 2016), trip distance (Handy, Cao, & Mokhtarian, 2006; Sun, Oreskovic, & Lin, 2014), and trip duration (Feuillet et al., 2016; Kamruzzaman et al., 2016; Rutt & Coleman, 2005). Some of these studies have put their focuses on specific pedestrian groups (e.g. the elderly, young mother), and extended earlier work by highlighting the significant role of subjective measures of the built environment in understanding walking perceptions and behaviour (Cohen, Han, Kraus, & Young, 2018; Hawkesworth et al., 2018; Lee & Dean, 2018). Others have adopted new technologies or data (e.g. GIS, google streetview, big data) to explore the links between built environment, individual characteristics and their heterogeneous impact on the shape of perceived walking neighbourhood and the odds of walking and total walking time (Guimpert & Hurtubia, 2018; Li, Deal, Zhou, Slavenas, & Sullivan, 2018; Lu, Sarkar, & Xiao, 2018).

However, the current literature is still based upon the assumption that people respond to particular environmental factors in fairly homogeneous ways (Kwan, 2018). In reality, individuals may not respond to the environmental features in the same way as we commonly assumed; rather, such responses may be highly personal and idiosyncratic, depending on personal background, past experiences and their own interpretation of the places (Degen & Rose, 2012; Kwan, 2018; Mennis & Mason, 2011). These person-related factors, include but are not limited to pedestrians' attitudes, perceptions, meanings and place attachment can shape people's walking behaviour and experiences, and cannot be captured by using the commonly used socio-demographic variables, such as age, gender, income, education level, car ownership. Nonetheless, these factors and attributes have not been fully explored in existing literature. Failing to consider people's unique responses in different situations and contexts may prevent researchers from having a comprehensive understanding of the phenomenon and even lead to incorrect estimates of the effects of the built environment on walking behaviour. In this study, I take these person-related factors into consideration and further explore how and in what ways these person-related factors influence individuals' walking behaviour and how their environments are perceived.

Existing studies on walking and walkability are dominated by studies from western geographical contexts and even if the focus is on non-western settings, the grounding is based in Euro-American theories and worldviews (Saelens & Handy, 2008; Zacharias, 2001). Overlooking the complexities of contextual influences and lacking sensitivities of cultural specificity may have ramifications, given that the meanings and experiences associated with walking are deeply embedded in unique cultural traditions (Bruner, 1990), and may not be universal in nature, but contingent upon specific historical and geographical contexts. Thus, findings and insights derived from the studies in western settings may not be fully transferrable to other socio-cultural contexts. Recently, researchers have call for more studies focusing on developing countries, which allow for more critical reflections on western-centric theories, approaches, value systems and worldviews (Roy & Ong, 2011; Schwanen, 2018). Informed by these calls, this study will critically reflect on the prevailing western-centric thinking in understanding urban walking behaviour and experience. It will also explore other salient points that can help to enrich our current understanding of walking behaviour and experience.

More importantly, many of the developing cities in the global South have been undergoing unprecedented changes in terms of population growth, socio-economic restructuring, and urbanisation, at a rate that is significantly faster than cities in the global North have witnessed in the past (Pucher, Peng, Mittal, Zhu, & Korattyswaroopam, 2007). Despite all the opportunities these changes create, their rapid economic development, social transformation and urbanisation also imposes severe environmental and societal challenges which need to be addressed in a timely manner. For example, a variety of problems associated with rapid urban development deserve particular attention, such as traffic congestion, pollution, increased automobile usage, etc. In this situation, understanding the multiple sources of influences on people's walking behaviour and experience based on a non-western city context are of crucial importance, as this will contribute to the generation of more context-specific knowledge and solutions for mitigating the negative impacts associated with the rapid rate of

development in these understudied developing cities.

This thesis aims to contribute both theoretically and empirically to current debates on the complex relationships between the built environment and people's neighbourhood-level walking behaviour and experience in a rapidly developing city context.

1.2 Major objective and research questions

Despite the cumulating evidence on the effects of the built environment characteristics on people's walking behaviour, the role of other person-related factors, such as attitudes, perceptions, meanings and place attachment has received much less attention and their connections with the built environment and walking have not been explored in sufficient detail. However, these factors may play significant roles in shaping people's walking behaviour, walking experience, and how people perceive the environment to be walkable or not.

Recognising that pedestrians' responses to the environment can be highly personal and idiosyncratic, this study aims to develop and offer a pedestrian-centred approach to understand the relationships between the built environment and neighbourhood-level walking behaviour and experience, and to the assessment of walkability. In this context, "pedestrian-centred" means placing pedestrians at the core in examining the built environment-walking relationships. This approach considers the means by which a wide range of person-related factors can be used in developing a new method of walkability assessment. These factors are shaped by the relationships between the built environment and walking behaviour and experiences, as well as addressing pedestrians' heterogeneous needs, capacities, and preferences. Two interrelated research questions have guided this project:

RQ 1) What are the relationships between the built environment, person-related factors and walking behaviour and experience?

RQ 2) How can walkability be assessed by considering the heterogeneity of the needs, capacities and preferences of pedestrians?

This thesis uses Chapter Five to Chapter Seven to answer these two research questions by addressing the following issues. Chapter Five used a qualitative approach to explore how urban pedestrians in a rapidly developing city context articulate their personal walking experience. Through studying the narrative accounts of everyday walking of local residents, this chapter uncovers the contextual complexities of urban walking in China and identifies significant person-related factors in shaping Shenzhen residents' urban walking experiences. The findings begin to open up a post-colonial sensibility to understanding of walking and can inform the development of theories of walking from the global South. This chapter addresses part of the first research question by highlighting three aspects of people's walking experience: the significance of meanings attached to walking, engagements with timescapes and attachment to place. These aspects offered a novel perspective to reconceptualise the relationship between pedestrians and their environments in a more dynamic way.

Building on the findings from the qualitative analysis, in Chapter Six, I continued to explore the significant person-related factors (walking attitudes) which have emerged as especially important in the narrative accounts, and their effects in moderating the relationships between the built environment and walking behaviour. This chapter is deductive in nature and investigates the independent and joint effects of objective neighbourhood characteristics, walking attitudes, and perceived environment for three specific purposes of neighbourhood-level walking. This chapter addresses the first research question (RQ1) by revealing the statistically significant interaction effects of objective neighbourhood characteristics and perceived environment. The findings suggest that positive perceptions of the environment can compensate for the effect that low objective walkability of neighbourhoods has on people's walking frequency.

Chapter Seven is dedicated to answering the second research question of how walkability can be measured in such a way that the heterogeneity of pedestrians' needs, capacities and preferences is taken into account. Findings from the above

two chapters (Chapter Five and Chapter Six) have demonstrated that what constitutes a "walkable" environment varies significantly among different people and groups, in different situations, and for various purposes of walking, based on the participants' own interpretations and perceptions towards the built environment. These findings have challenged one of the traditional assumptions in walkability assessment studies, namely that walkability is a measure that is transferable across places, contexts, and pedestrians. In this chapter, I seek to advance the understanding of walkability by introducing a multiple-scenario approach of walkability assessment that takes into consideration the differentiated needs, capacities and preferences of pedestrians.

1.3 Significance of this study

This study is positioned at the intersection of the fields of transport geography, urban planning, public health and mobilities studies. It aims to contribute to the debates on the environmental influence on walking behaviour and experience in the following ways. First, although studies on walking and walkability have increased rapidly in the past decade, the divide between disciplines in studying walking behaviour and experience is still apparent. For instance, studies from urban planning place greater emphasis on the design of favourable built environment features to improve the walking environment (Zacharias, 2001; Wunderlich, 2008; Sakar et al., 2015); public health studies address the issue of environmental influence on various forms of physical activity and the associated benefits to people's health conditions (Frumkin, Frank, & Jackson, 2004; Pucher, Buehler, Bassett, & Dannenberg, 2010); mobilities studies pay particular concern on the embodied practice of walking (Horton, Christensen, Kraftl, & Hadfield-Hill, 2014; Middleton, 2011); while transport geography has devoted most of their attention to estimate individual's mode choice decisions and travel behaviour (Manaugh & El-Geneidy, 2011; Millward, Spinney, & Scott, 2013). Indeed, walking is a phenomenon that should be understood comprehensively from various perspectives and disciplines. This is because personal characteristics, social and cultural values and preferences, built environment features, all play respective roles in shaping people's walking experience and behaviour. As a result, this study tries to bridge the gap between different strands of studies on

walking, to offer an inter-disciplinary perspective to the study of walking from both the behaviourial and experiential perspectives, through incorporating both the environmental and person-related factors into consideration.

Another significant contribution of this study has been the use of mixed-methods research design to explore the built environment – walking relationships in a rapidly developing city context. This approach advances our existing understanding of walking behaviour and experience by providing more context-specific knowledge that move beyond existing western dominated discourse on walking and walkability. Using a mixed-methods research design, two phases of fieldwork were conducted in sequence for data collection (to be discuss in more detail in Chapter Four). A qualitative study was conducted in the first phase in which semi-structured interviews were used to identify potential factors that shape people's daily walking experience and behaviour, explore the meanings that pedestrians ascribed to walking, in order to understand the important factors associated with their walking experience. This was followed by a second phase of fieldwork to collect quantitative data by using questionnaires and environmental audit. The questionnaires and environmental audit tool were developed based on the insights from the qualitative interviews. This research design has allowed me to rethink the established knowledge and worldviews that have dominated in existing westernised studies on walking and walkability, and it allows me to have a more context-specific understanding of people's walking experience and behaviour by drawing insightful information from the participants' own articulation. This approach has several advantages: firstly, this study contributes to a more contextualised understanding of walkability from a pedestrian-centered perspective. Secondly, this approach allows participants to articulate their own experiences and life stories associated with walking. Interactive discussions and reflections provide explanations on why they react to certain environmental features in a particular way and how these responses influence their walking experience and behaviour. This explorative method can provide important information to understand the causes and rationales behind the participants' behaviour and help to enhance the existing knowledge on the relationships between the built environment and walking experience and

behaviour (results from Chapter Five).

By considering the potential interaction effects between objective neighbourhood characteristics, perceived neighbourhood environment and walking attitudes on walking behaviour, this study (results from Chapter Six) also contributes to a more structured understanding on the relationships between the built environment, walking attitudes and walking behaviour. The similarities and differences of the environmental correlates between three specific types of walking behaviour are also revealed, which contributed to a more detailed understanding of walking behaviour associated with various purposes.

Based on a comprehensive review of existing literature and tools for walkability assessment (Chapter Seven), it is suggested that existing understandings and measures of walkability tend to focus on the built environment per se, disregarding the ways in which pedestrians perceive the walking environment. Therefore, I argue that walkability should be reconceptualised in a more relational manner by considering not only the built environment, but also how the pedestrians perceive the walking environment. Following this idea and borrowing insights from the field of decision-making sciences (compensatory and non-compensatory decision rules), I present a multiple-scenario approach to walkability measurement that takes into consideration the needs of different pedestrians. I also propose that walkability should not be considered as a universally applicable index and rather as a more flexible and context-specific set of scenarios. This new understanding of walkability challenges the traditional concept of walkability and opens up the possibilities to consider walkability as a relational and flexible concept.

1.4 Structure of the thesis

This thesis consists of eight chapters in total, building around the three journal articles submitted for publication in international, peer-reviewed journals. The first chapter is a general introduction of the overall structure of this thesis, and this is followed by a literature review chapter (Chapter Two). Then two chapters

illustrate the context of the study (Chapter Three) and research design and methods (Chapter Four) to offer readers a more detailed understanding of the methodological considerations for this project than the explanation that can be offered in the papers prepared for journal publication. The empirical studies in article format are presented in the following chapters (Chapter Five to Chapter Seven). The thesis ends with a conclusion (Chapter Eight). Figure 1.1 illustrates the structure of the thesis.

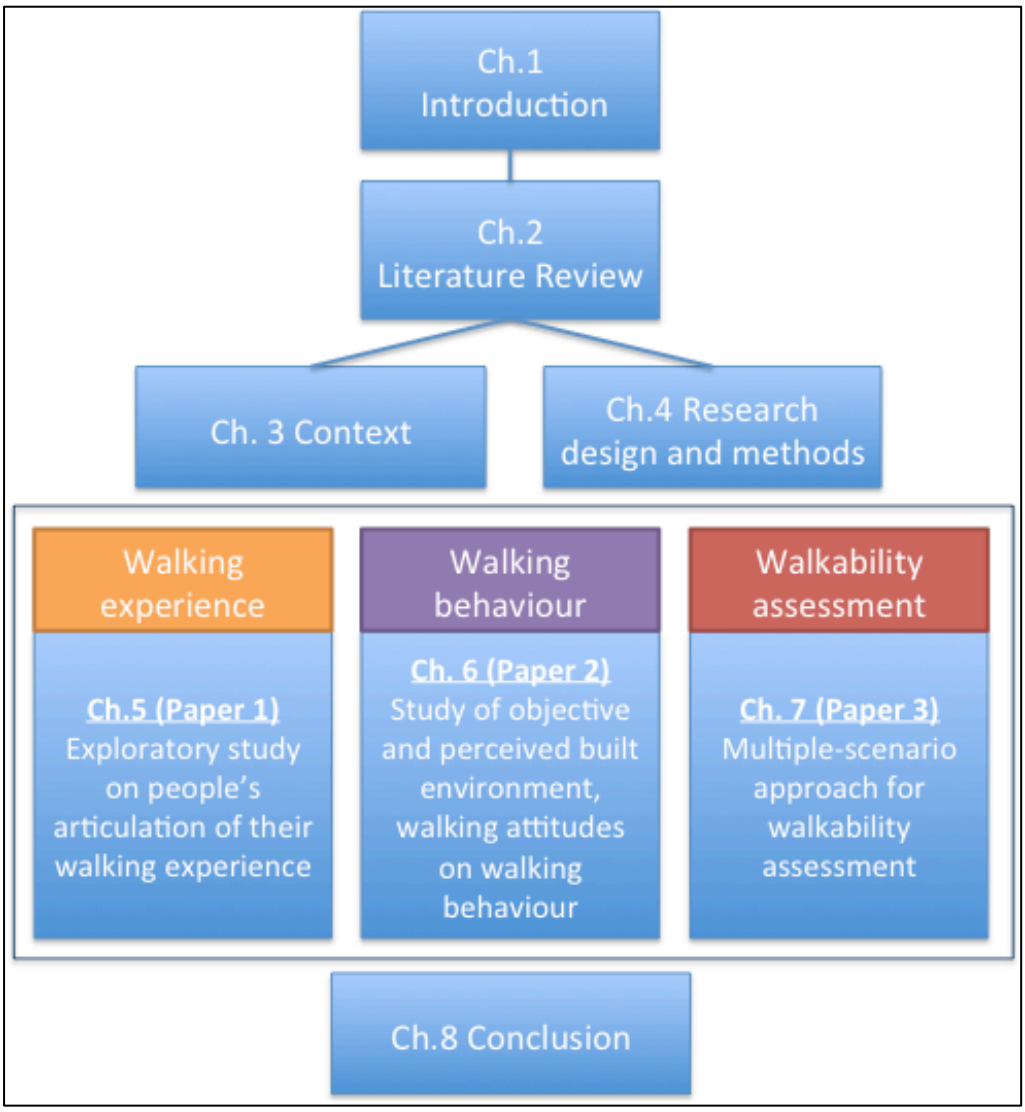


Figure 1.1 Structure of this thesis

Chapter Two presents a review of the literature on the links between the built environment and walking. First, the contributions of various disciplines to the study of walking are briefly introduced. Next, three major issues regarding

walking behaviour, experience and walkability that are directly relevant to this DPhil study are presented.

Chapter Three is about the context and the details of the case study. The first section discusses the case study approach, the importance and benefits of employing this approach. After that, the justifications for selecting Shenzhen as a case study are presented together with the background information about the city of Shenzhen, as well as the relevant policies on walking. The third section presents the neighbourhood selection process performed to select the neighbourhoods for further analysis.

Chapter Four is the methodological chapter that first revisits the research questions presented in Chapter One, then explains how each of the research questions are addressed by using a mixed methods approach. Next, the procedures in conducting fieldwork and the data collection processes are discussed and reflected upon as well. Finally, the limitations of this study are highlighted.

Chapter Five presents the findings of an exploratory qualitative analysis that explores the ways in which pedestrians articulate their daily walking practices and experiences. This study has highlighted the importance of cultural specificity in shaping the meanings and experiences of walking. Insights from this study will enable future studies to reconceptualise walkability as a more dynamic process that takes into consideration the temporalities of the walking environment and pedestrians' bodily and emotional capacities.

Chapter Six investigates the independent and joint effects of objective neighbourhood characteristics, perceptions of the neighbourhood environment, and walking attitudes on the frequency of three major types of walking at the neighbourhood level. Using logistic regression, it is found that the correlates of people's walking frequency vary considerably among different types of walking and statistically significant interaction effects of objective neighbourhood characteristics and perceived environment are found. The findings suggest that

positive perceptions of the environment can compensate for the depressing effects that objective walkability of neighbourhoods has on people's walking frequency. When seeking to encouraging walking at the neighbourhood level, policymakers should not only concentrate on improving objective neighbourhood characteristics but also consider people's perception of the neighbourhood environment and their attitudes towards walking.

Chapter Seven presents a study that addresses the existing problem in walkability assessment by proposing a multiple-scenario approach that considers the non-compensatory nature of certain qualities in the calculation of walkability scores under different scenarios. Using an environmental audit, walkability was measured by different characteristics classified under six major qualities: land use and destinations; safety; aesthetics; amenities; footpath design and condition; and subjective assessment and experience. The proposed multiple-scenario approach has been tested in four selected neighbourhoods in Shenzhen. The empirical analysis demonstrated that this approach could offer a more comprehensive and context-specific assessment of walkability.

Chapters Three through Seven should not be viewed separately from each other. The methodological underpinnings presented in Chapter Three and Chapter Four provide the foundation for the research design, sampling and data collection methods, as well as the rationale for selecting the case study city and area. The empirical work (Chapter Five to Chapter Seven) presents a step-by-step approach in tackling the two inter-related research questions. The findings presented in Chapter Five only cover some of the materials generated from the qualitative semi-structured interviews. The findings from the qualitative semi-structured interviews also informed the development of subsequent chapters. For instance, insights were drawn from the interview results for the design of questionnaire surveys applied in the quantitative analysis (Chapter Six) and the development of the environmental audit tool (Chapter Seven).

Chapter Eight concludes this thesis with a synthesis of major findings and

illustrates how this study answers the research questions presented in Chapter One. This is followed by a section reflecting on how the findings contribute to the wider literature on transport and urban studies. The theoretical, conceptual, and practical implications of this study are also highlighted. Recommendations for future studies are provided at the end of the chapter.

1.5 Concluding remarks

In this introductory chapter, I have briefly introduced the research background of my thesis, in relation to the research objectives and questions, and how the three studies contributed to answering these questions. I have highlighted the increasing attention current literature has paid to the importance of walking and its benefits to individual's physical and psychological health. However, I have also argued that it is pertinent to acknowledge the complex links between the built environment and people's walking behaviour by going beyond our traditional assumptions, especially by considering how person-related factors shape the built environment – walking relationships. The argument has also been made about the importance of exploring such relationships in a rapidly developing city context to advance our existing understanding of the built environment – walking relationships by providing more context-specific knowledge for future intervention. In view of these concerns, more studies are needed to further explore the connections between the built environment – walking behaviour. In the next chapter, I will discuss the differences between the behavioural and experiential perspectives in recent literature on the associations between the built environment, walking and experiences. By doing so, the research gaps will be identified in relation to my research questions.

2 Chapter Two - Literature review

2.1 Introduction

This literature review chapter is divided into two major parts. After this short introduction, Section 2.2 provides a brief overview of studies from various disciplines in understanding walking from the behavioural and experiential perspectives. It shows that the specific foci of the behavioural and experiential perspectives in these studies have contributed to various conceptualisations, measurements and approaches in understanding the phenomenon of walking. The models and frameworks developed in these studies will also be discussed. Next, Sections 2.3 to 2.5 focus on three major issues regarding walking behaviour, experience and walkability that are directly relevant to the three empirical studies (Chapter Five to Chapter Seven). These major issues form the research questions of this DPhil study (as presented in Section 1.2).

2.2 The conceptualisation of walking

As the most basic form of physical activity, walking is extremely common to most of the population except for those that are very frail or disabled. The ability to walk enables us to navigate both indoor and outdoor to reach various destinations. No matter how much, most people have to walk everyday, e.g. to get out of bed and walk to the bathroom. In this sense, walking is an integral part of our life and connects with our daily activities. In view of its importance, many disciplines have interests in studying walking with different perspectives and conceptualisations because of the respective focuses and disciplinary traditions. This section first summarises how walking is conceptualised in various disciplines and then discusses the relevant approaches and frameworks adopted in these studies. This section enables the exploration of the theoretical foundation connecting the environment and walking behaviour, which also helps to position this study in relation to the previous work.

Walking has been explored from the behavioural and experiential perspectives. The behavioural aspect of walking focuses more on understanding how pedestrians choose walking as a mode of transport; how they decide to walk for certain purposes; and the environmental features that are associated with more

frequent walking trips or more time spent on walking. In contrast, the experiential aspect of walking concerns more about how the pedestrians experience the walking environment, the encounters, activities, stimuli, emotions, feelings and affective experiences during the walking trips.

Studying walking from the behavioural perspective

Walking has been conceptualised as a derived demand in many transportation studies, meaning that the reason for travel is derived from the participation in activities that can be conducted at specific locations in space (i.e. trip destinations) (Handy, Boarnet, Ewing, & Killingsworth, 2002). Based on the assumptions derived from economics and psychology, it is generally assumed that individuals tend to make rational choices in their travel decision-making process by minimising the generalised travel costs (determined by the urban structure and transport infrastructures that connect the origins and destinations) (McFadden, 1974; Transportation Research Board, 2005).

Building on the travel demand theory, Cervero and Kockelman (1997) theorised the major land use factors that affect travel demand into the framework of 3Ds (density, diversity, and design). This was later modified into the 7Ds, including the original 3Ds plus destination accessibility, distance to transit, demand management and demography (Ewing & Cervero, 2010). The major contribution of the framework of 3Ds is to provide a theoretical connection that highlights the influence/association of the built or physical environment on travel behaviour. Based on this framework, researchers have used various measures to operationalise the concept of 3D to represent the built environment features that are influential to walking behaviour. Density is measured by land use intensity for housing, employment or other purposes; diversity is measured by entropy index about the heterogeneity of land uses; and use street network configurations or street furniture to represent the design of the built environment (Hong & Chen, 2014; Larrañaga et al., 2016; Munshi, 2016). This 3D framework also inspired the development of a walkability index to capture the level of friendliness of the walking environment (Frank et al., 2005; 2006) (to be discussed in more detail in Section 2.5 about the assessment of walkability).

Walking is also regarded as one of the most common forms of physical activity in many public health studies (Owen, Humpel, Leslie, Bauman, & Sallis, 2004). According to the World Health Organisation (2010), physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure. The significant benefits of physical activity in reducing global mortality and other non-communicable diseases (such as cardiovascular disease and type 2 diabetes) are well documented (Eckert & Kohler, 2014; Lee et al., 2012; Sheikholeslami, Ghanbarian, & Azizi, 2018). So, it is recommended that adults aged 18–64 should perform at least 150 minutes of moderate-intensity physical activity per week or conduct at least 75 minutes of vigorous-intensity physical activity or an equivalent combination of moderate- and vigorous-intensity physical activity (World Health Organisation, 2010).

Given the importance of physical activity to people's physical and psychological health (Penedo & Dahn, 2005), many studies (especially those in the public health) have drawn insights from earlier work of environmental influence on human behaviour, such as ecological theory (Barker, 1968), social ecology theory (Stokols, 1992), and applied a socio-ecological approach to examine the multiple dimensional influences of the environment (including natural, physical, social, cultural, organisational and personal factors) on walking and physical activity, as well as its associations with people's health and well-being (Lachowycz, & Jones, 2013; McLaren & Hawe, 2005; Stokols, 1992). For instance, in one of the earlier studies that applied the socio-ecological approach to study environmental correlates to physical activity (including walking), Saelens, Sallis, and Frank (2003) identified land use characteristics, safety, biking and walking facilities, leisure and recreation facilities, and neighbourhood aesthetics and topography as the major categories of environmental influences on physical activity (trips taken by walking or cycling for transportation and recreation purposes). The socio-ecological model provided new insights on the multiple dimensions of environmental influence on walking by paying particular attention to the micro-scale level facilities and infrastructures (e.g. quality of cycle track and footpath) that affect the movement of people. Other subsequent studies have

further explored the environmental features that constitute a walkable environment (Clifton, Smith, & Rodriguez, 2007; Kelly, Wilson, Baker, Miller, & Schootman, 2012; Pikora et al., 2002; Pikora et al., 2006; Van Cauwenberg et al., 2012); and identified the built and social environmental features (such as aesthetic qualities of footpaths, street furniture, and perceived level of safety) that are positively associated with individual's walking and other forms of physical activity; as well as its impacts on personal health outcomes, such as self-rated health condition (Kerr et al., 2012; Stronegger, Titze, & Oja, 2010; Yang & Matthews, 2010) or body mass index (Christian, Giles-Corti, Knuiman, Timperio, & Foster, 2011; Norman et al., 2006; Rutt & Coleman, 2005).

The socio-ecological approach has provided researchers with a new perspective to understand the multi-level influences of the environment on people's walking behaviour. However, the socio-ecological approach has also been criticised as being inadequate in theorising and operationalising the complex relationships shaped by the politics and power relations embedded in social systems and the built environment. For instance, the socio-ecological approach does not address the intragroup politics, power, and resistance dimensions adequately. This failure to understand the power and competing value systems limits its value to the understanding of the development and the functioning of the socio-ecological system (Stojanovic et al., 2016).

Although not explicitly stated in most of these studies, their focuses were limited to the influences of the physical environment, which has assumed that the presence of certain environmental features alone could shape people's walking behaviour. However, more recent studies have recognised the importance of other non-environmental factors, such as attitudes and perceptions in understanding people's walking behaviour, and these factors were not fully addressed in existing studies that adopted the socio-ecological approach (Kamruzzaman et al., 2016). More importantly, in most cases, the socio-ecological model and associated studies only implied a one-way relationship between the environment and people's behaviour, the learning and reciprocal relationships over time were rarely considered. It is because

individuals' capacities to consciously act, self-reflect and learn from each other are usually overlooked in the socio-ecological models. For instance, positive walking experiences in the past might lead to positive attitudes and gradually develop into a habit of walking, and this might modify people's walking behaviour in the future, but this complex relationship is rarely examined in existing studies (Armitage, Béné, Charles, Johnson, & Allison, 2012).

Applying the socio-ecological framework and Maslow (1943)'s hierarchy of needs to understand walking behaviour, Alfonzo (2005) argued that a similar hierarchy could be used to understand people's decision-making process of walking. A hierarchy of walking needs, ranging from the basic need (feasibility) to higher-order needs (accessibility, safety, comfort, and pleasurability) was proposed. This hierarchy assumed that people would not consider higher-level needs before the lower-level needs were satisfied. Later, Mehta (2008) extended Alfonzo (2005)'s work and suggested the inclusion of "sense of belonging" as a higher-order walking need and replaced the needs of feasibility and accessibility with the concept of "usefulness", which referred to the ability for the environment to satisfy the individual's daily basic needs, such as shopping, eating and entertainment. These studies applied the concept of "hierarchy of needs" to understand walking and regarded walking as a way for pedestrians to fulfill certain needs and considered how the built environment can be developed to "match" with people's needs of walking.

Although these "walking needs" studies offered a different way to understand walking by taking pedestrians' needs into consideration, they can be criticised in a number of ways. First, the walking needs proposed in these models were insensitive to place and context. Pedestrians' decision-making process was highly complex and could not be considered separately from the social, cultural, and geographical contexts, so these models overlooked the role of place and context in determining people's walking intention and behaviour. Furthermore, the "hierarchy of walking needs" model disregarded the direct cause and effect relationships between pedestrians' needs and behaviour, this is because walking behaviour can be triggered by different combinations of needs that do not

necessarily follow a hierarchical structure. Thus, the hierarchical structure of needs fulfillment may have failed to account for the complexity in explaining how such need connects with people's behaviour. Similar to the criticisms on Maslow's (1943) hierarchy of needs, the hierarchy of walking needs proposed by Alfonzo (2005) and Mehta (2008) were also based on an individualistic perspective, assuming that pedestrians' walking behaviour were solely determined by their desire to fulfill certain needs. Such an assumption contrasted with many household-level travel behaviour studies that highlighted the fact that people's travel behaviour are constrained by other factors external to an individual's own beliefs, such as household responsibilities and schedules of other family members (Pooley et al., 2011; McLaren, 2016). However, these studies have provided useful insights for me to rethink the heterogeneity in the needs of walking for different pedestrians. Building on these studies, pedestrians might regard a certain walking environment to be more "walkable" if that particular environment can afford or provide certain functions to fulfill his/her needs. This opens up a new possibility to rethink walkability in a more relational way, and to consider walkability as the product of the interactions between the pedestrians and the environment.

Studying walking from the experiential perspective

Experience emerges from the interaction of live creatures and their surrounding environment through the process of living, ranging from perception, thought, memory, emotion, embodied action, and social activity. The study of experience concerns the meanings embedded in our experience, such as objects, events, time, self and others as experienced in the "life-world" (Smith, 2013). Therefore, previous studies on walking have also adopted the experiential perspective, examining how and in what ways pedestrians feel, perceive, and interact with the environment during their walking trips.

The understanding of experience by American philosopher John Dewey (1925) is particularly relevant and it has offered some important insights that connect with the study of people's walking experiences. According to Dewey, experience is a dynamic interaction with one's environment (both physical and social), and

it is a self-contained whole and has its own meaning and significance (Capps & Capps, 2010). From Dewey's interpretations, the origins of our beliefs arise from our prior actions and the outcomes of our actions are found in our beliefs. In this case, meanings are created by experience through bringing beliefs and actions together (Morgan, 2014). It is through such experiences that we construct our beliefs of this reality and gain knowledge of how to control these changes. As walking is the most basic form of locomotion and method in interacting with places, pedestrians are usually more exposed and have direct contact with the surrounding environment. This direct contact provides an opportunity for pedestrians to establish more intense personal connections, construct understandings, generate place attachments and produce meanings associated with the environment (Givoni & Banister, 2010; Ingold, 2007; Moles, 2008). Based on this understanding, walking offers an embodied basis to experience and engage with the world (Rybråten, Skår, & Nordh, 2019). More importantly, Dewey (1922) treats experience as being both historically and culturally located, meaning that experiences occur within specific contexts (Morgan, 2014). It is therefore essential to consider the experiential aspects of walking and its relationships with the built environment in particular places, in order to have a comprehensive understanding of walking and walkability.

Some of the existing studies aimed at identifying potential facilitators and barriers to enjoyable/pleasurable walking experiences, such as safety, aesthetics, convenience and other perceptions, but not necessarily with due attention to the specific contexts in which experiences are generated or changed (Buckley, Stangl, & Guinn, 2017; Ferrer, Ruiz, & Mars, 2015). For instance, Johansson, Sternudd, & Kärrholm (2016) found that aesthetic quality, upkeep and order, and the presence of well-maintained greenery were important factors influencing pedestrians' walking experience. Bornioli, Parkhurst, & Morgan (2019) highlighted the role of traffic, city business, and aesthetics in shaping pedestrians' affective walking experience in Bristol, UK. While some other studies have focused on the diversified walking experiences of specific pedestrian groups, such as older adults (Finlay, 2018; Moran et al., 2017; Philips, Walford, Hockey, Foreman, & Lewis, 2013), pram users (Clement & Waitt, 2018), dog walkers

(Degeling & Rock, 2012; Westgarth, Christley, Marvin, & Perkins, 2017) and children (Banerjee, Uhm, & Bahl, 2014; Romero, 2015). These studies have highlighted the specific pedestrian groups' interpretations of the walking environment and their associated walking experiences and various practices of walking.

Another strand of related yet distinctive studies, referred to as "new walking studies" (Lorimer, 2011a), also paid particular attention to walking from the experiential perspective. However, these studies have portrayed walking as an embodied social practice and multi-sensuous experience, and focused more on understanding the actual practices of walking – what happens during these trips and how such practices matter (Cass & Faulconbridge, 2017; Cresswell & Merriman, 2011; Doughty & Murray, 2016; Gatrell, 2011; Horton et al., 2014; Middleton, 2010; Rybråten et al., 2019). By examining various types of walking practices, such as walking in mountains trails (Lorimer & Lund, 2008), urban explorations (Pinder, 2005), and reflections upon landscapes (Wylie, 2009), these studies have offered insightful understandings of walking not only as a destination-oriented mode of transport but also a form of fluid and active movement that involves body, mind and space (Lorimer, 2011b; Wunderlich, 2008). Through "walking-thinking-writing", these new walking studies have provided new and thought-provoking perspectives complementing the quantitatively oriented walkability measures and approaches with in-depth understandings pedestrians' practices of walking.

These writings are rich in detail, highlighting the complexities and diversities of the practice of walking, which is fundamentally important to the lives and experiences of individuals (Horton et al., 2014; Ingold & Vergunst, 2008). Key characteristics of these walking practices are emphasised, including their complexly sensed nature; the bodily, emotional, and sociotechnical attentiveness that is involved; and the connections that are invoked between landscapes, emotions and memories (Pinder, 2005). Nonetheless, walking is rarely seen as just walking in these new walking studies, but often as extraordinary, revelatory and sometimes sacred and spiritual. Some other studies have sought to

understand everyday walking by focusing on the "less remarkable, unspectacular and unreported everyday experiences associated with walking" (Middleton, 2010, p. 576), and exploring habitual and mundane walking practices (Horton et al., 2014, p. 98). Studying walking practices in London, Middleton (2009; 2010; 2018b) has observed that most journeys in everyday walking practices are not the outcome of rational intention or decision-making. She therefore argues that more attention should be given to the processual and experiential dimensions of walking itself (Middleton, 2011).

These new walking studies have adopted a relational ontology to understand the walking body; considered walking experience as an assemblage that involves material, visceral, social forces and connections between discursive and material entities; and foregrounded that there are multiple ways and styles of walking (Clement & Waitt, 2017; Cresswell, 2006; Middleton, 2011). The major argument of these new walking studies is to attend to the various forms and practices of walking, that is: understand the walk, as an event; the walker, as an embodied agent; and walking, as an embodied act (Lorimer, 2011a). The emphasis of the connections between pedestrians with other material objects internal or external to the human body during their walking trips opens up a new way for researchers to understand walking experience. Thus, walking should not be understood as an activity by itself, but situated and reproduced under particular subjectivities in combination with routes, movements, rhythms, and practices (Edensor, 2000). These studies have contributed to the understanding of the multifaceted nature and potentialities of walking experience and its connections with personal and societal values. The study of walking from the experiential perspective can complement with the behavioural perspective in understanding pedestrians' emotions, feelings, and meanings associated with their walking trips.

2.3 Pedestrians' responses to the built environment are person-specific

Pedestrians' responses to the built environment are highly complex and person-specific (Ewing & Cevero, 2010; Kwan, 2018), but such heterogeneities

are largely simplified in existing studies that examine the environmental influence on walking behaviour. Using perceptions as an example, perceptions of the environment reflects an individual's views and interactions with the environment, which involves a set of personal, psychological and social factors, such as age, gender, past experience, values, meanings and cultures, which might influence their interpretations of the environment. Hence, different pedestrians, even with the same socio-demographic characteristics might perceive the same built environment differently and result in different travel behaviour (Ewing & Handy, 2009).

Most of the existing studies used various socio-demographic variables (age, gender, income, car ownership, BMI and health condition, etc.) to capture such differences. For instance, in examining the impacts of land use on decisions for non-work walking trips, Greenwald and Boarnet (2001) used a vector of socio-demographic variables (age, car ownership, gender, income, number of children in household, number of workers in household, and race) to capture the differences in individuals' time costs of travel. Similarly, studying the associations between the built environment and walking in nine small towns and one metropolitan city in USA, Stewart et al. (2016) used a set of socio-demographic variables and an item measuring participants' neighbourhood residential selection as covariates, in order to capture the variations among individuals. Nonetheless, in these studies, only one or more of these socio-demographic variables are included as control variables, the variability for individuals with the similar socio-demographic characteristics are unclear. In view of this concern, some other studies consider the variation of individuals for particular socio-demographic characteristics (Agrawal & Schimek, 2007, Bates et al., 2005). For instance, exploring the age-related differences between perceived neighbourhood environment and physical activity, based on data collected from 1623 adults aged 20 to 97 in Seattle, USA. Shigematsu et al. (2009) found that younger participants' (ages 20-39) walking behaviour was significantly associated with all neighbourhood environment variables in the study, but fewer associations were found for older participants (ages +66).

Including one or more socio-demographic variables in these studies help to explain partially the variation by individuals with different characteristics. Nonetheless, researchers have begun to argue that people's responses to their environments may be highly personal depending on personal background, past experiences, attitudes, perceptions, and even emotional interpretation of the places where they walk, which cannot be simply captured by socio-demographic variables (Baldock et al., 2012; Degen & Rose, 2012; Kwan, 2018; Mennis & Mason, 2011). These studies have found that various person-related factors, including perceptions (Ma & Cao, 2019), attitudes (Joh, Nguyen, & Boarnet, 2012), habit strength (de Bruijn, Kremers, Singh, Van de Putte, & Van Mechelen, 2009), social support, social norms, and self-efficacy (Carlson et al., 2012; Verhoeven et al., 2016; Willis, Manaugh, & El-Geneidy, 2015) can help to explain people's travel as well as walking behaviour. Therefore, failing to consider people's unique responses in different situations and contexts may prevent researchers from having a comprehensive understanding of the phenomenon and even lead to unreliable estimates of the importance of the built environment in association with people's walking behaviour. How and in what ways do these person-related factors play a role in influencing individuals' walking behaviour is a question that needs more detailed investigation.

To sum up, this section has discussed the ways in which existing studies have captured the variation in individuals' response to the built environment by using basic socio-demographic variables, and by further exploring other person-related factors that are potentially influencing people's responses to the built environment. More recent studies have demonstrated that various person-related factors can influence how pedestrians respond to and interact with the built environment and hence their walking behaviour. However, the role of these person-related factors in understanding the built environment-walking connections has not been addressed sufficiently in existing literature, especially in a non-western city context. As a result, in this DPhil study, a pedestrian-centered perspective is proposed to better understand the pedestrians as individuals with various attitudes, perceptions, meanings and place attachment. As such, I would like to know what the critical person-related

factors are and how these factors shape the way pedestrians perceive and respond to the built environment and their walking behaviour. I begin to address this question with a qualitative exploratory study that allows me to uncover the factors that contributed to such differences and possibly shed light on the way such responses are generated. This qualitative study paves the way for the subsequent quantitative analyses and the development of the new method of walkability assessment.

2.4 Relationships between the built environment and walking

Studies that examine the environmental influence on walking behaviour are vast in number and multidisciplinary in nature. A number of literature reviews have attempted to synthesise the major research findings on this topic (Giles-Corti, Timperio, Bull, & Pikora, 2005; Humpel, Owen, & Leslie, 2002; Owen et al., 2004; Saelens & Handy, 2008; Saelens, Sallis, & Frank, 2003; Sugiyama, Neuhaus, Cole, Giles-Corti, & Owen, 2012; Trost, Owen, Bauman, Sallis, & Brown, 2002; Wang, Chau, Ng, & Leung, 2016). These reviews have confirmed the significant associations between certain built environmental features and walking behaviour. But the influence of the built environment on walking behaviour is complex and varies for different purposes of walking. For instance, consistent positive associations have been found between walking for transportation purposes and density, land use mix and presence of non-residential destinations (Barnett, Barnett, Nathan, Van Cauwenberg, & Cerin, 2017; D'Haese et a., 2015). On the other hand, walking for leisure purposes have been found to be positively associated with pedestrian infrastructure and aesthetics in many studies (Cerin, Sit, Barnett, Cheung, & Chan, 2013; Saelens & Handy, 2008). However, the associations between traffic safety and personal safety on walking (for transport or leisure) are less conclusive.

Most existing studies categorise walking into two major types: walking for transportation and walking for leisure (Humpel, Marshall, Iverson, Leslie, & Owen, 2004; Turrell, Haynes, Wilson, & Giles-Corti, 2013). For instance, these studies tend to classify all walking trips undertaken to reach a destination (e.g. walking to work and walking to shopping) as a generic type of "walking for

transportation", regardless of the trip's nature, main purpose, and activities generated by that trip. Overlooking the activities associated with the walking trips might be problematic, for most people may not make separate decisions regarding their walking trips, but they schedule their activities and walking in a daily pattern. As such, individuals' walking trips will be derived from the demand for participation in activities, according to the activity-based approach that considers travel as a derived demand (Kwan, 2000; Reichman, 1976; Schwanen, Kwan, & Ren, 2008; Vilhelmson, 1999).

An increasing number of studies start to distinguish different types of walking when examining the associations between built environment and walking behaviour. For example, although walking for work and walking for shopping and/or eating were both regarded as walking for transportation, the built environmental factors associated with these two types of walking were considerably different (Cho & Rodríguez, 2015). Therefore, it is necessary to study the environmental influence on walking behaviour by taking the purposes of walking into consideration, as different environmental factors are likely to be associated to specific purposes of walking. To investigate this further, in this study, I deliberately consider walking for three specific purposes (for work/school, leisure/recreation, and household responsibilities), in order to examine the variations in associations of the built environment on walking behaviour for different purposes.

The relationships between the environment and people's walking behaviour are more complex than suggested in many of the existing studies because of the potential influence of other non-built environmental factors. These factors might also play significant roles in shaping people's walking behaviour apart from the built environment (Zakaria & Ujang, 2015). Incorporating these often-overlooked factors in the models can help to advance our existing understandings of the built environment – walking relationships. For instance, Ewing and colleagues have conducted a number of studies to explore the linkages between the built environment and walking behaviour through five

major urban design qualities[1] (Ameli, Hamidi, Garfinkel-Castro, & Ewing, 2015; Ewing & Handy, 2009; Ewing, Handy, Brownson, Clemente, & Winston, 2006), as shown in Table 2.1 below. These studies have proposed a conceptual framework that considers the role of urban design qualities as a mediator between the built environment and walking behaviour. It is hypothesised that the built environmental features influence the quality of the walking environment both directly and indirectly through urban design qualities and pedestrians' unique responses. The conceptual model is shown in Figure 2.1 below.

Table 2.1 Urban design qualities and their definitions

Urban design qualities	**Definitions**
Imageability	The quality of a place that makes it distinct, recognisable and memorable
Enclosure	The degree to which streets and other public spaces are visually defined by buildings, walls, trees and other vertical elements
Human scale	Refers to a size, texture, and articulation of physical elements that match the size and proportions of humans and, equally important, correspond to the speed at which humans walk
Transparency	Refers to the degree to which people can see or perceive what lies beyond the edge of a street and, more specifically, the degree to which people can see or perceive human activity beyond the edge of a street
Complexity	Refers to the visual richness of a place

Source: Ewing & Handy (2009)

[1] Initially, eight urban design qualities were proposed by Ewing & Handy (2009), but only five of them could be operationalised in field survey, so subsequent analyses focused on these five urban design qualities.

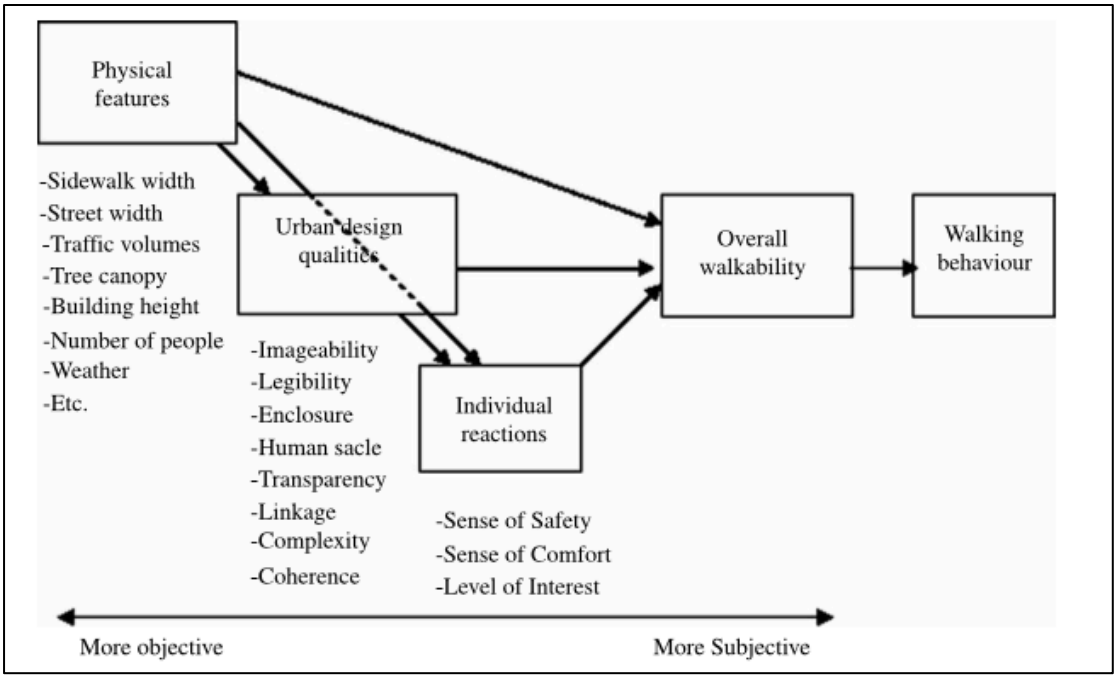


Figure 2.1 Conceptual framework connecting physical features with walking behaviour through urban design qualities
Source: Ewing & Handy (2009)

Likewise, apart from urban design qualities, other scholars have tested the mediation and moderation effects of other non-built environment variables in order to better understand the relationships between the built environment and walking behaviour. The mediation model provides explanation on how and why the dependent and independent variables are related through the intervening or mediating variable, which helps to answer question like "how does the built environment influence walking behaviour when other person-related factors are considered together?". In contrast, the moderation model explores whether the associations between a dependent variable and an independent variable differs across levels of a third variable (the moderating variable). The moderation model helps to answer question like "what are the effects of the built environment on walking behaviour vary among pedestrians with different levels of a particular person-related factor (e.g. attitudes towards walking)?" (Fairchild & MacKinnon, 2009).

Previous studies have demonstrated the role of other non-built environment factors in mediating or moderating the relationships between the built

environment on walking behaviour. For example, using data collected from 2,125 residents of eight neighbourhoods in the South Bay area of Los Angeles County, California. Joh et al. (2012) examined the role of a person's walking attitudes in moderating the impact of the built and social environment on walking. The findings revealed that the built and social environment have different impacts on walking trips depending on a person's walking attitudes. Individuals with positive attitudes are more likely to be influenced by the built environment and walking more frequently. In another study, Ma & Cao (2019) have confirmed that the objective built environment influences non-work travel behaviour through its influence on people's perceptions to the built environment using structural equations models. Their study demonstrated that perceptions mediate the relationships between the built environment and walking behaviour. Other studies have also identified significant moderating effects between built environment and various person-related factors on walking and physical activity for various populations groups, such as older adults (Fleig et al., 2016) and adolescents (Verhoeven et al., 2016; Wang et al., 2017). These studies have demonstrated the importance to consider these non-built environment factors in understanding the built environment – walking connection. Following these earlier studies, this study will examine the roles of the person-related factors in moderating the relationships between the built environment and walking behaviour.

In summary, this section has examined the complex relationships between the built environment and walking behaviour. First, it has demonstrated that the relationships may vary among walking for various purposes. Next, the roles of other non-built environmental factors have been shown to be important to understanding the relationships between the built environment and walking behaviour. This raises the first research question of this DPhil study:

RQ 1) What are the relationships between the built environment, person-related factors and walking behaviour and experience?

In addressing this research question, a qualitative study (Chapter Five) was first

conducted to explore pedestrians' own articulation of their daily walking experience, their interpretations of the built environment, and the various values and meanings associated with walking. After that, a quantitative study (Chapter Six) was conducted to explore the possible person-related factors (walking attitudes and perceived environment) in moderating the relationships between the objectively measured neighbourhood characteristics and walking behaviour. In addition, the relationships between the built environment and walking for three specific purposes (for work/school, for leisure/recreation, for household responsibilities) were also explored.

2.5 Problems associated with assessment of walkability

The earliest references to the term walkability can be traced to the 1990s (Southworth, 1997; Southworth & Owens, 1993), although no precise definitions were provided in these early studies, the major elements that contribute to walkability were identified. According to Southworth (2005), walkability is how the built environment is constructed to support walking and active lifestyle by providing a safe and comfortable environment, connecting pedestrians with various destinations within reasonable distances and time, and offer an appealing and well-maintained walking environment that are attractive to pedestrians. Following these early works, numerous studies began to provide their own interpretation and definition of walkability and/or walkable environment. For instance, Do (2002) defined walkability as "aesthetically pleasing, well lit with well-maintained footpaths"; Transport for London (2004) defined walkability as "the extent to which walking is readily available as a safe, connected, accessible and pleasant mode of transport"; Henson (2000) considered the pedestrian level of service, comfort, convenience, safety, security and economy as the defining characteristics of a walkable environment; Saelens et al. (2003) and Frank et al. (2005) defined walkability as residential density, land use max, and street pattern; the Congress of the New Urbanism (2001) defined walkability by: connectivity, mixed land use and diversity, quality architectural design, green transportation, sustainability and quality of life. Even though these definitions have their specific emphases on particular aspects of the walking environment, there are some common themes that cut across these

definitions; such as safe, comfortable, aesthetically pleasing, and destination-rich locations can be seen as highly walkable.

Following these definitions of walkability, numerous studies to date have been devoted to measure the walkability of the built environment by using geographic information systems, environmental audits, and questionnaire surveys for data collection (Cerin, Chan, Macfarlane, Lee, & Lai, 2011; Cole, Dunn, Hunter, Owen, & Sugiyama, 2015; Koohsari et al., 2016; Pikora et al., 2002). For instance, a widely applied walkability index was developed by Frank and colleagues (Frank et al., 2005; 2006; 2010), which consists of four components: net residential density, street connectivity, and land-use mix, and retail floor area ratio[2]. The z-scores of these four components are added to form the walkability index. Another well-known walkability index – Walk Score – is based on an algorithm that applies the distance decay function to calculate walkability based on the distance to 13 types of destinations[3]. After that, the score of each destination type is weighted equally and normalised to generate the Walk Score that ranges from 0 to 100 (Carr, Dunsigner, & Marcus, 2010; Cole et al., 2015; Duncan et al., 2016).

Despite the use of different methods for walkability assessment, the concept of walkability in these studies is limited to the built environment[4]. This conceptualisation of walkability regards the presence or absence of certain built environmental feature to have a positive or negative influence on walkability, based on the researchers' presumptions. However, given that pedestrians can have divergent views on whether a particular built environment feature is positively or negatively associated with walkability, walkability could be reconceptualised in a more relational way, as a product of the interaction between pedestrians and the built environment. This more relational

[2] In Frank et al. (2005), a three-component construct of walkability index was proposed, consists of net residential density, street connectivity and land-use mix. A fourth component: retail floor area was added in a follow-up study (Frank et al. 2006).

[3] According to Carr, Dunsigner & Marcus (2010), these 13 categories of destinations include: grocery stores, coffee shops, restaurants, bars, movie theaters, schools, parks, libraries, bookstores, fitness centers, drugstores, hardware stores, clothing/music stores

[4] Although in some cases, the "social environment" is also considered, the measurement items in capturing the "social environment" are still relying mostly on observable built environmental features.

understanding of walkability coincides with the work by Andrews, Hall, Evans, & Colls (2012), which stressed that it is necessary to consider "the assumptions about physically, socially and culturally differentiated bodies and environments inform understandings of what a walkable environment looks like and thus how it should be measured" (Andrews et al., 2012 p.1927). For example, graffiti has been considered as a sign of social disorder and assumed to have negative effects on walkability in many existing studies (Cain et al., 2018; Cerin et al., 2011; Millington et al., 2009). Yet other research has suggested that graffiti is not necessarily associated with crime or social insecurity, but can be regarded as a symbol of creative and culturally vibrant cities, which is attractive to local residents and tourists (Chatterton, 2000; Dovey, Wollan, & Woodcock, 2012; Schacter, 2014; Zukin & Braslow, 2011).

Another issue regarding existing walkability measures is the assumption that a single walkability index can be applied in many different locations, contexts and situations (Frank et al., 2010; Lefebvre-Ropars, Morency, Singleton, & Clifton, 2017). This assumption is referred as "ontological homogeneity", which implies that the way of defining and measuring walkability is the same for various contexts (Shashank & Schuurman, 2019). Recognising that there is no "one size fits all" walkability index (Manaugh & El-Geneidy, 2011), more recent studies have started to develop specific walkability indices for different population groups and/or various purposes of walking. For instance, Golan and colleagues (2019) applied a mixed method approach to develop a walkability index specifically for women. Focus groups were used to ask participants to identify and rank major environmental factors that the participants perceive to be important for walkability assessment. A walkability index was developed based on the participants' ranking exercise. When comparing the newly developed walkability index to Walk Score (the commonly used walkability index), contrasting differences can be observed, showing that the Walk Score cannot truly represent women's walkability (Golan, Wilkinson, Henderson, & Weverka, 2019). In line with this thinking, other studies have developed walkability indices for different trip purposes (Habibian & Hosseinzadeh, 2018), and for specific pedestrian groups (adults, children, seniors, and impaired mobility

pedestrians)(Moura, Cambra, & Gonçalves, 2017).

Although these specific walkability indices have been proposed to capture the variability of different pedestrian groups, one of the basic assumptions implied in these studies deserves further attention. In these studies, it is still assumed that the components of walkability in these indices are interchangeable. Using the walkability index developed by Frank et al. (2010) as an example, we can see that a lower score in one of the four components (e.g. residential density) can be compensated by a higher score from other components (e.g. land-use mix), and vice versa. However, this assumption might be unrealistic in some circumstances or for certain pedestrian groups, as a particular component of walkability may be too important and cannot be compensated by the other components (Dhar, 1996; Montgomery, 1983). In this case, it is necessary to rethink the appropriateness of the abovementioned assumption in walkability assessment.

To summarise, previous studies on walkability assessment have focused solely on the built environment, without viewing walkability as a relational concept constructed by the interplay of the pedestrians and the environment. In addition, it is also assumed that the different qualities of walkability are equally important and interchangeable with each other in assessing walkability. As such, existing studies on walkability assessment may not truly consider the heterogeneity of the needs and preferences of pedestrians. Therefore, it is necessary to reconceptualise walkability as a relational concept and examine how the existing methods of walkability assessment can be modified to capture the heterogeneity of the pedestrians. This raised the second research question of this DPhil study:

RQ 2) How can walkability be assessed by considering the heterogeneity of the needs, capacities and preferences of pedestrians?

To address this research question, I proposed a multiple-scenario approach for walkability assessment, which took into consideration the heterogeneity of the needs and preferences of pedestrians. This method was applied in four selected neighbourhoods in Shenzhen for illustration, and the results of this study are

presented in Chapter Seven.

2.6 Concluding remarks

In this literature review chapter, I have examined and summarised the vast literature from various disciplines associated with the study of walking from behavioural and experiential perspectives. After that, I have pinpointed the major issues regarding existing studies on walking and their links with the three empirical papers (Chapter Five to Chapter Seven) of this DPhil study. I have also summarised the major gaps identified from the literature review and discussed how this study can address these issues. The following two chapters will move on to discuss the background of the selected case study city and area, together with the research design and methods employed in this DPhil project.

3 Chapter Three - Context and Case Study

3.1 Introduction

As discussed in the introduction (Chapter One) and literature review (Chapter Two), existing walking studies have been dominated by case studies from cities in the developed countries, mostly in Western Europe and North America. In contrast, studies of walking in developing countries are relatively scarce. The dominance of studies has shaped the evidence base and our understandings of walking. "Westernised" walking studies share similar ontological and epistemological thinking and worldviews that are prevalent and they are generally adopted in most walking studies. Given that walking is a highly context-dependent behaviour and is constantly being shaped by different socio-cultural values (Fitt, 2017), the transferability of the dominant "westernised" understandings of walking to cities with different socio-cultural contexts (e.g. cities in the developing countries) cannot be simply assumed. Therefore, using a case study approach to study walking in a developing city context is urgently needed, as the findings from these non-western cities can allow researchers to reflect on and possibly advance the existing understandings of walking from a different perspective.

In this chapter, I first discuss the case study approach and its advantages of applying it to this study. After that, the rationale in selecting Shenzhen as the case study, the background information of Shenzhen, and relevant policies on walking are presented. Following that, I introduce the concept of neighbourhood, the neighbourhood effect and the definitions of neighbourhood adopted in this study. Next, I further explain the reasons for limiting the spatial unit of analysis to neighbourhood level, and I give an account on the procedures and rationales in the neighbourhood selection process. Detailed information of the neighbourhood selection process, including the variables used for selection, and the finally selected neighbourhoods are illustrated in the final section of this chapter.

3.2 Case study approach

Case study should not be treated as a methodological decision, but it is also the

process and the product of our learning through research (Stake, 1995). Some authors have criticised the case study approach because it only generates context-dependent knowledge and claims that the findings cannot be generalised; that is why some believe that the case study approach should only be used for a pilot study to generate hypotheses (Dogan & Pelassy, 1990). However, unlike natural sciences, it is nearly impossible to produce general, context-independent theory or knowledge in the social world, as predictive theories can be difficult to find in the study of human affairs (Flyvbjerg, 2006). As a result, the aim of adopting a case study approach is "not in the hope of proving anything, but rather in the hope of learning something!" (Eysenck, 1976, p.9).

Case study approach has the advantage of providing more in-depth, context-dependent understanding of the studied phenomenon by generating large amount of information from a small scale, but intensively studied sample (Curtis, Gesler, Smith, & Washburn, 2000). This advantage is particularly valuable for this DPhil project because individuals' walking behaviour is highly complex, context-dependent behaviour and is constantly being shaped by various socio-cultural values, meanings and the wider social context (Fitt, 2017; Mandic et al., 2017). Using a case study approach can help to examine the phenomenon (walking behaviour and experience in this study) from a real-life environment, which will help to explain the complexities of the situations that are not able to be captured through experimental or survey research (Gomm, Hammersley, & Foster, 2000). In addition, given that existing studies on walking and walkability are dominated by concepts and frameworks generated from cities of developed countries, or so called "westernised worldviews". Applying a case study approach in this study can help to explore and discover new information by combining various sources of data, which can contribute to advance our existing knowledge on walking behaviour and experience from a relatively under-studied developing city perspective (Merriam & Tisdell, 2015).

In terms of definition, the case study approach can be divided into three major types: instrumental, collective and intrinsic (Stake, 1995). The instrumental case study uses a particular case to gain a better understanding of an issue or

phenomenon; the collective case study uses multiple cases to generate a broader picture of a particular issue; and an intrinsic case study is used to study a unique phenomenon, in which the researcher has to define its uniqueness. Nonetheless, these categories are not mutually exclusive and can evolve during the research process when data are collected and analysed. This study adopts an instrumental case study approach, because it enables a "naturalistic inquiry" of the phenomenon to be studied. A naturalistic inquiry emphasises the importance to study the phenomenon in a real world setting and without attempting to manipulate the phenomenon (Patton, 2002). This approach allows participants to articulate their personal stories and perceptions, and the meanings they ascribe to walking in Shenzhen's urban environment. Taking a naturalistic approach is valuable for this study because relatively little is known about people's walking experience and behaviour in a developing city context, so this approach allows me to draw on various sources of data, including observations, interviews, as well as my own subjective experience to create a rich and evocative interpretations of people's daily walking experience and behaviour (Crowe et al., 2011; Yin, 2013). The findings from this study in a developing city context can complement with and contribute to the existing understandings on walking behaviour and experience.

3.3 The Case of Shenzhen

3.3.1 Why selecting Shenzhen as case study?

This sub-section explains the rationale for selecting Shenzhen as a case to study pedestrians' neighbourhood-level walking behaviour and experience. Firstly, the case of Shenzhen displays contrasting differences compared to other North American and European cities. Due to the shortage of land for development and the continuously growing population, most of the urban areas of Shenzhen are characterised by high-density, compactly developed and highly mixed land uses. Compared to the more sprawling and sparsely developed cities in North America, such an urban structure reduces the distances between destinations, and makes walking a more feasible and desirable option for short distance trips. For instance, comparing the level of physical activity for adults in 20 countries, in

general, adults in China conduct the highest level of physical activity (Bauman et al., 2009). Similarly, other studies have observed that older Chinese adults walk significantly more per week (735 minutes) compared to older adults in other western countries, such as Australia (333 minutes) (Bird et al., 2010) and Sweden (448 minutes for male and 301minutes for female) (Hurtig-Wennlöf, Hagströmer, & Olsson, 2010; Barnett et al., 2015). These studies have provided evidence to support that pedestrians in Chinese cities walk significantly more compared to pedestrians in other developed countries. Such differences might be attributable to a number of factors, including but not limit to, the built environment, the urban structure, density and diversity of developments, social norms, and cultural values. In this case, focusing on a rapidly developing Chinese city will generate new insights to advance our existing understandings on the environmental influence on walking behaviour and experience.

In addition, among the many Chinese cities, Shenzhen is also a case that deserves further investigation. Shenzhen has a unique history and process of urban development, which marks its distinctiveness from other large cities in China (to be discussed in more detail in the next section). In terms of walking, Shenzhen is one of the earliest cities in China to implement detailed planning for the development of pedestrian network at both city and local levels. Shenzhen has been recognised as one of the most walkable cities in China, according to a report assessing walkability of Chinese cities using four dimensions of safety, comfort, accessibility and policy (Shenzhen ranked second in this report, just after Hong Kong) (NRDC, 2014). Nonetheless, only 12 items[5] were used to assess walkability at the city level, the more fine-grained level of walkability within the city (district or neighbourhood level) was unclear. In addition, many of the items used in the report only consider the quantity (total length or total area) of the pedestrian network; the quality of the walking environment is overlooked.

[5] The 12 items applied in this study include: Safety (death rates from road traffic accidents, car ownership per capita, ratio of sidewalk area to total road area); Comfort (air quality index, ratio of sidewalk with tree coverage to total road area, WalkScore); Accessibility (ratio of total length of road network (km) to total built-up area (km^2), walkability assessment at random destinations within city, ratio of total road network area (km^2) to total length of road network (km)) and Policy (performance of government, sidewalk management, pedestrian network development).

According to the 2010 Shenzhen Travel Characteristics survey, about 50% of the trips made by Shenzhen residents are walking trips, which is much higher than other major Chinese cities, including Shanghai (26.2% in 2009), Hangzhou (30.8% in 2005), and Nanjing (25.43% in 2009) (Shenzhen Urban Planning Research Centre, 2011). This figure has demonstrated that Shenzhen has been performing much better than many other Chinese cities (achieving the 45% target set up by the central government on mode share for active transportation). However, improving the walking environment to support and encourage walking is still important in local government's agenda, as more recent travel characteristics survey showed that the percentage of walking trips decreased gradually from 53% in 2000 to 47% in 2016 (Shenzhen Urban Planning and Research Centre, 2017). One of the possible reasons for this trend is that most of the developments in Shenzhen in recent years are concentrated in the outer urban areas (due to the shortage of vacant land in the inner urban areas). These newly-developed districts are usually designed in a way that favours automobile use rather than active transportation. For instance, these districts are characterised with larger block size, large-scale gated residential developments and more segregated land uses. These factors combined to make walking less attractive in these newly developed districts and this observation many contribute to the decreasing trend of walking trips in Shenzhen. As a result, using carefully selected neighbourhoods in Shenzhen with different characteristics is an important consideration when measuring people's walking behaviour and experience.

The case of Shenzhen is unique, but at the same time, many problems faced by Shenzhen can also be found in other large cities in China. For instance, the increase in car ownership and usage in the past decade can be observed in Shenzhen as well as other major cities in China. In 2016, the number of motorised vehicles in Shenzhen was about 3.14 million (Shenzhen Urban Planning and Research Centre, 2017), making Shenzhen one of the cities with the largest number of motorised vehicles following Beijing, Chengdu, Chongqing, Shanghai, and Suzhou. However, since Shenzhen has long been a test-bed for many new policies, especially in economic and urban development (Chen & de'Medici, 2012; Deng, 2009), the Shenzhen local government takes a more

progressive approach in urban management. In terms of transport policies, Shenzhen has implemented numerous innovative measures, such as the electrification of public transport and the use of ICT for traffic management (Dong et al., 2018). In some cases, other Chinese cities will implement similar policies following the successful experience of Shenzhen. Therefore, using Shenzhen as a case study may provide meaningful results that are useful for other Chinese cities in the future.

3.3.2 Shenzhen – a city under rapid development

Located in the Guangdong Province of south China, Shenzhen has a linear shape, stretching about 90km from east to west, and 40km from north to south, and it is divided into 10 administrative districts[6], as shown in Figure 3.1. The land area of Shenzhen is 2,050km^2, which is only one-eighth the size of Beijing and one-third the size of Shanghai. Despite the relatively small land area compared to other major cities in China, with a population of over 12.9 million (in 2018), Shenzhen is still one of most densely populated cities in China (6,234people/km^2).

Compared to other large cities, such as Shanghai, Beijing, and Guangzhou, the history of Shenzhen is relatively short, but it is one of the fastest growing cities in China since the Open Door Policy in 1979. The aim of the Open Door Policy was to modernise the industry and economy by introducing the market economy principles in selected cities. Due to the geographical proximity to Hong Kong, Shenzhen was chosen as one of the Special Economic Zones (SEZs) that enjoyed special economic and tax policies to attract foreign direct investments (Saw & Wong, 2009), together with the trends of de-collectivisation and improvements in agricultural productivity, large amount of surplus workers were attracted to coastal cities in which industrial and service sectors are growing (Fan, 2002). Since then, migrants, capital, and technology have continued to flow into Shenzhen, transforming Shenzhen into the national commercial and financial centre of south China (see Bruton, Bruton and Li (2005) for further discussion about the urban development of Shenzhen). This massive growth can be

[6] 9 districts and 1 "new district" or management new areas (Dapeng New District)

illustrated clearly in numbers, the population of Shenzhen was only 0.3 million, with gross domestic product (GDP) of 196 million RMB in 1979. But in 2018, the population increased to 12.9 million[7], and GDP increased to 2.42 trillion RMB, ranked third in China, only after Beijing and Shanghai.

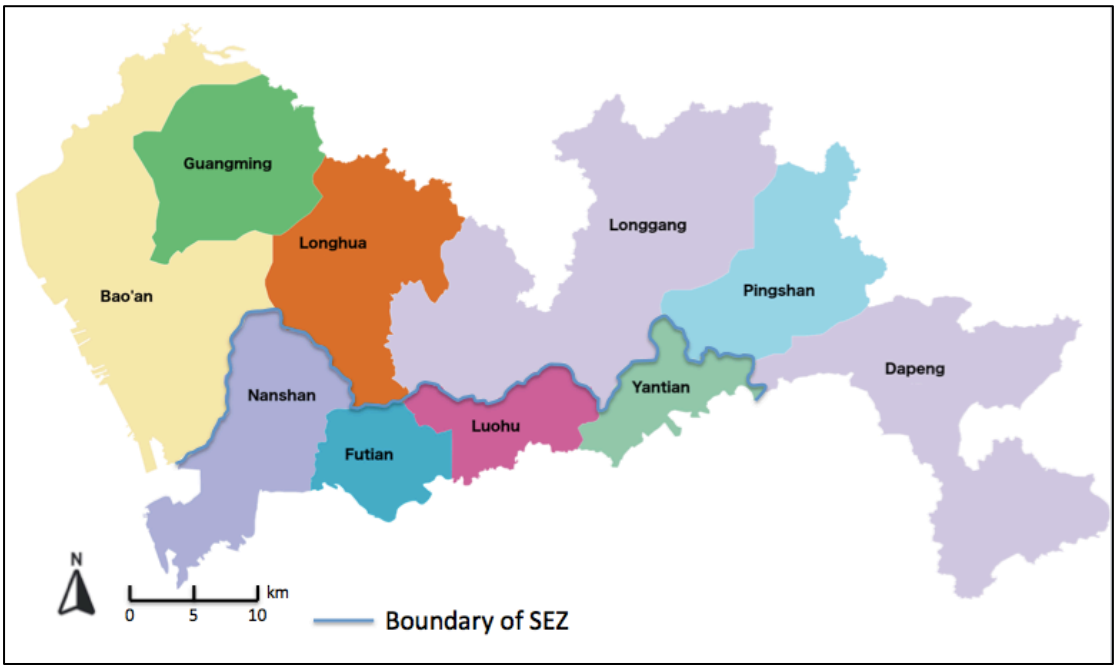


Figure 3.1 Administrative districts of Shenzhen

Before the 1990s, most of the new development in Shenzhen was concentrated in the districts within the SEZ[8], particularly in Luohu and Futian districts. These two districts are not only the geographical centre of Shenzhen, they are also located adjacent to Hong Kong and connected with Hong Kong through a number of border crossings. Because of the close proximity to Hong Kong, most of the investments and commercial activities have been concentrated in these two districts[9]. Later, more informal residential and industrial developments were developed outside the SEZ districts. When the boundary controls between the SEZ and the rest of Shenzhen were removed in the mid-1990s, developments intensified in these newly developed districts. Since 2000, developments have

[7] The registered population of Shenzhen was about 12.9 million according to the official statistics, but considering the substantial number of non-registered residents, it is estimated Shenzhen's actual population is about 20 million.
[8] The SEZ consists of four districts, including Luohu, Futian, Nanshan, and Yantian.
[9] As Hong Kong is a more developed city in terms of economic development compared to Shenzhen, a substantial amount of investments came from companies based in Hong Kong.

expanded further towards the outer urban districts, such as Longgang and Bao'an districts, partly because of the severe shortage of land in the inner urban areas (Qian, Peng, Luo, Wu, & Du, 2016).

The population composition of Shenzhen is also different from other metropolitan cities in China, characterised with a large proportion of temporary residents. Since the 1980s, Shenzhen has been attracting substantial number of migrants from all over China, and it has become a famous "migrant city". Today, over 65% of the residents in Shenzhen are migrants, or so-called temporary residents (without local hukou[10]) (Shenzhen Statistics Bureau, 2018). Most of these incoming migrants settled in the urban villages of Shenzhen. These urban villages were the by-products evolved from the rapid and unregulated urbanisation and the complicated dual-track land ownership system in China (Hao, Sliuzas, & Geertman, 2011) (see also Hin & Xin (2011) for more detailed discussion about the development of the urban villages in Shenzhen). Due to the unregulated nature of development, these urban villages are usually characterised with low-quality housing, infrastructural deficiencies and deteriorated urban environment. However, in recent years, the Shenzhen government has devoted significant efforts in "upgrading/renewing" these urban villages in order to improve people's living conditions. This has led to massive and rapid changes in the built environment in Shenzhen. For instance, some neighbourhoods received significant improvements in terms of physical infrastructure, including well-designed pedestrian footpaths and renewed public spaces. However, such improvements are not equally distributed across all neighbourhoods in Shenzhen, as many neighbourhoods remain less developed. The changes in the built environment at the neighbourhood level might have direct impacts on pedestrians' perceptions and experiences of walking.

Similar to other rapidly developing cities in China, the continuously growing population and private car ownership[11] have created numerous challenges to

[10] Hukou is a household registration system in China. Migrants settling in a city need to fulfill certain requirements (e.g. amount of investment, education level) to be eligible to register with a local hukou, otherwise they are referred to as temporary residents in the official statistics.

[11] The number of private vehicles registered in Shenzhen reached 3.36 million in 2018.

the transportation system, one of them being severe traffic congestion. In view of this situation, improvements in public transportation system, especially the development of a high capacity rapid transit system, have been necessary. In 2004, Shenzhen metro system started its operation, making it the fifth city in China to operate a metro system[12]. The first two metro lines (Line 1 and Line 4) were concentrated in the urban core, running from north to south and east to west across the city centre (e.g. Luohu and Futian districts). After that, the metro system gradually extends to cover other districts, such as Bao'an, Longgang, Nanshan, etc. In 2017, the system operates 8 lines and 198 stations in total, with a daily ridership of 5.23 million (Shenzhen Transportation Bureau, 2018). The system map is shown in Figure 3.2. To cope with the increasing demand, the Shenzhen government has proposed to expand the metro system to 32 lines (about 1142km) to cover the more distant districts of Shenzhen and even connects with neighbouring city, e.g. Dongguan (extension of Line 6), and Huizhou (extension of Line 14) (Shenzhen Government, 2016).

[12] Following Beijing, Tianjin, Shanghai, and Guangzhou

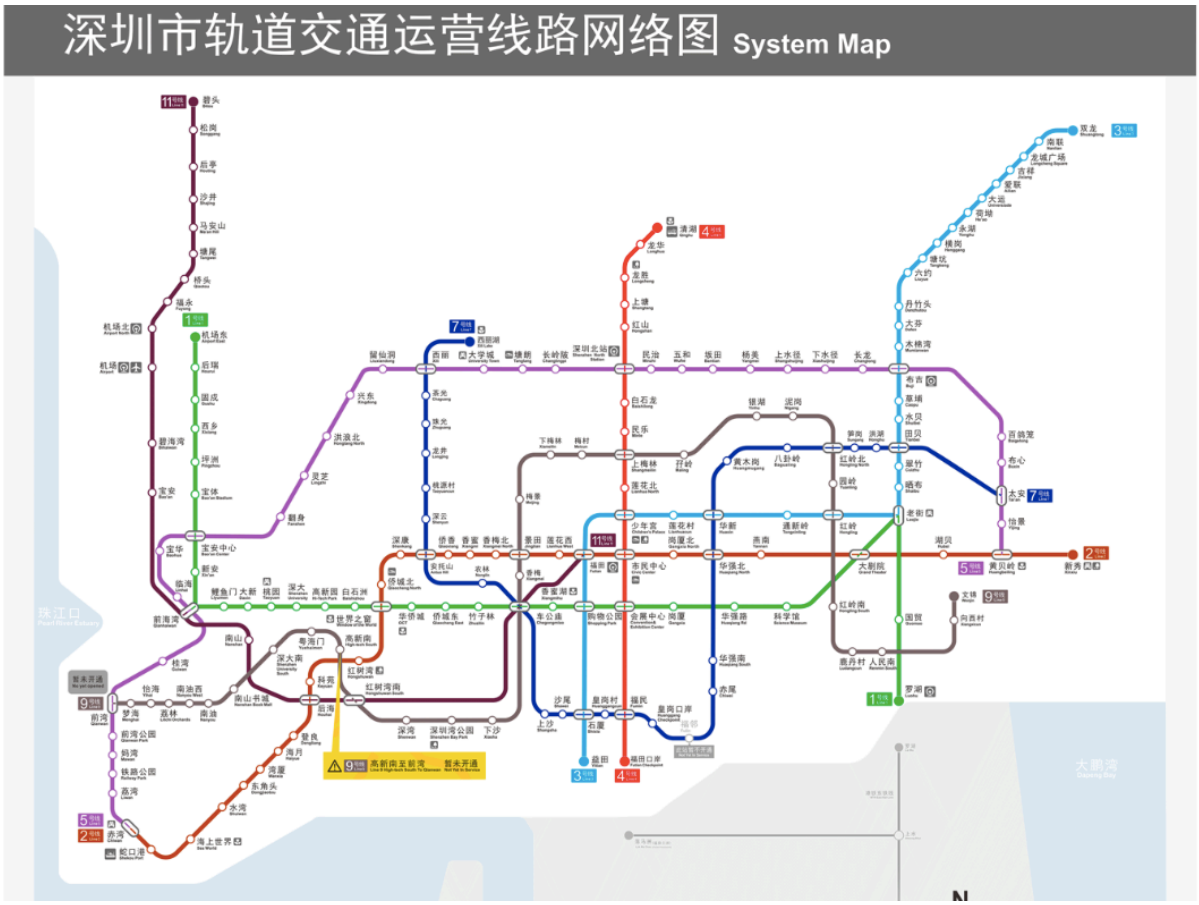


Figure 3.2 System map of the Shenzhen metro system

Source: Shenzhen metro (Shenzhen Metro Group Co. Ltd., 2019)

3.3.3 Policies regarding walking and the pedestrian system

Following the planning principles at the national and provincial level, the city-level government is responsible for developing their own Master Plan (城市總體規劃) and Detailed Plans (詳細規劃) to guide the future urban development. The Master Plan is the first stage of the planning system and forms the basis for urban development and management. According to the city's own characteristics, the Master Plan illustrates the economic and social functions of different areas of the city and the functional division of land uses. The major roads and transportation systems are also proposed in the Master Plans but only at the strategic level. For instance, only strategic roads and expressways are illustrated in the Master Plans, other arterial roads within districts are excluded. Based on the strategic-level Master Plan, Detailed Plans were developed. Detailed Plans include Regulatory Plans (控制性規劃) and Construction Plans (修建性規劃).

The Regulatory Plan combines the roles of planning and management and provides instructions on the land-use zoning, environment and transport developments, to act as the basis for relevant government departments in granting planning permissions. According to the existing planning system, the pedestrian network is only described and illustrated in the Regulatory Plans. In addition, the Construction Plans focus on the architectural construction and design details of particular land parcels. The respective role of the planning system is illustrated in the Figure 3.3 below.

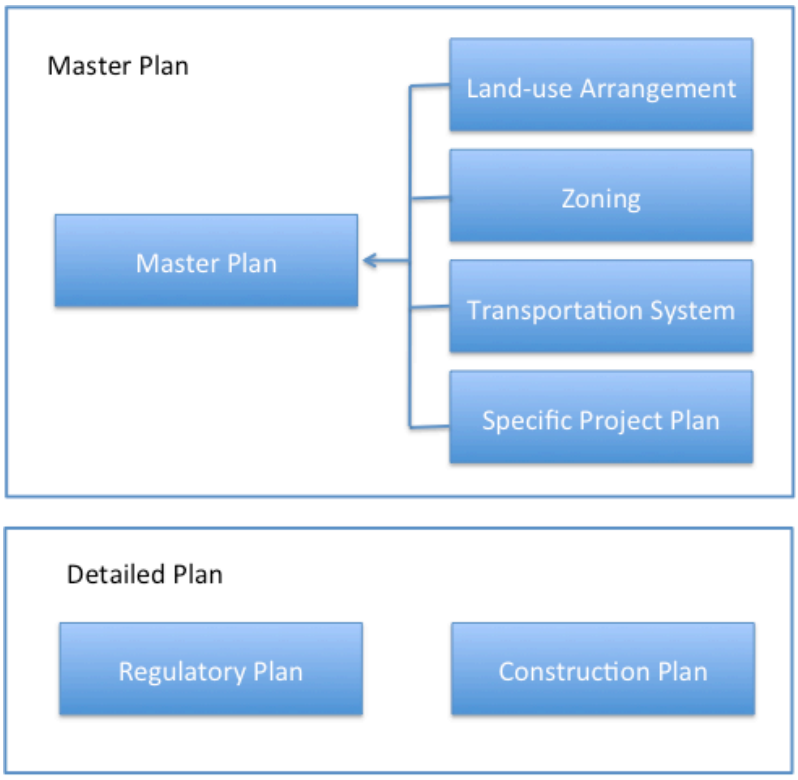


Figure 3.3 The planning system at city level
Source: Modified from NPCSC (2008) and Zhang (2013)

These plans will be formally demonstrated and consulted through a series of conferences held by the local government, after that, these plans will be published and delivered by the relevant local government departments for implementation. In the case of planning and management of the pedestrian network, it is the responsibility of the Shenzhen Municipal Transportation Committee to implement these policies. This committee is a joint bureau established in 2009 responsible for the planning, design and management of

transport related policies, which combines the functions and duties of former Shenzhen Municipal Transportation Bureau, Highways Bureau, Traffic Management Office, and Urban Management Bureau.

In recognition of the importance and benefits of promoting walking and cycling[13], various national and city level plans and policies have been developed over the past decade to guide the planning and design of pedestrian networks and to improve the quality of the walking environment. In 2013, the State Council published policy documents including "Opinions on strengthening urban infrastructure construction" and "Guidelines for the planning and design of urban walking and cycling systems". These documents stressed the importance of improving the pedestrian and cycling network, in response to the overreliance on the automobile in the current transportation system. It was proposed that an improved pedestrian and cycling network can help to build a safer and more sustainable transportation system in the future. In response to the State Council, the Ministry of Housing and Urban-Rural Development, National Development and Reform Commission, and Ministry of Finance co-published the "Guidance on strengthening the construction of urban walking and cycling systems", which set up the basic principles and targets in guiding the promotion of walking and cycling.

The following principles were proposed in the Guidance document:

1) Adoption of a people-oriented approach in planning. Taking people's actual travel needs into consideration to improve the construction of roads and other facilities, and provide a safe, convenient and comfortable urban walking and cycling environment.
2) To plan and design scientifically. Careful organisation of the planning of urban walking and cycling systems, strengthening of the coordination between relevant authorities, and improvement of the intermodal coordination between walking and cycling with other modes of transportation.
3) Adjusts the plans to local conditions. This depends on the actual situation of

[13] This study focuses only on walking behaviour, but in most of the policy documents, walking and cycling are usually discussed together because they are both active transport.

each city in determining the goals and strategies in improving the walking and cycling system.

Following these principles, this document also set up targets for large and megacities to achieve in the future, aiming at increasing the share of walking and cycling by 2020. For cities with an urban population of more than 10 million, it is expected that over 45% of the trips will be made by walking and cycling. A clear development goal was proposed for the construction of urban walking and cycling systems. The city level government will be required to organise and compile detailed planning for urban pedestrian and cycling systems, improved design of the walking environment, provision of bicycle lanes and bicycle storage facilities, and local improvements and modifications projects to upgrade existing infrastructures. A national design standard "Guidelines for the planning and design of urban walking and cycling systems" was also published to assist local level city government to achieve the targets (Ministry of Housing and Urban-Rural Development of the People's Republic of China, 2012).

At the city level, Shenzhen is one of the earliest cities in China to incorporate the planning of pedestrian and cycling network in the comprehensive transport development plans. Table 3.1 and Figure 3.4 show the major master plans and studies on walking and pedestrian system improvements since 2005, including both district level and city level plans and studies. From these relevant planning and transport studies, it can be observed that the Shenzhen government has paid particular attention to improve the pedestrian network at both local and city level.

Table 3.1 Relevant plan or study on Shenzhen's pedestrian network

Year	Plan or Study	Notes
2005	Shenzhen Comprehensive Transport Study	Highlight the importance of walking and cycling in the development of Shenzhen's transportation system, proposed that it is necessary to reconstruct Shenzhen's pedestrian and cycling network
2006	Study of Shenzhen Special	Focused on the four districts of

	Economic Zone Pedestrian System	Shenzhen Special Economic Zone
2007	Shenzhen Special Economic Zone Cycling and Pedestrian System Improvement Plan	
2008	Pedestrian facilities planning in Bao'an District	District level improvement plans, targeted specifically in improving pedestrian network and infrastructure
2008	Pedestrian facilities planning in Longgang District	
2008	Pedestrian facilities planning in Yantian District	
2011	Guangming New District Non-motorised Transport Study	
2011	White Paper on Shenzhen City Transport Study	City level transport study
2012	Shenzhen pedestrian and cycling transportation system planning	City level planning for walking and cycling
2014	Shenzhen City Traffic Congestion Comprehensive Management Strategy	Propose the reconstruction of pedestrian network and facilitate coordination with public transportation system

Sources: Shenzhen Planning and Natural Resource Committee (2013), NRDC (2014); Shenzhen Transportation Bureau (2015)

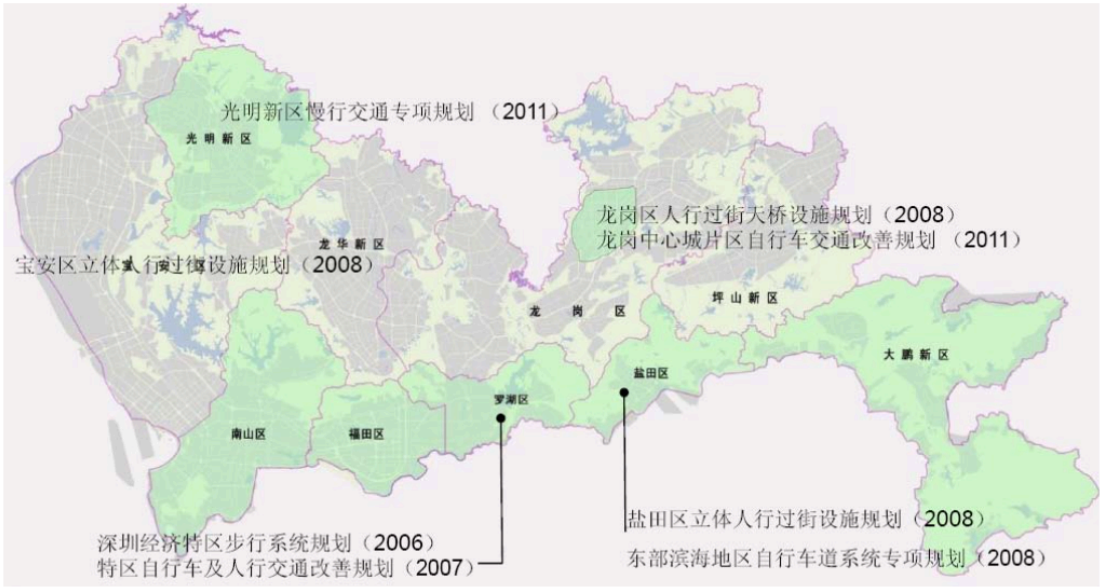


Figure 3.4 Major plans and studies on pedestrian and bicycling network in Shenzhen (from 2006 to 2012)

Source: Shenzhen Planning and Natural Resource Committee (2013)

3.4 Neighbourhood effect and neighbourhood boundaries

Since this DPhil study is about individuals' neighbourhood-level walking behaviour and experience, it is necessary to provide a brief overview of existing studies relevant to the spatial scale of neighbourhood. In this sub-section, I will provide a brief account of the neighbourhood effect and explain the definition of neighbourhood boundaries adopted in this DPhil study.

There has been considerable discussion in existing literature on neighbourhood effects on people's behaviour: the idea that neighbourhood characteristics (geographical context of the area) can have significant impacts on residents' behaviour over and above their individual characteristics (Galster, 2001; Van Ham, Manley, Bailey, Simpson, & Maclennan, 2012). In the study of people's walking behaviour, the influence of the geographical context on people's behaviour is of particular attention, as previous studies have found that neighbourhood environment can have significant impacts on people's physical activity, health and well-being (Giles-Corti, Broomhall, et al., 2005; Smith, Gidlow, Davey, & Foster, 2010). However, debate continues about how a "neighbourhood" should be defined, as the definition of neighbourhood is largely dependent on an individual's own interpretation. In previous studies, neighbourhoods have been defined by different characteristics and geographical scales based on various contexts and purposes, such as the use of administrative boundaries, vague spatial formulations like "neighbourhood" or "local area", and behavioural definitions like "within certain distance from a destination" (Smith et al., 2010).

Apart from the debates on the definition of neighbourhood, the differences in the meaning of "neighbourhood" in English and Chinese also complicate the problem. For instance, the direct translation of "neighbourhood" to Chinese is *linli* (鄰里), meaning "the neighbours adjacent to an individual's home", which implies only a very narrow interpretation of the concept (Forrest & Yip, 2007; Yip, 2014). However, there are other concepts that share similar meanings with neighbourhood, such as *shequ* (社區)[14]; *xiaoqu* (小區)[15]; and *danwei* (單位)[16]. In

[14] Shequ usually refers to the community or social organisations at the local level.
[15] Xiaoqu usually refers to the administratively defined area for planned residential developments, or used

view of such discrepancies in the definitions and meanings of neighbourhood, in this study, the concept of neighbourhood was used in a generic way, referring to the geographical area adjacent to individuals' residential location. In practice, neighbourhood was defined by using a 500m buffer surrounding the purposefully selected residential developments. This definition was adopted by considering a number of factors, including: Chinese residents' acceptable walking distance in a high-density Chinese city context; the use of 500m as a standard threshold for other planning studies in China to represent residents' common walking distance; and insights drawn from a mapping exercise conducted by local residents during my fieldwork in Shenzhen. This definition of neighbourhood matches with the multi-stage method of neighbourhood selection applied in this DPhil study (Further discussion on the definition of neighbourhood and the neighbourhood selection process will be provided in Section 3.6.3).

3.5 Why focusing on selected neighbourhoods in Shenzhen?

The previous sections explained the rationale of selecting Shenzhen as the city for case study, and it has presented the basic information and characteristics of urban structure and developments in Shenzhen. However, the geographical extent of Shenzhen is extremely large and the behaviour to be studied in this DPhil project is about people's walking behaviour and experience, which is usually confined to a much smaller geographical scale. As discussed in many previous studies, although the maximum distance that pedestrians are willing to walk is determined by many factors (such as presence of destinations, condition of walking environment), in most cases, pedestrians only accept to walk for short distances e.g. between 400m to 600m (SUTPC, 2012; Yang & Diez-Roux, 2012). For example, as shown in a recent study in China, the median walking distance for pedestrians to reach the farmer's market and supermarket in Beijing was only 576m and 483m respectively (Chen, 2017). For the case of Shenzhen, according to the 2010 Shenzhen Travel Characteristics Survey, the average duration of home-based walking trips are around 15 minutes (Shenzhen Urban

to represent a particular residential development.

[16] Danwei is a term used to denote the socialist work place in China, but it also refers to some of the neighbourhoods built by the work units during the socialist regime.

Planning and Research Centre, 2011), showing that pedestrians usually conduct their walking trips in close proximity to their residential neighbourhoods. As a result, in order to study local residents' neighbourhood-level walking behaviour, narrowing down the scope of this study from the city to the neighbourhood level offers a more suitable approach to explore this phenomenon, as behaviour can be matched with the local level built environmental features.

Differences in land use patterns, street networks, and urban design can be observed in different parts of Shenzhen, especially when inner urban and outer urban districts are compared (as discussed in Section 3.3). In view of such differences, a multi-stage neighbourhood selection method has been adopted to systematically select neighbourhoods that on one hand capture such differences, but on the other hand control for some basic socio-demographic variables to ensure these neighbourhoods are comparable.

3.6 Neighbourhood selection process

The administrative units in Shenzhen are divided into three tiers. The largest subdivision is the district (區), and Shenzhen is divided into 10 districts; the sub-district (街道) is the next level of administration managed by the sub-district office (or so called jiedao ban 街道辦), and there were a total of 59 sub-districts[17]; the neighbourhood (社區) or residential communities (居民區) is the smallest administrative unit. Nonetheless, census data published by the Shenzhen government are only available at the district level, and there are no publicly accessible statistical data for neighbourhood level. Hence, in view of the lack of suitable data at the appropriate geographical scale, I applied a multi-stage method for neighbourhood selection by first selecting suitable sub-districts and then further selecting neighbourhoods within the chosen sub-districts, as shown in Figure 3.5 below.

[17] When this study was planned in 2015, Shenzhen was divided into to 10 districts and 59 sub-districts. The classification of sub-districts changed in the end of 2015, increasing the number of sub-districts from 59 to 74. In this study, the pre-2016 classification system was adopted.

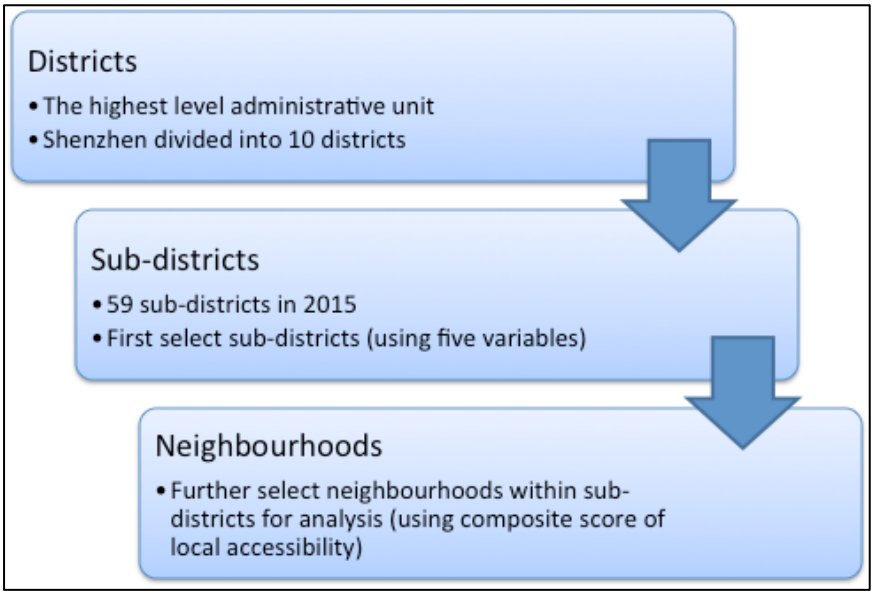


Figure 3.5 The multi-stage neighbourhood selection process

The objective of neighbourhood selection process is to maximise the variability of the study neighbourhoods in order to generate more in-depth information to enrich our understanding of the connections between the built environment and walking in a developing city context. So, rather than selecting a random number of neighbourhoods from all over Shenzhen to allow the generalisation of findings, we purposefully select neighbourhoods that can fulfill the objective of this study. For instance, the method in selecting sub-districts can capture the urban structure of the earlier-developed inner urban sub-districts and more newly-developed outer urban sub-districts, but at the same time ensure they are comparable in terms of public transport accessibility, car accessibility, age of residential buildings, and socio-economic status. The further selection of neighbourhoods within the two sub-districts based on high and low local accessibility can capture the contrasting built environmental features associated with neighbourhood-level walking at a more local scale.

In view of the lack of publicly available data, I have applied a systematic multi-stage approach to select the study neighbourhoods. The use of proxy variables to capture the variability of the sub-district and neighbourhoods during the selection process is the second best option available given the constraints in data, time and funding. This method of neighbourhood selection is

not to select the most representative neighbourhoods in Shenzhen, rather, this method of neighbourhood selection aims to select neighbourhoods in terms of differences in regional accessibility/respective location within Shenzhen (inner urban and outer urban) and local accessibility (high local accessibility and low local accessibility).

3.6.1 Variables used in selecting sub-districts

Five variables were used in the selection process to capture distinctive characteristics of the sub-districts. For instance, the variables "distance to city centre" and "age of residential buildings" capture the development history of the sub-districts, as most of the early developments in Shenzhen were concentrated in the urban core and later gradually spread towards the outer urban areas. Another two variables "accessibility to metro system" and "easy access by private cars" capture the connections of the sub-districts to other parts of Shenzhen by the metro system and the road network. The final "socio-economic characteristics" variable tries to capture the characteristics of the residents within the sub-districts. One of the advantages in using these proxy variables in the selection process is to maximise the diversity of sub-districts to be selected, but at the same time ensure that the selected sub-districts are to a certain extent comparable. The details of these five variables used for selecting sub-districts are presented below:

Distance from city centre. Measuring the straight-line distance from the centroid of each sub-district to the city centre, this variable captures the relative location of the sub-district within Shenzhen. This variable was used to capture the relative distance to the city centre of Shenzhen. When the development of Shenzhen started in the late 1970s, Luohu district was the city centre and most flourishing region. However, in the 1990s, in order to transform Shenzhen into an international city, the Shenzhen government decided to plan Futian as the city centre after a series of consultations (Ng & Tang, 2004). This is why I used the location of the Shenzhen municipal government office in Fuzhong Third Road (coordinates: 22.542722, 114.059548) as the starting point in measuring the

distance with other sub-districts. The distance from city centre for sub-districts ranges from 1.27km to 44.64km.

Accessibility to the metro system. This variable examines the accessibility provided by the metro system for the sub-districts. This variable was measured by counting the number of metro stations within the boundary of each sub-district. A point worth mentioning is that, as major roads were used to delineate the sub-districts, in some cases, the metro station is located exactly in-between the boundaries of two sub-districts. In this situation, this metro station was labelled as accessible for the two sub-districts.

Since its operation in 2004, the Shenzhen metro system has become one of the most important modes of public transport in Shenzhen, with daily ridership of 2.128 million in 2013 (Shenzhen Metro Group Co. Ltd., 2014). Metro system has become a major mode of transport connecting people's residential neighbourhoods to other destinations within the city. Therefore, it is important for the selected sub-districts that have comparable accessibility to the metro system, as the presence of the metro system might significantly affect pedestrians' mode choice decisions to reach destinations outside their sub-districts.

Ease of access by private cars. Given the growing number of vehicle ownership in Shenzhen, private car is becoming an important mode of transport for many Shenzhen residents. Ideally, the best way to capture car ownership is to use the official private car registration data, but such data are only available at the city level. So I use the number of entry/exit for major highways and trunk roads within the sub-district boundaries to capture the ease of access by the use of private cars. It is hypothesised that the higher accessibility (measured by more entry/exit to major highways and trunk roads), local residents are more likely to own and use private cars for their daily travel. Given that the concern of this variable is about the regional accessibility enabled by cars, only higher order roads, namely expressway and major trunk roads were included.

Age of residential buildings. This variable tries to reveal the age of residential developments within each sub-district, in order to capture different stages of urban expansion for different sub-districts in Shenzhen. As there is no detailed and disaggregated information available, I use the residential floor spaces built in each decade (e.g. 1960-1969, 1970-1979) extracted from the 2010 Shenzhen Population Census and Statistics (Shenzhen Government, 2011) as a proxy variable to capture the average age of residential floor spaces in each sub-district. In this way, the sub-districts can be distinguished by their history of developments.

Socio-economic characteristics. Personal or household income is usually used to represent socio-economic status of residents. However, sub-district level census data for income are not available, so I use educational attainment as a proxy to represent socio-economic status, as previous studies have shown that education level is highly correlated with personal income in the Chinese context (Ni, 2010). Educational attainment was computed with the following method. First, a value representing the years required to obtain a specific level of education was assigned to each level of educational attainment. For example, 6 years was assigned to primary education, and 12 years for secondary education, etc. Then, by summing up the total years of education of all people in each sub-district and divided by the number of people, we will get the average years of education to represent educational attainment of residents in each sub-district.

3.6.2 Procedures for selecting sub-districts

The procedures for selecting sub-districts are illustrated in Figure 3.6 below. First, the non-residential sub-districts were removed as no residential developments were planned in these sub-districts. After that, using the five variables listed in the above section, the sub-districts were ranked in decile groups. Sub-districts with any of the variables that belong to the two extreme groups (the highest 20% and lowest 20% of sub-districts) were excluded to ensure the selected neighbourhoods are comparable in these five aspects. Finally, two sub-districts, one located in the inner urban areas – Shatou sub-district;

another located in the outer urban areas – Longchen sub-district were selected, as shown in Figure 3.7.

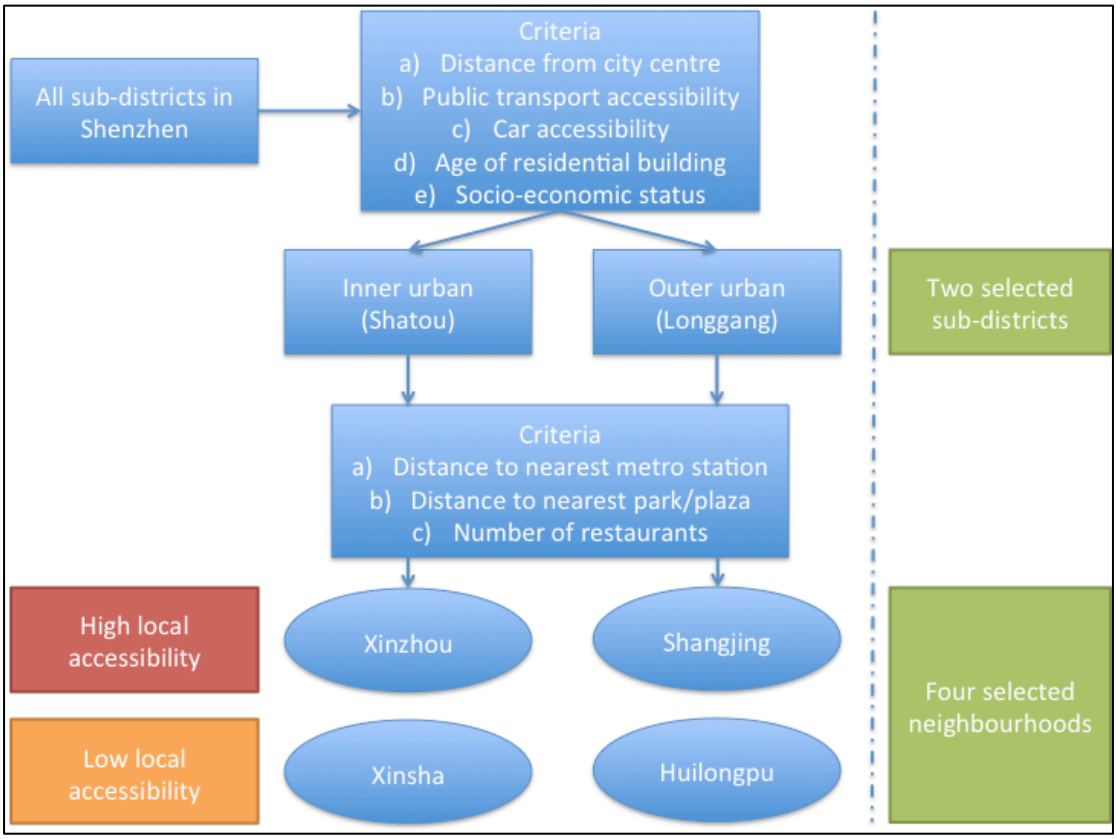


Figure 3.6 Flowchart of the multi-stages neighbourhood selection method

Figure 3.7 Location of Shatou and Longchen sub-district in Shenzhen

Source: Modified from Google maps

3.6.3 Procedures for selecting neighbourhoods within sub-districts

After the selection of the two sub-districts, the next step is to select residential neighbourhoods within the selected sub-districts for further analysis given that the focus of this study is neighbourhood-level walking experience and behaviour. The neighbourhood is the smallest administrative unit in Shenzhen. But given that the administrative boundaries of these neighbourhoods are created for other reasons (such as for governance and resource allocation), these administrative boundaries have little or no connection with people's walking behaviour. In view of this issue and the lack of available statistical data, I have decided to adopt an indirect method (as discussed in Section 3.6) in selecting the neighbourhoods within the selected sub-districts.

First, within the two sub-districts, all of the major residential developments were identified using Baidu map and the statutory zoning plans (regulatory plans) based on the designated land use types. For example, in Shatou sub-district, 149

residential developments[18] were identified. Using the central point of these residential developments as centroid, a 500m buffer was created for each residential development. A 500m buffer was chosen to define a neighbourhood for a number of reasons. First, according to some studies conducted in other Chinese cities, people's acceptable walking distance for their daily activities ranges from about 400m to 600m (SUTPC, 2012). Next, previous studies have demonstrated that pedestrians' perceived neighbourhood area is usually much smaller than the commonly defined administrative areas (Alidoust, Bosman, Holden, Shearer, & Shutter, 2017). This perceived neighbourhood area is closer to the "5 minute walking distance" or equivalent to about 0.25 miles or 400m surrounding their home (Smith et al., 2010). Practically, the 500m-buffer threshold was also used as the standard for the planning of pedestrian areas around major public transport stations (especially metro stations) in planning related documents of Shenzhen (Shenzhen Planning and Natural Resource Committee, 2013). In addition, the mapping exercise conducted by participants during the semi-structured interviews confirmed that most of the daily walking trips conducted were within 500 metres from their home. Therefore, considering all of the above reasons, I decided to use 500m-buffer as the definition of a neighbourhood.

Three variables ("distance to the nearest metro station", "distance to nearest park/plaza" and "number of restaurants") were used to create a composite index to capture the local accessibility surrounding these residential neighbourhoods. These three variables were chosen because they capture various aspects of local accessibility of neighbourhoods and the creation of composite index can represent the local accessibility comprehensively. The variable "distance to nearest metro station" represents the accessibility to access public transport; "distance to nearest park/plaza" captures the accessibility to leisure and recreation sites; and "number of restaurants" act as a proxy variable to show the accessibility to nearby commercial destinations. The details of these three variables are presented below:

[18] Some of the small-scale scattered residential developments, e.g. the residential buildings within the urban villages were combined based on the land use parcels indicated in the statutory zoning plans.

1) *Distance to nearest metro station.* This variable captures the convenience for residents to walk to nearby Shenzhen metro stations. Given that the metro system is a major mode of public transport and provide easy connections to other parts of Shenzhen, shorter walking distances to metro stations are more attractive for pedestrians, as they can walk to the metro stations easily and get access to other destinations in Shenzhen. Hence, shorter walking distance to metro station means higher local accessibility.

2) *Distance to nearest park or plaza.* This variable captures the accessibility to walk to nearby public parks or plazas to conduct various leisure and recreation activities. Public parks and plazas were selected because these locations are the common form of activity spaces in the context of Shenzhen.

3) *Number of restaurants.* This variable captures the number of destinations available for pedestrians to select when they decide to walk for short distances within their neighbourhoods to fulfil their needs (for shopping and other daily activities). The number of restaurants was selected rather than other variables because more comprehensive and accurate data are available from the online map for this type of establishment[19]. This variable can partially represent the presence of other destinations, as during my observation in the fieldwork, most of the restaurants are located within the more prosperous commercial areas.

The local accessibility composite index was calculated by ranking all of the residential developments into decile groups and assigning a score from 1 (lowest) to 10 (highest) to the sampled residential developments. Adding the scores of the three variables together, a composite index ranging from 3 to 30 was obtained. Within each sub-districts, the residential neighbourhoods with the highest and lowest composite index on local accessibility were chosen as the study neighbourhoods.

[19] This variable can partially represent the presence of other commercial destinations, as during my observation in the fieldwork, most of the restaurants are located within the more prosperous commercial areas.

The four selected neighbourhoods are Xinzhou, Xinsha, Shangjing and Huilongpu. Xinzhou and Xinsha are both located in the inner-urban, high-density sub-district of Shatou, as shown in Figure 3.8. Xinzhou is characterised by high local accessibility and a mixture of both high and medium-rise residential buildings. In comparison, Xinsha is a neighbourhood with low local accessibility and dominated by residential land uses with lower levels of land use mix. Shangjing and Huilongpu are situated in the outer-urban Longchen sub-district with the former offering high local accessibility and prevalence of high-rise residential buildings, and the latter dominated by a mix of large-scale high-rise residential developments and an extensive area of urban villages, causing lower level of local accessibility. The location of Shangjing and Huilongpu neighbourhoods are shown in Figure 3.9.

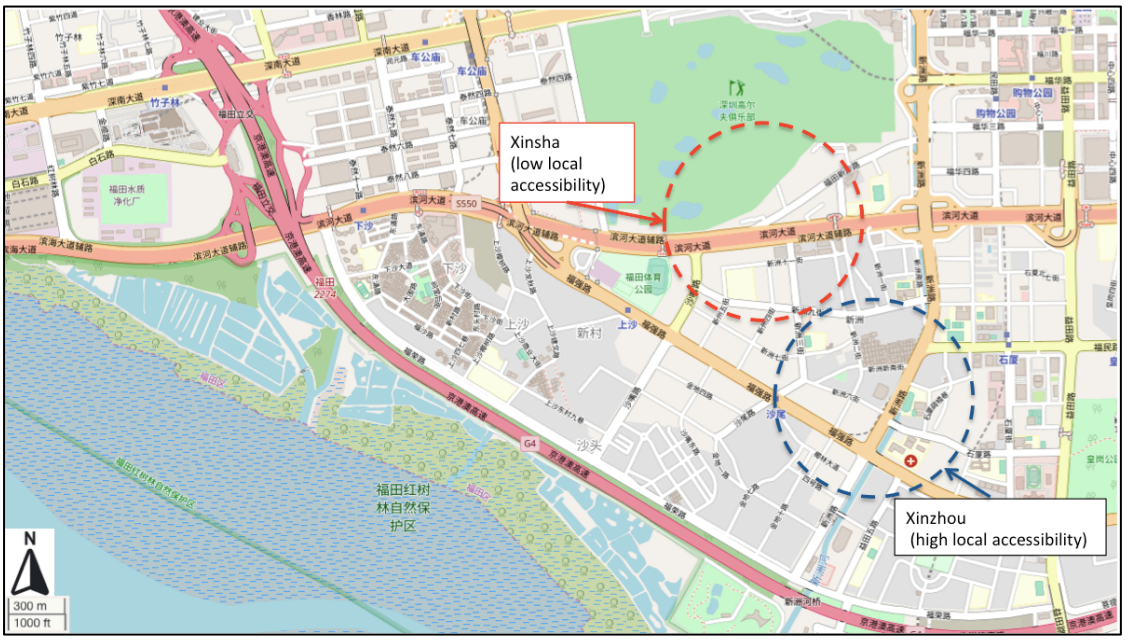


Figure 3.8 Location of Xinzhou and Xinsha neighbourhood within Shatou sub-district

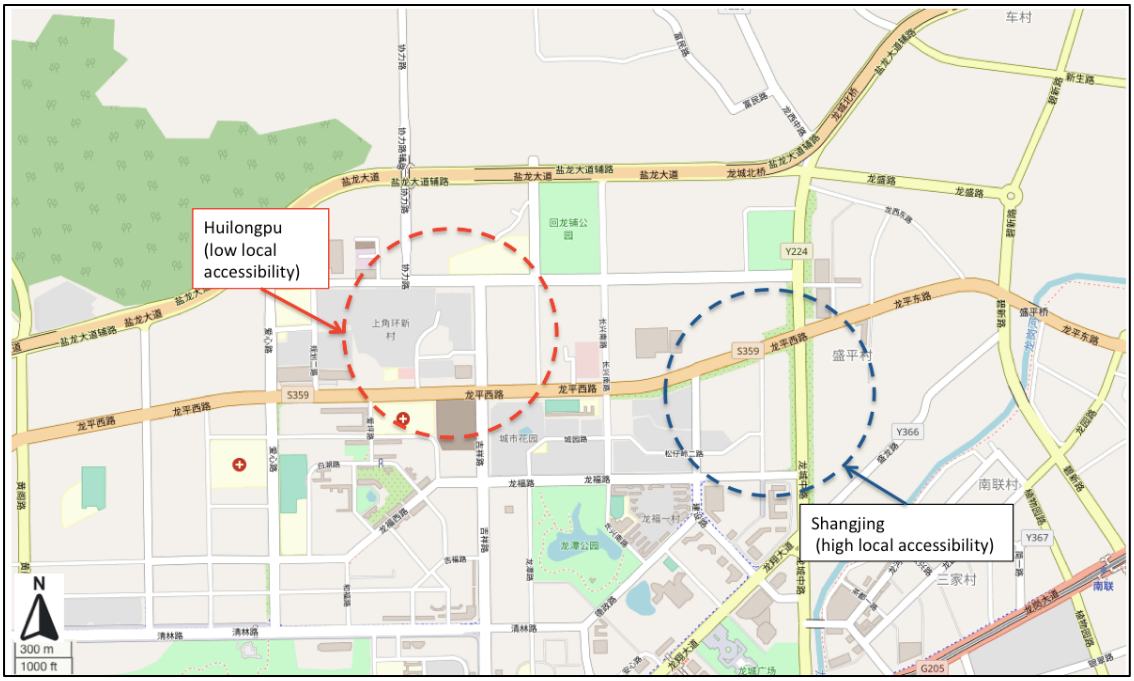


Figure 3.9 Location of Shangjing and Huilongpu neighbourhood within Longchen sub-district

3.6.4 Critical reflections on neighbourhood selection process

In view of the lack of statistical data at the neighbourhood level, I have employed a multi-stage process for neighbourhood selection, with the aim to purposefully select neighbourhoods with contrasting characteristics that can generate the maximum amount of information to enhance our understanding of the relationships between the built environment and neighbourhood walking behaviour. The current neighbourhood selection method is suitable in answering my research questions (with a particular focus on neighbourhood-level walking), but it also limits the ability to generalise the findings to cities in China or other Asia countries. However, as highlighted by Flyvbjerg (2006), the value of case study approach is not always about generalisability of findings, but about the lessons that can be learnt from these carefully selected cases. In this study, this neighbourhood selection method highlighted the variability of urban structure in new and old neighbourhoods, as well as the more localised differences in walkability among neighbourhoods within the same sub-district, which appeared to provide rich information for other neighbourhoods or cities to learn

about how walkability can be improved in neighbourhoods with different characteristics.

3.7 Concluding remarks

In this chapter, I have introduced the case study approach and illustrated the advantages of applying this approach to this DPhil study. The case study approach enables the generation of more in-depth, context-dependent knowledge of the studied phenomenon, which could advance our existing understanding of people's walking behaviour and experience. Next, the rationale of selecting a rapidly developing Chinese city – Shenzhen was discussed to highlight the specialties of this city. This chapter has provided the readers with the background information about the history of urban development, administrative structures, and relevant policies on the planning of pedestrian infrastructure and the walking environment in Shenzhen. Following that, I have also explained the importance of limiting the spatial unit of analysis to neighbourhood level, and illustrated the multi-stages process of neighbourhood selection. In the next chapter, I will explain the research methods employed in this DPhil study before moving on to describe the research findings of the three empirical studies (Chapter Five to Chapter Seven).

4 Chapter Four - Methodology and research design

Building on the previous three chapters, the discussion in this chapter extends to the more detailed issues about the research design and methodology employed in this study. The methodological issues to be discussed in this chapter are highly relevant and logically connect with the research questions raised in Chapter One (Introduction), the gaps in literature highlighted in Chapter Two (Literature Review) and the contexts of the case study presented in Chapter Three (Case study and context). In this chapter, I will first revisit the two research questions, and then explain the benefits and rationale in applying a mixed-method approach for this DPhil study, and how each of the research questions are addressed by different methods and use of different types of data. I then describe and reflect on the research design, fieldwork and data collection procedures applied in this study. Finally, the limitations of this study are highlighted.

4.1 Research Design and Mixed Methods Approach

A mixed-methods approach was selected to address the two research questions formulated in Section 1.2 because the environmental influences on people's walking behaviour and experience can be captured using different sources of data. For example, walking behaviour (such as frequency, trip distance and trip duration) are best-captured using numerical (quantitative) data; while walking experiences are better represented by using verbal (qualitative) data. As a result, a mixed-methods approach can enable me to make use of various types of data to examine this issue and provide a holistic and in-depth understanding of people's walking behaviour as well as walking experience (Clarke & Yaros, 1988).

Applying the mixed-methods approach also helps to extend the existing understandings of walking from a developing city context. To address the first research question, semi-structured interviews were conducted to explore how people perceive their neighbourhood built environment and identify the potential factors that can shape how they feel and experience during their walking trips. This qualitative exploration provides a more contextualised understanding of walking as a phenomenon. This is especially important as most of the existing studies on walking are based on case studies from North

American, European, and Australian cities, or following the concepts and worldviews developed from these cases. The social and personal values, meanings, norms associated with walking in Chinese city context are relatively unexplored. The exploratory qualitative interviews thus allow for the detection of underlying factors that affect people's walking experience and behaviour of pedestrians that are not fully explored in previous studies (for example, the person-related factors as discussed in Chapter One and Chapter Two).

In addition, the use of the mixed-methods approach enables the elaboration, enhancement and clarification of the results from one method to inform or development of the other method (Bryman, 2006; Greene, Caracelli, & Graham, 1989). In this DPhil study, the results generated from the qualitative study have contributed to the design and development of the questionnaires (for RQ1) and the environmental audit tool (for RQ2) in the subsequent studies. For example, since many interviewees had expressed that their attitudes towards walking are important in shaping their walking behaviour and experience. Given that there is no existing measure in capturing pedestrians' attitudes specifically towards walking, I have developed a seven-item scale to capture the participants' walking attitudes and subsequently tested its relationships with the built environment and walking behaviour in the quantitative analysis. These items were inspired from both previous literature and findings from the semi-structured interviews. For instance, participants have expressed that their walking attitudes were associated with their habit, the positive associations with health and the environment. The newly developed scale included statements that represent these different aspects of walking attitudes.

Likewise, the selection of measurement items to be included in the environmental audit tool also drew insights from the qualitative research findings. For example, most of the existing studies have used items such as "presence of broken glass", "presence of surveillance camera", or "presence of street lighting" to assess the safety of the walking environment. However, during the interviews, the participants have identified other factors that were associated with their perceptions of safety, such as the presence of a police stand

and police officers on street, and people that were gambling on the street. As a result, I have incorporated these factors into the environmental audit tool for walkability assessment (See Section 7.4.2 for further discussion).

Table 4.1 illustrates the use of various research methods and types of data in addressing each research questions respectively. The details of the research processes and activities are discussed in the next section.

Table 4.1 The selection of methods for each research questions

Research question	Methods for data collection	Use of data
Background information and pilot study	Literature review (secondary data) Interviews (textual data)	- Identify important factors associated with walking in a developing city context - Explore items to be included in environmental audit tool - Develop questions for questionnaires
RQ1	Interviews (textual data) and questionnaires (numerical data)	- Textual data to identify important person-related factors associated with walking - Numerical data to test the relationships between variables (built environment, walking behaviour)
RQ2	Environmental audit (numerical data)	- Numerical data to assess walkability

4.2 Research process

4.2.1 Research activities

As discussed in the previous section, a sequential mixed-methods approach was applied in this DPhil study. Table 4.2 illustrates the major phases of fieldwork for this study and the materials generated for subsequent papers of the thesis.

Table 4.2 Major phases of fieldwork and research activities

Phase	Research Activities	Research Questions	Corresponding Chapters
Preparation	- Desk research, literature review, gather government reports, planning and policy documents, and newspaper relevant to the topic - Identify potential study area - Design and pilot test interview	RQ1, 2	Chapters 1, 2, 3, 4

		questions		
Phase 1 (Nov 2015 - Mar 2016)	-	Fieldwork in Shenzhen	Mostly RQ1	Chapters 5, 6
	-	Field and participant observations		
	-	Semi-structured interviews		
	-	Pilot test of environmental audit tool		
	-	Small-scale pilot test of questionnaire		
Data analysis				
Phase 2 (Oct 2016 – Feb 2017)	-	Fieldwork in Shenzhen	RQ1, 2	Chapters 6, 7
	-	Field observations		
	-	Provide training to surveyors		
	-	Conduct environmental audit		
	-	Conduct questionnaire surveys		
Data analysis and Write-up				

Before conducting the two phases of research activities in Shenzhen, a number of preparation works were performed, including desk research and literature review to gather secondary information from various sources (including academic articles, government reports, newspaper or online articles, and other grey literature) to have a better understanding of the case study area. These activities contributed to the first four chapters of this DPhil thesis.

A qualitative exploratory study was conducted in the first phase of research followed by a quantitative study in the second phase. As discussed in the literature review (Chapter Two), most of the existing walking and walkability studies have been dominated by Euro-American concepts and worldviews, and few studies have examined people's walking behaviour and experience in rapidly developing cities in China. Given that the social, economic and cultural contexts of Chinese cities are significantly different from the western cities, I believe that it is necessary to carry out a qualitative study to explore the similarities and differences of local residents' understandings and experiences of walking and walkability at the beginning of the project. This practice not only provides the context for the second phase of quantitative study, but also allows the subsequent quantitative study to draw insights from the qualitative findings to facilitate the formulation of questions, data collection and analysis (Teddlie & Tashakkori, 2006). In Phase Two of this project, the focus shifted to collect quantitative data, including conducting surveys (for Chapter Six) and

environment audit (for Chapter Seven) within the selected neighbourhoods, to provide the much-needed quantitative evidence to address the two research questions.

In practical terms, conducting two phases of fieldwork and data collection is much more expensive and time consuming, but this approach can improve researchers' sensitivity to the local context and explore other possible factors associated with walking behaviour that have not been observed or tested in previous studies. The next sub-section discusses about the details of fieldwork in Shenzhen.

4.2.2 Fieldwork in Shenzhen

"The principal training of the geographer should come, wherever possible, by doing fieldwork" (Sauer, 1956, p.296)

Fieldwork has been regarded as an important tool for geographers and even an important criterion in defining geography as a discipline (Pawson & Teather, 2002). Fieldwork has a substantial history of application in the field of geography and cognate disciplines. Through the engagements between the researcher, the people and place in the field, various forms of data can be collected, and understandings of the place can be obtained (Gerber & Chuan, 2000). Early humanistic geographers have argued that it was impossible to understand the social world without listening to the interpretations of those who lived in it (Rose, 1993). But more recently, researchers have extended the concept of fieldwork and argue that the distinction of what constitutes a "field" should be challenged, as the knowledge generated from the fieldwork was co-produced through a process of interactions between the fieldworker and the participants in multiple locations (Whatmore, 2003). In line with this understanding of fieldwork, in this DPhil study, fieldwork was regarded as an on-going and iterative activity during the whole research process that constantly shapes the research questions and my interpretation of the data collected through the whole research process.

In this section, I have provided a detailed account on the research activities conducted in the study area – Shenzhen. Drawing insights from studies in anthropology, stressing that walking around is fundamental to the everyday practice of social life (Lee & Ingold, 2006), I have adopted an immersive approach in conducting the research activities in Shenzhen. These two phases of fieldwork, with a total duration of nine months, were conducted in Shenzhen. However, fieldwork in this study is not just about data collection but is a process of "materials generation" (Whatmore, 2003). It was a process that allowed me to reside in Shenzhen and immerse myself into the surrounding environment, to spend a significant amount of time working with the local residents and to engage in their everyday routines and exchanges. In particular, I walked every day in the selected neighbourhoods during different time periods (from early morning till after dark) and in all weather conditions. These walking trips ranged from a few minutes to several hours, some of these trips were destination-oriented, while others were spontaneous and unplanned. During these walking trips, I experienced the built environment and talked to and interacted with local residents, shop owners, park users and random pedestrians on the street. Although this approach to fieldwork is very time consuming, it has helped to generate a rich source of first-hand data that are more authentic, which allowed me to learn about the local socio-cultural contexts and daily practices of walking and to identify environmental features that affect people's daily walking experience in Shenzhen. Numerous benefits have been brought by these two phases of fieldwork, including:

- Familiarising myself with the study area and enabling more informative and interactive discussion during interviews
- Relating to the specific road segments discussed by interviewees by drawing on my own experience and observations
- Identifying the distinctive aspects of the streetscapes and pedestrian networks in the case of Shenzhen
- Identifying the other passageways to be audited in the neighbourhoods (to be discussed in Section 4.3.2 Environmental audit)

- Critically reflecting on existing environmental audit tools in terms of what aspects have been overlooked, and what other items can be included and tested that match with the local context and situation

4.3 Data collection

This section describes the data collection process, in which three major methods have been employed, including semi-structured interviews, questionnaires and an environmental audit. The sample selection, instruments used, and procedures for data collection are discussed below. Before commencement of the data collection process, ethical approval was sought and obtained from the Central University Research Ethics Committee (CUREC) to ensure that all ethical considerations are addressed properly. The reference number for this DPhil project is SOGE16 1A-2.

4.3.1 Interviews

The interviews sought to explore the daily walking experiences and behaviour of the residents within the selected neighbourhoods of Shenzhen, in order to identify the major factors (both environmental and person-related) associated with their walking, and their perceptions and experiences of and interactions with the built environment.

Mobile and go-along interviews have been deployed widely in many recent studies on everyday mobilities (Büscher & Urry, 2009; Carpiano, 2009; Van Hecke et al., 2016), as these methods can provide in-depth insights into the instantaneous feelings and experiences at the moment of the interview. On the other hand, the more traditional, stationary and semi-structured interviews in situ lack the potential spontaneity of actual situations but provide rich information on participants' memories and the meanings they associate with walking (Lincoln & Guba, 1985). After careful consideration of the pros and cons of these various interview methods, stationary and semi-structured interviews were selected for the current study to explore participants' own stories and

experiences of walking (Strauss & Corbin, 1990)[20]. Given that people's neighbourhood walking experiences are embedded in their daily activities and associated with their own feelings and interpretations of the environment, it is more effective to use semi-structured interviews for data collection, as interviews can help to understand how people experience and make sense of their own lives (Valentine, 1997). Using this method, participants can articulate and reflect on their own walking experiences that are less constrained to a particular route or environment, than in go-along interviews (Garcia, Eisenberg, Frerich, Lechner, & Lust, 2012). In addition, during the interview process, the participants can freely talk about various aspects of their walking experiences that they found interesting and worth discussion, which in turn can help to generate information beyond my expectations.

An interview guide was developed and questions were divided into three major aspects: neighbourhood characteristics, walking experience, and the built environment. The interview guide was enclosed in Appendix 4.1. But due to the semi-structured nature, participants were invited to express and share whatever they thought was relevant to their walking experience in Shenzhen, including but not limited to their own life stories, memories, and knowledge. The interviews were also accompanied by an interactive mapping exercise. Participants were provided with a set of maps on various scales showing the surrounding areas at their neighbourhood, they were then instructed to use these maps to indicate what areas constituted their neighbourhood boundaries; when, where, and why they walked and/or travelled to specific destinations for their daily activities and the experiences or feelings they had during these walking trips; and how such feelings were provoked. This mapping exercise not only allowed the participants to relate their daily practice of walking to the environmental features along their routes and provide more vivid expressions of their emotions and feelings; it also allowed me to have more in-depth understandings on the contextual conditions of the local walking environment.

[20] A few go-along interviews have been conducted with some of the participants, when we met in public spaces and walked along their desired footpaths before conducting the semi-structured interviews. I asked them questions about their daily walking experience and their interpretations of the environmental features we encounter during our short walking trips.

The target participants were residents who had walking experience in the selected neighbourhoods, but I intended to select a heterogeneous sample of participants in order to maximise the diversity and divergence among participants, as this method can help bring out greater coverage and variations among different aspects. A combination of purposive and snowball sampling methods was adopted to recruit participants. I approached people in public spaces by asking whether they resided in the selected neighbourhoods and then introduced them to the research project to determine whether they were willing to participate. I faced difficulties in recruiting participants in the beginning of the fieldwork, as I tried to ask pedestrians to stop when they were walking on the pedestrian footpaths or outside major shopping centres. However, I found that people were very unlikely to participate in the interviews, especially when approached on-street. Therefore, I tried to approach residents in parks and plazas, as people in these places were more relaxed and willing to spend some time to participate in the interviews. After that, some participants introduced their friends and relatives who lived in the selected neighbourhoods as potential participants.

A pilot study was performed on two Shenzhen residents who were not included in the final sample to test and improve the content and sequence the questions to allow a smoother communication during interviewees. The interviews were conducted either in public spaces (e.g. parks, plazas and cafes) or other destinations selected by the participants. A total of 20 semi-structured interviews were conducted between November 2015 and February 2016. Most participants were aged in their 30s to 50s, with the remainder split between 20s, 60s and 70s. Slightly more women (60%) participated than men (40%) and 13 of them were living in the sub-district of Shatou (eight in Xinzhou and five in Xinsha), against seven in Longchen (four in Shangjing and three in Huilongpu). Participants walked at least 2-3 times per week, but also travelled by car and/or public transport. Each interview lasted about 60-90 minutes and was audio recorded and transcribed for analysis. Pseudonyms are used to ensure participants' anonymity. The following table (Table 4.3) shows the basic

socio-demographic characteristics of the participants.

Table 4.3 The information of participants in semi-structured interviews

Pseudonyms	Age	Gender	Neighbourhood	Other characteristics
Mary	40	Female	Xinzhou	Full-time employed, have one child (3 yrs old)
Stacy	44	Female	Xinzhou	Full-time employed, have one child (11 yrs old)
Bonnie	35	Female	Shangjing	Shop owner, have two children
Alex	40	Male	Shangjing	Have two children
Ben	30	Male	Huilongpu	Full-time employed
Derek	26	Male	Shangjing	Chef
Frank	20	Male	Huilongpu	Student
Helen	24	Female	Shangjing	Sales representative
Nancy	25	Female	Huilongpu	Full-time employed
Henry	23	Male	Xinzhou	Real estate agent
Michael	53	Male	Xinsha	Part-time employed, have one child
Connie	52	Female	Xinsha	Retired
Karen	28	Female	Xinzhou	Full-time employed
Esther	Around 50	Female	Xinzhou	Retired, have two children
Theresa	58	Female	Xinzhou	Part-time employed
Ophelia	50	Female	Xinzhou	Dentist
Paula	Around 40	Female	Xinzhou	Homemaker
Audrey	Around 50	Female	Xinsha	Retired
Louis	56	Male	Xinsha	Retired
Lawrence	64	Male	Xinsha	Retired

The individual characteristics of a researcher, including age, gender, race, personal experience, beliefs, preferences and political and ideological stances determine their positionality and how they approach the research topic (Berger, 2015). More importantly, a researcher's positionality also influences the way they interpret information and produce knowledge. My identity as Chinese who was born in Hong Kong, but has lived in Shenzhen for many years has contributed to my understanding of the socio-cultural contexts of the case of Shenzhen. As a researcher from a foreign institution, most of the participants expressed strong interest in why I was interested in studying walking in Shenzhen, as this topic was such a common and banal aspect of their daily lives.

This interest in my research topic became a good icebreaker allowing me to introduce my background and explain to them why this topic was important. My previous professional experience as a traffic engineer equipped me with knowledge on the best design practices about the walking environment and infrastructure, which will have shaped how I view the problems observed in the walking environment in Shenzhen. However, I tried to prevent using this previous experience and knowledge in judging the situation of Shenzhen as much as possible, and let the participants articulate their own feelings and views on the walking environment and their personal walking experience.

4.3.2 Questionnaires

The questionnaires form an integral part of this DPhil project. The major aim of conducting the questionnaires is to collect quantitative data about the attitudes, perceptions and neighbourhood-level walking behaviour of pedestrians at the selected neighbourhoods. The quantitative data collected allowed me to test a number of hypotheses relating to the environmental influence on walking behaviour, and provided the much-needed quantitative evidence to inform policy recommendations.

Contents of the questionnaire

The questionnaire was comprised of five major parts: walking behaviour, perceptions of the neighbourhood environment, psycho-social factors (walking attitudes, habit, and attachment) and socio-demographics factors, as shown in Appendix 4.2. The details of each part are discussed below[21].

Walking behaviour and satisfaction with travel: To differentiate various purposes of walking trips, I deliberately separated walking behaviour into three specific purposes, namely walking for school/work, walking for leisure/recreation, and walking for household responsibilities. Walking behaviour was measured by asking respondents to recall the most recent

[21] In the questionnaire, another section was included to capture the respondents' well-being, by using 13 items adopted from the Satisfaction with Life Scale (5 items) and Psychological Well-being Scale (8 items). But these well-being measures were excluded from the major analyses of this thesis.

walking trips that they had performed for the three specific purposes of walking respectively in the past week within their neighbourhoods. They were then asked, "How often do you usually perform this trip?". Five options ranging from "less than once a week" to "more than 7 times a week" were provided. For each recalled walking trip, a series of questions were asked regarding the trip characteristics (duration, average frequency per week, companionship, etc), and satisfaction with the trip was captured using the Satisfaction with Travel Scale (STS) (De Vos, Schwanen, Van Acker, & Witlox, 2015; Ettema et al., 2011; Friman, Fujii, Ettema, Gärling, & Olsson, 2013). This scale consists of 9 items, divided into affective and cognitive evaluation respectively. The former measures the feelings and emotions that they experience during the trip; the latter concerns how they evaluate the trip being made. The data of respondents' walking behaviour for three specific purposes were used as the dependent variable in the quantitative analysis (as presented in Chapter Six). The data for respondents' level of satisfaction with travel was not used in the empirical chapters of this study, but these data will be used to develop other research papers in the future.

***Perceptions of neighbourhood environment*:** Selected items from the abbreviated version of the Neighbourhood Environment Walkability Scale (NEWS-A) (Cerin, Conway, Saelens, Frank, & Sallis, 2009) were used to measure the perceptions of the neighbourhood environment. Two sub-scores measuring residential density and land use diversity were excluded from this study to reduce the questionnaire length and hence respondent burden. Other modifications include eliminating items that were unsuitable for the case of Shenzhen. For example, one item asks participants whether "Walkers and bikers on the streets in my neighbourhood can be easily seen by people in their homes". In Shenzhen, as in other high-density cities, multi-storied residential buildings are common and it is nearly impossible to observe pedestrians from these high-rise buildings. A number of statements derived from the findings of qualitative interviews preceding the present study were added to capture some other aspects of the built environment, including "poor footpath condition" and "maintenance and upkeep". All neighbourhood perception items were measured using five-point Likert scales, ranging from 1 (strongly disagree) to 5 (strongly

agree). Eight neighbourhood perception sub-scores were computed. Five of them were positive, including access to destinations, street network, physical infrastructure, aesthetics and maintenance and upkeep. Three of them were negative, including traffic safety, personal safety, and poor footpath condition.

Person-related factors associated with walking: A number of person-related factors that are hypothesised to be associated with walking behaviour were included for exploratory purposes, including walking attitudes, neighbourhood attachment and habit strength for walking. Previous studies have found that attitudes are associated with travel behaviour in general (Bohte, Maat, & Van Wee, 2009). But there is currently no consensus on standardised measures on travel attitudes, let alone more specific walking attitudes. Drawing insights from previous literature (Handy, Cao, & Mokhtarian, 2005; Joh et al. 2012), seven statements were used to measure walking attitudes. Neighbourhood attachment was measured using four statements adopted from the Neighbourhood Attachment Scale (NAS) (Fornara, Bonaiuto, & Bonnes, 2010). Habit strength was measured using the Self-Report Habit Index (SRHI) (Verplanken & Orbell, 2003), which consists of 12-items associated with the basic features of habit, including the history of repetition, automaticity, and expressing identity. The wordings used were modified to capture participants' habit strength on walking. However, in this DPhil study, only the data of walking attitudes were used in Chapter Six. The variables of neighbourhood attachment and habit strength were not used in the present study, but their relationships with the built environment and walking behaviour will be explored in subsequent research papers in the future.

Socio-demographic factors: The socio-demographic variables used in this study include age, gender, employment status, educational level, household income, having a driver's license, length of residency in the present neighbourhood, self-reported body weight and height (used to calculate the body mass index), self-assessed health condition, etc.

Sampling and data collection process

The sampling design combined convenience sampling (all adults available in the

park or open space) and random probability sampling (surveyors were instructed to approach the next adult pedestrian they encounter as a potential respondents). The questionnaire survey was conducted in the four selected neighbourhoods with the assistance of trained surveyors from December 2016 to March 2017. To minimise potential selection bias, the surveys were conducted in multiple locations, during both weekdays and weekends, and in different time periods. Respondents were first asked if they were living in this neighbourhood, with the assistance of a map showing the neighbourhood area. A small gift (such as key chains, bookmarks, ball pens) was provided as an incentive for participation (about £1). The number of respondents totaled 890. Although detailed records on the number of people who refused to participate were not gathered, the response rate was estimated to be about 50% based on the feedback from surveyors.

The data collected from the questionnaires were mainly used to develop Paper Two (Chapter Six), which explores the influence of objective neighbourhood characteristics, the perceived built environment and walking attitudes on people's walking frequency for three purposes of neighbourhood-level walking.

Reflections on the questionnaires

First, I distributed the questionnaires based on postal addresses to a number of targeted residential developments within the selected neighbourhoods. The package included a leaflet introducing the objective of this research project with my information (including name, contact details, and affiliations), the questionnaire together with instructions on how to complete it, a written ethical consent form, and a pre-paid return envelope with a return address. The participants were instructed to read the introductory materials, complete the questionnaire and return the forms by using the pre-paid envelope. In total, more than 2000 questionnaires were sent to these addresses in two stages, but after waiting for three weeks, only less than 20 questionnaires had been returned, which resulted in a lower than expected response rate (less than 1%).

It is suspected that requesting the participants to read all of the enclosed

materials and to follow the instructions to complete the questionnaire imposed a heavy burden, lowering people's willingness to participate. Even if they were patient enough to complete the questionnaire, they still had to bring it to the nearest post office to send it back, which may have been too troublesome. In view of this problem, I revised the strategy in distributing the questionnaire. I developed a webpage to allow participants to complete the questionnaire online, using their computer or mobile phone (with the scan of a QR code that brought the participants to the online questionnaire). After that, I sent the one-page introductory letter with the QR code to another 800 target respondents. This practice resulted in a slightly higher response rate, with 35 individuals completing the online questionnaire (response rate about 4.4%). However, these two attempts have suggested that a mail-based participant recruitment method was not very effective in the case of Shenzhen, which might be caused by the factors below:

Imprecise addresses: given that the postal addresses were not publicly available, this information was assessed through the unofficial records from local property agencies. After obtaining these addresses, I have crosschecked their accuracy through other sources, including the Internet and local authorities, but the accuracy of the addresses could not be guaranteed.

Not directly addressed to the occupier: As the names or even the surnames of the occupier of the addresses were unknown, I was only able to use the term "To the current occupier" in our letter. It is suspected that this is the reason why some of the potential participants did not respond to the survey, as they may have thought the letter was not address to them.

Time and effort involved: The return of the completed forms involved extra effort for participants as they had to go to a nearby post office (which is usually crowded with people, and long waiting time is common) to send these forms back, which might lower their incentive to participate.

Insecurity about participating in surveys: This idea became apparent when I

talked to some of the participants during the on-street survey. They expressed that they felt insecure when participating in these kinds of surveys. This was because they were not sure whether the interviewer was going to collect their personal information for other commercial uses, or try to sell them any products they don't want, or such survey is a fraud. In avoiding such situations, many people expressed that they tend not to participant in these kinds of survey.

As a result of the extremely low response rate obtained from the postal survey, I revised the strategy of participant recruitment and decided to conduct on-street intercept survey for data collection. One of the major concerns of an intercept survey is that, unlike with a postal survey, the residential location of the participants will not be available. In order to mitigate this potential issue, I included an extra screening question to ask whether the participants resided within the neighbourhood area, and only residents living in the area were invited to participate. By doing so, I can ensure the participants are local residents of the selected neighbourhoods.

One of the important lessons that can be learnt from this data collection process is that the initially planned data collection method might be unsuitable for the local context. For example, in the case of China, there is little trust between researcher and the participants. Some of the participants told me afterwards that there are many reports on criminals that use various strategies, like in the form of academic or marketing research to gather people's personal information for commercial or even illegal purposes. Thus, peoples' awareness of their privacy (especially for sensitive data, like income, residential location, occupation, etc.) has been raised significantly, which makes academic research more difficult to conduct.

One of the possible ways to overcome this problem in the future is to develop collaborative relationships with local authorities or universities. As these local parties have stronger connections and trust among local residents, it might be easier to implement similar research projects to attract local residents to participate. However, for the research described here, the adaptations to the

research design and data collection method mitigated the problem to a large extent.

4.3.3 Environmental audit

Drawing insights from the early work of sociological and criminological studies (Reiss, 1971; Sampson & Raudenbush, 1999), researchers have developed numerous tools (also referred to as environmental audit or environmental assessment tools) to assess the availability of built environmental features that are associated with people's physical activity, e.g. walking and cycling (Clifton et al., 2007; Moudon & Lee, 2003; Sun, Webster, & Chiaradia, 2017).

Given the availability of so many environmental audit tools, the most convenient way to conduct the environmental audit would be to apply other tools that have been tested in previous studies. However, after a comprehensive review of existing audit tools, I decided to develop an environmental audit tool for this study because of the following reasons[22]. First, since most of the existing tools were developed based on cities in the western countries, not all of the measurement items used in these tools are suitable for our study area – a high-density rapidly developing city in China. Next, existing tools were developed with specific foci in mind, which do not fully match the objective of this study. For instance, one of the widely applied audit tools - the Systematic Pedestrian and Cycling Environmental Scan Instrument (SPACES) (Pikora et al., 2002) - was developed to assess the environment for walking and cycling, it focuses not only on the pedestrian environment, but the environment and facilities for cyclists.

I have also paid particular attention to a number of environmental audit tools that were developed based on case studies from Chinese cities. But after careful consideration of their foci and measurement items, I decided that these tools

[22] The tool was not developed completely from scratch, but substantial innovation can be found in this tool, including the selection and modification of measurement items to match with the major components identified from qualitative interviews. It also develops new items for the audit tool, and establishes new approach in identifying footpath for assessment and new protocols for assessment.

were inappropriate for this DPhil study. For example, the China Urban Built Environment Scan Tool (Su et al., 2014) uses six dimensions (residential density, street connectivity, accessibility, sidewalk quality, bike lane quality, aesthetics) for walkability assessment. However, this tool focused more on bikability (friendliness of the bicycling environment), which was not the focus of my DPhil project. Moreover, two important components of walkability assessment (identified from other audit tools and qualitative findings) - amenities and subjective assessment, were not included in this tool, making it unsuitable for this study. Likewise, another tool developed by Sun, Webster, & Chiaradia (2017) adopted a structure of seven dimensions (building density, land use diversity, elements on sidewalk, design, road beside sidewalk, transferability, subjective assessment) to study the access routes to urban rail transit. This tool focused particularly on the access routes to rail transit stations, which limited its applicability to measure the walking environment at and around residential neighbourhoods. As a result, these audit tools developed in the Chinese context were not chosen for this DPhil study.

Moreover, the findings from the exploratory qualitative interviews revealed other built environmental features that have not been applied or tested in existing environmental audit tools. As a result, I think it is necessary to incorporate these findings into a new environmental audit tool for a more holistic assessment of the walking environments found in rapidly developing Chinese cities.

The procedures in developing the environmental audit tool used in this study are described in more detail in Chapter Seven (Paper 3)[23]. A systematic process has been adopted to select the measurement items for the environmental audit tool. First, based on a comprehensive review of existing environmental audit tools and with the support of other reviews, the commonly used measurement items were identified (Nickelson, Wang, Mitchell, Hendricks, & Paschal, 2013). Then, these measurement items were considered for their appropriateness in the context of Shenzhen (some items were included, but modified to fit the local

[23] The environmental audit tool was presented in Appendix 7.2.

context). In addition, some new measurement items were developed from the findings of the qualitative interviews and insights gathered during the fieldwork. For instance, inspired by the sensory methodologies in ethnographic research (Low, 2015) and participant's narration from the qualitative interviews, I have developed and included a number of measurement items that capture the sensory experience of the walking environment, including volume of sound and presence of unpleasant smell. Finally, the audit tool consists of 87 measurement items[24], covering six major qualities: land use and destinations, safety, aesthetics, amenities, footpath design and condition, and subjective assessment and experience.

Unlike most existing studies that focus only on footpaths alongside major roads, this study identifies and includes other informal paths and alleys not typically available in printed and digital maps. Footpaths were divided into three categories: major footpaths, minor footpaths, and other passageways. Major and minor footpaths were categorised using the road hierarchy based on the Shenzhen district zoning plans. Major footpaths represent footpaths alongside trunk roads, district distributors, and local distributors. Minor footpaths represent footpaths alongside other non-major roads. Other passageways refer to informal footpaths, including small alleys and pedestrian only paths. These other passageways were identified during the fieldwork.

Four professional surveyors, who have extensive experience in conducting various forms of transport surveys were recruited to conduct the environmental assessment through my personal connections. The surveyors had to participate both in-class and on-site training before performing the assessment. First, a two-hour in-class training provided step-by-step instructions in conducting the environmental audit. Detailed descriptions and photos of the environmental features to be assessed were provided to allow the surveyors to identify and familiarise themselves with the environmental features of the local environment. After that, an on-site training section was performed to allow the surveyors to

[24] In Paper 3 (Chapter Seven), the number of measurement items used for analysis reduced from 87 to 71 items after the reliability tests.

conduct a pilot assessment. During this training section, I acted as the supervisor to instruct the surveyors how to conduct the assessment correctly, and they were given the chance to ask any questions for clarification. At the end of this training section, the surveyors were instructed to assess a number of sample footpaths, and their results were rated in comparison with each other to ensure at least 75% of consistency was achieved before the actual assessment was conducted. The surveyors conducted the footpath section observations from December 2016 to February 2017 under my supervision. The audit was conducted on both weekends and weekdays, during different time periods[25] within the selected neighbourhoods in Shenzhen.

The environmental audit collected first-hand data on the micro-scale features of the built environment associated with people's walking behvaiour. These data were used in the development of Chapter Seven (Paper 3), to assess the walking environment.

4.4 Limitations of the study

There are a number of limitations to the design and methodology of this study. Here, I will only focus on the limitations about the methodology for the whole DPhil project. The more specific limitations for each subsequent studies (in the form of articles) will be covered separately in Chapter Five to Chapter Seven.

Firstly, regarding the method of sampling, because this study considers people's walking behaviour and experience at a localised scale (neighbourhood level), the participants recruited for this study were limited to residents living in the four selected neighbourhoods in Shenzhen. This means that purposive and snowball sampling were used for recruiting participants for the semi-structured interviews; and random and purposive sampling were used for recruiting participants for the questionnaires. However, this sampling method makes it more difficult to generalise the findings to other neighbourhoods in Shenzhen

[25] Unlike most of the existing studies that conduct the environmental audit during day light hours, I deliberately decide to conduct the environmental audit in both daytime and after dark; in order to compare how certain built environmental measures varies during different time periods. But in this DPhil study, only the daytime assessment data were used for analysis.

and other cities in China. In addition, the method of sampling might exclude those who were less active or walk less frequently in their neighbourhoods. However, given that the focus of this study is to understand how people respond to the built environment and their walking experience, the focus of participants who were more active (in terms of walking) within the neighbourhood helped to generate richer information, as they were supposed to have more encounters and chances to experience the built environment.

Secondly, for the environmental audit tool, I have decided to include measurement items that capture the subjective or intangible features of the built environment, including the presence of visible air pollutants, sound, smell, subjective assessment of attractiveness, safety, and stressfulness of the walking environment (details to be presented in Chapter Seven). The reliability tests showed that these subjective measurement items have lower reliability compared to the objective items (as shown in Chapter Seven), which is consistent with the existing literature. However, the inclusion of such items provides a novel understanding of the intangible features affecting people's walking experience, which is also important as revealed by the participants from the qualitative interviews.

4.5 Towards the empirical chapters

This chapter has provided an overview of the research design and methodology applied in this DPhil study, bringing together the major issues illustrated in previous chapters, including the research objectives (Chapter One), review of relevant literature (Chapter Two), and the information of the case study city and area (Chapter Three) of this DPhil project. The following three chapters (Chapter Five to Chapter Seven) form the empirical parts of this DPhil project and in combination these three chapters help to achieve the research objective by addressing the two research questions highlighted in Chapters One and Four.

The following three empirical chapters present a step-by-step approach in tackling the two research questions. Chapter Five is a qualitative study, presenting the findings generated from the semi-structured interviews. Chapter

Five examines the way urban pedestrians articulate their own walking experience in a rapidly developing city context. This chapter, which also uncovers the contextual complexities by understanding how person-related factors shape people's urban walking experiences. Chapter Six is a quantitative study that explores the role of objective neighbourhood characteristics, perceived built environment, and walking attitudes in shaping people's walking behaviour. Chapter Six further investigates the differences in relationships of the built environment with walking behaviour for specific purposes. In combination, Chapter Five and Chapter Six contributed to address the first research question (RQ1).

Building on the findings from Chapter Five and Six, which demonstrated that what constitutes a "walkable" environment can vary significantly among pedestrians with different needs and purposes, depending on their own interpretations and perceptions towards the built environment, Chapter Seven further strengthens this argument and proposes that walkability should be reconceptualised as a more relational concept that is sensitive to the needs of individual pedestrians. As such, I proposed a multiple-scenario approach for walkability assessment that take into consideration of the heterogeneity of pedestrians. Chapter Seven mainly addresses the second research question (RQ2).

In combination, Chapters Five to Seven provide a multifaceted perspective to understand the relationships between the built environment and walking experience and behaviour in a developing city context.

Appendix 4.1 Semi-structured Interview Guide

Thank you very much for your time to accept my interview. I am a PhD Candidate from the University of Oxford, School of Geography and the Environment, specialising in transport studies. The purpose of this study is to investigate the role of the built environment in affecting people's walking and well-being. Information collected from this interview will only be used as research purpose and the interview is confidential. Your opinions about the subject will be very important and valuable for this research. If you agree to participate, you will be asked to sign a written consent form before the start of the interview.

Key Interview Questions

Themes	General Questions	Further Questions
Your neighbourhood	What does 'neighbourhood' mean to you? Where is your neighbourhood? (Use the map provided to draw) Why do you think it is your neighbourhood? Has the boundary of your neighbourhood as you see it change since the time when you first moved here?	How long have you been living in this neighbourhood? How/why does the size/shape of your perceived neighbourhood change? If yes, can you elaborate why do you think so?
About your walking behaviour and experience (to better understand your walking behaviour, we divide neighbourhood-level walking into three major types: work/school related, household responsibilities and leisure/recreational)		
Work/school related walking	Are you currently employed or studying full-time? Where do you work? How do you travel to work/school from home? Can you describe your work/school related walking experience in the neighbourhood? How do these trips make you feel? And why?	Who do you usually walk with when you walk to work? What would you say are the most important factors of the built environment when you are walking for work?
Household responsibilities related walking	Can you tell me about your walking trips for doing household responsibilities? (e.g. shopping for grocery, taking kids to school) Can you describe your walking experience when you're performing these household related walking trips? How do these trips make you feel? And why?	Who do you usually walk with when you walk for household responsibilities? What would you say are the most important factors of the built environment when you are walking for household responsibilities?

Themes	General Questions	Further Questions
Leisure related walking	How often do you walk for leisure? (Including jogging, running, walking for physical exercise, etc.) Where do you usually walk to? (Parks, plazas, community centre, etc.) Can you describe your leisure related walking experience in this neighbourhood? How do these trips make you feel? And why?	Who do you usually walk with when you walk for leisure? What would you say are the most important factors of the built environment when you are walking for leisure?
The built environment within the neighbourhood	Can you describe the similarities and differences among the three types of walking? How do you feel about the built environment within your neighbourhood? Why? What features of the built environment promote your walking? And why? What features of the built environment discourage your walking? And why?	Can you describe how the experience in walking is different when you're walking with others and alone? What are your major concerns when you walk in day-time/night time? And why?
How life-changing events influence your walking and well-being? (Optional for those who had life-changing events)	Have you experienced any changes in the built environment in your neighbourhood in the past three years? Have you experienced any changes in your walking behaviour in the past three years?	How do the changes happened to you or your household members influence your walking behaviour and your feelings?

Appendix 4.2 Questionnaire

Please read the information sheet about the information of this study and sign the written consent form before completing this questionnaire.

A. Well-being measures

Below are statements that you may agree or disagree with. Please indicate your level of agreement or disagreement with each of these statements by placing a "✔" in the box of your answer.

Statements	Strongly Agree	Agree	Slightly agree	Neither agree/ disagree	Slightly disagree	Disagree	Strongly disagree
1. I lead a purposeful and meaningful life							
2. My social relationships are supportive and rewarding							
3. I am engaged and interested in my daily activities							
4. I actively contribute to the happiness and well-being of others							
5. I am competent and capable in the activities that are important to me							
6. I am a good person and live a good life							
7. I am optimistic about my future							
8. People respect me							
9. In most ways my life is close to my ideal							
10. The conditions of my life are excellent							
11. I am satisfied with my life							
12. So far I have gotten the important things I want in life							
13. If I could live my life over, I would change almost nothing							

B. Walking behaviour

Think about the **<u>most recent</u> walking trip** for **work/school** that you can remember:
(For example, if you go to school by public transport, the walking trip for school will be the trip you walk from home to public transport station)

1. When did you perform this trip? ☐ Today ☐ Yesterday ☐ 2 days ago ☐ 3 days ago ☐ >3 days ago
2. How often do you usually perform this trip? ☐ More than 7 times a week ☐ 7 times a week ☐ 3-6 times a week ☐ 1-2 times week ☐ Less than once a week
3. This trip was conducted during day or night time? ☐ Day time ☐ Night time
4. How long did this walking trip take? _____ minutes
5. Who do you walk with? (Check all that apply)

☐ Alone ☐ Family member(s) ☐ Friend(s) ☐ Pet(s) ☐ Others: _____

6. Please assess the below adjectives and statements that describe your **<u>most recent</u> walking trip** to and from **work/school**, use a tick "✔" to indicate whether it is positive or negative to you.

Negative	Negative ←----------→ Positive							Positive
Example: Unhappy						✓		Happy
a. Bored								Enthusiastic
b. Fed up								Engaged
c. Tired								Alert
d. Stressed								Calm
e. Worried								Confident
f. Hurried								Relaxed
g. Travel was worst I can think of								Travel was best I can think of
h. Travel was low standard								Travel was high standard
i. Travel did not work out well								Travel worked out well
j. Noisy								Quiet
k. Unpleasant smell								Pleasant smell
l. Air is polluted								Air is clean

Think about the **<u>most recent</u> walking trip** for **leisure/recreation** that you can remember:
(Leisure or recreation walking trip refers to the walking trip for leisure or recreation purpose, such as walk to nearby park, jogging, or even scrolling around the neighbourhood as exercise, visiting friends/relatives, etc.)

7. When did you perform this trip?
   ☐ Today ☐ Yesterday ☐ 2 days ago ☐ 3 days ago ☐ >3 days ago
8. The main purpose of this trip was (Check one):
   ☐ Go to leisure destinations (park, plaza) ☐ Walking as physical activity
   ☐ Visiting friends/relatives ☐ Go to other destinations (cinema, library)
   ☐ Others: Please specify_____
9. How often do you usually perform this trip? ☐ More than 7 times a week ☐ 7 times a week ☐ 3-6 times a week ☐ 1-2 times week ☐ Less than once a week
10. This trip was conducted during day or night time? ☐ Day time ☐ Night time
11. How long did this walking trip take? _____ minutes
12. Who do you walk with? ☐ Alone ☐ Family member(s) ☐ Friend(s) ☐ Pet(s) ☐ Others: _____
13. Please assess the below adjectives and statements that describe your **<u>most recent</u> walking trip** for **leisure/recreation**, use a tick "✔" to indicate whether it is positive or negative to you.

Negative	Negative ←----------→ Positive							Positive
Example: Unhappy						✓		Happy
a. Bored								Enthusiastic
b. Fed up								Engaged
c. Tired								Alert
d. Stressed								Calm
e. Worried								Confident
f. Hurried								Relaxed
g. Travel was worst I can think of								Travel was best I can think of
h. Travel was low standard								Travel was high standard
i. Travel did not work out well								Travel worked out well

j. Noisy								Quiet
k. Unpleasant smell								Pleasant smell
l. Air is polluted								Air is clean

Think about the **most recent walking trip** for **household related activities** that you can remember:

(Household related walking trip refers to the walking trip to reach destinations for household related activities, such as doing shopping in supermarket, taking children to school, pick up laundry from shops)

14. When did you perform this trip?
    ☐ Today ☐ Yesterday ☐ 2 days ago ☐ 3 days ago ☐ >3 days ago
15. The main purpose of this trip was: (Check one):
    ☐ Grocery shopping ☐ Shopping for consumer goods ☐ Pick up/drop off child
    ☐ Other daily errands ☐ Others: Please specify _____
16. How often do you usually perform this trip?
    ☐ More than 7 times a week ☐ 7 times a week ☐ 3-6 times a week
    ☐ 1-2 times a week ☐ Less than once a week
17. This trip was conducted during day or night time? ☐ Day time ☐ Night time
18. How long did this walking trip take? _____ minutes
19. Who do you walk with? ☐ Alone ☐ Family member(s) ☐ Friend(s) ☐ Pet(s) ☐ Others: _____
20. Please assess the below adjectives and statements that describe your **most recent walking trip** for **household related activities**, use a tick "✔" to indicate whether it is positive or negative to you.

Negative	Negative ←----------→ Positive							Positive
Example: Unhappy						✓		Happy
a. Bored								Enthusiastic
b. Fed up								Engaged
c. Tired								Alert
d. Stressed								Calm
e. Worried								Confident
f. Hurried								Relaxed
g. Travel was worst I can think of								Travel was best I can think of
h. Travel was low standard								Travel was high standard
i. Travel did not work out well								Travel worked out well
j. Noisy								Quiet
k. Unpleasant smell								Pleasant smell
l. Air is polluted								Air is clean

C. Walking attitudes

The following statements describe your feelings when you walk in **the neighbourhood where you live**. Please indicate your agreement with each item. (Neighbourhood refers to the area about 5 to 10 minutes walk from your home)

Statements	Strongly Agree	Agree	Slightly agree	Neutral	Slightly disagree	Disagree	Strongly disagree
1. I enjoy walking in the neighbourhood where I live							

2. Walking is not important for me at all							
3. In general, my walking experience in the neighbourhood where I live is positive							
4. I walk because it is good to my health							
5. I walk because it is good to the environment							
6. I walk because it involves no monetary costs							
7. Walking in the neighbourhood where I live is a habit							

The following statements describe how you think about **walking in general.** Please indicate your agreement with each item.

Walking is something ……	Strongly Agree	Agree	Slightly agree	Neutral	Slightly disagree	Disagree	Strongly disagree
… I do frequently							
… I do automatically							
… I do without having to consciously remember							
… that makes me feel weird if I don not do it							
… I do without thinking							
… would require effort **not** to do it							
… that belongs to my (daily, weekly, monthly) routine							
… I start doing before I realise I'm doing it							
… I would find hard **not** to do							
… I have no need to think about doing							
… that's typically "me"							
… I have been doing for a long time							

D. Environmental perception

The following statements describe about your perception of the environment of **the neighbourhood where you live in**. Please indicate your agreement with each item. (Neighbourhood refers to the area about 5 to 10 minutes walk from your home)

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
F1. Stores are within easy walking distance of my home					
F2. There are many places to go within easy walking distance of my					

home					
F3. It is easy to walk to a transit stop (bus, train, MTR) from my home					
F4. Streets in my neighbourhood are hilly, making my neighbourhood difficult to walk in					
F5. There are major barriers to walking in my local area that make it hard to get from place to place (for example, freeways, railway lines, rivers)					
G1. The streets in my neighbourhood **do not** have many cul-de-sacs (dead-end streets)					
G2. The distance between intersections in my neighbourhood is usually short (100 yards or less; the length of a football field or less)					
G3. There are many alternative routes for getting from place to place in my neighbourhood. (I don't have to go the same way every time)					
H1. Footpaths are separated from the road/traffic in my neighbourhood by railings / bollards					
H2. My neighbourhood streets are well lit at night					
H3. There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighbourhood					
H4. Parks and plazas are within walking distance					
I1. There are trees along the streets in my neighbourhood					
I2. There are many interesting things to look at while walking in my neighbourhood					
I3. There are many attractive natural sights in my neighbourhood (e.g. landscaping, views)					
I4. There are attractive buildings in my neighbourhood					
J1. There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighbouhood					
J2. The speed of traffic on most nearby streets is usually slow (30mph or less)					
J3. Most drivers exceed the posted speed limits while driving in my					

neighbourhood					
J4. There are many cyclists riding on footpaths, which makes it unpleasant to walk in my neighbourhood					
K1. There is a high crime rate in my neighbourhood					
K2. The crime rate in my neighbourhood makes it unsafe to go on walks **during the day**					
K3. The crime rate in my neighbourhood makes it unsafe to go on walks **at night**					
L1. There are many commercial activities (e.g. hawkers, outdoor catering area) on the street that makes it unpleasant to walk in this neighbourhood					
L2. There are many construction works taking place that creates obstructions to my walking					
L3. I usually feel quite crowded when I walk in this neighbourhood					
L4. The presence of other people walking on street makes me feel safe					
L5. Most of the footpaths in this neighbourhood are wide enough					
L6. The surface of footpaths in this neighbourhood is well maintained in general					
L7. The footpaths are quite clean					
L8. Pedestrians signage is well-kept in this neighbourhood					
L9. Cars and bicycles are frequently parked on footpaths that obstruct my walking					

The following statements describe the **level of neighbourhood attachment**. Please indicate your agreement with each item.

Neighbourhood Attachment	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
NA1. This neighbourhood is part of me					
NA2. It would be very hard for me to leave this neighbourhood					
NA3. This is the ideal neighbourhood for me					
NA4. I do not feel integrated in this neighbourhood					

E. Some basic information about you

1. How old are you?
   □ less than 18 □ 18-30 □ 31-40 □ 41-50 □ 51-60 □ above 60
2. Your gender is? □ Male □ Female □ Rather not to say
3. How tall are you without shoes? _____ cm

4. How much do you weight? _____ kg
5. Your marital status?
   □ Never married □ With spouse □ Divorced □ Widow or widower
   □ Other _____ □ Rather not to say
6. Your are currently?
   □ Full-time employed (>20hrs) □ Part-time employed(<20hrs)
   □ Unemployed □ Retired □ Full-time student □ Home maker
7. Your occupation is?
   □ Owner of private firm □ Self-employed □ Professional
   □ Departmental director □ Clerical/office staff □ Skilled worker
   □ Service worker □ Other _____
8. Your highest completed level of education is?
   □ Elementary school or below □ Middle school
   □ Technical secondary school and junior college □ University or above
9. How many people in total are living in this address?
   □ 1 □ 2 □ 3 □ 4 □ more than 4
10. Please indicate the family members living in this household include (Please select all that apply):
    □ Your partner □ Your son(s)/daughter(s) □ Your Mother/father
    □ Your partner's mother/father □ Your grandchild(ren) □ Others: _____
11. How many bedrooms are there in this property?
    □ 1 □ 2 □ 3 □ more than 3
12. Do you have a driving license?
    □ Yes □ No
13. How many years have you been living in this address?
    □ less than 2 years □ 2 to less than 5 years □ 5 to less than 10 years
    □ 10 years and more
14. Which of the following groups best describe your annual household income (after tax) (in Chinese Yuan)?
    □ below ¥50,000 □ ¥50,000-¥100,000 □ ¥100,001-¥200,000
    □ ¥200,001-¥300,000 □ ¥300,001-¥500,000 □ ¥500,001-¥1,000,000
    □ more than ¥1,000,000 □ rather not to say
15. In general, would you say your health is?
    □ Poor □ Fair □ Good □ Very good □ Excellent
16. Do you have the following health problems?
    □ Gout □ Asthma □ Diabetes □ High blood pressure
    □ Stroke □ Heart trouble □ Obesity □ Cancer □ Others: _____
17. Do you need any mobility aids for assistance when you walk?
    □ No □ Yes, please specify:_____

The End – Thank you for your participation

5 Chapter Five – People and their walking environments: An exploratory study of meanings, place and times

Abstract

Seen as the most sustainable transport mode, people's walking behaviour has been well investigated in relation to its environmental correlates and benefits to physical and mental well-being in current transportation and public health literature. Much of this research has considered that environmental features determine people's responses, behaviours and level of satisfaction above individual or collective subjectivities. Nonetheless, more scholars begin to argue that people's responses to environments could be highly complex, depending on personal background, past experiences and emotional interpretation of the place. The meanings that people attach to their walking practices may differ by personal, social and cultural contexts, which consequently influence how they perceive and experience their walking environments. The transferability of the westernised understandings of walking to other developing cities, thus, is questionable, and will need to be examined empirically. This study focuses on a rapidly developing Chinese city, and explores how pedestrians in Shenzhen respond to the walking environment through their articulation of walking practices. Through analysing life stories of twenty local residents, three interrelated themes emerged to highlight the significance of meanings attached to walking, engagements with timescapes and attachment to place, illustrating how these themes were entangled with walking experiences. Insights from this study will enable future studies to reconceptualise the relationship between pedestrians and their environments as a more dynamic process which should take into consideration the temporalities of the walking environment and pedestrians' bodily and emotional capacities.

Keywords: walking experience, built environment, meaning, temporality, place attachment, urban China

5.1 Introduction

An established body of research has examined people's walking behaviour, its environmental correlates and benefits to physical and mental health by developing quantifiable indicators and scales to measure walking behaviour, walkability and well-being (Andrews, Hall, Evans, & Colls, 2012; Dovey & Pafka, 2019; Kelly, Murphy, & Mutrie, 2017; Vale, Saraiva, & Pereira, 2016). Much of this literature has heavily emphasised the environmental factors that stimulate walking, which was based on the assumption that environmental features determine people's responses, behaviour and satisfaction above individual or collective subjectivities (Andrews et al., 2012). However, this assumption has been challenged by researchers arguing that people's responses to their environments may not be consistent but highly complex depending on personal background, past experiences and emotional interpretation of the place (Ambrey & Bitzios, 2018; Kwan, 2018; Mennis & Mason, 2011). These factors can significantly mediate pedestrians' responses to the built environment and shape their walking behaviour (Kwan, 2018). Given that the existing understanding about pedestrians' perceptions and interpretations of their environments are still relatively limited, these factors are not commonly captured by traditional methods nor taken into consideration in existing walking studies. Therefore, it is timely to involve more qualitative information to explore pedestrians' knowledge, perceptions, interpretations, and the unique meanings ascribed to their daily walking experience.

Moreover, much research on walking and walkability has been based on empirical data from western geographical contexts and even, if the focus is on non-western settings, the grounding is based in Euro-American theories and worldviews. Overlooking the complexities of contextual influences and lacking sensitivities of cultural specificity may have ramifications, given that the meanings and experiences associated with walking are deeply embedded in unique cultural traditions (Bruner, 1990), and may not be universal in nature, but contingent upon specific historical and geographical contexts. Thus, findings based on western settings may not be transferrable to other socio-cultural contexts. New research is needed to move beyond adopting current theories,

approaches, value systems and worldviews and open up new dialogues that allow non-western experiences, ideas and concepts to be articulated (Schwanen, 2018).

In light of these considerations, the present study focuses on a rapidly developing city in Southern China, and explores how urban pedestrians in Shenzhen articulate the meanings and experiences of their daily walking practices. Shenzhen is one of the earliest cities to implement detailed planning for the development of pedestrian system in China. With its unique history as a special economic zone and urban features with high population density, it has become a world-renowned metropolis which has witnessed rapid economic and urban development. Situated in this urban context, this research adopts a qualitative design using in-depth interviews to explore the lived experiences of Shenzhen pedestrians and attend to contextual specificities of walking behaviour as a part of relational and complex interactions with time, bodies and places (Atkinson, 2013). Based on inductive analysis of 20 in-depth interviews with Shenzhen residents who were residing in their neighbourhoods and conducted walking trips at least 2 times per week. This study provides a more contextualised comprehension of how pedestrians interpret, respond to, and perceive their walking environments in a rapidly developing city context.

5.2 Literature Review

The literature on walking and walkability is extensive and spans over multiple disciplines. Here, we focus on two strands of literature highlighting the complexity of the practice of walking and the multifaceted interactions of the pedestrians and the walking environment. The first sub-section focuses on the practice and experience of walking, which emphasises walking as a diverse activity, while the second sub-section highlights the tangible (physical) and intangible (social, cultural and emotional) interactions between the pedestrians and the environment.

5.2.1 Walking as embodied social practice

A rich and multi-disciplinary body of scholarship has begun to portray walking as an embodied social practice and multi-sensuous experience. Various types of walking practices have been examined, including on mountains trails (Lorimer & Lund, 2008), urban explorations (Pinder, 2005), and reflections upon landscapes (Wylie, 2009). Work in this vein has offered insightful understandings of walking as not only a destination-oriented mode of transport but also a form of fluid and active movement that involves body, mind and space and varies in terms of purpose, pace, gait, and rhythm (Lorimer, 2011a; Wunderlich, 2008). By providing narratives through "walking-thinking-writing", the new walking studies have provided new and thought-provoking perspectives complementing the quantitatively oriented walkability measures and approaches with in-depth understandings of how reflexive walkers engage in purposeful, reflective and nurturing walking practices (Horton et al., 2014; Ingold & Vergunst, 2008). Key characteristics of these walking practices are highlighted, including their complexly sensed nature; the bodily, emotional, and sociotechnical attentiveness that is involved; and the connections that are invoked between landscapes, emotions and memories (Pinder, 2005).

Nonetheless, walking is rarely seen as just walking in these new walking studies, but often as extraordinary, revelatory and sometimes sacred and spiritual. More recent studies have, therefore, sought to understand everyday walking by focusing on the "less remarkable, unspectacular and unreported everyday experiences associated with walking" (Middleton, 2010, p. 576), and exploring habitual and less "willful and artful" walking practices (Horton et al., 2014, p. 98). Studying walking practices in London, Middleton (2009; 2010; 2018) has observed that most journeys in everyday walking practices are not the outcome of rational intention or decision-making. She argues that more attention should be given to the processual and experiential dimensions of walking itself (Middleton, 2011). Everyday urban walking involves all kinds of verbal and non-verbal interactions among pedestrians and other road users; "walking together" can create and extend supportive social spaces that strengthen

community cohesion and social interaction (Middleton, 2018; see also Doughty, 2013).

The above studies have highlighted the differentiated nature of walking, with various purposes and respective practices. These walking studies have provided rich insights that advanced our understanding of walking (Pooley et al., 2014; Shortell & Brown, 2014; Middleton, 2010). Nonetheless, the focui of most of these walking studies have been based on case studies from the developed western (global North) cities; similar work that explores walking in developing city contexts and outside the global North is very sparse. One exception is a study by Almahmood et al. (2017). Studying the walking experiences of young people in Riyadh, Saudi Arabia, these authors have shown that the practice of walking in an Islamic city is heavily shaped by gender norms and traditions. Women in Piyadh tend to walk in "privatised" spaces like shopping malls, because these spaces can "justify" their presence (to go out for shopping is a socially acceptable reason to for women to walk), and young women are prevented to walk in urban spaces to avoid any unpleasant gendered encounters. This study demonstrates that the meanings, practice, and experience of walking in developing cities in cities of the global South may be significantly different from our current understandings and deserve further investigation.

5.2.2 Contextual uncertainty of environmental influences on walking

The term "context" has been used to describe the circumstantial environment for certain activities to take place, such as social, physical, cultural environments that shape an individual's behaviour and experience (Orton et al., 2017; Taylor, Clark, & Gilliland, 2018; Bean, Kearns, & Collins, 2008). In studies of walking and environment, one of the basic assumptions is that the environmental influences to behaviour are reasonably consistent among all individuals and they respond in more or less similar ways. However, given that places (and environments) are social constructions named, bounded and experienced differently by different

individuals (Lee, Oropesa, & Kanan, 1994), people's responses to their environments could be highly personal and vary significantly by their background, past experience, perceptions, emotions and interpretations to the environment (Kwan, 2018; Coulton, Jennings, & Chan, 2013; Mennis & Mason, 2011). As a result, the contextual influences on individual's behaviour and experience will be highly complex and idiosyncratic, as the same environmental factors may lead to different behavioural outcomes due to various person-specific attributes (Kwan, 2018).

Although contextual influences play a critical role in shaping individuals' health, energy-consumption and travel behaviour (Aldred & Jungnickel, 2014; Fitt, 2017; Stephenson et al., 2015; Viner et al., 2012), the extant studies on people's walking experiences and behaviour in the public health and transportation literature have largely focused on the role of physical infrastructure. Relatively few studies have addressed the question of how the effects of social and cultural contexts affect people's walking, even though these contextual factors may significantly mediate individuals' perceptions and their associated walking experience and behaviour. For instance, some studies have explored how and in what ways social and cultural meanings ascribed to walking shape individual's daily walking. Using a qualitative method, Fitt (2017) examined how social meanings associated with individual's status, accomplishment, risk, and body shape in modifying their walking behaviour and other commute mode choice decisions in New Zealand. Focusing on low-income urban mothers in the United States, Segar et al. (2017) found that walking was associated with negative meanings, such as low socio-economic status, psycho-social stress, and little control over physical environments, which affected urban mothers' priorities to walk. These studies have highlighted the complexity of social and cultural factors and their influences on people's walking behaviour and experience.

Apart from social and cultural factors, previous studies have also found that some aspects of pedestrian's characteristics or attributes are significantly associated with walking, such as habit, place attachment and ageing. For instance, habit has been found to be associated with walking behaviour even after

residential relocation (Curl, Kearns, Macdonald, Mason, & Ellaway, 2018) and have positive effects on the affective experience of walking (Johansson et al., 2016). In addition, previous literature has also touched to some extent on the potential relationships between place attachment and people's walking behaviour. For example, Ferreira et al. (2016) showed that the effects of environmental quality on walking intentions and behaviours were mediated by neighbourhood attachment. The literature on ageing can also advance our understanding of walking, by considering how the changes in body functions of older pedestrians shape their preferences towards the walking environment (de Melo, Menec, Porter, & Ready, 2010) and risks of fall during walking (Curl, Thompson, Aspinall, & Ormerod, 2016). The aforementioned studies have suggested that the factors associated with pedestrians' habit, place attachment and ageing are associated with their walking experience and behaviour, but more in-depth investigations are needed to understand how these factors shape people's walking experience, particularly outside the global North.

5.3 Research context and methodology

5.3.1 Research setting

Located in the Guangdong Province of south China, the city of Shenzhen has a linear shape, stretching about 90 km from east to west, and 40 km from north to south. With only 2,050km^2 of land area, the size of Shenzhen is small compared to other major Chinese cities. For example, the land areas of Shanghai and Beijing are three and eight times larger than that of Shenzhen respectively. Despite the relatively small land area, the population is greater than 12.9 million, making Shenzhen one of most densely populated cities in China (6,234people/km^2).

Shenzhen has witnessed rapid and profound changes in its urban structure during transformation from a fishing village to one of the largest cities in China after the Open Door Policy in the late 1970s. However, different parts of the city have experienced dissimilar rates of development and thus created neighbourhoods with distinctive characteristics in terms of development density, land use mix and urban structure. As a result, residents in different parts of the

city are likely to have differing walking experiences. To capture the variation of their experiences, we recruited participants from four neighbourhoods with different geographical locations within the city (inner urban and outer urban) and levels of local accessibility[26] (high and low): Xinzhou (Inner-high), Xinsha (Inner-low), Shangjing (outer-high), Huilongpu (outer-low). The rationale behind and processes of selecting these four neighbourhoods have been discussed in a companion study (Chan, Schwanen, & Banister, 2019).

5.3.2 Fieldwork and data collection

This study applied a qualitative method to explore Chinese urban pedestrians' walking experiences. A naturalistic approach was adopted, which emphasises the importance of studying the phenomena in a real world setting and without the researchers attempting to deliberately manipulate the phenomena of interest (Patton, 2002). This approach allow participants to articulate their personal stories, perceptions and meanings that they ascribe to walking in Shenzhen's urban environment, as well as look into how they experience a particular issue as part of everyday life (Lincoln & Guba, 1985). Nonetheless, one of the major concerns when conducting interviews is the power imbalance between researchers and participants. A number of measures have been used in the data collection process to reduce such power imbalance as much as possible, including using open-ended questions to allow participants to talk freely on topics that they are interested in, asking follow-up questions based on participants' responses, and creating a comfortable interview environment according to participants' preferences (Elmir, Schmied, Jackson, & Wilkes, 2011).

Interviewees' narratives were considered to be social performances in which realities are crafted in the interactions between interviewer and interviewees (Silverman, 2015). The first author conducted fieldwork in the selected neighbourhoods between November 2015 and February 2016. First, purposive sampling was adopted to approach residents living in the selected

[26] Due to the lack of publicly available data on micro-scale built environment features in the case study city, local accessibility was measured by a composite index measuring the distance to the nearest Shenzhen metro station, distance to the nearest park/plaza, and the number of restaurants within the neighbourhood.

neighbourhood in public spaces who have conducted walking trips at least two times per week. Then, snowball sampling was employed to ask the participants to introduce other potential participants for participation. The combination of these sampling techniques was the most effective way to reach participants with diversified socio-demographic characteristics in a pre-selected spatial area.

In order to enable participants to articulate their walking experience in the most comfortable way, participants were asked to choose to conduct either walk-along or sedentary interviews in locations (including public spaces like parks and cafes or their home for sedentary interviews) or along routes (footpaths and routes that the participant walk for their daily activities) that they found appropriate. In total, three walk-along and seventeen sedentary interviews were conducted. A combination of walk-along and sedentary interviews were chosen for this study because these two methods have their own strengths and weaknesses, which can help to uncover different aspects of people's walking experience. For instance, walk-along interviews can provide rich information on participants' memories, the meanings they associate with walking and the events and thoughts that happened during actual walking situations (Büscher & Urry, 2009; Carpiano, 2009); while sedentary interviews allow participants to recall the most memorable events and stories that they have encountered in their past walking experience without being focused on or constrained to specific locations.

The final sample includes twenty individuals age ranged from 30 to 80. Of these 12 were female and 8 male, 8 lived in Xinzhou and 5 in Xinsha, 4 in Shangjing and 3 in Huilongpu. Our main purpose is to obtain a wide range of variation in urban walking experience. Thus, instead of drawing a statistically representative sample, we tended to reach individuals in the selected neighbourhoods and collected valuable interpretations from each individual. A set of semi-structured questions was used to guide the sedentary and walk-along interviews, which focused on three aspects: neighbourhood characteristics, walking experience, and the built environment. These questions were carefully prepared, tested and modified through a pilot study with two residents in Shenzhen. Most of the

interviews lasted about 60-90 minutes and were audio-recorded. Data saturation was achieved when hardly any new themes relevant to our topic emerged from the new interviews (Guest, Bunce, & Johnson, 2006). Pseudonyms are used in transcripts to ensure participants' anonymity.

5.3.3 Data analysis

During the first stage of analysis, transcripts were read a number of times to achieve data familiarisation and then coded using NVivo 10. The use of NVivo allows the researchers to organise and manage the transcripts and facilitate the coding process. Initial codes were generated and labeled with the expressions by the participants (Strauss & Corbin, 1998). These codes were gradually converted into six broader categories: habit, social exchanges, traffic safety, hopes for future, affective responses to urban dynamics, and walk as regimen, all of which participants have identified as significant in interpreting their urban walking experiences. In the second stage, the identified codes and categories were revisited, linked to each case, and developed further. Three more general themes – meaning, timescapes, and place – emerged as the process of abstraction proceeded (Ritchie, Lewis, Nicholls, & Ormston, 2013). As part of this stage, interactive and iterative discussions and exchanges were conducted between the research team to ensure the consistency and reliability of the themes (Boyatzis, 1998). Coding discrepancies were resolved through full discussions among the authors while unnecessary codes/themes were reduced until final themes, sub-themes and their interrelationships were agreed upon.

5.3.4 Limitations

Limitations in the research design should be acknowledged. First, in terms of sampling, the participant recruitment process may have reduced the inclusion of individuals who are less physically active or lack time to visit public spaces, and thus insufficiently explored these individuals' views and experiences. Second, only four neighbourhoods within Shenzhen were selected for analysis, and these cannot represent all conditions and contexts for walking across Shenzhen. The

neighbourhoods were selected to make systematic comparisons in terms of distance from the urban core of Shenzhen and local accessibility as part of a broader research project (see Chan et al., 2019). However, future research may involve more neighbourhoods across different districts of Shenzhen.

5.4 Findings and discussion

This section discusses three themes that emerged from the two-stage analysis of participants' narratives – meanings, timescapes and place – and how these relate to their walking experiences. In combination, the themes (see also Figure 5.1) help to deepen our understanding of the contextual complexities (Kwan, 2018; Kwan & Schwanen, 2018) of urban walking experience.

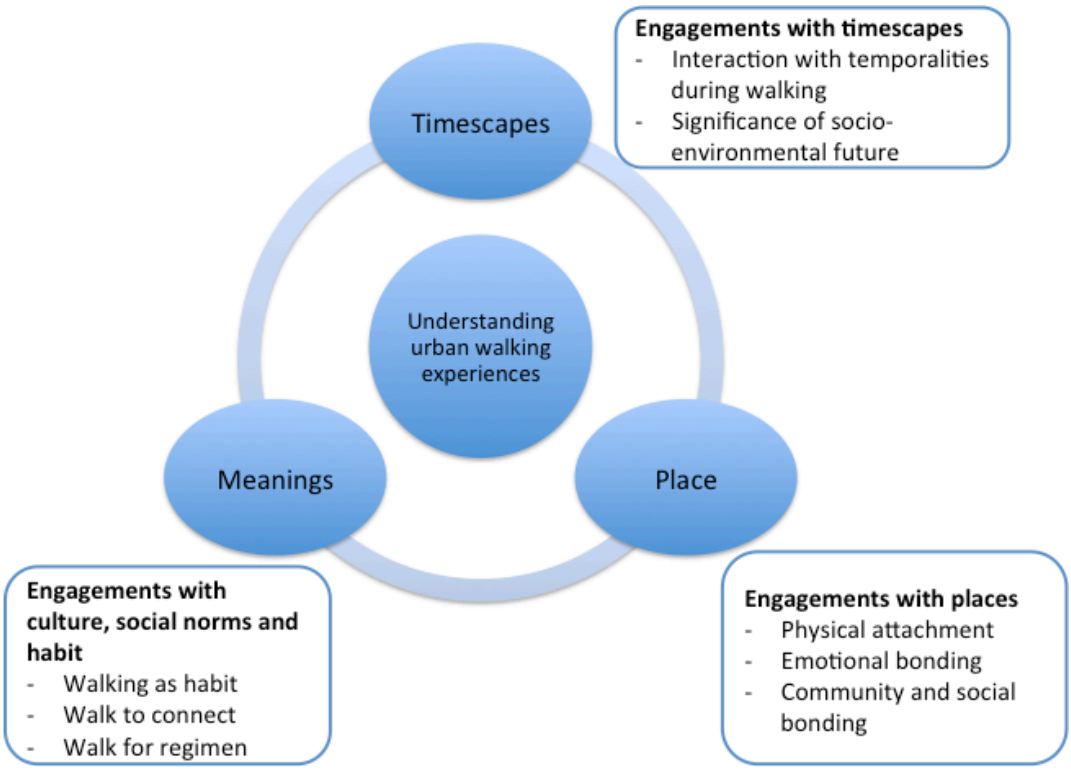


Figure 5.1 Understanding walking experiences in urban China: A conceptual framework

5.4.1 Meanings of walking in modern China: A habitual practice for harmony and regimen

5.4.1.1 Walking as habitual and self-perpetuating process

All participants conducted short-distance, routinised trips to access other modes of transport or to access various types of activities at destinations on a daily basis. However, many rarely regarded these trips as walking trips, even though they performed walking every day and regarded it as a habit. This was evident from, among others, the ways in which many participants struggled to describe what these trips meant to them. They only indicated that walking was an automatic and habitual everyday behaviour and did not normally reflect upon its meanings. This observation was very common among our participants, and this coincide with the Chinese saying "xiguanchengziran" (習慣成自然), meaning that once a habit is formed, it becomes something very natural and thus difficult to change. Walking thus is a common and natural activity for our participants to do every day.

For instance, Karen, a young woman who worked full-time and travelled by bus every day, talked about how she felt while walking from home to the bus stop every morning and got used to her "fine" short trips:

> *"I cannot say I feel excited when I walk, [and] it's not relaxing or stressful … I come across the same buildings, and I walk along the same path every day. It's already a regular routine of mine…To be honest, when you see the same things every day, you will not pay attention to any particular thing. Maybe I'll pay attention to something in the very beginning, but with time passed by and you keep walking along the same route, you will not pay special attention to any of them anymore." [female, 28, Xinzhou, inner-high]*

From narratives such as Karen's we can infer that walking as habit emerges from the relations between the individuals and their environment as a process in

which with repetition, sensation recedes into the background and the activity escapes reflective thought altogether (Schwanen, Banister, & Anable, 2012). Here, urban pedestrians are actively incorporating their physical surroundings, other objects and people to enable this open-ended and self-perpetuating process (Dewey, 1922). Walking becomes something people just do during which they can turn their minds to other matters.

5.4.1.2 Walking to connect

Several participants saw some of their walking trips as valuable moments while they can spend quality time to develop connections, intimacy and sense of trust with their significant others. The idea of considering walking as a meaningful social activity coincides with the work by Laurier et al. (2008), who explored the interactions of friends, families, and colleagues traveling in private vehicles and demonstrated that a car can act as a social space and that traveling together is in fact a valuable social activity in and of itself. For our participants, walking trips play an essential connecting role in their daily lives that they valued so much by centering the trips on communication and affective exchanges.

An example is Bonnie, a shop owner who had to look after her business the whole day. She valued her short trips for picking up her child from kindergarten. She interpreted her short but important trips as an everyday practice which helped her know more about her son and strengthened their bonding:

> *"Because of the nature of my work, I don't have much time to walk for leisure… Every morning when I walk my kid to school, I feel it's a brand new day. When I pick him up after school, he tells me what happened in school and what he has learnt. I listen and talk to him… I think he must have learnt something new today, so I feel very good… In my opinion, family is the most important thing. We should always keep family relations in harmony… Although I am the only one responsible for walking my kid to school, I appreciate this. This is the moment that belongs to the two of us." [female, 35, Shangjing, outer-high]*

For others participants walking trips served to connect them to both their current place of settlement and their ancestral village. For instance, 'walking together' with laoxiang[27] had very special meaning in the lives of participants who had migrated from other parts of China to Shenzhen. They considered walking as not only a common leisure activity but also something they needed to do to help them maintain solid connections with their ancestral origin. These trans-local ties between migrants and their home communities are particularly important, as previous studies have shown that these social ties are associated with better mental health and subjective well-being (Jin, Wen, Fan, & Wang, 2012; Liu, Zhang, Liu, Li, & Wu, 2019).

This practice, then, becomes an important means to connect people to different places, which manifests the broader Chinese cultural customs of appreciating kinship, ancestral roots and even collectivism. For example, Mary, among others, said that she enjoyed walking to the plaza nearby to meet with *laoxiang*, and then they walked together and shared the news in their ancestral hometown:

> *"I have a lot of laoxiang living in this neighbourhood. Futian Sports Park and Cultural Plaza are my favorite places to meet with my friends. When I go shopping, we usually meet there and go together. It is like, we still keep connected with our hometown. We still have updated information about our ancestral village and other fellows who remain living there." [female, 40, Xinzhou, inner-high]*

Another example is Theresa. She moved from her hometown to Shenzhen and started to live in her present neighbourhood 20 years ago. Her walking was so meaningful that it completely changed her early time in Shenzhen. She illustrates how her walking to the park helped her build connections to, and belongingness in, the new place of settlement:

[27] Laoxiang (老鄉) is a common term in Chinese, indicating ancestral fellows who are originated from the same geographical area of China.

"I knew no one from this neighbourhood at the beginning. I started to walk to Huanggang Park for relaxation and exercise. It took me 20 minutes [from home to the park]. There were a lot of activity groups in the park, dancing, singing, Taichi, etc. You could choose what you like and participate… I 'discovered' my activity group and joined one of the dancing groups. Gradually I made friends with some of my dancing group members. Now I look forward to going to the park every day to meet my friends and dance together… We also arrange other group activities like singing karaoke, group tours overseas or go short trip within Guangdong province." [female, 58, Xinzhou, inner-high]

5.4.1.3 Walking as regimen

Walking was also attached to a specific meaning of regimen (yangsheng 養生) and perceived as an important way to stay healthy by many participants. In Chinese, yangsheng is an integrated concept that relates to not only improving physical fitness, but also maintaining internal and external harmony, through exercise, diet, and even spiritual practice (Zhou, Zhang, & Du, 2017). Many participants interpreted walking as a major part of a nurturing life, and their interpretation of walking differed from the emphasis of bodily fitness that has been established in studies in the western world (Pooley et al., 2013). The participants' interpretation is deeply embedded in the Chinese traditional thinking of "prevention is much more important than treatment", which can be traced back to one of the basic principles in Chinese medicine (Yang et al., 2018; Chen, Song, Hu, & Brunner, 2012). Many participants referred to the old Chinese saying "with one hundred steps after dinner, you will live to 99 years old" when they talked about their walking habits. This suggests that walking plays a vital role in Chinese people's growing awareness of maintaining health. To these urban walkers, walking is not just a practice to relieve stress and recover from fatigue, but more as a preventative activity to stick to for potentially limiting illness. This preventative function of walking was particularly highlighted by those individuals who expressed more concerns over healthiness and regimen, although several have also mentioned the therapeutic effects of walking. They

expressed that aesthetically pleasing views, fresh air, and well-regulated traffic and walking environment all made them feel "much better", "relaxed" and "energised".

For instance, Ophelia, a fifty-year old woman who took yangsheng as her major task in her life explained why she saw daily walking contributing to her healthy life:

> *"I walked to a nearby park every day to dance and do exercises. For young people, you may assume Yangsheng (養生) is not as important as other things in your life. But to us, we are getting older, walking and doing exercises turn to be a very important task for our lives. It is a long-term thing that you have to insist on so that you can stay away from illness…otherwise it would be too late… [female, 50, Xinzhou, inner-high.]*

In summary, the narratives from our participants denote that walking is more than just a form of movement, but a way to connect to the new place, maintain social relationships, and preserve emotional connections with ancestral origins. Meanings across multiple geographies are thus associated with the daily practice of walking.

5.4.2 Engagements with timescapes

5.4.2.1 Temporal complexity of urban walking experience

Participants' responses to their urban environments and experiences of their walking trips were shaped by elements of the timescape (Adam, 2008), such as the timing, tempo, rhythm, duration of their walking trips, the sequence of their walking routes. The temporalities of both the built and social environment were particularly emphasised by many participants, for walking in different time determined their encounters in and responses to the walking environment. Some perceived favorable features of the neighbourhood environment negatively

when they were walking in a different time of the day. A clear example of this were broad, evenly surfaced pavements that were appreciated in the early morning but experienced as annoying and disrupting the flow of their walking later during the day when hawkers and vendors had arrived (as shown in Figure 5.2). Alex's explanations are particularly helpful in elaborating this point:

> *"I like to walk from home to the park on Sunday mornings. It's not noisy and not much traffic then. Hawkers have not arrived yet and it is clean… I feel comfortable to walk in the mornings… but when you walk in the evening, it will be completely different situation. Hawkers occupy the whole footpath, and some restaurants sell their barbecue food on the street. The street is filled with smoke, litter, and water. It will be stressful and chaotic experience when you walk at night." [male, 40, Shangjing, outer-high]*

Figure 5.2 The presence of hawkers and vendors on pedestrian footpaths in late afternoon

Nancy drew attention to other diurnal rhythms in walking experience. She appreciated urban greenery in her neighbourhood, and enjoyed the shade of trees on her footpaths particularly during Shenzhen's high-temperature summers. Nonetheless, she also concerned that these trees blocked the streetlights when she walked at night, making the same street unsafe after dark:

> *"I like to walk along Long Cheng Road during daytime, [because] there are trees on both sides of the road, and they are so green and lush. I can*

relax my eyes by looking at them, and I will not get sun burnt if I forget to bring my umbrella with me… but the branches and leaves of the trees block the street lights at night, this makes the footpath very dark… there are no shops or buildings along this road, and sometimes I feel scared while walking at night alone." [female, 25, Huilongpu, outer-low]

5.4.2.2 The significance of "futurescapes"

The temporal elements in understanding urban walking experience were also manifested in our participants' discussions of their socio-environmental future. The way in which they situated their present and past experiences into a larger timeframe associated with their hopes, plans, fears, and expectations was also articulated as significant in producing their walking experiences. This theme is particularly important in light of Shenzhen's ongoing urban transformation, whereby construction work either short-term (e.g. a few months) or long-term (5-10 years) such as construction of different lines of mass transit, the redevelopment of urban villages[28] (*Chengzhongcun*) can be observed in many inner and outer urban areas. This urban (re)development has caused aspects of the built environment in Chinese cities to change significantly, in particular its uses and the practices occurring in it (Law, 2005), and encountering construction sites was a common experience for most of our participants. They nonetheless expressed optimistic views about the transformations that their neighbourhoods were undergoing and imagined how the narrow and absent sidewalk would be different in the near future. Karen, for example, mentioned a short-term construction project undergoing in her neighbourhood caused disruptions against pedestrians (as shown in Figure 5.3). But interestingly, she talked more about her expectations for the future and she felt optimistic when she was walking past the construction site:

"They are building a new metro station opposite to the shopping mall.

[28] Urban villages in Chinese cities were originally rural settlements that became absorbed into urban areas as transitional neighbourhoods under unregulated rapid urbanisation. They are usually characterised by apartment blocks of 2–8 floors in close proximity of each other.

Roads and sidewalks are blocked; we don't have enough space to walk, [for] construction wastes are everywhere. But I am more used to this now. I understand it is a necessary process when a city is developing. All these negative impacts are unavoidable… But I am sure the situation will be changed once all the work is done…so I feel ok walking along this route…I am always thinking It will be more convenient to travel in the future because we will have a metro station here!" [female, 28, Xinzhou, inner-high]

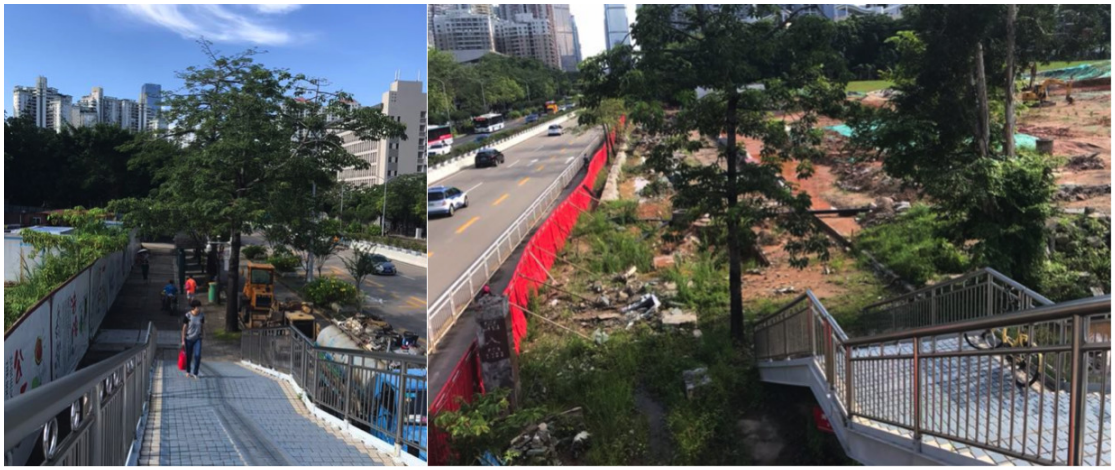


Figure 5.3 Construction sites narrowing pedestrian footpaths and creating walking obstacles

Participants also related their current walking experience to their future bodily capacities. For example, Michael, who described that the hawkers were common in his neighbourhood, explained he had to walk very carefully when he was exhausted after work. He also talked about the future, expressing more concerns over walking in his neighbourhood:

"I think I am quite fit right now compared to my friends and family. I am pretty flexible to avoid the vendors and hawkers. But I will become older and I may not be as fit or flexible as I am now. I am older, may need to use a cane in the future, I don't think I can walk along this road anymore. It is far too difficult to pass these obstacles for the elderly, those who need wheelchair, or visually impaired… it will be impossible

for them to pass… [male, 53, Xinsha, inner-low]

Narratives such as this suggest that understanding urban walking experience does not only connect present to past experience, but also to how people expect the future to be. What we do and feel in our lives is not just embedded in our socio-historical past, but also projected into a socio-environmental future (Adam, 2008). As such, how pedestrians perceive urban walking is relational, implicating their past and future which expand and contract when they move along their life course (Adam, 2008). This observation aligns with the literature on ageing that explained how older pedestrians' level of mobility changes in their later life (Ziegler & Schwanen, 2011). Nonetheless, the participant's narratives show a more complicated relationship connecting the present and future, emphasising that futurescapes may override the short-term negative impacts of the changing built environment on residents' walking experience.

The participants' elaborations draw attention to the temporal complexities of urban pedestrians' walking experience and the relationships between people's body, their walking behaviour, and environments. Most current environmental studies on walking tend to capture the built environment at a given time period of day, usually in daytime, which may be overlooking the dynamics across multiple timescales in the associations between the built environment and people's walking behaviour. Embracing the complexity of time will help researchers to challenge implicit assumptions in current frameworks of more or less stable associations between context and walking and question whether walking and environmental studies should be constrained to attending to the availability/presence of the built environment features (Lu et al., 2018; Ghani, Rachele, Loh, Washington, & Turrell, 2018).

5.4.3 Engagements with places

How individuals engage with places was also identified as significant in shaping urban pedestrian's behaviour and walking experiences. These engagements

include their physical and emotional bonding with their neighbourhood (shequ), district (qu), or city (shenzhen), the level of their place dependence, and how they identified with these places. Some talked about how their relationships with these places affect their walking experience in the neighbourhood. For instance, when Theresa talked about the chaotic walking environment in her neighbourhood because of the metro construction, she emphasised she had been living in this neighbourhood for over ten years, and felt the place was her home. This expression concurs with the literature on place attachment, stating the positive associations between people's attachment to place and length of residency (Brown, Perkins, & Brown, 2003; Lewicka, 2011). However, she further elaborates that because of her strong attachment to the neighbourhood, she was more tolerant of the chaotic walking environment, and would still keep walking despite the construction works. She said:

> *"The construction works are annoying, but it is my neighbourhood, isn't it? It will get better after these works [are done] … We will have better living conditions, the property prices in this district will be much higher… We will have a metro station right here that can take us to anywhere in Shenzhen… this is my neighbourhood, so I want to see it improved." [female, 58, Xinzhou, inner-high]*

Stacy's articulations about how her life was dependent on the park and plaza nearby, where she usually brought her child for leisure walking, suggested strong place attachment as well. She shared:

> *"My life will be different if we were not living nearby Futian Sports Park and the Plaza. It's very lively there even at night: children play in the plaza and ladies can dance. There are also lights everywhere, and a big TV screen that we can watch news…they put fences around so that we don't need to worry about children going outside… it had a construction work on the way to the park, it was chaotic. But I felt fine. Before the construction work, the road surface was not even, and it was difficult for me to push my baby stroller. They spent some time*

resurfacing it, and now it is much easier for me to walk [to my park]." [female, 44, Xinzhou, inner-high]

Our participants' narratives revealed how their attachment to neighbourhood plays an important role in mediating their walking experiences (Gustafson, 2001). However, previous studies have only demonstrated positive environmental perception was a strong contributing factor to place attachment, while the role of place attachment on environmental perception was unclear (Mesch & Manor, 1998; Bonaiuto, Aiello, Perugini, Bonnes, & Ercolani, 1999). Our participants' narratives have suggested that a strong sense of place attachment may led to a more optimistic view in perceiving the walking environment, despite the chaotic conditions that they had to endure during the construction. This demonstrated a possible bi-directional relationship between participants' place attachment and perceptions of the neighbourhood environment that has not been examined in existing literature.

5.5 Conclusion

The qualitative analysis of Shenzhen pedestrians' narratives led to the identification of three major themes for understanding urban walking experiences in the Chinese context. These three themes demonstrated that urban pedestrians' experiences are entangled with the meanings ascribed to walking and with their engagements with timescapes and with places; these themes will combine to or individually shape people's walking experience in important yet subtle ways. In combination, these themes bring forward a more contextualised comprehension of how urban pedestrians interpret, respond to, and perceive their environments. The following insights can be derived from the analysis discussed above.

First, walking is a culturally specific behaviour, and cultural differences, social norms, and values will all play a role in shaping pedestrians' experience. Despite there being several important parallels between participants' articulations in this study and in earlier work (e.g. Pooley et al., 2014; Middleton, 2018), several differences in terms of meanings, perceived benefits, and the discourses around

walking with previous research can be identified. For example, our study participants did not have much to say about the cost aspects of walking, or about connotations of walking with low socio-economic status, psycho-social stress, etc. (Segar et al., 2017). With regard to health benefits, the participants in the current study did not talk as much about the therapeutic and restorative functions of urban walking (Doughty, 2013; Gatrell, 2013) and placed only limited emphasis on the bodily fitness resulting from walking as exercise. Instead, the discourse tended to centre on harmony and balance: walking was seen as a way to maintain harmony between their mind, body, and the environment. This focus reflects a broader concern with harmony in health promotion and a focus on prevention – walking as regimen – over treatment that is deeply embedded in Chinese culture (Kwok & Sullivan, 2007).

Second, the participants in the present study talked extensively about obstructions to urban walking due to construction works and unregulated commercial activities along streets, implying the rapid urban transformation that Shenzhen is undergoing while also exhibiting characteristics that are often associated with streets in other cities in the global South. Discourses about these obstructions were, however, optimistic as it seemed to be widely expected that those obstructions were temporary and would diminish in the future. Such observations have not been reported in earlier walking studies. Our participants have explained that such positive attitudes can be attributed to the continuous improvements they have experienced in the past years. They have witnessed how their neighbourhood has become a better place to live. Such thinking leads to a more positive attitude in accepting the short-term inconvenience brought to their neighbourhoods.

Third, our findings also highlight the significance of temporality in understanding how the built environment affects walking experience. In previous studies, the built environment and its presumed effects on walking have mostly been treated as static or at best as only slowly changing. Hence, policy-directed and targeted changes in urban design are considered an important means to modify the built environment in existing walkability studies.

However, our findings highlight that people's walking experiences are shaped in complex ways by all kinds of short-term dynamics in the built and social environment, which concern how physical space is used and the practices it affords at specific moments. Consider, for instance, the presence of commercial activities on sidewalks. Not only can their physical appearance change over the course of the day, week or month; these activities can also afford different experiences for pedestrians at different moments in time. They can act, and be regarded, as obstacles during morning peak hours when pedestrians are rushing to get to work on time, but they can also be experienced as a source of personal safety (presence of other people on street) when they walk at night. As Andrews et al. (2012) posit, much of the urban planning and design literature on walkability tends to use standardised scales in design manuals and technical guidelines to assess walkability, like walking speeds and distances. Such practices overlook the differences in pedestrians' bodily capacities, the time of day that the walking take place, and the emotional experiences of walking. As a result, it is proposed here that walkability should be understood more comprehensively than just as urban design. The ways in which pedestrians experience the walking environment, the temporal variability of the environment, as well as the differences in pedestrians' bodily capacity should also be considered.

As one of the first studies to explore walking experience in the Chinese context, it suggests that understandings about walking experience and also of walkability developed from studies in western cities should not be transposed directly to cities in China, and possibly elsewhere outside the West. If those understandings are directly transposed, important dimensions of urban walking and walkability that are embedded in local cultures and histories are likely to be disregarded. Explorative studies in non-western cities, such as the current one, can bring more context-sensitivity to attempts to promote walking. The findings of studies such as this also enable future studies to reconceptualise and measure walkability not only as a static entity but a dynamic process that involves relations and interactions of pedestrians with the walking environment. Insights from this study might also prove useful to policy-makers in acknowledging the

diversified meanings that walking has for various pedestrians, and hence to consider appropriate policies in designing walkable cities.

6 Chapter Six - The role of perceived environment, neighbourhood characteristics, and attitudes in walking behaviour: Evidence from a rapidly developing city in China

Abstract

The associations between objective and subjective dimensions of the built environment and walking behaviour have been examined extensively in existing studies. However, the interaction effects of those dimensions of the built environment on walking behaviour are understudied and may be more complex than hitherto suggested. Apart from the subjective dimensions of the built environment, walking attitudes also play a role in moderating these relationships. This paper investigates the independent and joint effects of objective neighbourhood characteristics, people's perceptions of the neighbourhood environment, and walking attitudes on the frequency of walking by using Shenzhen as a case study. Since those effects may vary across different kinds of walking trips, the analysis looks separately at three major types of walking at the neighbourhood level – walking for work/school, walking for leisure/recreation, and walking for household responsibilities. Logistic regression analyses confirm that the correlates of people's walking frequency vary considerably among different types of walking. Statistically significant interaction effects of objective neighbourhood characteristics and perceived environment are found. The results suggest that positive perceptions of the environment can compensate for the depressing effects that objective walkability of neighbourhoods has on people's walking frequency. When seeking to encouraging walking at the neighbourhood level, policymakers should not only concentrate on improving objective neighbourhood characteristics but also consider people's perception of the neighbourhood environment and their attitudes towards walking.

Keywords: walking behaviour, built environment, perceived environment, attitudes, Shenzhen, China

6.1 Introduction

Physical inactivity is one of the major challenges to global public health (Sallis et al., 2016). Studies have shown that 18% of the population in developing countries is physically inactive (Dumith, Hallal, Reis, & Kohl, 2011). For instance, the average level of physical activity for adults in China has dropped by nearly 50% from 1991 to 2011 (Zang & Ng, 2016), and almost 80% of its adolescents were reported having inadequate exercise (Chen et al., 2014). In this context, walking has become a most sustainable form of physical activity in our daily lives, which enables people to interact with the environment in a more direct way due to its slow speed (Kamruzzaman et al., 2016; Larrañaga et al., 2016). Increasing evidence reveals that the improvements of the built environment can facilitate walking and other types of physical activity by providing more convenient transportation (Ball et al., 2001), accessible destinations (Owen et al., 2007), aesthetically pleasing features (Inoue et al., 2010), and well-maintained footpaths (McCormack et al., 2010), etc.

However, several recent studies have drawn attention to the divergent effects of objective and subjective dimensions of the built environment in explaining variations in walking behaviour (Hanibuchi et al., 2015; Koohsari et al., 2015). It is suggested that both dimensions of the built environment should be included, as different associations have been found between the objective and subjective dimensions of the environmental features with walking behaviour (Ma & Dill, 2015; Orstad, McDonough, Stapleton, Altincekic, & Troped, 2017). Nonetheless, the relationships between those dimensions of the built environment and walking behaviour may be more complex than hitherto suggested. There may be interactions in how objective neighbourhood characteristics and neighbourhood perceptions affect walking behaviour. Such interaction effects need to be examined further in a structured manner.

Additionally, walking attitudes may moderate the environmental influences on physical activity (Yang & Diez-Roux, 2017), although previous research has largely focused on measuring travel attitudes in general (Kitamura et al., 1997; Larrañaga et al., 2016). Recent studies suggest that compared to general

attitudes, behaviour-specific attitudes have stronger correlations with the behaviour (Kroesen & Chorus, 2018). How walking attitudes play a role in shaping the associations between the built environment and walking behaviour deserves further exploration (Ma & Cao, 2017; Kamruzzaman et al., 2016). Hence, including behaviour-specific attitudes (walking attitudes in this study) may help to improve our understanding on the associations between the built environment and walking behaviour.

In this study, rather than portraying walking as a generic form of movement, we paid special attention to the purpose of and activities generated by the walking trips. The influence of the built environment on walking behaviour may vary for trips with different purposes, such as household responsibilities, work/study, and leisure. Thus, it is opportune to examine the influence of the built environment on different purposes of walking behaviour. Moreover, our current knowledge of the associations between the built environment and walking is mostly based on findings from developed cities in North America, (Western) Europe, Australia and New Zealand (Feng, 2016). Case studies in rapidly developing countrie (particularly in China) are still limited to date. Metropolitan cities in China, such as Beijing, Shanghai, and Shenzhen, have highly mixed land uses, extremely high population densities and are less car-dependent compared to Western cities (Kenworthy & Hu, 2002). In view of such differences in social, cultural, and economic contexts, it is urgently needed to investigate the associations between the built environment and walking behaviour in the Chinese context. The results of such studies will inform urban planners and policymakers in designing more appropriate and contextualised strategies for intervention.

To fill these gaps, this paper examines the association between objective neighbourhood characteristics, perceptions of the neighbourhood environment, walking attitudes, and walking behaviour for three specific types of neighbourhood walking trips. We include both objective and subjective dimensions of the neighbourhood environment and explore their interaction effects in order to understand the impacts of the built environment to walking

behaviour more comprehensively. Using Shenzhen as a case study allows us to enrich the literature of walking by incorporating a non-western perspective. This paper is organised as follows. First, drawing insights from current literature, we discuss the links between the built environment, walking attitudes, and walking behaviour. We then present the methodology of this research, followed by discussions of the empirical results. Lastly, the conclusion summarises the major findings and provides directions for future studies.

6.2 Literature Review

In this section, we discuss the connections between the built environment, walking attitudes, and walking with different purposes by reviewing the comparable and contradictory findings that derived from both the Western and Chinese contexts. We acknowledge that the experiences, practices, and theories generated from previous studies may not be transferable to other contexts, especially rapidly developing countries like China.

6.2.1 Understanding walking behaviour

Public health literature has provided important insights into the connections between environment and behaviour by exploring complex interactions between people's perceptions and cognitions, the social, cultural, and physical environment, and human behaviour (Sallis & Owen, 2015; Millward et al., 2013). These studies usually categorise walking into two major types: walking for transportation and walking for leisure (Humpel, Owen, Iverson, Leslie, Bauman, 2004; Turrell et al., 2013). For instance, they tended to classify all walking trips undertaken to reach a destination (e.g. walking to work and walking to shopping) as a generic type of "walking for transportation", regardless of the trip's nature, main purpose, and activities generated by that trip. Overlooking the activity and demand associated with a walking trip might be problematic, for most people may not make separate decisions regarding their walking trips but schedule their activities and walking in a daily pattern. As such, most of their walking trips will be derived from the demand for participation in activities, as argued from the activity-based approach that travel is regarded as a derived demand (Golob,

1998; Reichman, 1976; Kwan, 2000; Schwanen et al., 2008; Vihelmson, 1999). Increasing number of studies start to distinguish different types of walking when examine the association between built environment and walking behaviour. For example, a recent study by Cho and Rodríguez (2015) found that the built environmental factors associated with walking for work and walking for shopping and/or eating were considerably different, although these two types were both regarded as walking for transportation.

Following the work of Reichman (1976) and many others (Lu & Pas, 1999; Wang & Lin, 2013), the present study distinguishes walking into three types associating with respective activities, namely walking for work/school, for leisure/recreation, and for household responsibilities, based on traditionally classified daily activities such as work-related, leisure and obligatory activities. By doing so, we intend to explore further the influence of the built environment on different types of walking trips.

6.2.2 Environmental influence on walking behaviour

Numerous studies that based on Western contexts have revealed that land use mix and proximity to destinations are positively related with frequency of walking (Krizek, 2003; King et al., 2015) and more pedestrian activities can be found in the neighbourhoods with more complete street networks (Moudon et al., 1997). Some contrasting findings that obtained from Chinese studies have told different stories. For example, a study conducted in Shanghai found that street connectivity was negatively associated with leisure time physical activity (Zhou et al., 2013). Similarly, based on a survey of 1070 residents in Shanghai and Hangzhou, Alfonzo and her colleagues (2014) found that people who perceive their residential environment to be less convenient actually spent more time walking. It might be because people with few alternatives to reach their destinations (e.g. lower automobile access) would have to walk more for non-commuting purposes.

Safety has been considered as one of the common issues in walking in many

Western cities (Foster et al., 2004). A recent review has demonstrated how concerns over safety are triggered by factors such as social incivilities, absence of people on street, and other undesirable environmental features (Brown et al., 2007). Speedy traffic and inadequate pedestrian crossing facilities are also found to be negatively associated with walking (Saelens et al., 2003). However, no conclusive findings have been found in Chinese cities to date. Some studies found that traffic safety was negatively associated with physical activity for adults in Shanghai (Zhou et al., 2013), while in other studies, no significant associations were found between traffic safety and leisure time physical activity (Su et al., 2014).

The quality of pedestrian environment was found to be another influential factor to walking in both Western and Chinese studies. For example, Michael et al. (2006) found that well-maintained streets (without litter and graffiti) increased older people's inclination to walk. Likewise, the aesthetic qualities of the built environment, such as presence of attractive buildings and green spaces, have been found to be positively associated with walking (Moudon et al., 2007). Similarly, positive associations between aesthetic qualities and leisure time walking have been found in a Chinese study, but no associations with walking for transportation have been reported (Su et al., 2014).

Regarding the relationships between objective, perceived built environment and walking behaviour, two types of relationships have been proposed in previous studies – through mediation or moderation effects. The former hypothesised that the objective built environment influenced walking through perceived environment (Ma & Cao, 2017; Orstad et al., 2017); while the latter proposed that the relationships between objective environment and walking depends on the perceived environment. For instance, some recent studies have explored various moderation effects between neighbourhood environment and physical activity through psychosocial factors (Serrano et al., 2018; Perez et al., 2016), and walking attitudes (Yang & Diez-Roux, 2017). However, the effects of perceived environment in moderating the relationships between objective neighbourhood characteristics and three types of walking frequency are

understudied and deserve more structured examination.

6.2.3 Attitudes and walking behaviour

Travel attitudes are usually measured by using factor analysis or carefully validated psychometric scales to capture meaningful constructs from numerous statements to reveal travelers' preferences, fondness and perceptions towards different transport modes, as well as intention to travel. Travel attitudes have been found to have significant effects on travel behaviour (Kitamura et al., 1997; Kamruzzaman et al., 2016; Vale & Pereira, 2016). For example, Cao et al. (2006) identified four types of travel attitudes: pro-bike/walk, travel minimising, safety of cars, and car dependent during their investigation of relationships between built environment and travel behaviour. Likewise, Larrañaga et al. (2016) identified three types of travel attitudes: pro-walking, pro-car, and safety-neighbourhood by studying environmental influence and travel attitudes on walking in Porto Alegre, Brazil. Nonetheless, most of these studies devoted to capturing travel attitudes in general rather than attitudes associated with specific travel behaviour (Kroesen & Chorus, 2018).

Recently, some studies started to examine the role of walking attitudes in understanding walking behvaiour. Such behaviour-specific attitudes towards walking activity, like enjoyment, importance, and positive experience in the past were considered to have close relationships with people's walking behaviour. For instance, through examining the interaction effects of walking attitudes and neighbourhood environments on walking, Yang and Diez-Roux (2017) found that positive walking attitudes were associated with walking for transportation and leisure regardless of the environmental characteristics. However, some of these studies used a single item to measure attitudes, which might increase the sensitivity to measurement error. In light of the above considerations, the present study draws insights from previous studies on travel and walking attitudes (Joh et al., 2012; Handy et al., 2005) and develops a 7-item scale that specifically measures people's walking attitudes to explore the relationships between the built environment and walking behaviour.

6.2.4 Summary

The literature review pinpoints a number of gaps from the current walking and travel behaviour literature. First, it is noted that most of the current studies tended to treat walking as generic form of travel without fully considering its associations with people's demand, activities and purposes, which may have oversimplified the relationships between the built environment and walking. Second, existing studies have revealed both similar and contrasting findings between cities in the Chinese and Western context. More research is called for to focusing on non-Western context and providing useful insights on appropriate policy recommendations. Finally, recent studies have suggested to measure behaviour-specific attitudes and examine its associations with specific travel behaviour, as behaviour-specific attitudes may capture unique variabilities compared to general travel attitudes.

The present study aims to investigate the associations between objective neighbourhood characteristics, perceived neighbourhood environment, walking attitudes, and frequency of three types of walking. In addition, possible interaction effects between objective neighbourhood characteristics and perceived built environment and walking attitudes on walking frequency are explored. First, we expect positive associations for favourable perceived environmental factors and walking attitudes on walking frequency. Next, given that few studies have explored the interactions effects between objective neighbourhood characteristics and perceptions of the neighbourhood environment in relation to frequency of three types of walking, this part of the study will be exploratory in nature. This study can contribute to the literature in understanding the possible moderation effects of objective and perceived built environment on walking frequency.

6.3 Methodology

6.3.1 Study design and neighbourhood selection

Shenzhen is located in the southern region of Guangdong Province in China. By the end of 2015, it had a population of 11.38 million on its 1992 square kilometers land area (Shenzhen Statistical Bureau, 2016). Established as one of the special economic zones in 1980, Shenzhen has witnessed rapid economic growth and urban development since then, making it one of the major metropolitan cities alongside Beijing, Shanghai and Guangzhou. In 2012, the Ministry of Housing and Urban-Rural Development and National Development published a national-level policy document guiding the improvements of walking and cycling infrastructures in cities. Following this national guideline, Shenzhen was one of the earliest cities in China to develop its city level planning guidelines on encouraging walking and cycling.

We adopted a neighbourhood-based study design to limit the focus to the selected neighbourhoods. Unlike other transport modes that are usually performed at regional or city scale (traveling across different locations within the city), home-based walking trips were usually performed within people's own residential neighbourhoods. As such, neighbourhood-based design allows the researchers to have a more in-depth understanding of the associations between neighbourhood built environment and walking behaviour. A multi-stage sampling method was applied in selecting neighbourhoods for analysis. In the first stage, two sub-districts with contrasting regional accessibility were chosen, one in the inner urban area of the city (Shatou), and another in the outer urban area (Longchen). Most of the early development in Shenzhen was concentrated in the inner urban areas, and it was only in the past decade that the development gradually spread towards the outer urban areas. According to the 2010 census, 64% of the residential units in Shatou were built in 1980-1999, compared to only 38% in Longchen during the same period (Shenzhen Government, 2011). Differences in land use patterns, street networks, and urban design can be observed in these areas. In view of such differences, it is necessary to select neighbourhoods in both areas to capture such variations (Su et al., 2017). In the next stage, within each sub-district, two neighbourhoods with the highest and

lowest local accessibility were selected for further study. Local accessibility was measured by a composite index measuring the distance to nearest Shenzhen metro station, distance to the nearest park/plaza, and the number of restaurants within the neighbourhood boundary, using data from Baidu Map. For Shatou sub-district, Xinzhou (high local accessibility) and Xinsha (low local accessibility) were selected. For Longchen sub-district, Shangjing (high local accessibility) and Huilongpu (low local accessibility) were selected.

6.3.2 Survey

The data were obtained by means of a questionnaire survey conducted in the four selected neighbourhoods in Shenzhen from December 2016 to March 2017. The sampling design combined convenience sampling (all adults available in the park or open space) and random probability sampling (surveyors were instructed to approach the next adult they encounter as a potential respondents). To minimise potential selection bias, we have conducted the surveys in multiple locations, both weekdays and weekends, and during different time periods. Respondents were asked if they were living in this neighbourhood, with the assistance of a map showing the neighbourhood boundaries. A small gift (such as key chains, bookmarks, ball pens) was provided as an incentive for participation (about USD$1). The number of respondents totaled 890. Although detailed records on the number of people who refused to participate were not gathered, the response rate was estimated to be about 50% based on the feedback from surveyors. The survey was divided into four parts, containing questions relating to well-being, walking behaviour, environmental perceptions and attitudes, and socio-demographic characteristics.

6.3.3 Variables

The variables used in this study consist of five categories: walking behaviour, perceptions of the neighbourhood environment, objective neighbourhood characteristics, walking attitudes and socio-demographics. Walking behaviour was measured by asking respondents to recall their most recent walking trips

that they have performed for the three specific purposes of walking respectively in the past week within their neighbourhoods. They were then asked, “How often do you usually perform this trip?”. Five options ranging from “less than once a week” to “more than 7 times a week” were provided.

Perceptions of the neighbourhood environment were measured using selected items from the abbreviated version of the Neighbourhood Environment Walkability Scale (NEWS-A) (Cerin et al., 2009). Selected items were modified to make them more applicable to the context of the city of Shenzhen. Two sub-scores measuring residential density and land use diversity were excluded from this study to reduce the questionnaire length and hence respondent burden. Other modifications include eliminating items that were unsuitable for the case of Shenzhen. For example, one item asks participants whether “Walkers and bikers on the streets in my neighbourhood can be easily seen by people in their homes”. In Shenzhen, as in other high-density cities, multi-storied residential buildings are common and it is nearly impossible to observe pedestrians from these high-rise buildings. A number of statements derived from the findings of an exploratory qualitative study conducted preceding the present study were added to capture some other aspects of the built environment, including “poor footpath condition” and “maintenance and upkeep”. All neighbourhood perception items were measured using five-point Likert scales, ranging from 1 (strongly disagree) to 5 (strongly agree). Eight neighbourhood perception sub-scores were computed. Five of them were positive, including access to destinations, street network, physical infrastructure, aesthetics and maintenance and upkeep. Three of them were negative, including traffic safety, personal safety, and poor footpath condition. The statements used to measure neighbourhood perception are presented in Appendix 6.1.

Neighbourhood characteristics were measured by two dummy variables capturing the objective characteristics of the selected neighbourhoods. The first variable denotes whether the neighbourhood was an outer urban neighbourhood, the other variable distinguishes whether the neighbourhood was a low local accessibility neighbourhood.

There is currently no consensus on standardised measures on travel attitudes, let alone more specific walking attitudes. Drawing insights from previous literature (Handy et al., 2005; Joh et al., 2012), seven statements were used to measure walking attitudes. Respondents were asked whether they agree or disagree with the statements in Appendix 6.1 using seven-point Likert scales ranging from 1 (strongly disagree) to 7 (strongly agree). A walking attitudes sub-score was constructed based on the mean score of the seven statements.

The socio-demographic variables used in this study include age, gender, employment status, educational level, household income, having a driver's license. Length of residency in the present neighbourhood and body mass index (BMI) are also included, as length of residency might affect the decision of a person to walk for various purposes and BMI can control for body type. Self-reported height and weight were collected, the weight in kilograms was divided by the height in meters squared (kg/m^2) to obtain the BMI. The socio-demographic variables are shown in Table 6.1, and compared with the 2010 Shenzhen Population Census. Within the sample there is an over-representation of older people, women and people without full-time employment and higher education level.

Table 6.1 Descriptive statistics of socio-demographic variables

Variables	Categories	Sample	Population (%)
Age	18-30	182 (24.9%)	36.90%
	31-40	191 (26.2%)	24.20%
	41-50	120 (16.4%)	14.20%
	51-60	133 (18.2%)	4.50%
	Over 60	104 (14.2%)	2.90%
Gender	Male	316 (43.3%)	54.80%
	Female	414 (56.7%)	45.90%
Employment	Full-time	303 (41.5%)	81.50%
	Not full-time	427 (58.5%)	18.50%
Education level	Primary or lower	42 (5.8%)	5.30%
	Secondary	305 (42.0%)	75.80%
	Tech. institute/ junior college	183 (25.2%)	10.30%
	University and above	196 (27.0%)	8.60%
Household income, Chinese Yuan (CNY)	Less than 100,000	251 (40.3%)	N/A
	100,000 to 300,000	305 (49.0%)	

	More than 300,000	67 (10.8%)	
Driver's license	Yes	405 (56.0%)	N/A
	No	318 (44.0%)	
Length of residency	Less than 2 years	107 (14.7%)	N/A
	2-5 years	337 (46.4%)	
	6-10 years	205 (28.2%)	
	More than 10 years	78 (10.7%)	
Body Mass Index (BMI)	Less than 18.5	54 (7.5%)	N/A
	18.5-24.9	499 (69.4%)	
	25.0-29.9	148 (20.6%)	
	30.0 or above	18 (2.5%)	

Note: Shenzhen population data was obtained from 2010 Shenzhen Population Census

6.3.4 Limitations of this study

There are several limitations in this study. First, this study is cross-sectional, so it is impossible to evaluate whether the established correlations reflect causality. Future studies can benefit from the use of longitudinal data or intervention design. Second, walking behaviour, attitudes, and perceived environmental features are all based on self-reporting, and there may be discrepancies between individuals' perception and a more general intersubjective consensus view. Although the basic socio-demographic variables have been controlled for in all of the regression models, it is possible that some other unobserved (or unmeasured) variables might also play a role in mitigating the relationships between the built environment and walking behaviour, thus affecting the results of the analyses. Besides, objective built environment was only measured with neighbourhood characteristics in two dimensions (inner or outer urban neighbourhoods and high or low local accessibility), which might not truly capture the micro environmental features that the respondents encounter during their daily walking. The recruitment of local residents in public spaces using intercept survey might have resulted in selection bias. It might be expected that people who are healthier or more willing to walk and use the public areas are over-represented, whilst other people who might have mobility limitations could be underrepresented. Although the surveys were conducted both on weekdays and weekends at various times of the day and multiple locations to minimise the impact of this problem, such bias might still be possible. Future studies with less

selection bias can enhance rigor in this field of research. Moreover, this study focused on one city – Shenzhen, and within a number of selected neighbourhoods only, which might limit the application of the results to other cities.

6.3.5 Data analysis

Since the dependent variables are categorical data, logistic regression analyses were used to examine the relationships between neighbourhood characteristics, perceived environment and walking attitudes in affecting the frequency for three types of walking (Hosmer, Lemeshow, & Sturdivant, 2013). Given that the focus of this paper was to explore the environmental influences on different types of walking, rather than people's mode choice decision, so separate logistic regression models were constructed for each type of walking. Binary logistic regression was used for work/school related walking frequency model to distinguish between those who walk for work/school at least half of trips per week[29] (medium and high frequency) and those who only walk occasionally (low frequency). Multinomial logistic regression was used for walking for leisure/recreation and household responsibilities related activities (low vs medium vs high frequency). In addition, we examined the possible interaction effects between the objective neighbourhood characteristics and perceived environment and walking attitudes. For each interaction, the product term was added separately and P value of the interaction term was used to evaluate the statistical significance. Interaction terms that were significant at the 0.05 level were entered into the model. After that, insignificant variables were removed stepwise to maintain the parsimony of the final models, except for the basic socio-demographic variables, including age, gender, employment, and income, which were included in all regression models as control. The inclusion of interaction variables into logistic regression models might lead to multicollinearity problems because the interaction terms are correlated with the main effects terms used to calculate them. Following Kreft and Leeuw (1998),

[29] As most of the employees and students need to go to work or school for only five days per week, separating walking frequency into low (less than 3 times) and medium-high (3 times or more) allow us to indicate whether walking is the common choice for their daily travel (3 out of 5 times per week).

the method of centering was adopted in this study to reduce multicollinearity between the main and interaction effects. The perceived environment variables and walking attitudes were mean-centered by subtracting the mean from each variable's observed value. To account for the clustered nature of data, all of the regression models were adjusted to ensure the standard errors are not underestimated. Statistical analysis was conducted using STATA 14.0.

6.4 Results

6.4.1 Descriptive statistics

Table 6.2 shows the responses for walking frequency, and three major points are worth discussing. First, there are more respondents who walk 7 or more times per week (29.5%) for leisure/recreation walking, compared to walking for household responsibilities (26.6%). Second, walking 7 or more times per week occurs more often in neighbourhoods with higher local accessibility, especially for leisure/recreation (39.1% vs 29.5%) and for household responsibilities (36.5% vs 26.6%), but not much difference can be found for work/school walking. The above observations suggest that respondents' walking frequency for the three types of walking varies considerably. These results reinforce the need to consider the purpose of walking trips in understanding people's walking behaviour.

Table 6.2 Descriptive statistics of frequency for three types of walking

Walking frequency	All respondents (%)	Inner urban neighbourhood (%)	High accessibility neighbourhood (%)
Work/school related walking			
Low (less than 3 times/week)	78 (15%)	37 (15.4%)	37 (15.1%)
Medium-High (3 times and more/week)	442 (85%)	204 (84.6%)	208 (84.9%)
Leisure/recreation related walking			
Low (less than 3 times/week)	347 (43.1%)	176 (43.7%)	144 (34.8%)
Medium (3-6 times/week)	221 (27.4%)	103 (25.6%)	108 (26.1%)
High (7 times or more/week)	238 (29.5%)	124 (30.8%)	162 (39.1%)
Household responsibility related walking			
Low (less than 3 times/week)	315 (42.06%)	164 (43.2%)	135 (34.7%)
Medium (3-6 times/week)	235 (31.37%)	121 (31.8%)	112 (28.8%)
High (7 times or more/week)	199 (26.57%)	95 (25%)	142 (36.5%)

6.4.2 Regression analysis

Tables 3 to 5 below show the logistic regression results, illustrating the influence of socio-demographics, walking attitudes, perceived environment and neighbourhood characteristics on walking frequency for the three types of walking trips. Table 6.3 is a binary logistic model for work/school related walking; Table 6.4 and 6.5 are multinomial logistic models for leisure/recreation walking and household responsibilities related walking respectively. The reference category is walking for low frequency (less than 3 times/week) for all three models. In order to obtain parsimonious models, all of the independent variables and interaction terms that were insignificant at the 0.05 level were removed from the final models[30].

Table 6.3 Binary logistic model for work/school related walking frequency

Variables	B	*P* value	Odds ratio
Constant	.410	.427	
Socio-demographics			
Length of residency (ref=>10 years)			
Less than 2 years	.162	.781	1.177
2 to 5 years	.669	.046*	1.953
6 to 10 years	.753	.099	2.125
BMI (ref=>30.0)			
Less than 18.5	1.708	.002**	5.523
18.5-24.9	1.308	.002**	3.702
25.0-29.9	1.325	.095	3.761
Neighbourhood characteristics and environmental perceptions			
Outer urban neighbourhood (ref=inner urban)	.380	.000*	1.462
Low accessibility neighbourhood (ref: high)	-.155	.613	.985
Poor footpath condition	-1.046	.000**	.351
Significant interaction effects			
Low accessibility x Poor footpath condition	1.569	.000**	4.802
Log-likelihood (final model)		-134.849	
Log-likelihood (constants only model)		-152.277	
Log-likelihood (equally-likely model)		-266.169	
Pseudo r^2 (equally-likely base)		.493	
Pseudo r^2 (constants only base)		.114	
Sample size		384	

Reference category: Low frequency (less than 3 times/week)
Other socio-demographic variables were controlled for in this model.

[30] Except for the main effects of the significant interaction terms.

*p<.05; **p<.01

Table 6.4 Multinomial logistic model for leisure/recreation walking frequency

Variables	Medium frequency			High frequency		
	B	***P* value**	**Odds ratio**	**B**	***P* value**	**Odds ratio**
Constant	-1.05	.002**		-.025	.973	
Socio-demographics						
Age (ref=18-30)						
31-60	.212	.364	1.236	.107	.702	1.129
Over 60	1.060	.000**	2.886	.731	.035*	2.078
Length of residency (ref= less than 2 years)						
2 to 5 years	.814	.000**	2.258	-.442	.384	.643
6 to 10 years	.621	.000**	1.861	.011	.983	1.011
More than 10 years	.772	.061	2.163	.160	.722	1.173
Walking attitudes						
Walking attitudes	.006	.945	1.006	.405	.000**	1.499
Neighbourhood characteristics and environmental perceptions						
Low accessibility neighbourhood (ref=high)	-.403	.163	.668	-1.025	.000**	.359
Poor footpath condition	-.287	.040*	.751	-.289	.101	.749
Access to destinations	-1.020	.016*	.361	-.359	.223	.698
Aesthetics	.603	.002**	1.827	.076	.477	1.079
Personal safety	-.034	.711	.967	.185	.048*	1.203
Significant interaction effects						
Low accessibility x Poor footpath condition	.677	.012*	1.969	-.027	.876	.974
Low accessibility x Access to destinations	.998	.047*	2.712	.393	.297	1.481
Log-likelihood (final model)	-643.063					
Log-likelihood (constants only model)	-703.917					
Log-likelihood (equally-likely model)	-718.492					
Pseudo r^2 (equally-likely base)	.105					
Pseudo r^2 (constants only base)	.086					
Sample size	654					

Reference category: Low frequency

Other socio-demographic variables were controlled for in this model.

*p<.05; **p<.01

Table 6.5 Multinomial logistic model for household responsibilities related walking frequency

Variables	Medium frequency			High frequency		
	B	***P* value**	**Odds ratio**	**B**	***P* value**	**Odds ratio**
Constant	-1.44	.000**		-.124	.627	
Socio-demographics						
Age (ref=>18-30)						
31-60	.568	.000**	1.764	.175	.298	1.191
Over 60	.636	.140	1.888	.608	.011*	1.837
Length of residency (ref=less than 2 years)						
2 to 5 years	1.256	.000**	3.512	-.243	.241	.784
6 to 10 years	1.275	.000**	3.579	.178	.516	1.195
More than 10 years	.752	.128	2.122	-.721	.119	.486
Employment (ref=not full time)						
Full-time employed	-.579	.062	.560	-.482	.000**	.617
Neighbourhood characteristics and environmental perceptions						
Outer urban neighbourhood (ref=inner urban)	.030	.843	1.031	.072	.000**	1.074
Low accessibility neighbourhood (ref=high)	-.052	.743	.949	-1.037	.000**	.354
Physical infrastructure	.348	.038*	1.416	.274	.075	1.315
Maintenance and upkeep	-.278	.000**	.757	.269	.237	1.310
Significant interaction effects						
Low accessibility x Physical infrastructure	-.833	.000**	.435	-.287	.186	.750
Low accessibility x Maintenance and upkeep	.636	.000**	1.889	-.120	.633	.887
Log-likelihood (final model)				-647.233		
Log-likelihood (constants only model)				-703.554		
Log-likelihood (equally-likely model)				-798.691		
Pseudo r^2 (equally-likely base)				.190		
Pseudo r^2 (constants only base)				.080		
Sample size				727		

Reference category: Low frequency
Other socio-demographic variables were controlled for in this model.
*p<.05; **p<.01

6.4.2.1 Walking to work/school

For work/school related walking (Table 6.3), only one perceived environment variable – "poor footpath condition" – was significant at the 0.05 level. The interaction effect of this variable and accessibility level of neighbourhood was also significant, so the interpretation will combine the main and interaction

effects. The interaction effects are shown in Figures 6.1 below.

Figure 6.1 Predicted probabilities of work/school walking frequency for low- and high-accessibility neighbourhoods with changes in poor footpath condition (FC)

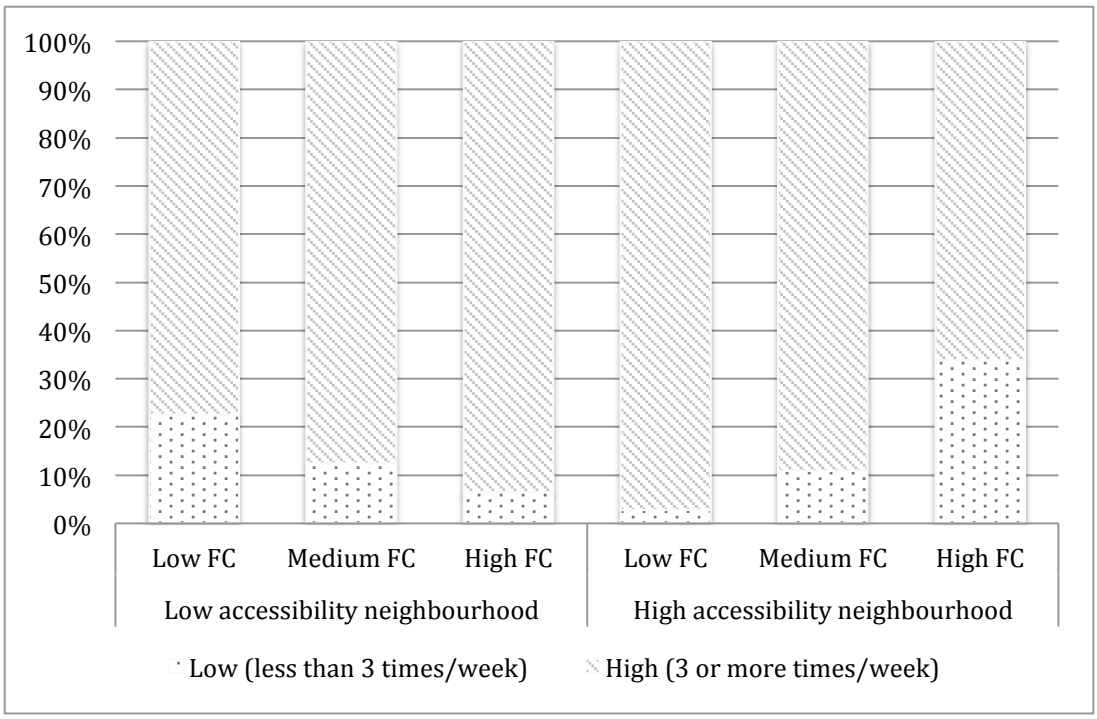


Figure 6.1 shows the interaction effect of poor footpath condition and the objective level of neighbourhood accessibility. After converting the findings to predicted probabilities, we found that when the perception of poor footpath condition increased, the probability to walk for work/school less than 3 times per week was 11 times higher for people who live in a high-accessibility neighbourhood. But the same increase in poor footpath condition decreased the probability to walk for work/school less than 3 times per week, for people living in low-accessibility neighbourhoods. This might seem counterintuitive in the first instance, but it might reflect that the limited transport options available (e.g. bus stops and other public transportation) in low-accessibility neighbourhoods force people to walk more despite their perceptions. This finding is in line with a recent study conducted in China showing that respondents who perceived their neighbourhood to be less convenient for walking actually spent more time walking compared to other respondents (Alfonzo et al., 2014).

Among the socio-demographic variables, BMI was found to be associated with walking to work/school. People with lower BMI (less than 25) were more likely to walk to work/school 3 or more times per week. Length of residency was also found to be significant, people living in the neighbourhood for 2-5 years were more likely to walk to work/school 3 or more times per week.

6.4.2.2 Walking for leisure/recreation

For leisure/recreation related walking (Table 6.4), four perceived environment variables – "access to destinations", "poor footpath condition", "aesthetics" and "personal safety"– were significant in the model. Significant interaction effects were found for the first two perceived environment variables and accessibility level of the neighbourhood (Figures 6.2 and 6.3).

Figure 6.2 Predicted probabilities of leisure/recreation walking frequency for low- and high-accessibility neighbourhoods with changes in perceived access to destinations (PA)

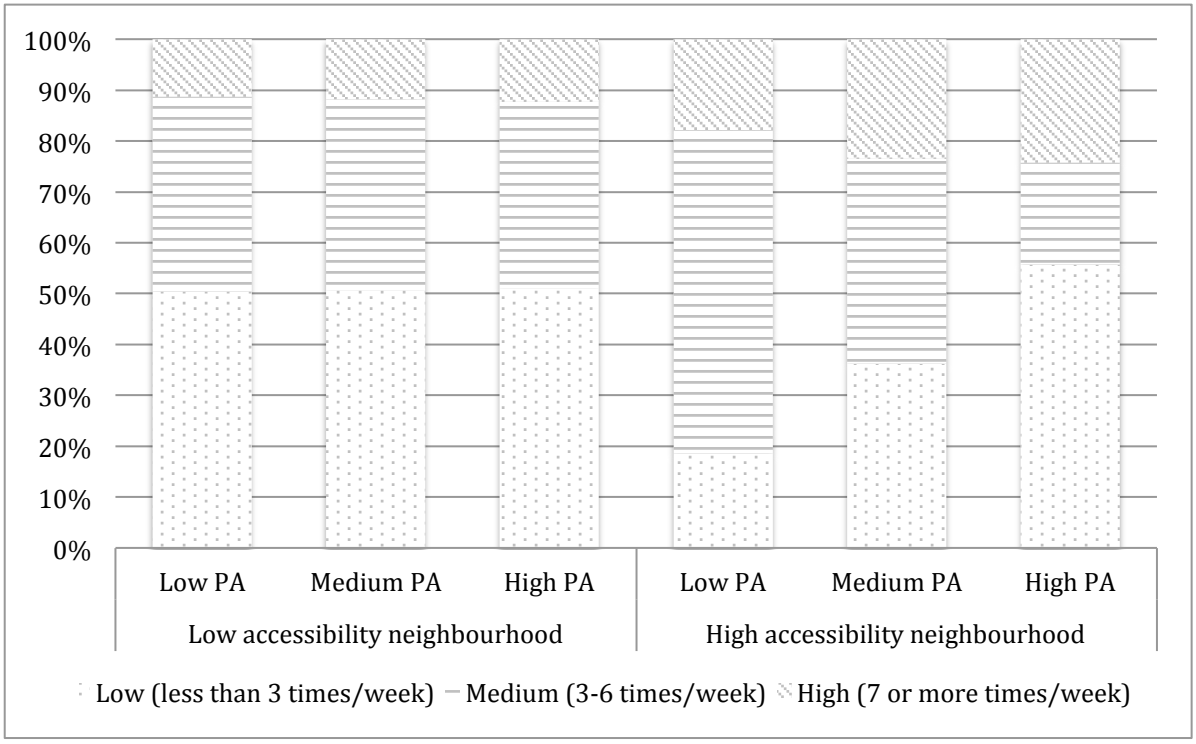


Figure 6.3 Predicted probabilities of leisure/recreation walking frequency for low- and high-accessibility neighbourhoods with changes in poor footpath condition (FC)

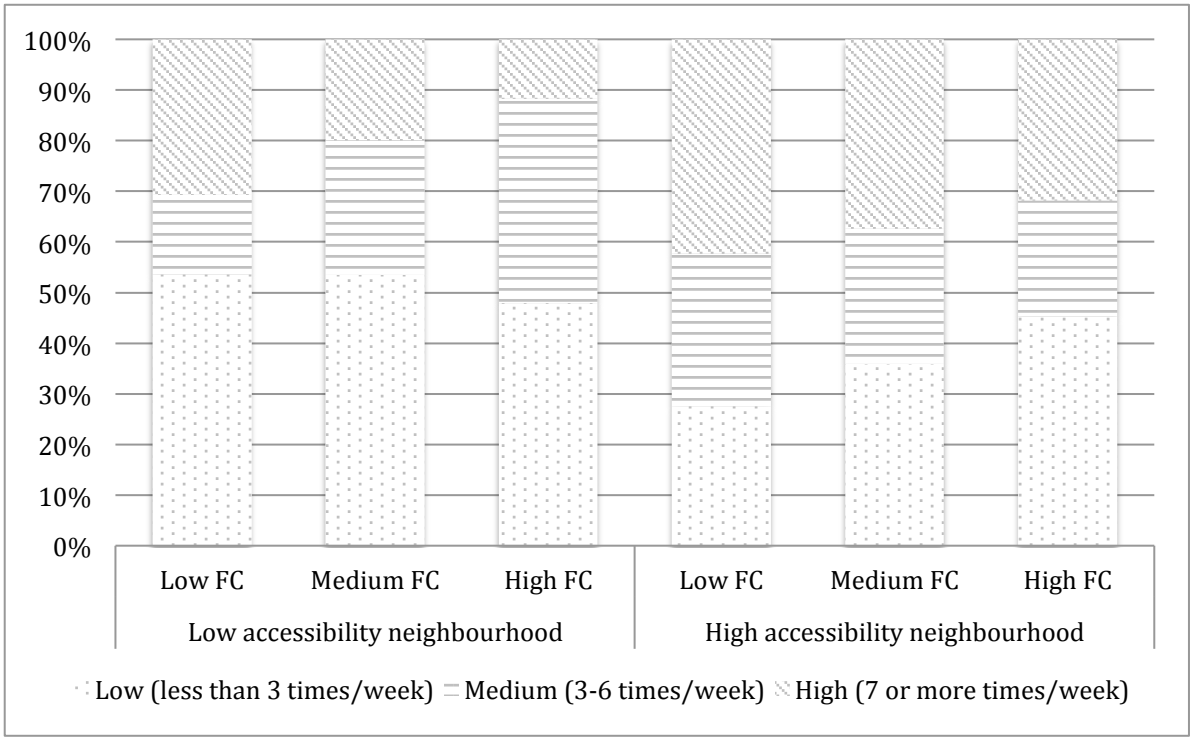


Figure 6.2 shows the interaction effect between perceived access to destinations and low accessibility neighbourhood for medium frequency (3-6 times/week) compared to low frequency (less than 3 times/week) of leisure/recreation walking. After converting the findings to predicted probabilities for interpretation, we noted that perceived access to destinations played a limited role in low-accessibility neighbourhoods. When the value of perceived access to destinations was low, the probabilities to walk for leisure/recreation more than 3 times per week was higher in high-accessibility neighbourhoods. In addition, perceived access to destinations changed the distribution of frequency of walking in the high-accessibility neighbourhoods. When perceived access to destinations increased, people were more likely to walk for higher frequency in the expense of reduction in medium frequency walking.

Figure 6.3 shows the interaction effect between local accessibility and the perceived poor footpath condition. When we convert the findings to predicted

probabilities, it was observed that, in high-accessibility neighbourhoods, poor perceived footpath conditions were associated with less frequent walking. But in low-accessibility neighbourhoods, perceived poor footpath conditions had no influence on low frequency walking, but more negative perceptions were correlated with a shift away from high to medium frequency of walking.

In terms of perceived environment variables, "aesthetics" was associated with walking for leisure/recreation in medium frequency compared to low frequency, but no significant association was found for high frequency walking. The positive coefficient of "aesthetics" indicated that a one-unit increase in perceived aesthetic value increased the odds of walking 3-6 times per week for leisure/recreation by 82.7%. This finding is in line with previous studies which suggest that an interesting and attractive neighbourhood environment is associated with higher frequencies of leisure walking (Ball et al., 2001; Saelens et al., 2012). "Personal safety" was also found to be associated with walking for leisure/recreation in high frequency compared to low frequency only. The positive coefficient indicated respondents were more likely to walk for 7 or more times per week for leisure/recreation when they perceive the built environment to be safe. This finding coincides with previous studies that people tends to walk more when they feel safe in their neighbourhoods (Mason et al., 2013).

The effect of walking attitudes was positive in the model for leisure/recreation, showing that respondents who have more positive walking attitudes were more likely to walk 7 or more times per week. It is found that a one-unit increase in walking attitudes increased the odds of walking for high frequency for leisure/recreation by 50%, but a similar effect was not found for medium frequency (3-6 times per week). In addition, age and length of residency were also significant in the model. Older adults (over 60 years old) were more likely to walk for medium (3-6 times per week) and high frequency (7 or more times per week) for leisure/recreation. For length of residency, respondents who lived in the neighbourhood for 2 to 10 years were more likely to walk 3-6 times per week for leisure/recreation.

6.4.2.3 Walking for household responsibilities

For walking related to household responsibilities (Table 6.5), significant interaction effects were found for "physical infrastructure" (Figure 6.4) and "maintenance and upkeep" (Figure 6.5) with accessibility level of the neighbourhood.

Figure 6.4 Predicted probabilities of household responsibilities walking frequency for low- and high-accessibility neighbourhoods with changes in physical infrastructure (Phy inf.)

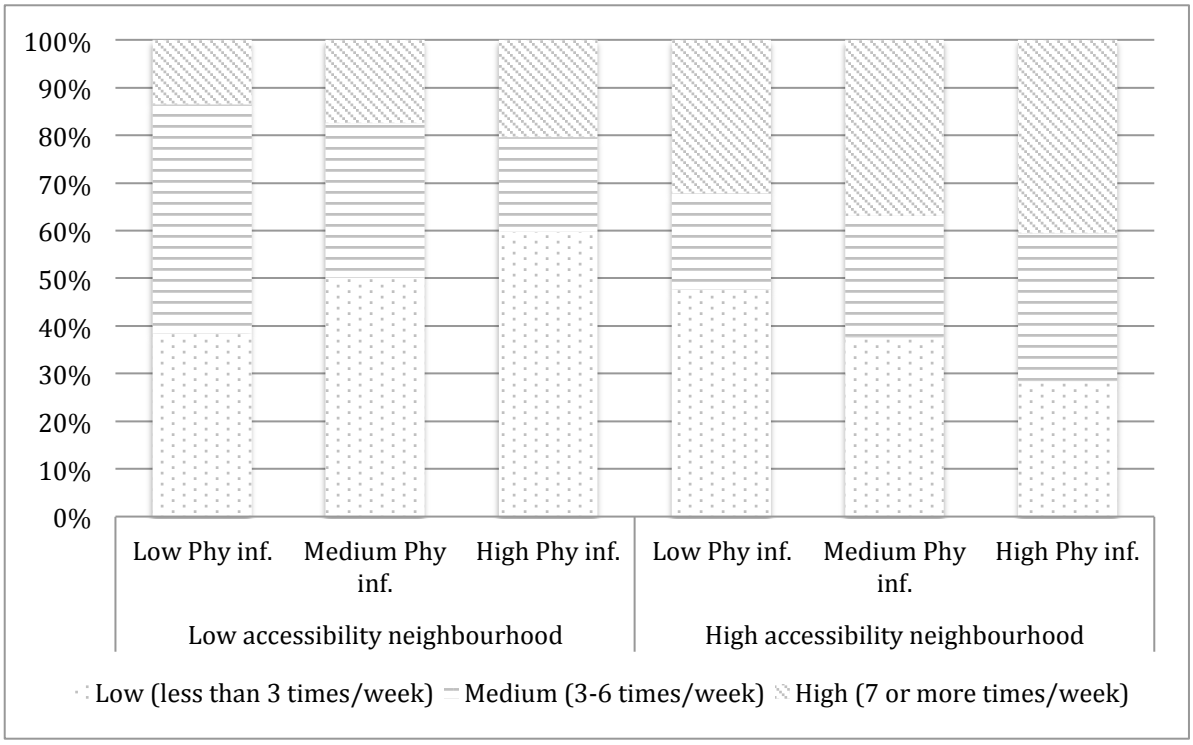


Figure 6.5 Predicted probabilities of household responsibilities walking frequency for low- and high-accessibility neighbourhoods with changes in maintenance and upkeep (M&U)

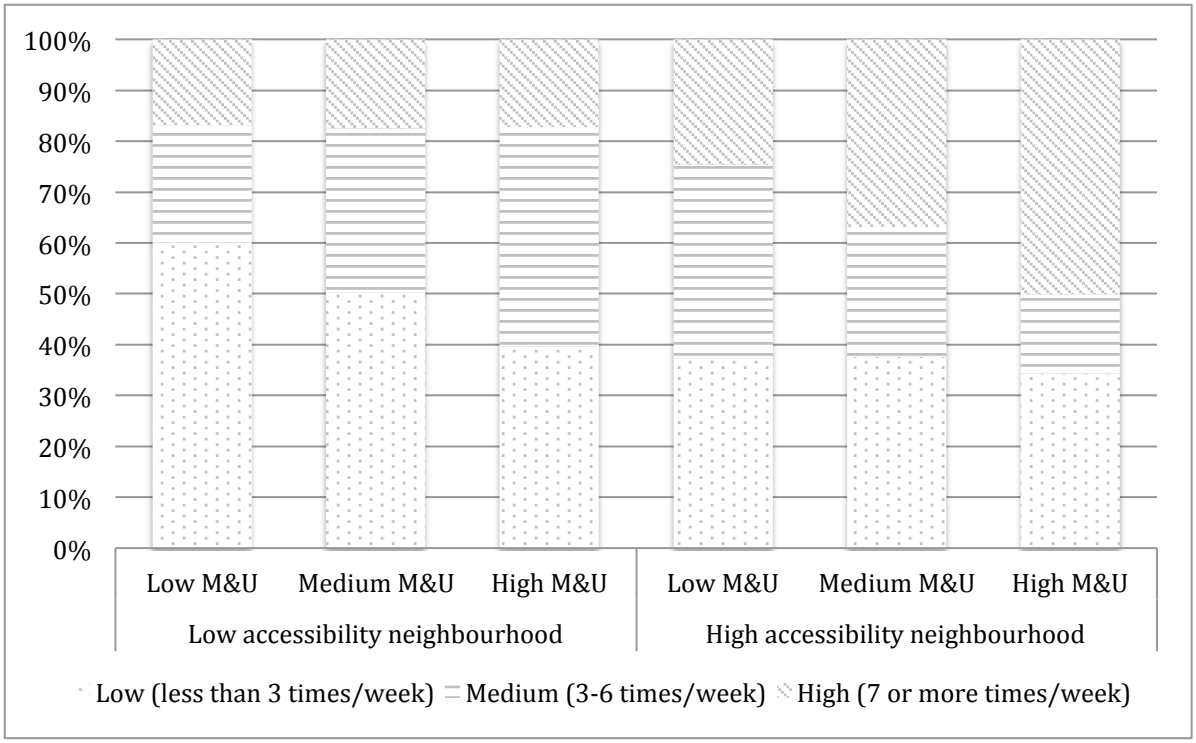


Figure 6.4 shows the interaction effect between local accessibility and perceived physical infrastructure. When we convert the findings to predicted probabilities, it was observed that, those who lived in the low-accessibility neighbourhoods and had positive perceptions on physical infrastructure were less likely to walk 3-6 times per week for household responsibilities. But for respondents who lived in the high-accessibility neighbourhoods, the increase was occurring in the high frequency category only at the expense of the low frequency, suggesting that people were more likely to walk 7 or more times per week when perceived physical infrastructure was high.

As shown in Figure 6.5, when the value of "perceived maintenance and upkeep" increased, people were more likely to walk for household responsibilities for 3-6 times per week in the expense of reduction in low frequency walking in low-accessibility neighbourhoods. But in high-accessibility neighbourhoods, the probabilities to walk for household responsibilities for 7 or more times per week

increased in the expense of reduction in medium frequency walking.

In addition, respondents who live in outer urban neighbourhoods were more likely to walk very often (7 or more times per week) for household responsibilities. Among the socio-demographic variables, respondents in full-time employment were less likely to walk frequently to carry out household related activities. Respondents who had lived in the neighbourhood for more than 2 years (2-5 years and 6-10 years) were more likely to walk at least 3 times per week for household related activities. Age was also significant in the model, middle-aged (31 to 60 years old) respondents were more likely to walk for 3-6 times per week for household responsibilities, and older (over 60) respondents were more likely to walk for 7 or more times per week.

6.5 Discussion and Conclusion

This study examines the associations between the objective neighbourhood characteristics, perceptions of the built environment, walking attitudes and walking frequency for three different activities – work/school, leisure/recreation and household responsibilities – in Shenzhen. The regression analyses demonstrate that the variables associated with walking frequency vary markedly among different types of walking, which is in line with previous studies (Saelens & Handy, 2008; Vale & Pereira, 2016). More perceived environment variables are found to be associated with walking for leisure/recreation than for household responsibilities and work/school. Such differences can be explained by Vilhelmson's (1999) work on time use and mobility. Trips for leisure/recreation – and associated activities – are more flexible in time and space; their location and timing can be altered more easily than is the case with, say, commuting to work/school. The flexibility of these walking trips allows pedestrians to interact with the environment more actively (Edensor, 2000). Built environment features, thus, could pose stronger influence on the trips associated with more flexible activities compared to those with more fixed activities (Cho & Rodríguez, 2015).

Another innovative aspect of this study is that we further explored the

associations by examining the interaction effects between objective neighbourhood characteristics, perceived environment and walking attitudes. Significant interaction effects were found in all three types of walking. The identified interaction effects demonstrate how the objective and subjective dimensions of the built environment influence people's walking behaviour simultaneously. For walking for leisure/recreation, significant interaction effect between low-accessibility neighbourhood and "access to destinations" was found. This suggests that the perceived access to destinations has a stronger facilitating effect on walking frequency among those who lived in neighbourhoods with lower local accessibility. People may have a positive perception, despite a less walkable built environment, and this may result in a positive influence on their walking behaviour, suggesting that positive perceptions of the environment can compensate for the depressing effects of less walkable neighbourhoods on people's walking frequency. This implies that policies that aimed at promoting physical activity could include other measures such as place-making activities (Friedmann, 2010) and educational campaigns for perceptional and behavioural change (Spears, Houston, & Boarnet, 2013), instead of only focusing on improving physical infrastructure. These "soft" measures would also be helpful for shaping people's perceptions and/or attitudes towards the environment and subsequently encouraging walking.

The significance of perceived environment variables was also revealed in different types of walking. However, there were some contradictions showing between our findings and previous research. For instance, different from results from Hong Kong (Cerin et al., 2013) and Shanghai (Zhou et al., 2013) which demonstrated neighbourhood aesthetics were not associated with walking for transport or leisure, we found that perception of aesthetics was associated with leisure/recreation walking. Local residents in Shenzhen were more likely to walk more frequently for leisure or recreation if they considered the environment to be more attractive. This is in line with several studies conducted in Western countries (Ball et al., 2001; Inoue et al., 2010). Possible explanation may be that we examined walking frequency instead of walking time; and also different measurement items were used to represent the aesthetic qualities of the

neighbourhood environment.

The newly developed variables – "maintenance and upkeep" and "poor footpath condition" – were used to measure the perceived upkeep of the pedestrian environment, as well as the temporary barriers on footpaths, such as the presence of commercial activities, crowdedness and parked cars and bicycles on the footpath, which were particularly common in rapidly developing cities in China. Our findings showed that there were significant associations between these two variables and the three types of walking, suggesting that instead of only examining static physical infrastructure, the dynamics and the changing conditions of the walking environment are worth considering in a more rigorous manner in future studies.

This study also highlights the significant associations of walking attitudes and walking for leisure/recreation, which is in line with the wider literature on travel behaviour and attitudes (Kamruzzaman et al., 2016; Vale & Pereira, 2016). However, no significant associations were found between walking attitudes and walking for work/school and household responsibilities, and this warrants attention. Unlike walking for leisure/recreation, most people who walk for work/school conduct walking as part of their trips, and their trips would involve other transport modes. The decision to choose a particular combination of transport modes to work/school may depend more on other factors, such as the quality of public transport services, availability of other transport modes. Similarly, for household-related walking, it is also possible that pedestrians already established a daily routine in terms of when and where to fulfil their household responsibilities. Thus, in this case, other possible factors, such as preferences and habit, may have stronger influences on these two types of walking.

Several directions for future research are recommended here to advance the present discussions. First, existing studies have put much emphasis on the effects of the built environment on walking behaviour. However, more recent studies start to highlight the importance of other psychosocial factors (e.g. habit,

intentions, and preferences) in moderating or mediating such relationships (Kamruzzaman et al., 2016; Ma & Cao, 2017). Future studies could further explore these potentially important factors by developing more advanced strategies for measurement and examining their effects in more details. Second, future studies can include other difficult-to-measure, yet potentially important variables, such as social status. As these variables may help to prevent unobserved variable biases and provide further explanations to some of the unusual results from the analyses. Additionally, given that pedestrians' walking behaviour is embedded within a wider socio-cultural context (Fitt, 2017), more qualitative studies in the future can extend the current discussions by further exploring the ways in which pedestrians perceive their walking environment in different social and cultural contexts. Future studies could also rethink how the built environment can be conceptualised by moving beyond the static measures of the 3Ds (density, diversity and design) (Cervero & Kockelman, 1997), and considering how people actually perceive the built environment, as well as the influence of dynamic condition of the walking environment on people's walking behaviour.

Appendix 6.1 Statements used to measure environmental perceptions and walking attitude

Variables (Cronbach's Alpha)	Statements
	Environmental perceptions
Access to destinations (0.692)	Stores are within easy walking distance of my home There are many places to go within easy walking distance of my home It is easy to walk to a transit stop (bus, train, MTR) from my home Streets in my neighbourhood are hilly, making my neighbourhood difficult to walk in* There are major barriers to walking in my local area that make it hard to get from place to place (for example, freeways, railway lines, rivers)* Parks and plazas are within walking distance
Street network (0.680)	The streets in my neighbourhood do not have many cul-de-sacs (dead-end streets) The distance between intersections in my neighbourhood is usually short There are many alternative routes for getting from place to place in my neighbourhood
Physical Infrastructure (0.693)	Footpaths are separated from the road/traffic in my neighbourhood by railings / bollards My neighbourhood streets are well lit at night There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighbourhood
Aesthetics (0.718)	There are trees along the streets in my neighbourhood There are many interesting things to look at while walking in my neighbourhood There are many attractive natural sights in my neighbourhood (e.g. landscaping, views) There are attractive buildings in my neighbourhood
Traffic safety (0.667)	Most drivers exceed the posted speed limits while driving in my neighbourhood* There are many cyclists riding on footpaths, which makes it unpleasant to walk in my neighbourhood*
Personal safety (0.752)	There is a high crime rate in my neighbourhood* The crime rate in my neighbourhood makes it unsafe to go on walks during the day* The crime rate in my neighbourhood makes it unsafe to go on walks at night*
Poor footpath condition (0.707)	There are many commercial activities (e.g. hawkers, outdoor catering area) on the street that makes it unpleasant to walk in this neighbourhood* There are many construction works taking place that creates obstructions to my walking* I usually feel quite crowded when I walk in this neighbourhood* Cars and bicycles are frequently parked on footpaths that obstruct my walking*
Maintenance and upkeep (0.799)	Most of the footpaths in this neighbourhood are wide enough The surface of footpaths in this neighbourhood is well maintained in general The footpaths are quite clean

	Pedestrians signage is well-kept in this neighbourhood
	Walking attitudes
Walking attitudes (0.767)	I enjoy walking in the neighbourhood where I live
	Walking is not important for me at all*
	In general, my walking experience in the neighbourhood where I live is positive
	I walk because it is good to my health
	I walk because it is good to the environment
	I walk because it involves no monetary costs
	Walking in the neighbourhood where I live is a habit

Notes: * negatively scored items

7 Chapter Seven - Rethinking walkability relationally: A multiple-scenario approach for walkability assessment

Abstract

Walkability represents the quality of the walking environment and is usually measured with one or more composite indicators. Existing studies have assumed a single walkability index can be applied in many different contexts and situations. This traditional concept of walkability overlooks the fact that what constitutes a walkable environment may vary considerably between pedestrians who have different needs and purposes. Their understandings and experiences of walkability may be mediated by the places in which they have lived in the past or currently reside. In this paper we argue that walkability needs to be understood in a more relational way as emerging from current and past interactions between pedestrians and the environments in which they dwell, walk and use different means of transport. Based on this relational understanding, we propose a multiple-scenario approach for walkability assessment, which recognises that in valuation, walkability qualities may not always compensate each other. The analysis accommodates the idea that some aspects may be so important to certain people or situations that they act as hard and non-negotiable constraints on valuation. Other aspects are negotiable and lower scores can be compensated by, and traded against, higher scores on other factors. The procedures for conducting this multiple-scenario approach are presented and empirically tested with data from selected neighbourhoods in Shenzhen, China. The results demonstrate that the proposed approach offers a way to account for different situations of assessing walkability, and that walkability can be reconceptualised from a single entity into a more flexible, dynamic, and context-specific process.

Keywords: neighbourhood walkability; multiple-scenario approach; street-level; built environment; heterogeneity; Shenzhen

7.1 Introduction

The accumulating evidence on the benefits of walking for physical and psychological health has attracted much interests from policymakers in creating more "walkable" environment (City of Melbourne, 2014; Transport for London, 2018). In line with this trend, many studies have been devoted to using different methods to assess walkability, including geographic information systems, environmental audits, and questionnaire surveys (Cerin et al., 2011; Cole et al., 2015; Koohsari et al., 2016; Pikora et al., 2002). However, most of these studies have seen walkability as a universal quality and assumed that a single walkability index can be applied in many different locations, contexts and situations (Frank et al., 2010; Lefebvre-Ropars et al., 2017; Nickelson, Wang, Mitchell, Hendricks, & Paschal, 2013; Zuniga-Teran et al., 2019). Such practice implicitly assumes that all pedestrians perceive and respond to the walking environment in a similar way. Nonetheless, this mode of thinking overlooks the fact that the meaning of a walkable environment may vary considerably between different groups of people who have their own specific needs, purposes and preferences.

Moreover, individuals' experiences of walkability may be mediated by the places in which they have lived in the past or currently reside, as previous experience and preferences may shape how pedestrians portray specific features of the built environment and their associations with the understanding of walkability. As a result, in this paper we argue that walkability needs to be understood in a more relational way. Rather than seeing walkability as a single quality that unifies the environmental features, we argue that walkability should be reconceptualised as a relational quality that emerges from the current and past interactions between pedestrians and the environments in which they dwell, walk and use different means of transport. Unlike other studies that try to capture walkability with a single index, we develop a set of walkability scenarios to assess walkability for different pedestrian groups or situations. This is achieved through the application of the principle of non-compensatory decision rules to create multiple walkability scenarios. This analysis takes into account that for some pedestrians or in certain situations, certain environmental qualities must be

present for a segment of a street or footpath to be considered walkable; its absence, or a low level of quality, cannot be compensated by the presence of other qualities. The five scenarios presented in this study can be regarded as a starting point to widen our understanding of walkability with a more flexible and relational perspective.

The literature on walkability assessment has been dominated by studies in the global North. Recently, studies from cities in less developed countries are growing but are still relatively scarce (Albers, Wright, & Olwoch, 2010; Su et al., 2014; Sun, Webster, & Chiaradia, 2017). Given that the population density, urban structure and walking environment are hugely different between cities in the developed and developing countries (Alfonzo, Guo, Lin, & Day, 2014), studies that are focused specifically on understanding walkability in the developing world are essential. Although Shenzhen has been recognised as one of the most walkable cities in China (NRDC, 2014), it is also experiencing rapid urban expansion and growth in automobile ownership. The daily average number of walking trips made by Shenzhen citizen has been decreasing as indicated in the most recent travel characteristics survey (Shenzhen Urban Planning and Research Centre, 2017). In view of this situation, improving the understanding and assessment of walkability in this rapidly changing urban environment are urgently needed.

The aim of this paper is to present a multiple-scenario approach in walkability assessment and empirically apply this approach in selected neighbourhoods of Shenzhen. The approach allows us to reconceptualise walkability as a relational construct where the saliency of specific attributes may differ according to population groups and/or situation.

7.2 Literature Review

7.2.1 Walkability and relational thinking

Drawing on the framework developed by Ewing and Cervero (2010), a large number of studies to date have developed various tools and/or indices to

measure the walkability of the built environment based on the concept of 5Ds (density, diversity, design, destination accessibility and distance to transit). These studies can be broadly classified into two major groups based on their respective focuses.

The first strand of studies uses GIS data to capture the 5D variables and develops quantitative indices to assess walkability (Cole et al., 2015; Frank et al., 2010; Glazier et al., 2012; Leslie et al., 2005; Neckerman et al., 2009; Tsiompras & Photis, 2017). These studies have provided a novel and direct way to quantify the walkability of the built environment. Nonetheless, walkability in these studies was assessed at a larger geographical scale, such as census tracts (Frank et al., 2010; Owen et al., 2007) and other administrative spatial units (Cho & Rodríguez, 2015). As a result, the components used to construct these indices focus more on capturing the density and diversity of land uses, such as residential or population density, land use mix, intersection density, retail floor area ratio, distance to nearest subway stops/parks/retail areas (Cho, & Rodríguez, 2015; Cole et al., 2015; Glazier et al., 2012). Less attention has been placed on quantifying the smaller scale streetscape features along the footpaths[31].

Giving that walking is a much slower activity and pedestrians have more direct interaction with the surrounding environment (Clifton, Smith, & Rodriguez, 2007), micro-scale features might be more effective than district or regional scale land use variables in capturing walkability. The other strand of studies has sought to assess walkability at a more localised scale, emphasising the importance of street-level attributes and design features such as footpath width, pavement flatness, presence of trees and various amenities, etc. in representing walkability. These studies develop numerous environmental audit tools in developed countries (Clifton et al., 2007; Day, Boarnet, Alfonzo, & Forsyth, 2006; Millstein et al., 2013; Pikora et al., 2002) and developing countries (Albers, Wright, & Olwoch, 2010; Su et al., 2014); for walking routes with specific

[31] In this study, the term "footpath" is used to represent all types of walkways used by pedestrians, including walkways along the sides of a road and pedestrian only paths. The term "footpath" is used interchangeably with similar terms, like "sidewalk" and "pavement".

purposes (Sun, Webster, & Chiaradia, 2017; Troped et al., 2006); and in different settings, like rural areas (Fisher, Richardson, & Hosler, 2010; Scanlin, Haardoerfer, Kegler, & Glanz, 2014) and the workplace (Dannenberg, Cramer, & Gibson, 2005). In general, these audit tools paid more attention to the objectively measurable physical features and developed numerous items to measure them. Nonetheless, the subjective features, such as comfort, attractiveness, smells and sound, which have been identified to have significant influence on walking experience in other studies have largely been overlooked (Cook, Bose, & Main, 2014; Ferrer, Ruiz, & Mars, 2015). The major environmental audit tools reviewed are shown in Table 7.1 below.

Table 7.1 Major environmental audit tools reviewed

Name of tool	Study area	Author(s)	Objective of tool	Specifications of tool	Comment
Systematic Pedestrian and Cycling Environmental Scan (SPACES)	Perth, Australia	Pikora et al. (2002)	To measure the physical environmental factors that may influence walking and cycling in local neighbourhoods	71 items in four dimensions (functional, safety, aesthetics, destinations)	Not only use audit data, but also GIS and desktop method
Walking Suitability Assessment Form (WSAF)	North Carolina, USA	Emery, Crump, & Bors (2003)	To assess the suitability of sidewalks for walking and roads for cycling.	10 items for walkability, 27 items for bikability	Focus more on bikability, few items on amenities and destinations
Path Environment Audit Tool (PEAT)	Massachusetts, USA	Troped et al. (2006)	To develop a reliable measures of trail characteristics	40 items in three dimensions (design features, amenities, maintenance /aesthetics)	Focus on trails in parks and outdoor recreation areas, more design and maintenance items
Pedestrian Environmental Data Scan (PEDS)	University of Maryland, College Park, USA	Clifton, Smith, & Rodriguez(2007)	To develop a tool to capture a range of elements of the built and natural environment efficiently and reliably	40 questions and 83 measures in five groups (subjective assessment, environment, pedestrian facility, road attributes, walking/cycling environment)	Few items on land use and destinations Include subjective assessment items
Active Neighbourhood Checklist (ANC)	St. Louis, USA	Hoehner, Ivy, Ramirez, Handy, & Brownson (2007)	To assess major street-level features of the neighbourhood environment that are related to physical activity behaviour	40 items in five major areas (land use, public transit stops, street characteristics, quality of the environment for a pedestrian, and places to walk and bicycle)	Few items concerning safety and aesthetics

Table 7.1 Major environmental audit tools reviewed (con't)

Environment in Asia Scan Tool (EAST-HK)	Hong Kong	Cerin et al. (2011)	To objectively measure aspects of the neighbourhood environment assumed to affect walking in Hong Kong and other ultra-dense Asian cities	91 items in four dimensions (functionality, safety, aesthetics, destinations)	Extensive selection of items on destinations tailored for local context
Microscale Audit of Pedestrian Streetscapes (MAPS)	San Diego, Seattle, and the Baltimore metropolitan areas, USA	Millstein et al. (2013)	To develop a tool and create summary scores that can be used to assess detailed attributes of the built environment relevant to physical activity	160 items in four sections (overall route, street segments, crossings, and cul-de-sacs)	Extensive selection of items and structured scoring system in creating summary scores
China Urban Built Environment Scan Tool (CUBEST)	Hangzhou, China	Su et al. (2014)	To design an assessment tool of urban built environment related to adult physical activity in China	41 items in six dimensions (residential density, street connectivity, accessibility, sidewalk quality, bike lane quality, aesthetics)	More focus on bikability, and accessibility to various destinations, few items on amenities and subjective assessment
Irvine–Minnesota Inventory-China (IMI-C)	Shanghai & Hangzhou, China	Alfonzo et al. (2014)	To objectively measure "micro-scale" built environment features that may be tied to walking and bicycling	286 items in 11 dimensions (density, proximity, connectivity, form, parks and public space, pedestrian infrastructure, bike infrastructure, personal safety, traffic safety, aesthetics, recreational facilities)	Extensive selection of items, but the detailed measurement items used in IMI-C is not available
China Urban Rail Walking Access Scan Tool (CURWAST)	Nanchang, China	Sun, Webster, & Chiaradia (2017)	To measure the walking environments of access routes to urban rail transit	67 items in seven dimensions (building density, land use diversity, elements on sidewalk, design, road beside sidewalk, transferability, subjective assessment)	Target specifically on access routes to rail transit, few items on footpath condition and maintenance

Despite the substantial number of studies conducted on walkability and considerable efforts to assess walkability, the "relational turn" in human geography and the social sciences offers a new perspective to explore the fluidity of places and spaces as well as our understanding of walkability (Ettema & Schwanen, 2012; Hui & Walker, 2018; Jones, 2009). Scholars have sought to bring attention to the relational capabilities of human body, and its encounters and interactions with multiple environmental features, other bodies and objects in places (Andrews, Hall, Evans, & Colls, 2012; Duff, 2010; Schwanen, Banister, & Bowling, 2012). In this view, walkability can be reconceptualised in a more relational way in which we take the specific needs, capacities and preferences of pedestrians into consideration and a greater concern over the pedestrians' current and past interactions with their environment in which they dwell, walk and travel. Taking the variability of pedestrians' needs, capacities and preferences into consideration, the concept of walkability can move from a previous "absolute" view towards different "relational" conditions (Ingold & Vergunst, 2008; Jones, 2009; Stevenson & Farrell, 2018).

Recognising that walkability can be reconceptualised in a more relational way by considering the differentiated needs, capacities and preferences of pedestrians and their interactions with the environment, the next issue that we need to account for is how to incorporate such ideas in practical walkability assessment. This leads us to rethink the assumptions about the extent to which different qualities can compensate for each other in existing walkability assessment studies.

7.2.2 Decision rules in walkability assessment

In calculating the walkability index, many studies have assumed a fully compensatory structure among the major qualities and attributes concerned in walkability assessment, implying that a low score on one dimension can be compensated by a high score on another. For instance, in the widely applied walkability index (Frank et al., 2010; Leslie et al., 2005), the additive rule is applied to sum the z-scores of all walkability qualities together. In other studies,

researchers assign certain weightings to each walkability quality based on results from questionnaire surveys or factor analysis and summarise the scores of each quality (Glazier et al., 2012; Tsiompras & Photis, 2017). However, the use of weightings only considers the relative importance of different walkability qualities. It does not account for the fact that certain factors have determining effects on walking behaviour, especially for specific population groups (e.g. older adults, women and people with disabilities) (Ferrer et al., 2015; Golan, Wilkinson, Henderson, & Weverka, 2019; Gullón et al., 2015). These factors could be regarded as hard constraints for some pedestrians (these criteria need to be satisfied for the pedestrians to choose this option). In this case, assuming a fully compensatory structure among the walkability qualities might oversimplify the complex situation and unable to reflect the true walkability for certain pedestrians.

As individuals make their daily decisions based on various decision rules and heuristics, we draw on insights from the behavioural sciences in order to better consider the relationships between various qualities of walkability in constructing a walkability index. Behavioural scientists have identified numerous decision strategies to further our understanding of the complexity of people's evaluation and decision-making proceses. These decision rules include lexicographic rules (Tversky, 1969), elimination-by-aspects (EBA) (Tversky, 1972), and conjunctive / disjunctive rules (Einhorn, 1970). A key distinguishing factor among these decision rules is the extent to which trade-offs can be made between the attributes within the model. A rule is considered compensatory if the decision maker can trade a low value on one dimension against a high value on another dimension; it is non-compensatory if deficiencies in one dimension cannot be compensated by surpluses in another dimension (Payne, 1976).

In view of these concerns, it is necessary to reconsider the reliance on compensatory mechanisms in existing walkability assessment studies and to include the non-compensatory mechanism to consider the irreplaceable nature of certain qualities in walkability assessment. In this case, we propose to use a combination of multiplicative and additive functions to create multiple scenarios

of walkability indices for walkability assessment.

7.3 Research procedures

This section introduces the procedures for conducting the multiple-scenario and relational walkability assessment, which consists of four major parts, namely: tool development, data collection, data preparation, and scenario construction. Figure 7.1 shows the major steps involved in this approach.

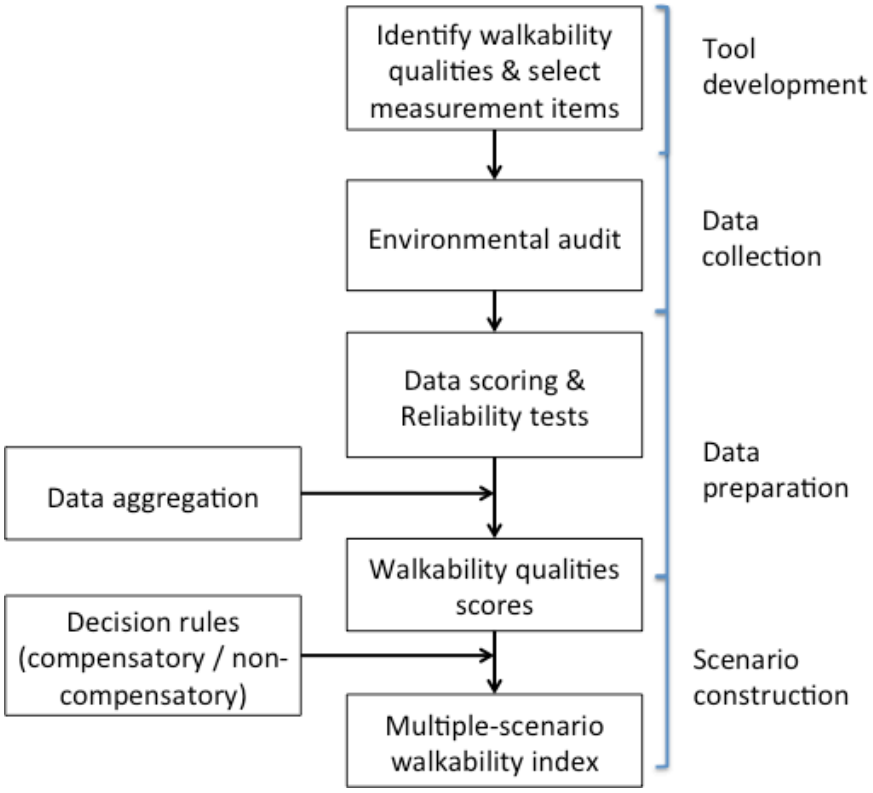


Figure 7.1 Procedures in conducting multiple-scenario walkability analysis

The first stage has been to identify the major qualities of walkability and select appropriate measurement items to be included in the environmental audit tool. This was done by using a combination of methods, including literature review, semi-structured interviews, and the researcher's own experience of the local environment. After that, an environmental audit was conducted in randomly selected samples of footpaths within the selected neighbourhoods, to collect data on walkability. The next stage was data preparation. Inter-rater and intra-rater reliability tests were performed to ensure the quality of the measurement items included for further analysis. Through a series of aggregation and scoring

procedures, the data was transformed into scores to represent specific qualities of walkability. The final stage was the walkability scenario construction, where various combinations of compensatory and non-compensatory decision rules were applied to create different walkability scenarios for assessment.

7.4 Empirical application

The proposed multiple scenario walkability approach can provide a diversified and context-sensitive understanding of walkability by considering the different needs and preferences of pedestrians. The empirical application of this approach to the case of Shenzhen is discussed below.

7.4.1 The case of Shenzhen

As one of China's largest metropolitan cities, Shenzhen is experiencing rapid urban transformation and sprawl. Urban development has created neighbourhoods with diverse and distinctive characteristics, for instance, with varied road and pedestrian network structures, different block sizes and land use mix. This distinctive neighbourhood environment may influence people's walking behaviour. For instance, a recent report noted that residents living in the outer urban neighbourhoods in Shenzhen conduct more walking trips than those living in inner urban neighbourhoods (Shenzhen Urban Planning and Research Centre, 2017). In order to capture the variability of Shenzhen's neighbourhood environments and its associations with walkability, we purposefully selected four neighbourhoods for analysis, including Xinzhou (Inner urban - High accessibility, IH), Xinsha (Inner urban - Low accessibility, IL), Shangjing (Outer urban - High accessibility, OH) and Huilongpu (Outer urban - Low accessibility, OL).

7.4.2 Development of environmental audit tool

This process has involved two steps: 1) identifying major walkability qualities and 2) selecting measurement items. Major walkability qualities were selected based on a summary of existing literature to identify major factors that were

used to capture key features of walkability. In total, six qualities were identified: Land use and destinations (LAND), Safety (SAFE), Aesthetics (AEST), Amenities (AMEN), Footpath design and condition (PATH), and Subjective assessment and experience (SUBJ). Next, three methods were used in combination to select the measurement items: First, a comprehensive review of the walkability assessment literature was performed to identify the measurement items used in existing studies. Second, semi-structured interviews were conducted with local residents in Shenzhen to understand their views on the built environment features that are important in determining their walkability. Third, the lead author conducted a three-month fieldwork in the selected neighbourhoods to familiarise himself with the local context and immerse himself into the local walking environment (Phillips & Johns, 2012). This fieldwork has not only provided important localised insights in developing and modifying the measurement items, but also offered a valuable opportunity for the lead author to observe, sense and experience the walking environment in the study areas. As such, we further selected and modified measurement items according to walking environment in the Chinese context. For instance, we added novel items such as the volume of sound, air quality, and presence of a police stand to reflect particular characteristics of the local walking environment. This selection process was iterative and was conducted in parallel with the fieldwork until the finalisation of the walkability qualities and measurement items. The environmental audit consists of 87 measurement items, as shown in Table 7.2 below (A brief review of the measurement items used in existing studies is included in Appendix 7.1).

Table 7.2 Major qualities (in bold), sub-qualities (in italics) and measurement items used in this study

Land use and destinations (LAND)	**Aesthetics (AEST)**	**Footpath design and condition (PATH)**
Residential land use [a]	*Surrounding environment*	*Footpath design*
Destinations	Streetscape features [k]	Steepness
Food related [b]	Tree coverage	Width
Commercial / Retail [c]	*Views*	Protection from weather
Leisure related [d]	Sightlines	*Footpath condition*
Office / Institutional [e]	Horizontal sightlines	Trip hazards

Transport related [f]	Proportion of sky	Physical obstructions [o] Temporary obstructions [p]

Safety (SAFE)	**Amenities (AMEN)**	**Subjective assessment and experience (SUBJ)**
Traffic safety	*Pedestrian amenities*	*Subjective assessment*
Roads beside footpath	Street lights	Sufficient illumination
1 or 2-way street	Amenities [l]	Feel safe
Ingress on segment	*Amenities for special needs*	Feel stressful
Parking spaces on footpath	Tactile paving	Feel attractive
Presence of buffers [g]	Problems with paving [m]	*Sensory experience*
Presence of other users [h]	Way-finding aids [n]	Any unpleasant smell
Personal safety		Any unpleasant sound
Physical disorder [i]		Volume of sound
Social disorder [j]		Observable air pollution
Police office/stand		$PM_{2.5}$
Police officer		PM_{10}

Notes:
[a]: detached or semi-detached houses (1-3 stories); residential buildings 4-6 stories; 7-13 stories; 14-20 stories; over 20 stories
[b]: Food: supermarket/fresh food market; restaurant; 24hr convenient store
[c]: Commercial/Retail: shopping mall; bank; hotel; other retail shops
[d]: Leisure: plaza; playground/park; sports ground/ball court
[e]: Office/Institutional: government buildings; office buildings
[f]: Transport: car park; bus stop
[g]: railings; bollards; trees; planters
[h]: cyclists; electric scooter/bike users; motorcycles; mini-trucks
[i]: graffiti/flyer; abandoned building/land; noticeable litter/dog faeces
[j]: street fouling; idlers/gambling on street
[k]: sculpture; fountain; landscape garden; bodies of water; greenery
[l]: trash bins; benches/sitting spaces; bicycle rack; public toilets
[m]: paving worn out; paving misalignment; inappropriate design; blockage on paving
[n]: public transport map; neighbourhood map; local destination sign; metro station sign
[o]: rubbish collection point; electric switch box; stores/kiosks; stairs/steps
[p]: parked cars/bikes; street vendor; eating/catering area; other commercial activities; construction waste

7.4.3 Conducting the environmental audit

An environmental audit was conducted with the approach developed in the previous section and a stratified random sample of footpaths in each selected neighbourhood was examined. Four professional surveyors were recruited to conduct the environmental audit. All of the surveyors had to participate both in-class and on-site training by the lead author before performing the audit. First, a two-hour in-class training included the introduction of the aim, procedures,

and standard of the assessment. Detailed descriptions and photos of the environmental features to be assessed were provided to allow the surveyors to identify and familiarise themselves with the environmental features of the local environment. After that, an on-site training section was provided to allow the surveyors to conduct a pilot assessment. Their performances were monitored before the actual audit was conducted. The environmental audit tool is included in Appendix 7.2.

Footpaths in this study were defined by roads, streets or pedestrian paths bounded by two consecutive junctions or cross streets. Footpaths were categorised into three types: major footpaths (footpaths alongside major roads), minor footpaths (footpaths alongside non-major roads), and other passageways (other informal footpaths and small alleys). This study pays particular attention to identifying informal paths and alleys that have typically been excluded from consideration in most existing studies, because the lead author's fieldwork has demonstrated that these paths were often used by pedestrians. Major and minor footpaths were categorised using the road hierarchy published by Shenzhen Planning and Natural Resources Bureau, while other passageways were identified during the lead author's fieldwork. If the footpaths were longer than 200m, they were subdivided into separate segments to ensure consistency in segment length and allow for better comparison across footpaths. Although previous studies had shown that auditing 25% of randomly selected footpaths within a neighbourhood could provide sufficiently reliable estimation of walkability (McMillan, Cubbin, Parmenter, Medina, & Lee, 2010), we randomly selected 50% of major footpaths and 30% of minor footpaths and other passageways in each neighbourhood for our audit to err on the side of caution. In total, 406 footpath segments were assessed, including 132 segments of repeated measures for the reliability tests.

7.4.4 Data preparation

Scoring of data collected from environmental audit

Dichotomous items (no/yes) were scored as 0/1 to indicate the presence of

certain attributes. Measurement items with multiple categories were scored as 0, 1, 2 (or more) to capture frequency or magnitude of environmental features. Continuous items were categorised into separate groups based on relevant standards. For example, $PM_{2.5}$ was categorised into 3 groups: <36μg/m^3, 36-75μg/m^3 and >75μg/m^3, based on national standards[32]. For ease of interpretation, all items were scored so that higher value indicates better walkability.

Reliability tests

To ensure the reliability of the measurement items, both intra-rater and inter-rater tests were conducted (as shown in Table 7.3 and 7.4). Intra-rater reliability was assessed by comparing the surveyor's repeated assessments of the same segment, and inter-rater reliability was evaluated by comparing the results of paired surveyors for the same segment. Cohen's kappa (k) and the intraclass correlation coefficient (ICC) were calculated for categorical and continuous variables respectively. We also computed the percentage agreements to consider the reliability of those items that exhibit little variation (Day et al., 2006). For measurement items with fewer than 3 observations, kappa and ICCs were not computed, but instead percentage agreement was presented with the caution that agreement due to chance may be high.

[32] Ambient air quality standards (GB3095-2012) published by Ministry of Ecology and Environment of the People's Republic of China

Table 7.3 Overview of intra-rater reliability results by walkability qualities

Walkability Qualities	No. of items	Kappa / ICC [a]				Percentage Agreement [b]			
		Substantial - Perfect	Moderate	Fair - Poor	Items with insufficient variability	High	Moderate	Low	Items with insufficient variability
Land use and destinations	19	15	0	0	4	16	0	0	3
Safety	22	13	3	5	1	15	3	3	1
Aesthetics	9	7	0	0	2	4	3	0	2
Amenities	14	8	1	1	4	12	0	0	2
Footpath design and condition	13	9	3	1	0	11	2	0	0
Subjective assessment and experience	10	0	5	5	0	2	6	2	0
Total (percentage)	87	52 (59.77%)	12 (13.79%)	12 (13.79%)	11 (12.64%)	60 (68.97%)	14 (16.09%)	5 (5.75%)	8 (9.20%)

[a]: Substantial - Perfect: >0.6; Moderate: = 0.4 – 0.6; Poor - Fair: <0.4.
[b]: High: ≥ 75%; Moderate: 60 – 74%; Low: <60%

Table 7.4 Overview of inter-rater reliability results by walkability qualities

Walkability Qualities	No. of items	Kappa / ICC [a]				Percentage Agreement [b]			
		Substantial - Perfect	Moderate	Fair - Poor	Insufficient variability	High	Moderate	Low	Insufficient variability
Land use and destinations	19	12	0	0	7	17	0	0	2
Safety	22	20	1	0	1	20	1	0	1
Aesthetics	9	5	1	0	3	5	2	1	1
Amenities	14	9	1	0	4	12	0	0	2
Footpath design and condition	13	10	1	0	2	13	0	0	0
Subjective assessment and experience	10	4	5	1	0	6	4	0	0
Total (percentage)	87	60 (68.97%)	9 (10.34%)	1 (1.15%)	17 (19.54%)	60 (68.97%)	9 (10.34%)	1 (1.15%)	17 (19.54%)

[a]: Substantial - Perfect: >0.6; Moderate: = 0.4 – 0.6; Poor - Fair: <0.4.
[b]: High: ≥ 75%; Moderate: 60 – 74%; Low: <60%

We found that items in "Subjective assessment and experience" presented lower reliability compared to other walkability qualities for both intra-rater and inter-rater reliability tests, and this result is consistent with previous studies (Sun et al., 2017; Pikora et al., 2002). Nonetheless, moderate to high level of percentage agreement was observed from these items. Considering the results from reliability tests, 16 items with low kappa/ICCs or without sufficient variability were removed, and 71 items were retained for final analysis.

Data aggregation

Multiple levels of aggregation were performed to combine the scores of the measurement items into 11 sub-qualities and then they were further aggregated into six major qualities to represent walkability. As the measurement items have different scales of measurement, they were normalised using the following formula to bring the values into the (0, 1) range:

$$X' = \left(\frac{X - X_{min}}{X_{max} - X_{min}}\right)$$

X is the selected variable; X' is the normalised value of the variable; X_{max} and X_{min} are the maximum and minimum values respectively. All items under each sub-quality were then averaged to obtain the sub-quality score. After that, all sub-quality scores were averaged and rescaled into values between 0 to 10, to form the quality scores (The distribution of walkability quality scores are summarised in Appendix 7.3).

7.4.5 Construction of walkability scenarios

This section presents the five walkability scenarios derived from the use of different decision rules. The first two scenarios present the two extremes of the spectrum (completely compensatory and non-compensatory), the other three scenarios are partial non-compensatory (with certain walkability qualities considered non-compensatory), and these scenarios try to measure walkability for specific population groups and/or in specific situations more realistically.

However, the walkability scenarios presented here are by no means comprehensive. Different scenarios based on other method of combination could be developed in the future.

Scenario 1 – Completely compensatory

This scenario presents the most traditional and widely adopted method in calculating walkability index in existing studies, by assuming that all walkability qualities can be compensated by one another. The walkability index is computed by adding the scores of six qualities together. This method is common as it is easiest to compute and able to provide a general picture of the data. The walkability index can be calculated by using the following formula:

$$WS_1 = LAND + SAFE + AEST + AMEN + SUBJ + PATH$$

Scenario 2 – Completely non-compensatory

In this scenario, we assume that none of the six walkability qualities can be compensated by the others. Thus, the scores of six walkability qualities were multiplied to get the walkability index. For example, a footpath with a lower score in aesthetics cannot be compensated by a higher score in another quality, e.g. safety. Hence, a lower score in any one of the qualities will significantly lower the overall walkability using this completely non-compensatory method of calculation. The walkability index can be calculated by using the following formula:

$$WS_2 = LAND \times SAFE \times AEST \times AMEN \times SUBJ \times PATH$$

Scenario 3 – Preference for short distances and safety

This scenario represents the circumstances in which the scores on the two qualities of land use and destinations, and safety are considered to be hard and non-compensatory criteria in assessment of walkability. This scenario assumes that pedestrians need or have a strong imperative to walk for short distances (e.g. because of poor physical condition or time constraints) and consider a safe walking environment as necessary. In this instance, having destinations in close proximity and being able to access them via safe routes are both essential. Other qualities are considered compensable by each other in this scenario. The

walkability index can be calculated by using the following formula:

$$WS_3 = LAND \times SAFE \times (AEST + AMEN + SUBJ + PATH)$$

Scenario 4 – Emphasis on footpath quality

This scenario highlights the non-compensatory nature of the qualities of footpath design and condition, and amenities in computing the walkability index. This scenario assumes that the features and conditions of footpath are essential criteria for making walking attractive to certain people. The other four qualities can be compensated by each other in this scenario. The walkability index can be calculated by using the following formula:

$$WS_4 = AMEN \times PATH \times (LAND + AEST + SAFE + SUBJ)$$

Scenario 5 – Emphasis on sensory experience

This scenario assumes that aesthetics and subjective experience as non-compensatory, indicating the circumstances in which sensory experience (e.g. pleasure and comfort) such as those depending on various stimuli from the environment (e.g. lights, sounds, smells) are critical constituents of walkability (Mehta, 2008). The other four qualities are regarded as compensatory in this scenario. The walkability index can be calculated by using the following formula:

$$WS_5 = AEST \times SUBJ \times (LAND + AMEN + SAFE + PATH)$$

7.5 Results

This results section consists of two parts. The first sub-section presents the descriptive statistics and one-way ANOVA to compare the overall walkability among neighbourhoods for the five walkability scenarios; the next sub-section further compares the changes in walkability for footpaths when assessed using different scenarios and highlights the applicability of each walkability scenario in different situations and conditions.

7.5.1 Descriptive statistics

The descriptive statistics of the walkability scenarios are presented in Table 7.5 below. First, the use of the traditional compensatory approach (WS_1) for

walkability assessment results in a higher mean walkability compared to other scenarios. In contrast, Scenario 2 (WS_2) results in the lowest mean walkability. Next, a comparison of footpath types indicates that major footpaths are the most walkable (highest mean walkability), followed by minor footpaths and other passageways across all five scenarios. But the differences between the footpath types vary across the scenarios. For instance, the mean walkability for major footpaths is about six times higher than for other passageways in WS_2, which is much higher than in the other scenarios (ranging from 1.78 to 3.39).

Table 7.6 compares the mean walkability of the four neighbourhoods using one-way ANOVA. No statistically significant differences can be found for WS_1 ($F=2.459$, $p=.063$) and WS_3 ($F=1.286$, $p=.280$), but statistically significant differences at $p<0.05$ can be observed in the other scenarios (WS_2, WS_4 and WS_5) using fully or partially non-compensatory methods. The outer urban - low accessibility neighbourhood is, on average, the most walkable and the inner urban - high accessibility neighbourhood is the least walkable in all scenarios except for WS_3. In WS_3, the outer urban - high accessibility neighbourhood ranked second, followed by the inner urban - low accessibility neighbourhood. This is due to the higher scores for the walkability quality "land use and destinations" in the outer urban - high accessibility neighbourhood. The post-hoc tests demonstrated that the differences in walkability among neighbourhoods vary in each scenario, showing that these walkability scenarios capture different aspects of walkability.

Table 7.5 Descriptive statistics of five walkability scenarios

	WS_1	**WS_2**	**WS_3**	**WS_4**	**WS_5**
Median	.488	.034	.215	.228	.186
Mean	.480	.114	.271	.259	.246
(by footpath types)					
Major footpaths	.570	.162	.322	.356	.304
Minor footpaths	.491	.125	.296	.254	.263
Other passageways	.321	.026	.162	.105	.134
Skewness	.126	2.336	1.123	.664	1.191
Percentiles					
25	.289	.001	.088	.058	.079

50	.488	.034	.215	.228	.186
75	.641	.125	.385	.430	.346

Table 7.6 Compare the mean walkability indices (and rankings) of the five scenarios by neighbourhoods

	WS_1	**WS_2**	**WS_3**	**WS_4**	**WS_5**
Inner-High (IH)	.438 (4)	.074 (4)	.257 (4)	.202 (4)	.192 (4)
Inner-Low (IL)	.512 (2)	.117 (2)	.258 (3)	.296 (2)	.286 (2)
Outer-High (OH)	.483 (3)	.116 (3)	.265 (2)	.268 (3)	.260 (3)
Outer-Low (OL)	.538 (1)	.216 (1)	.335 (1)	.346 (1)	.310 (1)
Test stat.	2.459	6.076	1.286	5.063	4.946
p value	.063	.001	.280	.002	.002
Sig. differences	IH-IL, IH-OL	IH-OL, IL-OL, OH-OL	-	IH-IL, IH-OL	IH-IL, IH-OH, IH-OL

7.5.2 Comparing relative walkability of footpaths

This section further compares the changes in walkability for footpaths in each scenario with reference to Scenario 1 (WS_1). We first ranked all of the footpaths into ten equal groups based on their walkability scores ranging from 1 (least walkable) to 10 (most walkable) for each scenario. The walkability of footpaths in decile groups for Scenarios 2 to 5 (WS_2 to WS_5) were then compared with the reference scenario (WS_1) respectively by using a number of tables (similar to that presented in Figure 7.2). If the walkability indices of footpaths are similar between the reference scenario (WS_1) and other scenarios (WS_2 to WS_5), most of the footpaths will be concentrated along the diagonal line. Otherwise, more scattered patterns will be observed. In this way, we can examine the changes in relative walkability of footpaths during different scenarios.

		Decile group of WS5										
		1	2	3	4	5	6	7	8	9	10	No. of observations
Decile group of WS1	1	20	6	1	0	0	0	0	0	0	0	
	2	6	14	6	1	0	0	0	0	0	0	
	3	1	4	12	8	3	0	0	0	0	0	
	4	0	4	5	8	7	3	0	0	0	0	
	5	0	0	1	7	8	8	4	0	0	0	
	6	0	0	1	1	7	8	7	1	2	0	
	7	0	0	1	1	3	6	9	7	1	0	
	8	0	0	0	1	0	2	7	12	5	0	
	9	0	0	0	0	0	0	1	7	14	6	
	10	0	0	0	0	0	0	0	0	6	21	27
Total		27	28	27	27	28	27	28	27	28	27	274

Indicates two footpaths changes from 6 (medium walkable) in WS_1 to 9 (highly walkable) in WS_5

Figure 7.2 Example of changes in decile group of WS_5 compare to reference scenario (WS_1)

The results of the changes in walkability (in decile groups) of WS_2 to WS_5 (compared with WS_1) are summarised in Table 7.7 below. The changes between scenarios were classified into five groups: Major decrease (decrease by more than one decile group); Minor decrease (decrease by one decile group); No change; Minor increase (increase by one decile group); Major increase (increase by more than one decile group). As shown in Table 7.7, the relative walkability of footpaths changed substantially compared to the reference scenario (WS_1). For example, a large proportion of footpaths have increased in relative walkability (19.3% minor increase and 28.1% major increase) in WS_3, indicating that many footpaths that are less walkable in WS_1 became more walkable in WS_3. To further disaggregate the changes in relative walkability by neighbourhoods and types of footpath, we present two separate figures 7.3 and 7.4.

Table 7.7 The changes in relative walkability of footpaths in WS_2 to WS_5

Percentage of footpaths	WS_2	WS_3	WS_4	WS_5
Major decrease	11.3%	17.2%	9.5%	6.2%
Minor decrease	12.4%	13.1%	17.9%	20.1%
No change	39.4%	22.3%	40.9%	46.0%
Minor increase	29.2%	19.3%	21.9%	21.9%
Major increase	7.7%	28.1%	9.8%	5.8%

The discussion below concentrates on showing how the relative walkability of footpaths varies in different scenarios and how these scenarios can be applied in different situations to understand walkability in a more relational way. In WS_3 (top right corner of Figure 7.3), about 40% of footpaths in the two low accessibility neighbourhoods (Xinsha and Huilongpu) become less walkable, while more than 50% of footpaths in the high accessibility neighbourhoods (Xinzhou and Shangjing) become more walkable. This demonstrates that footpaths in the two high accessibility neighbourhoods are relatively safer and have more destinations, since "safety" and "land use and destinations" are non-compensatory qualities in WS_3. This scenario could be applied to pedestrians who are especially concerned about the ability to reach destinations within short distances and regard safety as a critical factor that influences their

walking intention and experience, such as children and older adults (Ferrer, Ruiz, & Mars, 2015). If information on walkability were provided to these pedestrians, they might want to make use of this scenario to identify footpaths and routes offer safe and short-distance walking trips without disregarding other dimensions of walkability.

In Scenario 4 (bottom left corner of Figure 7.3), a larger proportion of footpaths in the high accessibility neighbourhoods (IH and OH neighbourhood) have decreased in walkability (27% (OH) and 36% (IH)). This reflects that many footpaths in these neighbourhoods are of relatively poor quality and that "footpath design and condition" and "amenities" are non-compensatory qualities in WS_4. This situation is especially significant in Xinzhou (IH) because of the presence of urban villages within this neighbourhood. Many footpaths within the urban villages are characterised by poor design and lack of maintenance because of their rapid and unregulated developments in the past. WS_4 is especially suitable for assessing walkability for pedestrians that have special concern over the quality of footpath, such as pram users, people with disabilities or mobility impairments (Imrie, 2000). In practice, this scenario (WS_4) can also be applied to examine the pedestrian network in proximity to specific destinations, such as hospitals and healthcare centres. The walking environment around these destinations requires special attention to ensure pedestrians (e.g. patients) can walk without being affected by obstructions on footpath.

For Scenario 5 (bottom right of Figure 7.3), distinctive pattern can be observed in Xinsha (IL). Here only 13% of footpaths decrease in walkability compared to the reference scenario, which is much lower than for the other three neighbourhoods (around 30%). At the same time, more than 30% of footpaths in this neighbourhood become more walkable. As aesthetics and subjective experience were found to be associated with walking for leisure in previous studies (Sugiyama et al., 2012), WS_5 can be especially relevant for pedestrians who pay special attention to sensory experiences of walking. In practice, the results for this scenario could be used to provide information for leisure or recreational walking trips where enjoyable and aesthetically pleasing footpaths

can help to increase pedestrians' level of trip satisfaction.

When attention is directed towards relative walkability according to footpath type, the most noticeable observation is the increase in relative walkability for other passageways in Scenario 3 (WS_3) (top right corner of Figure 7.4). In this scenario, more than 44% of the other passageways increased in walkability compared to the reference scenario. This shows that unlike traditional understandings that regard these other passageways as unimportant in walkability assessment, these other passageways are really quite safe and many destinations can be found along these paths.

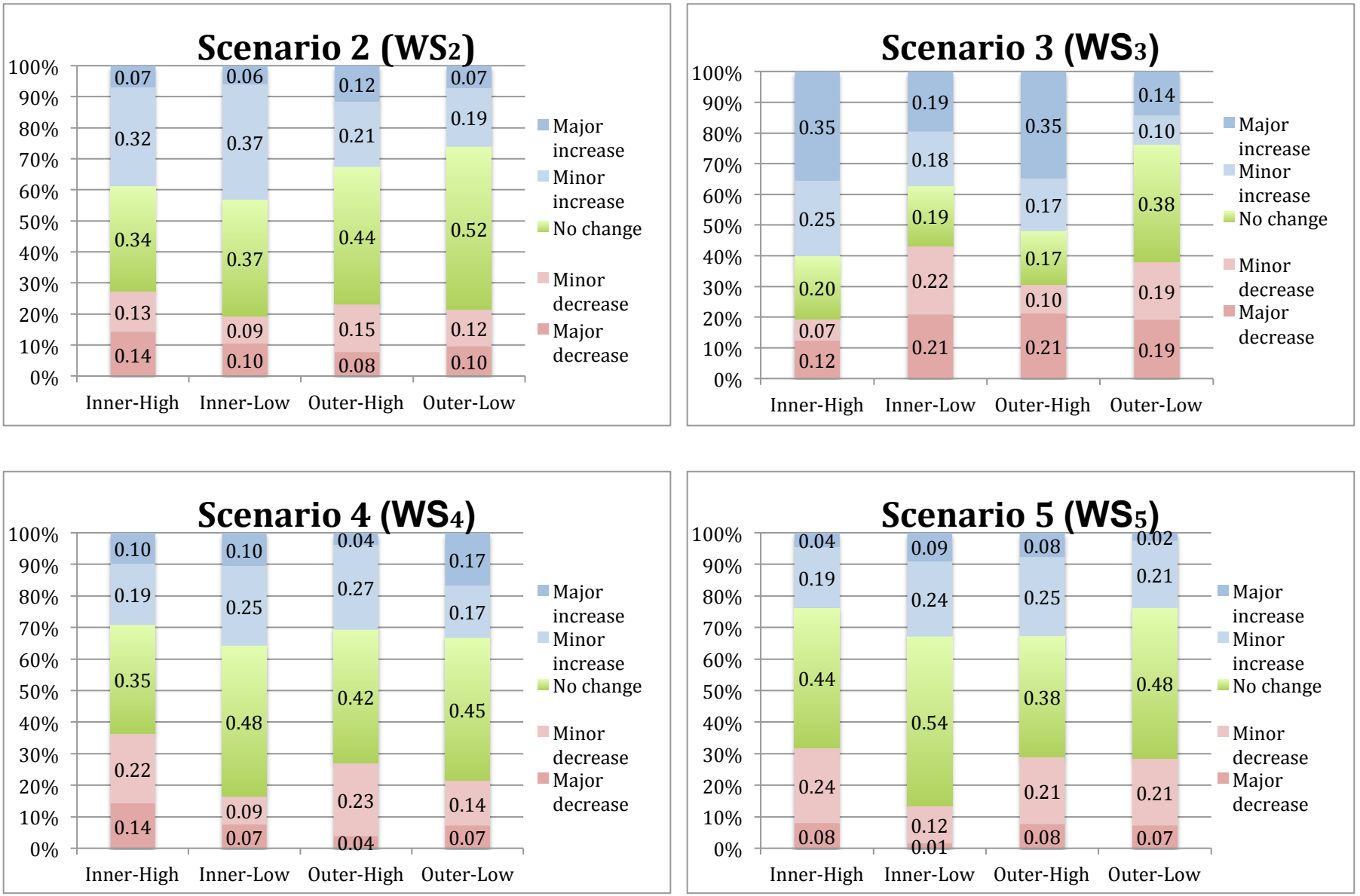


Figure 7.3 Summary of the changes in walkability scenarios (WS_2 to WS_5) compare to the reference scenario (WS_1) by neighbourhoods

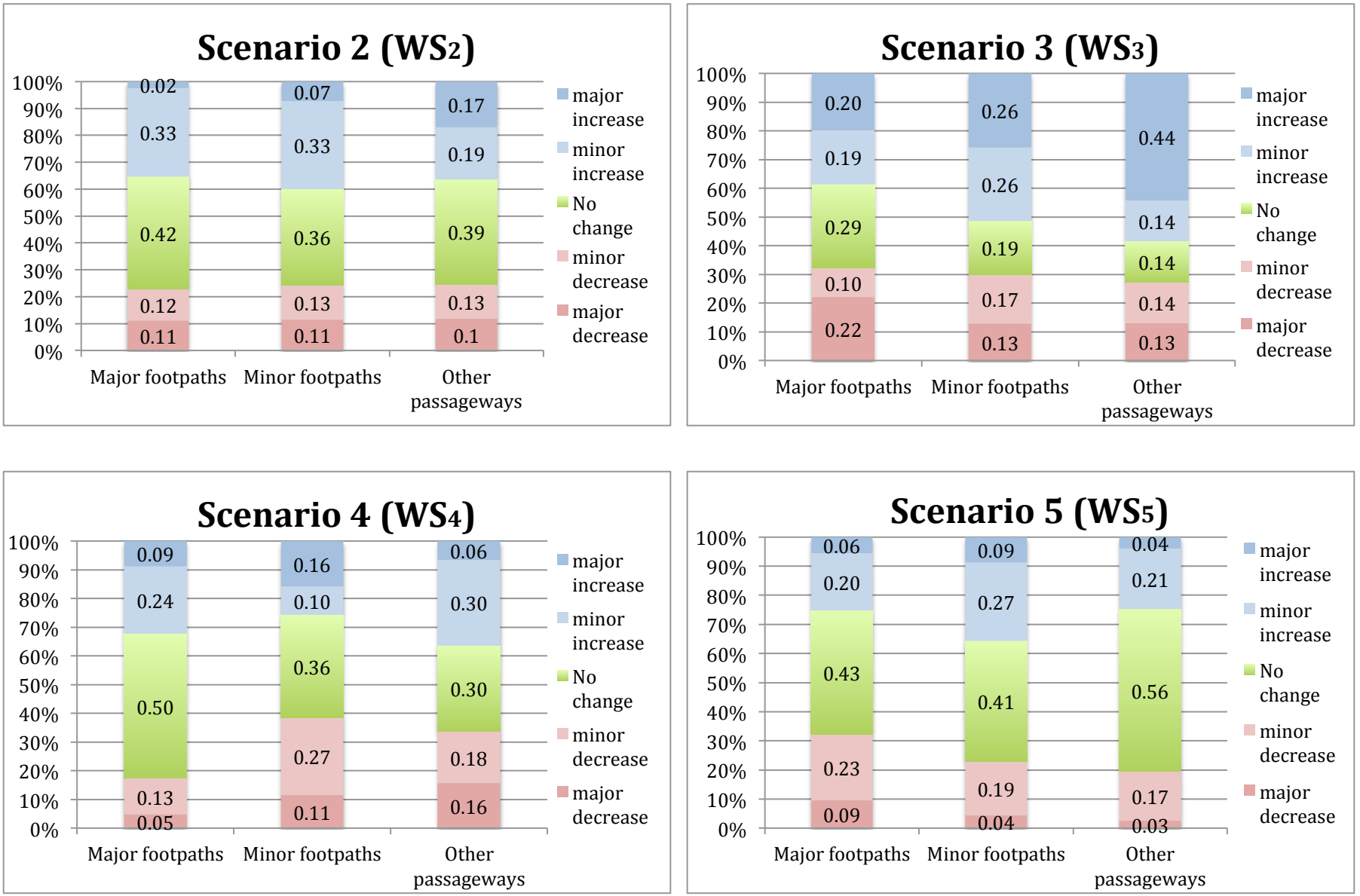


Figure 7.4 Summary of the changes in walkability scenarios (WS_2 to WS_5) compare to the reference scenario (WS_1) by types of footpath

7.6 Discussion and Conclusion

In this study, we have argued that walkability can be reconceptualised as relational and emerging from the interactions between the pedestrians and their environment. Based on this understanding, we have proposed a multiple-scenario approach for walkability assessment.

Conceptually, the multiple-scenario walkability approach challenges some of the basic assumptions adopted in most current walkability studies. Instead of applying a single index to represent the level of walkability, we argue that the understanding of walkability should take into consideration the heterogeneity of pedestrians, as a footpath that is regarded as walkable to one individual may not be equally walkable to others. Therefore, it is more appropriate to create multiple walkability scenarios to better consider the needs, capacities and preferences of different population groups, and/or for different neighbourhoods in assessing walkability. In this way, walkability can be reconceptualised from a static, single entity to a more flexible, dynamic, and location-specific process.

Existing studies have assumed that various aspects of walkability can compensate each other and applied the additive rule in calculating the walkability index. However, actual pedestrians may employ various decision rules in assessing the friendliness of the walking environment and make respective decisions on walking. Hence, in this study, we take the idea that, in valuation, elements may not always compensate each other. We assume instead that certain aspects are so important to certain people or in certain situations that they act as hard constraints on valuation and therefore cannot be compensated b other aspects. At the same time, certain aspects may be negotiable and it is possible that lower scores are compensated by, and traded against, higher scores on other factors. This practice can be regarded as a starting point for future studies to consider using other decision rules, like lexicographic rules (Tversky, 1969) or elimination-by-aspects (EBA) (Tversky, 1972) for walkability assessment.

The proposed multiple-scenario walkability approach is also highly flexible

compared to conventional methods of walkability assessment. The five walkability scenarios proposed and tested in this study are by no means exhaustive, policymakers and practitioners can develop other possible walkability scenarios that match with their specific needs and requirements of local context. Furthermore, it is also possible to assess walkability using other tools and methods (e.g. other audit tools) than those employed in the current paper, and then apply the non-compensatory decision rule to generate other walkability scenarios for assessment.

Following the ongoing trends of "smart city" development, walkability indices of the kind proposed here can be made accessible to all residents, possibly in the form of mobile phone applications (Neirotti et al., 2014). For example, most of the existing trip-planning applications only consider travel time as the sole criterion in route choice decision-making; the walkability of footpaths is rarely taken into consideration. If walkability indices are incorporated into these mobile applications, residents can make informed decisions on route choice and selection of residential location based on their own needs and preferences. Following this idea, it is even possible for future mobile applications to enable residents to decide which sets of environmental features and/or walkability qualities are non-compensatory for their walking trips. By doing so, walkability assessment can move from a top-down approach in which the local authorities or private companies provide information on walkability to the residents, to a bottom-up participatory approach that allows residents to choose their own criteria and calculate their personalised walkability indices based on their specific needs and preferences.

This study can be advanced in the following ways. The multiple-scenario walkability approach could be further examined in conjunction with pedestrians' walking behaviour data to validate its applicability (Moura, Cambra, & Gonçalves, 2017). Future research can also be conducted to identify other important qualities in assessing walkability or try to develop different scenarios that are applicable to other population groups and/or in different situations. Finally, similar studies can be performed in other cities and more diversified neighbourhood types to further

assess the applicability of this approach to measuring walkability.

Appendix 7.1 Major walkability qualities and measurement items in environmental audit tool

Walkability qualities	Description of features	Examples of measurement items in existing studies	Newly added and modified items
Land use and destinations	This quality considers both the origins and destinations of neighbourhood level walking trips, which captures the residential development density and presence of various commercial and non-commercial destinations.	● Residential density (Malecki et al., 2014; Su et al., 2014; Cerin et al., 2011) ● Building density (Sun et al., 2017) ● Various destinations (Su et al., 2014; Sun et al., 2017; Cerin et al., 2011; Troped et al., 2006; Millstein et al., 2013; Pikora et al., 2002)	● Destinations were selected to focus on five major types (food/restaurants, commercial/retail, leisure, office, transport)
Safety	This quality covers all design features that are directly or indirectly associate with people sense of safety, including both traffic and personal safety.	● Street network (Sun et al., 2017; Troped et al., 2006; Millstein et al., 2013; Cerin et al., 2011; Pikora et al., 2002) ● Litter and Graffiti (Su et al., 2014; Cerin et al., 2011; Millstein et al., 2013; Malecki et al., 2014) ● Buffers between road and footpath (Sun et al., 2017; Cerin et al., 2011; Troped et al., 2006; Millstein et al., 2013; Malecki et al., 2014) ● Signs of crime/disorder (Cerin et al., 2011; Troped et al., 2006; Millstein et al., 2013) ● Aggressive drivers (Cerin et al., 2011) ● Signage for drivers (Millstein et al., 2013) ● Surveillance (Pikora et al., 2002)	● Presence of other users on footpath ● Presence of police office / stand ● Presence of police officers
Aesthetics	This quality consists of features that capture the aesthetic qualities of the walking environment, including streetscape features and views from the footpath.	● Natural sights (Su et al., 2014; Cerin et al., 2011; Malecki et al., 2014) ● Cultural landscape (Su et al., 2014) ● Trees (Sun et al., 2017; Millstein et al., 2013; Pikora et al., 2002) ● Attractive buildings (Cerin et al., 2011; Millstein et al., 2013; Pikora et al., 2002; Malecki et al., 2014) ● Sightline (Troped et al., 2006) ● Public art (Millstein et al., 2013) ● Interesting views (Pikora et al., 2002)	● Proportion of sky ● Horizontal sightline

Appendix 7.1 Major walkability qualities and measurement items in environmental audit tool (con't)

Amenities	This quality comprises of design features that can facilitate safe and efficient movement of pedestrians. Including amenities for the general pedestrians and amenities for people with special needs.	● Lighting (Sun et al., 2017; Millstein et al., 2013; Pikora et al., 2002) ● Benches (Sun et al., 2017; Malecki et al., 2014) ● Trash bins (Sun et al., 2017; Millstein et al., 2013; Malecki et al., 2014) ● Public telephone (Millstein et al., 2013) ● Drinking fountains (Millstein et al., 2013)	● Way-finding aids ● Tactile paving ● Problems with tactile paving
Footpath design and condition	This quality captures the functional characteristics (including steepness, effective width) and the condition of footpath (including trip hazards, physical and temporary obstructions).	● Footpath width (Su et al., 2014; Pikora et al., 2002) ● Walking barriers (Sun et al., 2017; Cerin et al., 2011) ● Well-maintained footpath (Cerin et al., 2011) ● Steepness of footpath (Cerin et al., 2011; Pikora et al., 2002) ● Footpath surface (Pikora et al., 2002) ● Obstructions on footpath (Pikora et al., 2002)	● Revised and new items on temporary obstructions
Subjective assessment and experience	This quality relates to the subjective assessment and the sensory experience associated with the walking environment.	● Attractive for walking (Sun et al., 2017; Pikora et al., 2002) ● Difficult for walking (Pikora et al., 2002) ● Feels safety for walking (Sun et al., 2017) ● Noise pollution (Cerin et al., 2011) ● Air pollution (Cerin et al., 2011)	● Sufficient illumination ● Pleasant smell ● Pleasant sound ● Feel stressful ● Volume of sound ● $PM_{2.5}$ ● PM_{10}

Appendix 7.2 Environmental audit tool

Auditor ID _____ Name _____
Neighbourhood _____
Date_____
Day: Mon/Tue/Wed/Thur/Fri/Sat/Sun
Segment No_____
Start Time_____

Section: Land use and destinations

1. What type of residential uses can be observed? *(Check all that apply)*
   - ☐ Detached or semi-detached houses (1-3 stories)
   - ☐ Residential buildings (4-6 stories)
   - ☐ Residential buildings (7-13 stories)
   - ☐ Residential buildings (14-20 stories)
   - ☐ Residential buildings (over 20 stories)

2. What type of land uses can be observed? *(Check all that apply)*
   - ☐ Supermarket / Fresh food market
   - ☐ Restaurant
   - ☐ 24hr convenient store
   - ☐ Shopping mall/department store
   - ☐ Bank/Financial institution
   - ☐ Other retail stores
   - ☐ Hotel
   - ☐ Plazas
   - ☐ Playground / Park
   - ☐ Sports ground / ball court
   - ☐ Government buildings
   - ☐ Office buildings
   - ☐ Bus stop
   - ☐ Multi-storey car park

Section: Safety

1. Which of the following types best describe this road?

☐ Road with separated footpath
☐ Road without separated footpath
☐ Pedestrian only road
☐ Internal road mixed with car park

2. Is this road 1-way or 2-way?
   ☐ 1-way ☐ 2-way ☐ unclear

3. Are there any driveways (ingress / egress) on the segment?
   ☐ Yes ☐ No

4. Are there any parking spaces on footpath? ☐ Yes ☐ No

5. Are there any buffers between road and footpath? *(Check all that apply)*
   - ☐ Railings ☐ Bollards
   - ☐ Trees ☐ Planters

6. Are there other users on the footpath? (On pedestrian section if cycle lane is present) *(Check all that apply)*
   - ☐ Cyclists
   - ☐ User of e-bike / electric scooter
   - ☐ Motorcycles
   - ☐ Mini-truck
   - ☐ Others _____

7. Which of the following physical disorders are present? *(Check all that apply)*
   - ☐ Graffiti / commercial flyer
   - ☐ Abandoned building / Vacant land
   - ☐ Noticeable litter / dog faeces

8. Which of the following social disorders are present? *(Check all that apply)*
   - ☐ Street fouling
   - ☐ Idlers / People gambling on street

9. Are there any police booth or security stand along this segment?
   a) ☐ Yes ☐ No
   If Yes, can you see any police in it?
   b) ☐ Yes ☐ No

Section: Footpath design and condition

1. Steepness of footpath
   - ☐ Nearly flat ☐ Slightly sloped
   - ☐ Strongly sloped that affect balance

2. What is the average effective width of footpath?
   - ☐ less than 1m ☐ 1m – <2m
   - ☐ 2m – 3m ☐ more than 3m

3. To what extent the road segment is protected from inclement weather? *(e.g. building hangover, shelter, covered walkway)*
   ☐ 0% ☐ 1-25% ☐ 26-50%
   ☐ 51-75% ☐ 76-100%

4. Are there poorly maintained sections of the footpath that constitute trip hazards? (e.g. heaves, misalignment, cracks, overgrowth)
   ☐ None ☐ Some ☐ Ample

5. Are there any of the following physical obstructions along the footpath? *(Check all that apply)*
   - ☐ Rubbish collection point
   - ☐ Electricity switch box
   - ☐ Store / Kiosk
   - ☐ Stairs / Steps / Slopes

6. Are there any of the following temporary obstructions along the footpath? *(Check all that apply)*
   - ☐ Parked cars/bikes/motorcycles
   - ☐ Street vendor
   - ☐ Outdoor eating/catering area
   - ☐ Other commercial activities
   - ☐ Construction waste

Section: Aesthetics

1. Can you observe any following hardscape features *(Check all that apply)*

☐ Sculptures ☐ Fountains
☐ Landscape garden ☐ Bodies of water
☐ Greenery view

2. What is the percentage of tree coverage along the segment?

□ 0% □ 1-25% □26-50%
□ 51-75% □ 76-100%

3. Can you have clear sightlines (both directions) along this segment of footpath?
□ Good (can see the whole segment)
□ Fair (can see part of this segment)
□ Poor (some blockage of this segment)

4. Can you see both sides of the footpath (horizontally) without any obstruction, like tall buildings, walls, etc.
□ Continuous lateral visibility
□ Moderate lateral visibility
□ No lateral visibility

5. From the middle of the segment, what proportion of sky can you see?
□ 0% □ 1-25% □26-50%
□ 51-75% □ 76-100%

Section: Amenities
1. Are street lights installed along the segment?
□ None □ Some □ Ample

2. Can you observe these amenities? *(Check all that apply)*
□ Trash bins
□ Benches or other sitting spaces
□ Bicycle rack
□ Public toilets
□ Others _____

3. What is the percentage of tactile paving along the segment? (For guiding purpose)
□ 0% □ 1-25% □26-50%
□ 51-75% □ 76-100%

4. Are there any problems associated with the tactile paving for visually impaired people?
□ Paving worn out
□ Misalignment of paving
□ Inappropriate design
□ Paving blocked by other things

5. Are there way-finding aids available in this segment? *(Check all that apply)*
□ Public transport route map
□ Neighbourhood area map
□ Directional sign (local destination)
□ Directional sign (MTR station)
□ Others _____

Section: Subjective assessment and experience
1. Is there sufficient illumination to see the path clearly along the segment?
□ Insufficient □ Fair □ Sufficient

2. How safe do you feel when you walk along the segment?
□ Safe □ Neutral □ Unsafe

3. Do you feel stressful when you walk along the segment?
□ Relaxed □ Neutral □ Stressful

4. How attractive visually is this segment of footpath?
□ Attractive □ Neutral □ Unattractive

5. Can you smell any unpleasant smell along the segment?
□ Yes □ No

6. What can you hear along the segment?
a) Pleasantness of sound
□ Some pleasant sound
□ Little or no sound
□ Some unpleasant sound

b) Measure the volume of sound
_____ (dB)

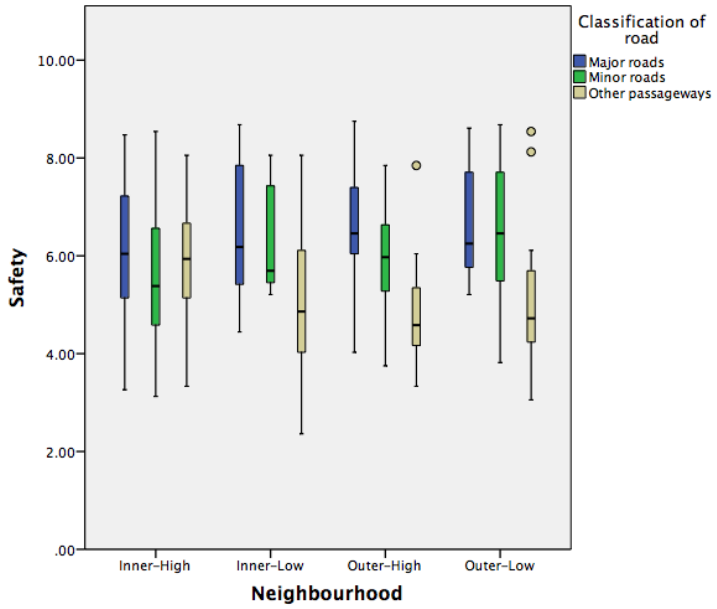
7. Is there any smog or observable air pollution?
□ Yes □ No

8. Measure the air quality for PM2.5 and PM10.
a) PM 2.5_____
b) PM 10 _____

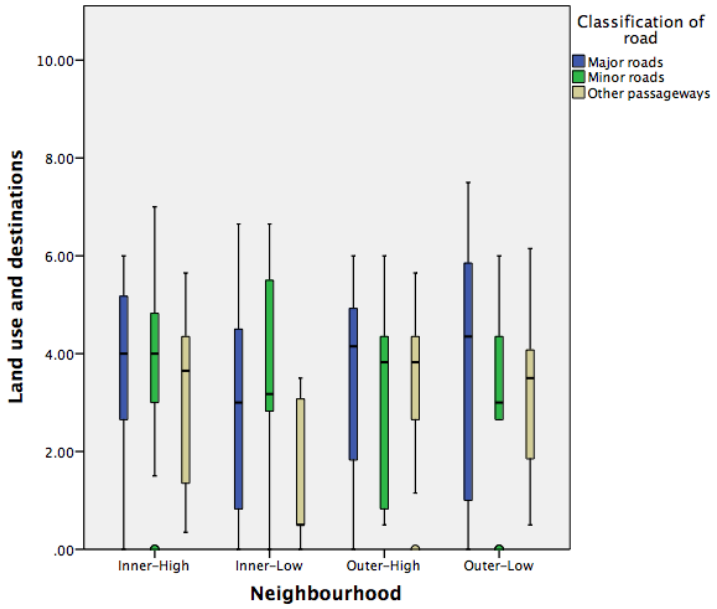
Other special observations:

End Time _____

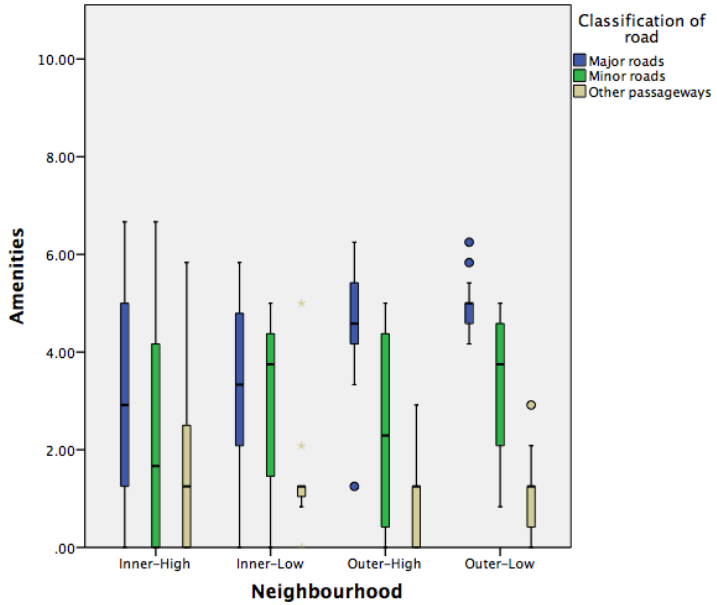
Appendix 7.3 Walkability quality scores by neighbourhoods and types of footpath



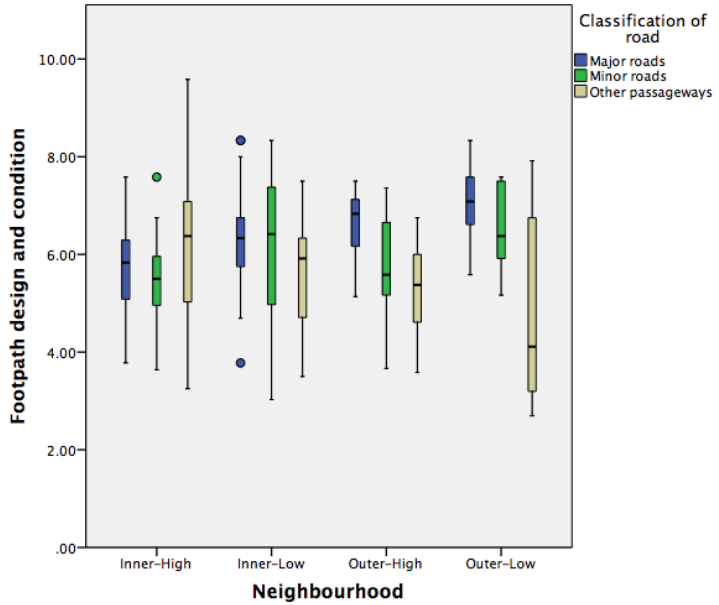
Safety



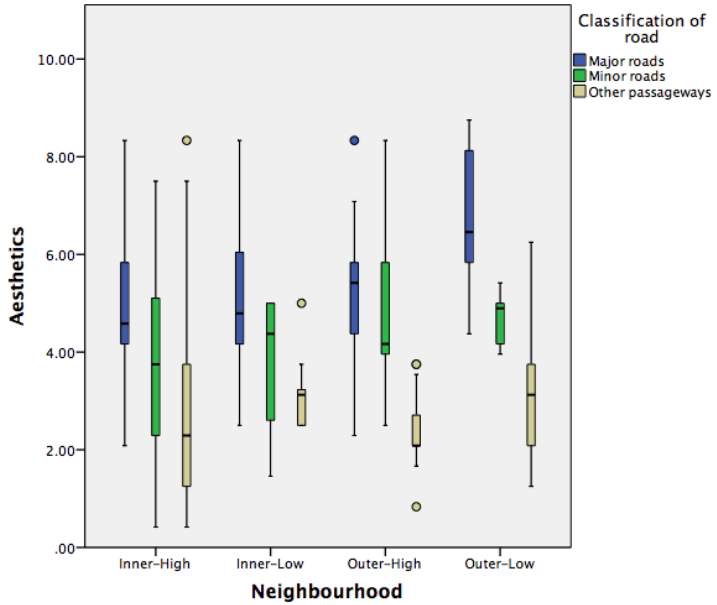
Land use and destinations



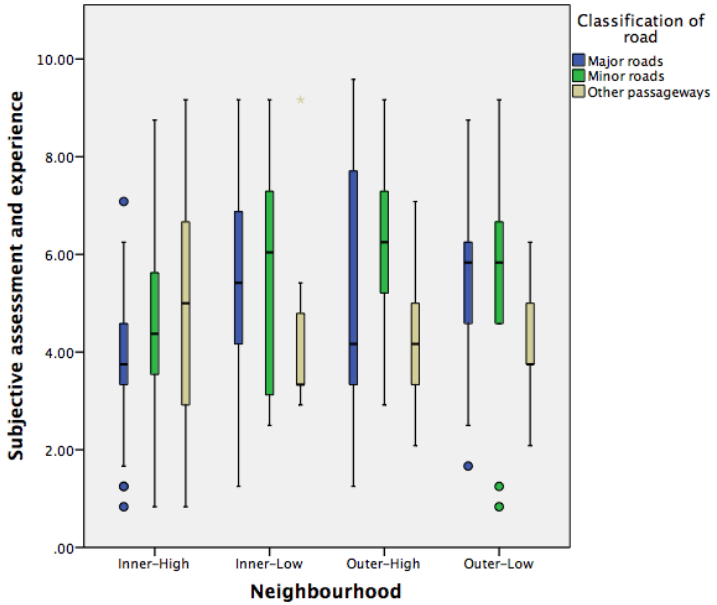
Amenities



Footpath design and condition



Aesthetics



Subjective assessment and experience

8 Chapter Eight – Conclusion

This final chapter summarises the major findings of this DPhil research project and highlights the contributions of this study in theoretical, methodological and practical terms. Based on these contributions, the associated implications for future studies and potential policy recommendations are also discussed. After that, I have provided some critical reflections of the whole DPhil research project. The thesis ends with a section of concluding remarks.

8.1 Summary of findings

Performing the recommended amount of physical activity[33] can reduce the risks of many non-communicable diseases including obesity, cardiovascular disease, and hypertension (Haskell et al., 2007; Warburton, Nicol, & Bredin, 2006; Warburton & Bredin, 2017). Given that a large proportion of the world population does not reach the recommended level of physical activity, various measures have been proposed to mitigate this situation, ranging from exercise prescriptions (Nied & Franklin, 2002), education campaigns (Booth, Bauman, Oldenburg, Owen, & Magnus, 1992), to modifications of the built environment (Sallis, Bauman, & Pratt, 1998). By reviewing the relevant literature, Chapter Two of this thesis has highlighted the positive associations of certain built environmental features with people's walking behaviour. For instance, high-density developments, mixed land use and easily accessible destinations are found to be associated with more walking activities (Larrañaga et al., 2016; Orstad et al., 2017). However, despite the growing evidence on the built environment's influences on people's physical activity, the role of other person-related factors, such as attitudes, perceptions, meanings and place attachment in shaping the built environment–walking behaviour connections deserve greater attention in academic research (Gifford, 2007; De Vos, Mokhtarian, Schwanen, Van Acker, & Witlox, 2016). Limited understanding of the role of these person-related factors might hinder the development of effective measures to promote people's walking behaviour.

[33] According to World Health Organisation (WHO), adults aged 18-64 should do at least 150 minutes of moderate-intensity physical activity or at least 75 minutes of vigorous-intensity physical activity per week.

To address this issue, two major research questions were raised in the introductory chapter to guide this DPhil study. In this section, discussions regarding each of the research questions are provided and the thesis's contribution to the understanding of the influence of environmental and the person-related factors on walking in a developing city context is summarised. The first research question is as follows:

RQ 1) What are the relationships between the built environment, person-related factors and walking behaviour and experience?

This research question was addressed by using both qualitative and quantitative methods. Firstly, semi-structured interviews were conducted to explore how the participants articulated their daily walking experience. The results from Chapter Five have demonstrated that people's walking experience and behaviour was a complex interaction of numerous factors including personal meanings, social values, place attachment, and temporal changes of the built environment. Based on this understanding, a framework was proposed to deepen our existing understanding of pedestrians' walking experiences. The proposed framework has demonstrated that walking is a culturally specific behaviour, in which place-specific values and social norms play significant roles in shaping the meanings that pedestrians attach to walking. These meanings help to shape how people interpret their walking as a habit, as a way to connect with significant others, and for regimen purposes. It was further stressed that the engagements with places in terms of physical attachment, emotional bonding and social bonding have all affected pedestrians' walking experiences. The importance of time was also emphasised, and it was found that pedestrians' walking experiences could be shaped by the changing built environment features during different time periods (temporality) and pedestrians' expectations of the future (futurescape). Chapter Five has helped to improve our existing understanding of walking by illustrating how the three interrelated themes (place, meanings, and timescapes) are integral to pedestrians' walking experiences.

The identification of these themes has reinforced the importance of

understanding how the built environment and person-related factors affect people's walking behaviour. So, in the subsequent quantitative analysis (Chapter Six), I have addressed the first research question further by examining the influence of objective neighbourhood characteristics, perceived built environment, and walking attitudes in people's walking behaviour. In this analysis, I categorised neighbourhood-level walking trips according to three specific purposes – walking for school/work, walking for leisure/recreation, and walking for household responsibilities – because the frequency with which participants walked for those purposes differed markedly and the correlates for the frequency of each type of walking might differ as well. Using logistic regression analyses, I have identified significant moderation effects between the objective neighbourhood characteristics, perceived environment, and walking attitudes in association with specific purposes of walking frequency. The findings have demonstrated that pedestrians' positive perceptions about the built environment and walking attitudes can offset the negative effects of the poor objective neighbourhood environment, and in combination they contributed positively to people's walking frequency. For example, I have found significant interaction effects between living in a low-accessibility neighbourhood and "perceived access to destinations" for leisure/recreation walking trips. This finding suggested that "perceived access to destinations" has a stronger facilitating effect on walking frequency among those who live in neighbourhoods with lower local accessibility. This has suggested that positive perceptions of the environment (in this case, the "perceived access to destinations") can, in some circumstances, compensate for the effects of living in less walkable neighbourhoods on people's walking frequency in a manner that is different from what is observed in more walkable environments.

The second research question is:

RQ 2) How can walkability be assessed by considering the heterogeneity of the needs, capacities and preferences of pedestrians?

Walkability is considered as a relational concept that has emerged from the interactions of the pedestrians and the built environment, and this was analysed

in Chapter Seven where a new approach for assessing walkability was developed and tested. First, an environmental audit tool consisting of six major qualities was developed based on a critical review of the past literature and results from the explorative study in Shenzhen, China. After that, applying the principle underpinning non-compensatory decision rules, I developed five walkability scenarios to represent walkability for different pedestrian groups and/or situations. The findings of this study demonstrated that walkability varies significantly in different walkability scenarios. This provides support for the multiple-scenario approach that considers the heterogeneity of pedestrians, and accounts for the different situations in assessing walkability. This study (Chapter Seven) not only provided a conceptual advancement in seeing walkability as a more relational concept, but also proposed a new approach (multiple-scenario walkability approach) to assess walkability that can capture the heterogeneity in needs and preferences of pedestrians.

8.2 Contributions of this study and implications for future research

Studying people's daily walking behaviour and experience in and around their neighbourhood provides important theoretical, methodological and practical insights to the literature and contributes to the discussions on walking experiences, walking behaviour, and walkability. Based on these contributions, the implications for future studies are outlined here.

8.2.1 Theoretical and conceptual contributions

Previous studies have usually assumed that people tend to respond to the environment in fairly homogeneous ways (Kwan, 2018). However, in reality, individuals' responses to the environmental influences are personal and highly complex. Many person-related factors (including attitudes, perceptions, meanings, and place attachment, etc. as revealed in this project) can mediate or moderate such responses and influence people's behaviour. However, these person-related factors are not usually considered comprehensively in existing studies. To tackle this issue, this study has applied a pedestrian-centred perspective to further investigate the potential influences of these

person-related factors on people's walking behaviour. The argument here is not that future travel behaviour studies (especially those studying other motorised travel behaviour) should completely follow this method (to capture more detailed and extensive data on small(er) samples) instead of using traditional methods (to collect less extensive data from large(r) samples). It is more about examining the potential for a more detailed and advanced person-based approach. This alternative approach would focus on assembling both in-depth and extensive data that in combination offer a comprehensive perspective on the links between the built environment and walking behaviour and experience.

Compared to other modes of transport, walking involves more direct exposures to and interactions with the surrounding environment at a localised scale. In this regard, the various person-related factors could play significant roles in shaping people's walking behaviour, as individuals' own response to and interpretations about the built environment may be significantly different. Recognising the importance of these person-related factors in shaping people's walking behaviour and experience, future studies could further examine the roles of the short and long term influences of these factors in association with people's health and well-being. More importantly, future studies could also benefit from deeper engagements with the life course perspective to understand how major life events (changes in car access, household members, employment status) shape the formation, maintenance and changes of these person-related factors on people's behaviour (Klinger, 2017; Müggenburg, Busch-Geertsema, & Lanzendorf, 2015; Scheiner, Chatterjee, & Heinen, 2016).

Another contribution of this study has been to develop a framework to advance our existing understandings of urban walking experiences in a developing city context (in Chapter Five). This framework has explained how pedestrians respond to the built environment through their complex engagements with time, place and the meanings ascribed to walking. Investigating pedestrians' walking experience in relation to their personal, social and cultural values, preferences and attitudes, and the dynamic conditions of the walking environment. This framework has provided important insights to broaden our existing

understanding of walking behaviour and experience from a developing city perspective. Following this line of thought, more qualitative studies could be undertaken to explore this issue further by examining other important social and cultural factors that may shape people's views on and the practices of walking in other developing contexts.

This study also enables future studies to rethink the prevailing approaches to and understandings of the built environment. In most studies to date, the built environment (especially the micro-scale built environmental features) has been assumed to be static or at most change at a very slow rate (in terms of years). Thus, the built environment has usually been measured in a single point in time. However, in the exploratory qualitative study, many participants explained how their walking experience was constantly shaped by and associated with the dynamics and the diurnal changes of the built environment. The changes in physical features include the temporary catering areas of cafes and restaurants; the display of commodities on footpaths by local shops; and the presence of local vendors and fresh food markets during specific time periods of the day (e.g. early morning or late afternoon). Such changes not only modify the physical environment, they also shape the functions and activities afforded by the walking environment during particular time periods. For instance, such changes in physical features create or reduce activity spaces for people to conduct various activities at certain time periods, and at times they create barriers that hinder some pedestrians' walking trips. As such, the same walking environment could stimulate different perceptions and emotions among different pedestrians during different times of the day.

The conclusion that the flexible and continuously changing nature of the built environment should be considered in studies of walking behaviour and experience coincides with some recent studies that have started to recognise the varying temporal influence of the built environment on people's physical activity. For example, Cerin et al. (2017) examined the variations in associations between the objectively measured built environment and physical activity by time of the day and day of the week in 14 cities. Time-specific environment-physical activity

associations were found for certain environmental characteristics. Residential density, intersection density and land use mix were positively associated with physical activity during weekday mornings, while density of public transport was positively associated with physical activity during weekends. Cerin and colleagues (2017) have demonstrated the need to consider time-specific associations between the built environment and physical activity. Nonetheless, the existing tools used to measure the built environment did not account for such time-specific variations. The dynamics (or changes) of the built environment in different time periods of a day have not been taken into consideration.

This conceptualisation of a more dynamic built environment allows future researchers to explore how these short-term changes of the built environment influence people's walking behaviour and experience. By doing so, the environmental influence on people's behaviour could be understood in a more dynamic and precise manner. This idea can be developed further in the future with the use of various approaches inspired from citizen science, in which local residents can engage in collecting/generating data using more advanced technologies. For example, residents could use more advanced methods such as sensors, smartphones, and other gadgets to report on their perceptions of the built environment (including but not limited to air quality, crowdedness, presence of any barriers, etc.) (Rathore, Ahmad, Paul, & Rho, 2016). With these more precise data, future studies could establish more time- and context-specific associations between the built environment and walking behaviour.

8.2.2 Methodological contributions

This study has advanced methods for walkability assessment by first arguing that walkability should be reconceptualised as a more relational concept that considers not only the built environment, but also how the pedestrians perceive and interact with the built environment. Secondly, a multiple-scenario approach was developed for walkability assessment to address the diverse needs and preferences of pedestrians. This approach has allowed researchers to create multiple walkability scenarios based on different criteria tailored to the specific

situation that is being considered. Future studies can apply this method to examine the variability of walkability scenarios based on different criteria, and investigate how these walkability scenarios reveal distinctive features of the walking environment in different contexts. In this sense, this study has not only developed a method that allows researchers to use in other contexts, but also proposed a change in the framing of how researchers could make use of their data to better represent walkability. For example, with the integration of other mobile technologies (e.g. mobile phone apps), future studies can collect data on the built environment and apply this multiple-scenario walkability approach to let the pedestrians calculate their own walkability for any particular route based on their specific criteria and preferences. By doing so, walkability assessment can be truly personalised and tailored to the needs and capacities of individual pedestrians.

This study has also identified and applied the concept of walking attitudes in examining the influences of the built environment on walking behaviour. This variable was identified on the basis of the qualitative survey (Chapter Five), and seven statements were used to measure the participants' walking attitudes, including: "I enjoy walking in the neighbourhood where I live", "Walking is not important for me at all", "In general, my walking experience in the neighbourhood where I live is positive", "I walk because it is good to my health", "I walk because it is good to the environment", "I walk because it involves no monetary costs", and "Walking in the neighbourhood where I live is a habit". This "walking attitudes" variable is innovative for several reasons. First, most existing studies tend to measure travel attitudes by using multiple statements to capture respondents' general attitudes towards different modes of transport. Studies that measure the behaviour-specific attitudes, e.g. attitudes to walking or cycling, are scarce. Secondly, other studies that have tried to capture behaviour-specific attitudes relied on a single item to measure attitudes, which might increase the sensitivity to measurement error (Yang & Diez-Roux, 2017). The "walking attitudes" variable was tested in Chapter Six and a statistically significant and positive correlation with walking frequency was found, showing that when, all else equal, attitudes are more positive, pedestrians walk more frequently each

week for leisure or recreation. As such, the development and test of other behaviour-specific attitudes and their associations with people's active travel behaviour could be another promising avenue for future studies.

Likewise, several new measurement items have been developed to measure other aspects of the perceived built environment that are not commonly captured by using existing tools, such as the Neighbourhood Environment Walkability Scale (Cerin, Saelens, Sallis, & Frank, 2006), and the Instruments for Assessing Levels of Physical Activity and Fitness questionnaire (ALPHA) (Spittaels et al., 2009). These new items include "poor footpath condition" and "maintenance and upkeep". The results in Chapter Six have demonstrated that these variables were significantly associated with walking behaviour for all three purposes of walking. The results suggested that instead of focusing on the static physical infrastructure of the built environment, the conditions and quality of the walking environment should also be considered in a more rigorous manner in future studies. This means that future studies could explore the applicability of these variables in other contexts and examine their associations with various walking behaviours. Further comparison of the explanatory power of these variables to other perceived built environment variables is also worth investigation.

The method of conducting fieldwork[34] in the case study area can also be regarded as a methodological advancement. This study has shown that an immersive approach to fieldwork can be highly valuable, especially in a relatively under-studied city or country. An immersive fieldwork enables the researcher to experience the local walking environment in person and discover new themes and items which are more precisely representing the local walking environment. As a result, the design of surveys for walkability assessment would benefit from an immersive style of fieldwork by revealing the importance of both formal and informal passageways to people's daily walking behaviour.

[34] A narrow definition of fieldwork is used here referring to the research activities conducted in the study area only.

8.2.3 Practical contributions

Existing methods of walkability assessment have their focuses on "formal" footpaths, the sidewalks along major vehicular roads. The walkability of the "informal" footpaths, including small passageways and alleys has been greatly neglected. This might lead to inaccurate and overly positive assessment of walkability, as these "informal" footpaths are commonly used by local pedestrians, although they tend to have lower walkability scores in the empirical analysis summarised in Chapter Seven. In the future studies, researchers can take these "informal" footpaths into consideration for walkability assessment to obtain accurate estimates of walkability of a neighbourhood. By doing so, local government will be able to work on policies to improve the walkability of these "informal" but equally important footpaths in the pedestrian network.

Existing policy measures to promote walking have been largely focusing on modifications of the built environment features. However, findings of this study indicates that policy could also attend to person-related factors in terms of how they may shape pedestrians' responses to the built environment and the frequency of their walking activities. As the findings suggest, such person-related factors can moderate the effect of the built environment on walking (results from Chapter Six). For example, walking attitudes could be paid more special attention to during policy development. In line with other previous studies, my analysis confirmed that walking attitudes can moderate the relationships between the objectively measured built environment and walking frequency (Rhodes, Courneya, Blanchard, & Plotnikoff, 2007; Yu & Zhu, 2016). Influences on residents' attitudes towards walking might be a possible measure of policy intervention to promote walking in addition to those improving physical infrastructure, which, in most cases, could be more expensive. Whilst policies targeted at changing person-related factors may provide alternative options to promote walking, these measures might be difficult to implement, as some of these person-related factors are less susceptible to change. For instance, it normally requires a long time to change pedestrians' neighbourhood attachment and habit. In some circumstances, intention to promote walking might even

receive politically controversial feedback. Thus, the effectiveness and practicability of walking-promoting policies require further investigations in future studies. Although this research only used cross-sectional data regarding pedestrians' walking behaviour and various person-related factors, future studies could draw insights from the present study for using longitudinal data or quasi-experiential designs to explore the relationships between these person-related factors and walking behaviour.

From a national perspective, the central government of China has already dedicated to promoting active transportation through a series of policies that guided the development of walking and cycling infrastructure, especially in large cities such as Beijing, Shanghai, and Shenzhen. These cities have abundant financial resources to implement relevant policies to improve the pedestrian and bicycling infrastructure (e.g. development of greenways in Shenzhen). By contrast, relevant financial support could be limited in less-developed second- and third-tier Chinese cities, and the problems associated with the walking environment there would be more serious than we assumed. In this sense, some lessons from the case of Shenzhen could be learnt and Shenzhen's experience could illuminate the improvement of other Chinese cities' pedestrians' networks by adjusting to their specific context. For example, the multiple-scenario approach can be modified and applied in other Chinese cities to identify a suitable assessment scenario for the footpaths or areas with poor walkability. The findings can provide policy makers with necessary information in guiding the allocation of resources for future improvements in the physical infrastructure.

In practice, existing planning for walking has been premised on the behavioural perspective of walking, by focusing more on the relationships between pedestrian flow, walking speed, the space and density required by pedestrians, and how these factors contribute to different level-of-services (LOS) of the walking environment (Gupta & Pundir, 2015). Under the current discourse, pedestrians' walking experience has rarely been taken into consideration in the planning and design of the pedestrian network and associated facilities. Here, I

am not suggesting using pedestrian's walking experience as an alternative to replace the current methods (such as LOS) as guidelines in planning the walking environment. Instead, it would be beneficial for future studies to consider the potential for incorporating different aspects of walking experience into the planning of pedestrian environments and local networks. Pedestrians commonly regard walking not only as a mode of transport, but also as leisure, social and even community activities (Gatrell, 2013; Bean, Kearns, & Collins, 2008). How they feel and experience the walking environment during their trips affect the way they perceive the environment and whether they conduct other walking trips (or even develop a habit of walking) in the future.

Given that most of the walking trips conducted by pedestrians are very localised at and/or around their residential neighbourhoods, the use of the neighbourhood as the spatial unit of analysis is more effective for examining pedestrians' needs, feelings, experiences and behaviours. In combination with more recent studies that have explored the potential influence of small-scale local interventions on people's travel behaviour, this study also opens up debates over the development, applicability and effectiveness of neighbourhood-level intervention which might be having direct influences on people's travel behaviour. For example, in Aldred, Croft & Goodman's (2019) study, through the mini-Hollands programme, they explored the influence of a series of measures, including infrastructure improvements, traffic calming measures, and redesign of town centres on people's cycling behaviour in selected sites in London. It was found that these localised interventions could have positive influence on residents' active travel behaviour. Local government could draw insights from these studies to consider various policies to improve the walking environment (e.g. the importance of the maintenance and condition of the walking environment as highlighted in Chapter Six) in order to promote physical activity.

8.3 Reflections

Most of the existing studies on walking and walkability have been following the technical (engineering) tradition, in which researchers and planners pay particular attention to the collection and analysis of quantitative datasets that

usually cover a large geographical area. Nonetheless, the place-specific cultural, social, economic, political, institutional and physical – in short, geographical - context where such information was obtained is largely ignored (or assumed to be of limited importance) in these large-scale studies. This separation of the researcher, participants and the local context reinforces a prevailing discourse that stratifies participants based on different socio-demographic characteristics and strives to suggest a top-down approach to the planning and development of the transportation system that serve the needs of the general population (Hernandez, 2017).

This traditional approach can provide quantitative and generalisable findings for a large area and population. It also helps to provide a general understanding of that population's travel behaviours and patterns at the macro level and inform decisions that conform to the principles of utility maximisation for "average travelers". However, more so than other forms of travel behaviour, walking is a very personal activity and strongly related to pedestrians' own physical abilities, preferences, attitudes, and their interactions with the micro-level neighbourhood built environment features. As a result, people's walking behaviour can vary significantly even among those with similar socio-demographic characteristics.

To reach a more diverse sample, I have employed a multi-stage method for neighbourhood selection, through which residents in neighbourhoods with high and low accessibility in both urban core and outer urban areas of Shenzhen have been recruited. This method is more efficient for selecting neighbourhoods with contrasting characteristics, especially under the circumstances of lacking official statistical data at the neighbourhood level, and more importantly it can ensure the comparability of these neighbourhoods as some socio-demographic factors were used as control in the neighbourhood selection process. However, if more time and financial resources were available, it would have been beneficial to select more neighbourhoods in both the urban core and outer urban areas for comparison, and the results would have provided a more comprehensive sample of neighbourhoods that are representative for the case of Shenzhen.

In the qualitative study (Chapter Five), I have conducted a total of twenty in-depth interviews with pedestrians in Shenzhen by using a purposive and snowball sampling technique for participant recruitment. During this recruitment process, the aim was to reach participants with diversified socio-demographic profiles, such as in different age groups, gender, employment status, occupation, and those who have been living in their neighbourhood for different periods of time. With hindsight, the recruitment process could have been improved if special attention was paid particularly to potential participants with different levels of physical abilities prior to the recruitment process, as shown in Figure 8.1 below. For example, with more effort, participants with various levels of physical ability could have been reached [35] in each neighbourhood. This would enable me to gain more detailed knowledge of participants' physical abilities, the associations with their perceptions, attitudes and behaviours, and we may have been able to unveil more interesting patterns emerging from the comparisons of participants with different abilities, their walking behaviour and experiences.

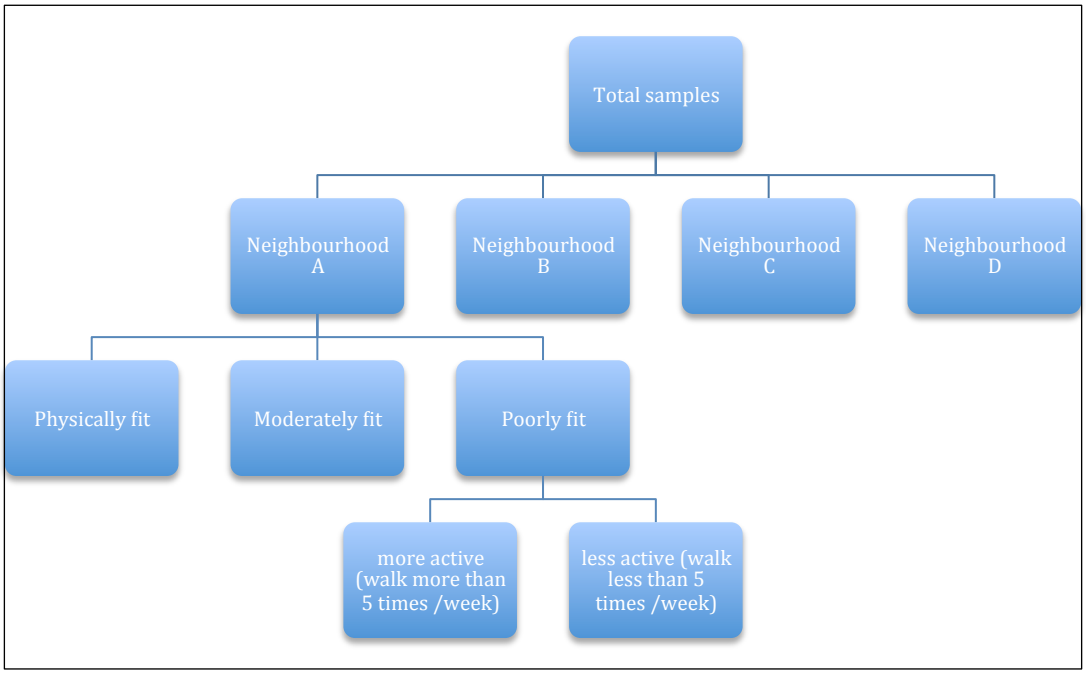


Figure 8.1 Proposed improvements in qualitative sampling protocol

[35] This variable is only used as an example for illustration, researchers can use other potential important factors to stratify the sample population into different sub-groups for participant recruitment.

The major challenge in recruiting respondents in China was the difficulty in inviting local residents to participate in the research. Lacking sense of trust and concerns over privacy were huge issues in the Chinese society, which have created barriers for similar research. This research could have benefit from support from more local universities, communities, and governmental departments, in terms of integrating the research activities into the local community or neighbourhood social activities. In this way, higher level of trust and reciprocal relationship could have been developed throughout the research, which may have created more opportunities to recruit participants with diversified characteristics.

Another limitation of the present study is a 500m buffer was used to define the neighbourhood area when capture the walkability of the selected neighbourhoods. Although there was no perfect solution to the problem of how a neighbourhood should be defined, sensitivity tests could have been undertaken to explore how different definitions of neighbourhood area, for instance both network or circular buffers with different sizes (500m and 1000m), would have impacted on the built environment influence on walking behaviour. Considering that MAUP (modifiable areal unit problem) may modify the associations between the built environment and travel behaviour, by altering the magnitude and significance of these effects (Mitra & Buliung, 2012; Houston, 2014; Li, Zhao, & Schwanen, 2020), this issue should have been examined more deeply, as a source of bias associated with the use of data aggregated to different areal units (Openshaw, 1984; Fotheringham & Wong, 1991).

Finally, participants have expressed the importance of person-related factors in shaping their walking experience during the semi-structured interviews. These factors include but are not limited to place and neighbourhood attachment, habit and routine, and preferences and attitudes. However, in the following quantitative study, I have only been able to incorporate walking attitudes into the model to test the moderation effects of this variable on the associations between the built environment and walking behaviour. Although some of other

person-related factors (e.g. habit strength and neighbourhood attachment) have been collected in the questionnaires, I have not incorporated these factors into further analysis. Similarly, the questionnaires also included items capturing participants' level of satisfaction with their walking trips, but this data has not yet been considered for the same reason. Subsequent studies will be undertaken to make use of the data to further explore their effects on people's walking behaviour and level of walking satisfaction.

8.4 Retrospect and prospect

This thesis has raised a series of important issues on the future urban and transport development. First, there is an urgent need to further understand pedestrians and their associated environmental exposures in different spatial-temporal settings. The focus of this study is limited to the neighbourhood-level environmental influences on people's walking behaviour and experience; however, a substantial proportion of people's daily walking (as well as other travel behaviour) is performed outside their own residential neighbourhood. This suggests a need for further investigations of the environmental effects on walking and travel behaviour at other spatial scales. Another dimension of this research would be to examine differences in walking behaviour in specific spatial settings, including walking trips connecting to metro stations, walking trips around work place, and other indoor trips, such as walking in shopping malls and other public spaces (King et al., 2016), walking in underground spaces (Gu, Osaragi, & Lu, 2019), and even walking in virtual reality (VR) environment (Usoh et al., 1999). A range of new technologies and devices, such as mobile phones, GPS, and accelerometers, generating new types of data could be possible to capture individuals' routes, speeds, and exposures to various environmental factors (Fernandes, Caiaffa, & Chaix, 2019; Helbich et al., 2016). Studies could also focus on using new techniques to develop more precise measurement of the dynamic aspects of the environment, in which people undertake walking and other trips. This could help to reduce the risk of drawing inaccurate conclusions about the causal relationships of the environment on people's behaviour and experience.

A second group of possibilities is to examine in detail the multisensory experience of walking and other travel trips. Following the so-called "affective turn" in the social sciences and humanities, researchers started to address the emotional, performative, and the non-representational aspects of life (see Anderson & Harrison, 2010). For example, one of the major focuses of geographers is the issue of sound, and they have developed a number of sonic methodologies, such as sonic mapping (Thulin, 2018), field recordings (Ritts, 2017), and sound walks (Gallagher, 2015), to complement the more traditional forms of data collection. The purpose is to understand the role of sound and soundscapes in people's affective and sensory experience (MacFarlane, 2019). Viewing people's walking (and travel) experience from a multisensory perspective can help to reveal how such experiences are co-produced by both human and non-human agents. And more importantly, it can help to examine how the growing popularity of ICTs and other mobile technologies affect the way pedestrians (and travellers) make use of their time during walking (and travel). For example, activities such as listening to music, watching videos, playing games, texting and using social media can shape pedestrians' (and travellers') experiences during the trip, by creating different affective, sensory and even participatory experiences (e.g. the use of an augmented reality (AR) devices).

A third set of issues concerns the wider impacts of proposed and existing policies associated with walking. Walking plays an important role in creating a more sustainable transport system, and a healthier city by improving people's physical and mental health, along with reducing the pressure on health services. In view of the importance of walking, various policies in promoting walking have been proposed and tested in many cities and countries worldwide (Ogilvie et al., 2007; Panter, Guell, Humphreys, & Ogilvie, 2019; Pooley et al., 2013). Nonetheless, the effectiveness of these policies and the transferability of these results to other locations are uncertain. Therefore, more detailed investigations are required to understand the outcomes and implications of these policies in different settings (urban or rural areas, developed or developing countries, high or low income regions). Although some recent studies have been devoted to examining the implications of various transport policies to social processes and conditions,

such as transport disadvantage and social exclusion (Xia et al., 2016; Rachele et al., 2017), the wider impacts of these policies have not been studied in detail. Especially in the developing city context, where walking is one of the most important mode of transport, how policy helps to address the issues of transport disadvantage, exclusion and inequality needs further examination. One of the most pressing problems in transport is transport inequality, including concerns over the distribution of transport-related impacts (Banister, 2018). Improvements in walking and public transport services can provide significant benefits to the disadvantaged population and have a substantial potential in contributing to the mitigation of transport inequality, yet the role of walking in mitigating inequality has not been widely studied. Transport inequality opens up further debates to reconsider the wider social, cultural, environmental, and economic impacts of the current (car dominance) transportation system in general, and walking related policies in particular.

Finally, technological innovations are significantly shaping the transport sector and people's travel patterns, for example through ride-sharing apps (e.g. Uber, Didi), food delivery platforms (Deliveroo), dockless bicycle hire (e.g. Mobike) and e-scooters (e.g. Lime) (Dudley, Schwanen & Banister, 2019; Alemi, Circella, Handy & Mokhtarian, 2018). Studies have begun to examine the impacts of these new technologies on people's future travel behaviour (Rasouli & Tsotsos, 2019; Wong, Hensher, & Mulley, 2020), but the extent to and ways in which these new forms of mobility are complementing or rather competing with walking are rarely discussed. For instance, what will be the impacts of these new forms of mobility on the planning of the built environment and competition for the limited road space, including pavements? How will these new forms of mobility influence people's walking and other active travel behaviour? How will the social, cultural, and regulatory factors condition people's acceptance of these new technologies? In order to understand these changes of the transportation system in the future and their multifaceted impacts on people's walking behaviour, health, and well-being, new perspectives and frameworks, such as the new mobilities paradigm, more-than-representational approach, socio-technical transitions framework, and systems thinking can be applied as unique analytical

lens to explore the impacts of the technological innovations on people's travel behaviour.

8.5 Concluding remarks

To most people, walking is their most common physical activity that they perform in their everyday life. Most of these walking trips are mundane and people usually perform them on a daily basis repeatedly and even habitually. But unlike other modes of transport, walking can be performed independently regardless of other actors (e.g. public transport operators) or the requirement for additional facilities (e.g. bicycles and automobiles), so it is the most simple but personalised form of transport. More importantly, compared to users of other transport modes, pedestrians are usually more exposed to the surrounding environment, and this provides an opportunity for pedestrians to have direct contact with the environment, and hence establish more intense personal connections and interpretations of the environment (Givoni & Banister, 2010).

Another important issue that has been discussed and woven into the three empirical chapters of this DPhil thesis concerns the importance of adopting a differentiated or personalised perspective to understanding pedestrians, their walking behaviour, experience, and walkability. Indeed, many recent studies have been focusing on studying various pedestrians groups, including older adults (Copeland & Esliger, 2009; Perchoux et al., 2019; Taylor et al., 2004), children and teenagers (Beets, Patton, & Edwards, 2005; Giles-Corti, Kelty, Zubrick & Villanueva, 2009; Hume, Salmon, & Ball, 2007), female pedestrians (Heesch, Van Uffelen, van Gellecum, & Brown, 2012; Troped et al., 2016), and people with disabilities or mobility impairments (Clarke, Ailshire, Bader, Morenoff, & House, 2008; Orellana, Bustos, Marín-Palacios, Cabrera-Jara, & Hermida, 2020; Rosenberg, Huang, Simonovich, & Belza, 2013). These studies have advanced our understanding of the factors that facilitate and constrain people's walking behaviour for specific pedestrian groups. However, these categorisations are mostly based on pedestrians' basic socio-demographic characteristics, such as age, gender, and physical condition. How individual pedestrians' preferences, attitudes, perceptions and habits shape the

relationships between walking and the built environment within these pedestrian groups has in most cases disregarded. Hence, researchers are unable to obtain a clear understanding of the variability of individual pedestrians' personal responses to the built environment and walking within these pedestrian groups.

Walking behaviour is also a highly differentiated activity that is consistently shaped by various factors, including the purposes of walking trips, characteristics of the built environment along the route, and pedestrians' encounters, companionship, and emotions during the trip (Gatrell, 2011). For instance, previous studies have shown that utilitarian walking trips are generally shorter in duration and faster in speed compared to recreational walking trips (Kang, Moudon, Hurvitz, & Saelens, 2017). So, walking behaviour and experience might be significantly different even for the same pedestrian who walks along the same footpath for different purposes and during different times of a day. A rushing pedestrian walking in the morning in order to get to office on time is less likely to pay attention to the surrounding environment, such as the aesthetics features and amenities available along the footpath, while a more relaxed pedestrian might be more likely to be attracted by various aspects of the built environment when they walk along the same footpath at other time periods for leisure/recreation. This more differentiated view of pedestrians and walking behaviour offers a new perspective for future researchers to rethink how various policies and interventions can be designed to be more effective in encouraging walking for pedestrians with different attitudes, preferences, meanings and place attachment.

There are several advantages in applying a mixed-methods approach to study neighbourhood-level walking behaviour and experiences. As walking is usually performed unconsciously or regarded as a habitual behaviour (as expressed by participants in the interviews as presented in Chapter Five), a mixed-methods approach offers an opportunity for the researcher to develop a more in-depth understanding of walking by using semi-structured interviews to capture these short, fragmented and often neglected walking trips. These walking trips are

usually underreported in existing methods of data collection, such as traditional travel surveys and travel diaries, which are primarily designed to measure motorised trips (Kang, Moudon, Hurvitz, Reichley, & Saelens, 2013). A mixed-methods approach does not only help to uncover these unconsciously performed and usually neglected walking trips, but it also provides more detailed account of the characteristics and the experiences associated with these walking trips.

The use of mixed-methods approach also facilitates the identification of important context-specific factors that can help to explain participants' walking behaviour and experiences. Due to the prevailing use of quantitative methods that attempt to provide context-independent results, less attention has been paid to understanding the role and importance of these context-specific factors in existing studies. For instance, in this study, I have highlighted the importance of personal meanings, attitudes towards walking and attachment to place in shaping pedestrians' perception of the built environment and their walking experiences, which are largely overlooked in existing studies on the environment-walking connections. This finding has inspired me to develop and test new hypotheses – to further examine the interaction effects of walking attitudes, perceived built environment and objectively measure neighbourhood characteristics on walking behaviour. These factors have all helped to explain people's neighbourhood-level walking frequency. The use of a qualitative exploratory study can allow researchers to identify new factors that might contribute to a better understanding of the phenomenon to be studied, and subsequent quantitative analyses can enable them to develop new hypotheses and examine these relationships in a numerical way.

Nonetheless, there are several disadvantages associated with the use of mixed-methods approach. The first and most important one is resource requirement, especially for mixed-methods studies that are conducted sequentially. For instance, in this study, I have conducted the first stage of fieldwork for semi-structured interviews, then analysed the data and used the qualitative data to develop the questionnaires to collect quantitative data in the

second stage of fieldwork. This process has involved a lot of time (for transcription and analysis of results) and resources (monetary costs to travel and collect data in two separate stages). Next, it also requires the researcher to have the knowledge and skills for conducting both qualitative and quantitative analyses. As I did not have any experience or training in conducting qualitative data analysis in the past, it took more time than expected for me to learn how to conduct semi-structured interviews, analyse qualitative data and write up the findings, which in fact, is very rewarding, but nonetheless, challenging and time consuming.

In combination, the empirical analyses of this DPhil project have demonstrated that the use of a pedestrian-centred perspective has provided a comprehensive understanding of the environmental influences on people's walking experience and behaviour, by considering individuals' responses to the environment as being more personal and idiosyncratic. This pedestrian-centred perspective has also embraced the complexity of interacting components involved in the co-production of various practices that enables and constrains people's behaviour. Researchers are now able to consider the potential factors (such as various person-related factors, like attitudes, perceptions, meanings and place attachment) that are commonly neglected. The incorporation of these other factors helps to understand the potential causal pathways that explain the environmental influences on people's behaviour, through the formation of various values, preferences, or lifestyles, which might provide more theoretically driven understandings of the environment-behaviour connections.

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