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Walking to Occupational Activities in Basra City: developing and testing an ecological model to support evidence-based feedback in neighbourhood planning

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Author's Declaration:

'This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.'

Signed:
Date:

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Abstract:

The widespread pattern of urban sprawl, consistent with many modern urban developments, is considered in contemporary planning literature as anti-pedestrian. Conversely, the 'traditional neighbourhood' is widely considered by those in the field as offering a pedestrian-friendly environment. Recent research interests in the potential walkability of traditional neighbourhoods conform to the neo-traditional approach in urban planning, design, and development, and have influenced the emergence of New Urbanism. The transformation of Basra City's urban form during the 20th Century (from traditional to modern) remains unexplored in terms of its impact on the walking behaviour of residents, and therefore, this research develops and tests an ecological model of walking to occupational activities at a neighbourhood scale within Basra City, and generates evidence-based feedback to guide further master planning in the region. The thesis comparatively applies the ecological model to the neighbourhood scale in order to shift the walking-neighbourhood relationship from a correlational approach to a casual and multilevel approach, examining socio-demographic factors, urban planning and design measures, the perceived environment, and social cognition factors based on the construct of the Theory of Planned Behaviour (TPB). Walking behaviour was modelled on three types of influence by the neighbourhood environment on walking outcomes, namely mediation, moderation, and determination (or prediction), in order to address research questions and generate evidence-based feedback. Each model combines and tests several variables to address research questions and statistically evaluate the significance of individual walking outcomes. The mediation model combines the objectively measured walkability index (X: predictor), perceived environment factors, or belief-based measures of walking from the TPB (M: mediators), and a walking outcome (Y: dependent variable) in order to evaluate the extent to which M mediates the direct effect of X on Y. The moderation model combines the objectively measured walkability index (X: predictor), socio-demographic factors (Mo: moderators), and a walking outcome (Y: dependent variable) to establish whether the interaction between X and Mo have a significant effect on Y; in other words, to establish the extent to which Mo moderates the direct effect of X on Y. The determination model tests the extent to which the objective measures of the physical environment can predict the walking outcomes; in this respect, the objective measures of urban design and urban form morphology are tested. The objective measures of the physical environment indicate the high to moderate predictability of walking outcomes. Meanwhile, the subjective measures (socio-demographic factors, perceived environment factors, and belief-based measures of walking) indicate a moderate to weak predictability of walking outcomes. Moreover, the results indicate that meeting the recommended ≥150-minutes walking per week is largely determined by spatial factors within the neighbourhood typology constituent of traditional and modern neighbourhood classifications. Subsequently, feedback to the master planning of Basra city is generated, and general guidance on neighbourhood design is proposed.

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1 Introduction

1.1 Research background

In promoting the walkability of the built environment, which is an activity considered important for public health (Pate et al., 1995), and based on research-evidence that initiatives related to the built environment and policy ensure easy and accessible opportunities for physical activity (Sallis et al., 2006; Sallis et al., 2016), this research develops and tests an ecological model of walking to occupational activities at the neighbourhood scale. The aim is to address the impact of the social and physical environments on walking within the built environment. These occupational activities include undertaking work and study, practising a type of sport, going to the Gym, meeting with friends or equivalents, shopping for food, shopping for consumer goods, visiting a doctor, and conducting personal business investigates this within the context of ecological models of physical activity, which are a widely recognised means of intervention. This research is influenced by a number of factors, which are; firstly, an identified gap in the body of knowledge concerning the ecological models of physical activity. This body currently lacks an understanding of the ecological models of walking to occupational activities. Secondly, there is a widely-agreed notion within the literature that 'urban sprawl', which is consistent with modern development, is automobile-oriented and thus risks losing the inherent human/social spirit of urban areas by being poorly pedestrianised; in comparison, more traditional neighbourhoods tend to provide more pedestrian-friendly environments (Davies, 2015; Davies & Townshend, 2015; Duany, Plater-Zyberk, Krieger, & Lennertz, 1991; Duany, Plater-Zyberk, & Speck, 2001; Jacobs, 2016; Katz, Scully, & Bressi, 1994;).

For these reasons, this research will examine three case studies in Basra city to test the ecological model developed for the study. These case studies have been selected as their urban forms adopt a range of traditional and modern master planning principles, and it is thus possible to identify and compare three evolutionary stages of the urban form of Basra city and thus the impacts on ecological models of physical activity. Therefore, the ecological model of walking to occupational activities at the neighbourhood scale needs to investigate the unexplored multiple levels of walking-environment relationships, or more specifically, determine the effects of the social and physical environments on walking behaviour. As such, the study is concerned with testing: the moderation role of socio-demographic factors, the mediation effect of the perceived environment and belief-based measures of walking, and the determination effect of the physical environment. These will be applied to three neighbourhood typologies in Basra city. Moreover, it is anticipated that the study will provide evidence-based feedback on a neighbourhood scale for future developments and current master planning criteria. Moreover, it could provide an additional understanding of the current advances made by research into ecological models of physical activity, which significantly explained characteristics of physical activity and environmental factors; for example, between a sedentary lifestyle and obesity (Sallis, 2006; Sallis, Bauman, & Part, 1998; Sallis, Floyd, Rodriguez, & Saelens, 2012; Sallis, Owen, & Fisher, 2008; Sallis et al., 2009).

1.2 Walking in the built environment

Walking is a widely promoted human physical activity due to its benefits for public health (Kahlmeier et al., 2011; WHO, 2011). However, a sedentary lifestyle is recognised as a serious threat to public health and has been linked to an increase in the rates of obesity (Committee, 2008; Sallis et al., 2006; Sallis et al., 2012). Nevertheless, within the contemporary urban environment, the trend of adopting modern master planning is widely considered an anti-environmental intervention because it encourages riding at the expense of walking (Davies, 2015; Jacob, 1961). Recently, two types of study have examined the relationship of the walking built environment (Figure 1-1) and these are: the ‘phenomenological trend’ associated with the New Urbanism NU, and the ‘study type’ trend, which focuses on ecological models of physical activity.

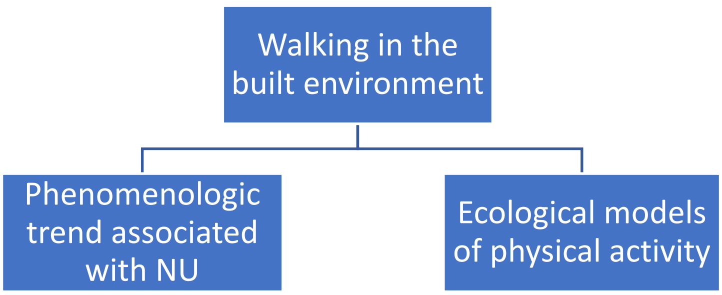

Figure 1-1: Types of studies related to walking in the built environment: (the author)

The first type is the phenomenological trend of studies; these tend to qualitatively investigate human activity and the built environment as two observed phenomena (e.g. Friedman, Gordon and Peers, 1994; Handy, 1993, 1996, 2006; Hess, Moudon, Snyder,

& Stanilov, 1999; Kitamura, Mokhtarian, and Laidet, 1997; Lee & Moudon, 2006a, 2006b). On the level of theory, this type of study relates to the New Urbanism movement, which recognises that the traditional organisation of the built environment provides more appropriate solutions for a better urban life (Davies, 2015). In contrast, the modern movement tends to focus on the suburban, automobile-based built environment, with homogenised land use, the neglect of a sense of place and community engagement, and the decline of the role of neighbourhood units in the formation of urban environments (Jacob, 1961).

Jacob (1961) was a notable contributor to the debate concerning the loss of the inner life of American cities, which she argued was caused by modern development. Jacob therefore advocated traditional over modern styles of built environment formation. Similarly, the New Urbanism movement has more recently advocated for the pre-modern quality of the built environment. New Urbanism (NU) emerged as a reaction to the modern movement that predominated from the end of the 19th Century and during the 20th Century. Within the concept of NU, neighbourhood design is considered a basic influential factor on the persuasion to walk. Indeed, walking is strongly advocated by the New Urbanism movement that has also called for the redesign of neighbourhoods in the USA to provide more pedestrian-friendly built environments, as opposed to the existing urban sprawl of modern developments (Duany & Plater-Zyberk, 1992). This approach could be applied to urban development on varying scales; for example, at the scale of the neighbourhood it has been called Neo-Traditional Development NTD. This movement adopted certain qualities from traditional neighbourhoods that were felt to be particularly positive and reflective of more compact traditional urban tissue; key qualities included mixed land use, housing typologies, grid-like streets, and high densities. NU often expresses the need to, “rediscover the neighbourhoods and sense of community through more human scale development” (Davies, 2015:p.18), and conceives a better “public transit connectivity”, more walking amongst the community, and an increase in the social experience of a community (Davies, 2015).

Moreover, based on empirical studies, inhabitants consider the qualities of the built environment fundamental to the travel choices adopted. In this regard, Levinson and Wynn (1963) demonstrate that travel demand could be reduced according to the density of the neighbourhood. However, Handy (1993) compared trips to shops between the traditional and auto-oriented neighbourhoods of San-Francisco on nonwork travel and revealed that the walk/bicycle trips per week to local shops within traditional neighbourhoods was four times greater than those within automobile-oriented neighbourhoods. Furthermore, Friedman, Gordon and Peers (1994) demonstrated a considerably higher walking rate amongst traditional neighbourhoods compared with post World War II suburban developments. Their study recommended extending the transit-neighbourhood trend to include individual and socioeconomic factors, which may have contributed to explain this relationship. More precise qualities were considered in other studies; for example, Kitamura, Mokhtarian, and Laidet (1997) studied the different factors of four neighbourhoods in terms of their effect on walking, and included mixed land use, density, walkways, proximity to local shops, house typology, and the quality of neighbourhood structures. Their study reported the significant explanatory potential of these factors, which were subsequently added to the socio-economic influences.

Furthermore, NU identifies that the hierarchical configuration of the urban form is important for walking because it influences how users perceive space; in this respect the neighbourhood, district, and corridor are considered basic elements of the metropolitan area. Neighbourhoods must be compact, of mixed-use, and pedestrian friendly, whereas a district generally concerns a specified land use that follows the neighbourhood scale, while corridors connect the regional, district, and neighbourhood scales. Moreover, daily activities mostly take place within walking distances of a defined centre, and in this respect, streets must be well connected to ease the flow of pedestrians (Davies, 2015).

The second trend in terms of study type (Figure 1-1) is the ecological models trend of active living within the built environment, where the relationship between the social and physical aspects of the built environment and an active living style are widely considered in the light of the increase in sedentary lifestyles and obesity (Feng, Glass, Curriero, Stewart, & Schwartz, 2010; Le Marchand, Wilkens, Kolonel, Hankin, & Lyu, 1997; Martínez-González, Martinez, Hu, Gibney, & Kearney, 1999; Sallis, 1993; Sallis & Glanz, 2006; Wing et al., 2001). Indeed, this multilevel, quantitative trend of studies tests the influences of the social and physical environments on physical activity. In this regard, Sallis, Owen, & Fisher (2015) report that the ecological models developed from an increasing awareness of the importance of environmental influences in developing precise models that concern particular environmental factors and the specific categories of participants (e.g. Giles-Corti et al., 2005; Saelens et al, 2003; Sallis, Owen, & Fisher, 2015). The results can help parties from the human behaviour and health-related disciplines, and the built environment-related disciplines.

The following discussion aims to discuss the theoretical trajectories between physical activity, the built environment, and health. Bauman et al. (2002) explained that the notion of causality was applied to, “disease-based epidemiologic studies”, and state that a group of factors indirectly cause several diseases, like coronary heart disease. These factors are the primary reason for such diseases and contribute to micro-physiologic alterations; such instances of these factors include physical inactivity, and smoking. Such a causal pathway suggests that behavioural change reduces the likely occurrence of some diseases by causing physiologic change (Bauman, Sallis, Dzewaltowski, & Owen, 2002). Since the identification of this understanding, behavioural change has become crucial to public health. Moreover, it has become a matter of interest for different fields of research concerned with improving physical activity, like social science, behavioural psychology, and the built environment.

Active living means incorporating physical activity into everyday life (Sallis, Linton, & Kraft, 2005). It accounts for physical activity in terms of everyday human activities, like shopping, working, entertainment, or even walking. In this respect, the quality of the built environment is important and, in terms of walking, has a direct effect. Studies related to the built environment, active living, and physical activity identified different factors that were thought to be influential on physical activity, and these include; density, proximity, mixed land-use, and streets connectivity. These urban qualities result in significant impacts on the decision to walk to transport and recreation activities (e.g. Frank & Engelke, 2001; Frank et al., as cited by McCormack, Giles-Corti, & Bulsara, 2008).

NU recognises that the importance of the physical environment on physical activity stems from the creation of cues and opportunities for human actions (Davis, 2015). It significantly influences human behaviour through the connectedness of urban planning and urban design. For example, the accessibility and distance in different community designs, whether determined through objective or subjective measures, has demonstrated a significant association with walking and urban structures (e.g. Owen, Humpel, Leslie, Bauman, & Sallis, 2004; Owen et al., 2007). Moreover, the influence of the physical environment on physical activity levels was widely examined, especially within ecological models (e.g. Bourdeaudhuij, Sallis, & Saelens, 2003; Gebel, Bauman, & Petticrew, 2007; Giles-Corti and Donovan, 2002; Humpel, Owen, & Leslie, 2002;

McCormack et al., 2004; McCormack et al., 2007; Pikora et al., 2002; Sallis et al., 2012).

1.3 Theoretical roots of the ecological models of physical activity

The increasing consideration of ecological models in the study of physical activity is partially attributed to the need to attend public health problems by addressing multilevel intervention plans based on research evidence (Sallis, Owen, & Fisher, 2015). As an inactive lifestyle increases the risk of developing several diseases, such as diabetes mellitus and obesity (Physical Activity Guideline Advisory Committee, 2008), improving physical activity is fundamental to the prevention of such diseases. To help people become physically active, evidence-based intervention plans go through multiple levels of association between physical activity and the social and physical environment; these plans are otherwise known as ecological models (Sallis et al., 2006; Sallis et al., 2012; Sallis, Owen, & Fisher, 2015). Also, improving physical activity, especially by walking, meets with the principle aims of a sustainable agenda (Brundtland, 1987), through reducing residents' dependence on automobiles; such a change helps to reduce CO_2 emissions. This has developed in the context of an increasing awareness of the rapid growth of urban areas and their populations; indeed, the United Nation (2016) reports that the worldwide urban population will continue to increase from 56.2% in 2016 to 60% in 2030. In context, this means that a megacity of one million inhabitants will increase from 512 in 2016 to 600 in 2030 (United Nations, 2016) (Figure 1-2). This population expansion and significant urban growth has prompted ecologists, urban planners, and decision makers to urgently reconsider ecological knowledge within urban life to ensure that future cities will to be better places for living, with minimal environmental impact.

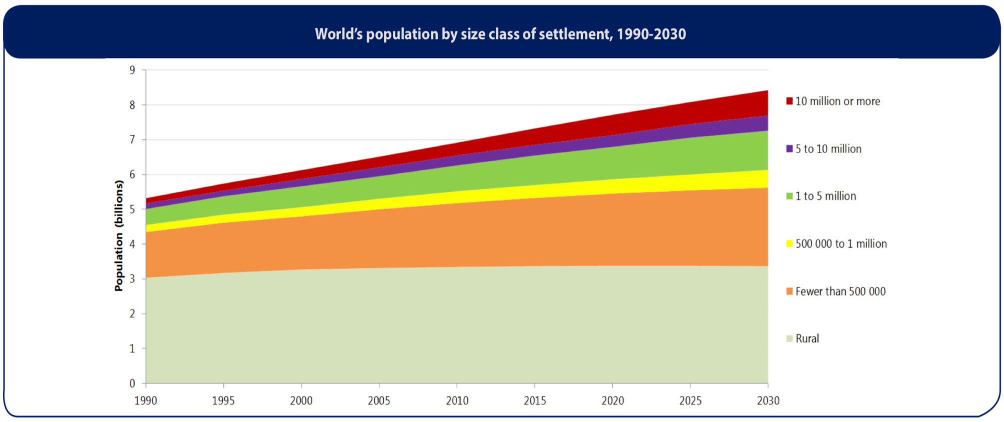

Figure 1-2: Urban population growth (United Nation, 2016)

By examining physical activity as an ecologic phenomenon, it is possible to perceive the urban phenomenon as an ecosystem. Essentially, ecology is a disciplinary area of knowledge that concerns the interaction processes within/between biotic and abiotic systems, or the living and the non-living ingredients of the system (Odum & Andrews, 1971). The city as an emergent, human-dominated, ecological phenomenon consists of a myriad of systems; therefore, the ecological outcome of cities depends on the interaction of its secondary systems and impacts both humans and the environment (Alberti et al., 2005). Thus, ecological studies concerning the human-environment relationship focus on the structures and the processes of interaction. Pickett (2013) defined the urban ecology as:

> "The study of structure, dynamics, and processes in urban ecological systems" which takes into consideration "the relationships of human and nonhuman organisms in urban areas, the interactions of these organisms with the native and built physical environment, and the effects of these relationships on the fluxes of energy, materials, and information within individual urban systems and between urban and nonurban systems" Pickett (2013:p.6).

Thus, Pickett considers that ecologic processes are indivisible from the urban phenomenon, and distinguishes two distinct approaches of urban ecology. The first approach is "the ecology in cities", which studies the "ecological structure and function of habitats or organisms within cities" as an ecosystem (Pickett, 2013). This approach emphasises the, "physical environment, soils, plants, and vegetation, and animals and wildlife"; these represent the fundamentals when studying urban ecosystems, and accord with a case study research methodology. The interaction of functionally-related or structurally-adjacent patches can inform and predict the casual systematic changes; this is also called the "patches-oriented ecology approach". An example offered by Oke (as cited by Pickett et al., 2013), is the study of the physical environment that leads to an understanding of the differential between urban areas and surrounding rural areas with respect to urban heat islands. This arises because of the differentiation between the land cover and energy consumption.

The second trend of urban ecology is called the "ecology of the city", which considers the city as an ecosystem that has a mutual impact on the whole ecosystem of the earth and the surrounding areas of the city (Grimm et al., as cited by Pickett et al., 2008). This type of ecology is associated with an increasing consideration of the ecological systems in the city, where the understanding of nature and the interaction processes between the various systems produce a greater understanding of ecological processes within cities. Pickett (2008) states that scientists, planners, and decision-makers must understand interaction processes between social, economic, and ecological factors in order to properly assess the ecological connections, particularly in terms of the dynamics and feedback of the systems' interactions. According to Pickett, the "system-oriented approach" of urban ecology contrasts with the "ecology in the city" as it is not constrained to individual or group organisms but takes into consideration multiple systems of different interacting entities, like organisms, landscapes. This means including knowledge of each system, without considering the external links of the interacting systems. Also, from an ecological perspective, the structural qualities are less important than the emerging functional systems (Pickett, Cadenasso, & McGrath, 2013a). There is a general consensus among contemporary urban ecologists, that urban areas represent ecosystems that are associated with human activities and thus produces different emerging systems, like the economy and everyday life human activities (e.g. Alberti, 2005; Grimm et al., 2000; Pickett et al., 2008). Therefore, human activities ought to be reconsidered ecologically and as a key driver of the human-environment interaction (Figure 1-3), rather than by limited similarity, which contributed to the emergency of the social-ecology approach.

Figure 1-3: The broader disciplines of knowledge of the ecological models: (the author)

1.4 Social ecology approach

Not only is the human-free ecological paradigm no longer considered by recent studies, but contemporary ecology states that human and social drivers are both undeniable forces within the urban ecosystem (Alberti, 2005; Gaston, 2010; Grimm, Grove, Pickett, & Redman, 2000; McHale et al., 2015; Marzluff et al., 2008). Thus, Alberti et al., (2005) argued that humans must be incorporated into all ecological domains, and recently, humans have become an essential element of the urban ecosystem. Sukopp (as cited by Pickett, 2008) and Deelstra (as cited by Pickett, 2008) addressed urban ecology from urban planning perspective "emphasize designing the environmental amenities for urban residents" and "provides ecological justification for planning goals" like mitigation the environmental impact (Pickett et al., 2008:p.29). As such, urban studies that take the human dimension into consideration as an ingredient of the urban ecosystem can play an important role in future sustainable development (McHale et al., 2015).

The emerging socio-ecological perspective is a thorough approach concerning the human-environment association, which incorporates multidisciplinary factors within proposed interdependency relationships (Emery & Trist, 2012; Fischer-Kowalski & Haberl, 2007; Glaser, Krause, Ratter, & Welp, 2008; Ungar, 2011). Albert (2005) stated that social ecology, as a socio-ecological system, could be disjointed into human and environmental systems, where the former either creates the built environment or uses it, and the later represents the natural, man-made, and social environment. Thus, human activity in everyday life within the built environment stimulates the processes of human-environment interaction by fulfilling human needs that include shelter, work, shopping food, and recreation. Nevertheless, within the broader field of social ecology, there is a trend for studies that explore ecological models concerning physical activity. These have emerged to address the widely promoted topic of active living within the built environment.

1.5 Ecologic models of physical activity

This thesis recognises the importance of urban ecology and the social ecology paradigm, including the importance of interaction processes among the urban systems and the outcomes associated with human activities in the built environment. Nevertheless, ecological models of physical activity also consider these. The numerous studies that provide evidence of the importance of the human-environment interaction for both sides, have encouraged the development of ecological models of healthy behaviour that particularly concern active living lifestyles and are associated physical activities (Sallis, Owen, & Fisher, 2015).

Thus, the influences of the social and physical environments on physical activity are widely reviewed in terms of three types of ecological processes. These processes include, "determination", "moderation", and "mediation" (Sallis et al., 2006), and define the dimensions of the physical activity ecological models within this area of research. Thus, ecological models concerning physical activity is defined as seeking to inspect multiple levels of association between individuals' physical activities and their social and physical environments (Ding, Sallis, Kerr, Lee, & Rosenberg, 2011; Ding et al., 2012; Sallis et al., 2006; Sallis, & Kerr, 2012; Sallis, Owen, & Fisher, 2015). Generally, these models are concerned with extending the scope of behavioural studies from the narrow perspective, which correlates behaviour with the physical surroundings (phenomenological approach), to multi-level environmental and individual measures, including; “intrapersonal (biological, psychological), interpersonal/cultural, organisation-al, physical environment (built, natural), and policy (laws, rules, regulations, codes)” (Sallis, Owen, & Fisher, 2015:p.466).

However, this research agrees with the arguments against such correlations concerning physical activity. This is because the problems concerning low physical activity levels are not solely due to lack knowledge, but are instead multidisciplinary and interdependent, and include the social, institutional, individual, and so forth. Therefore, any intervention must be multi-level in terms of its effect on active living (Sallis, 2006; Sallis, Owen, & Fisher, 2015). This creates the opportunity to involve the urban planning and design disciplines in the planning for interventions to enhance the physical activities of people.

Sallis et al. (2006) state that the principle theoretical posits of the ecological models that embrace an interdisciplinary approach relate to active living domains and physical activity. Their study explains that there are several environmental and policy factors associated with these domains and relevant physical activity. They emphasise the role of the built environment within ecologic models, and the complexity of factors that relate to every single characteristic of the built environment, such as policy, urban planning, management, and so forth. Four active living domains were identified by Sallis et al. (2006), which are:

1. Active recreation: human activities in parks and athletic fields, recreational activities in designed settings, like playgrounds, swing parks, and so on.
2. Active transportation: human activities related to transport modes, especially walking and biking.
3. Household activities: activities which occur in the environment of the home, like cleaning, watching TV, playing, and so on.
4. Occupational activities: all human activities related to everyday life routines. In other words, all human activities after excluding the previous three types of

domain. Examples of occupational activities include; work, study, shopping, meeting friends or colleges (Sallis et al., 2006).

Furthermore, several models were developed to inspect walking behaviour, especially with regard to recreation, leisure-time, and transportation, as an active living domain (e.g. Giles-Corti, Kelty, Zubrick, & Villanueva, 2009; Lee & Moudon, 2006; Lee & Shepley, 2012; Pikora, Giles-Corti, Bull, Jamrozik, & Donovan, 2003; Rhodes, Courneya, Blanchard, & Plotnikoff, 2007; Van Dyck et al., 2013; Witten et al., 2012). However, within the wider physical activity models there are currently few existing ecological models included limited concerns about the walking and occupational activities (e.g. Abu-Omar & Rütten, 2008; Hu et al., 2003; and Hu et al., 2005). Moreover, there is no specific ecological model of walking to occupational activities at the neighbourhood scale.

1.6 The research statement

The research statement is addressed through articulating two different topics; urban ecology and the associated ecological models of physical activity, and the significant alteration of the quality of the urban form of Basra city from a traditional to modern status. With regard to the first topic, there is a gap in the body of knowledge concerning the ecological models of active living. **There are currently no ecological models concerned with occupational activities of the active living domains with walking mode of transport at the neighbourhood scale.** This is the domain that this doctoral research aims to address. Moreover, the ecological models involve case study research, which relies on contextual factors to reveal the processes of interaction. Thus, three neighbourhoods of Basra city are systematically defined as the arena in which to apply the model. Therefore, the main contribution of this research is to design and test an ecological model of walking to occupational activities at the neighbourhood scale to reveal the multi-level influences of the social and the physical environments. This will be applied within three neighbourhoods of Basra city to examine the impact of altering the quality of the neighbourhood typologies from traditional to modern during the 20th century. In this regard, the research trend for ecological models of physical activity significantly distinguish the role of the built environment on physical activity, particularly amongst the community design components (e.g. De Bourdeaudhuij, Sallis, & Saelens, 2003; Ding et al., 2012; Ding et al., 2013; Ding, Sallis, Kerr, Lee, & Rosenberg, 2011; Ewing & Cervero, 2001; Sallis et al., 2006; Sallis et al., 2009; Sallis, Floyd, Rodríguez, & Saelens, 2012). The evidence from this type of study could contribute to the creation of intervention plans on the level of policing and master planning to create appropriate settings that could promote sustainable behaviour (Sallis, 2006; Sallis, Owen, & Fisher, 2015).

The aim of this research is directly developed from the research statement and defines what this study intends to achieve. Also, the objectives of this research are developed to define how the research is going to achieve this aim. In this respect, it is intended that the ecological model of walking to occupational activities at the neighbourhood scale explain the multiple levels of environment-activity relationships that are associated with the research statement. The nominated relationships (human-environment) are associated with the three mechanisms of the ecologic process of physical activity that were defined by the ecological models. These include "determination", "moderation", and "mediation" (Bauman, Sallis, Dzewaltowski, & Owen, 2002), and are directly utilised to define the research questions. Moreover, the directional hypothesis of this research proposes a significant association between the independent and the dependent variables, which is based on evidence from the literature reviewed in Chapter Three.

1.7 The aim of this research

This research aims to statistically infer the multiple levels of social and physical environmental influences on walking behaviour to occupational activities in three different neighbourhood typologies in Basra city, to provide evidence-based feedback to inform neighbourhood master planning changes to encourage an increase in walking.

1.8 Research objectives

1. To elaborate the three evolutionary stages of the urban form of Basra city, the case studies, in terms of the effects of altering their neighbourhoods planning during the 20th Century from a self-organised (unplanned) to a planned status.
2. To systematically define the case studies, and produce a cadastral map for each typology. The cadastral maps will provide raw information to compute the measures related to urban planning and design.

3. To develop the required theory-based conceptual framework of this study, which will establish for the required instruments to gather data concerning walking to occupational activities at the neighbourhood scale.
4. To implement an appropriate methodology that applies the questionnaire of this research within the case study, and to employ SPSS software to analyse the collected information. This objective develops the dependent and independent variables required to response the research questions, based on the statistical analyses. Also, these analyses will include testing the normality and reliability of the dependent and independent variables.
5. To establish the effects of the individual traits of residents (socio-demographic and BMI) on the walking outcomes .
6. To determine the effect of the subjectively measured (perceived environment factors and belief-based measures of walking) on the walking outcomes.
7. To determine the effect of the objectively measured physical environment attributes on the walking outcomes.
8. To provide recommendations for current master planning of neighbourhoods in Basra city concerning neighbourhood designs that are considered to be supportive of walking.

1.9 Research questions

The indicators of this research, namely (1) the socio-demographic and BMI, (2) the perceived environment and belief-based measures, and (3) the objective measures of the physical environment, are categorised in the light of the defined ecological processes (section 3-1) of physical activity into the moderation, mediation, and determination variables, respectively, of this research. They will be tested with these regards as the sources of influence on the walking outcomes. Thus, the following research questions are formulated as the basic enquiries of this research.

1. Do neighbourhood typology[1], personal traits[2] and individual traits[3] have effects on the walking to occupational activities in the neighbourhoods of Basra city?

[1] Three neighbourhoods in Basra city are utilised in this research as case studies
[2] Personal traits: socio-demographic information and Body Mass Index (BMI)
[3] Individual traits: the perceived environment, and the belief-based walking measures of the Theory of Planned Behaviour (TPB)

2. Do the belief-based measures of walking mediate the direct effect of the physical environment on the walking outcomes[4]?
3. Do the factors of the perceived environment mediate the direct effect of the physical environment on the walking outcomes?
4. Do the personal trait factors moderate the direct effect of the physical environment on the walking outcomes?

1.10 Research hypotheses

Based on evidence from the reviewed literature (Table 3-1), this research develops a 'directional hypothesis' (Creswell, 2013), in that the walking outcomes to occupational activities among adults are associated with the tested mediation, moderation and determination variables from the social and physical environments. In this regard, the evidence obtained from the application of the research methodology responds to the research questions throughout concerning the extent of the consistency with the hypothesis. Moreover, any non-significant association supports the null hypothesis of a non-association between the tested variables.

1.11 Research design

Creswell (2014) described two research strategies that span theory and reality; these are *inductive,* and *deductive.* Inductive and deductive strategies can be two divisions of one process; for example, the inductive strategy is a "process of working back and forth between the themes and the database until the researchers have established a comprehensive set of themes", and the deductive strategy can systematically explore a case study or data that are collected on an inductive level, to confirm or refute hypotheses that were addressed on an inductive level (Creswell, 2013). In this respect, the structure of this study covered an inductive, and deductive level to deal with the theoretical and empirical aspects of this research, respectively (Figure 1-4). Moreover, the ecological models highly consider the logical positivism on the methodological level in term of splitting the study into induction level (qualitative) and deduction level (quantitative) (Glanz, Rimer, & Viswanath, 2008:p.29).

[4] Walking outcomes: total walking distance, total number of walking journeys, total walking minutes, and the recommended ≥150 minutes per a week (Hagströmer, Troiano, Sjöström, & Berrigan, 2010)

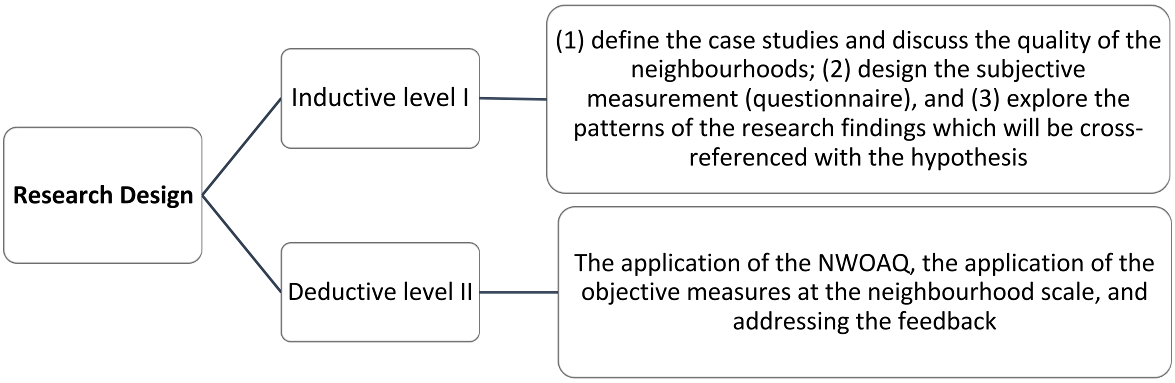

Figure 1-4: Illustration of the Research Design: (the author)

1.11.1 Induction level

The induction level aims to achieve the qualitative objectives of this research, which are to; (1) define the case studies and comparatively discuss the quality of the neighbourhoods; (2) design the subjective measurement (questionnaire), which, in this research, is called the Neighbourhood Walking and Occupational Activities Questionnaire (NWOAQ); and (3) explore the patterns of the research findings which will be cross-referenced with the hypothesis. This measurement is based on subjective instruments of physical activity, and designed in accordance with the belief-based questions of walking from the Theory of Planned Behaviour (TPB). It also involves the conduct of an interview to define the domains of the occupational activities at a neighbourhood scale.

1.11.2 Deduction level

The deduction level aims to achieve the quantitative objectives of this research. In this regard, the Neighbourhood Walking and Occupational Activities Questionnaire (NWOAQ) is applied. A cross-section quantitative method is used to distribute the questionnaire amongst a random sample of adults (aged 18-65) who have no disabilities to impede their ability for walking, and who reside within the sampled urban typologies. Also, the objective measures at the neighbourhood scale, and the urban planning and design measures, are based on data from the developed cadastral maps. Moreover, based on the research questions, a multiple level of statistical analysis was conducted based on the variables developed in this research (Table, 7-1). This included the determination (or prediction) models, mediation models, and moderation models.

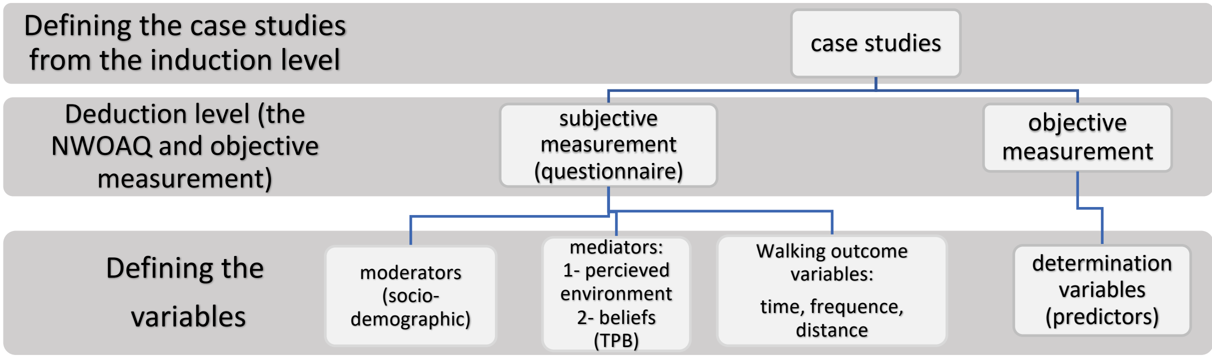

Figure 1-5: Empirical levels of this research: (the author)

1.11.3 Summary of the research methodology

A mixed research methodology is adopted in this study based on six criteria defined by Creswell (2013), and thus this research could be considered an exploratory sequential mixed method design (Creswell, 2013) because its approach starts with a qualitative (induction) level, and then quantitatively applies the NWOAQ questionnaire (which forms the deduction level), which is applied to three residential neighbourhoods. These three case studies represent the three evolutionary stages of the urban form of Basra city. These neighbourhoods are: Al-Saymmar, Al-Mugawleen, and Al-Abassya. The physical tissue of each neighbourhood is sampled on a 10-minute (400-metre radius), and a 15-minute (600-metre radius) walking criteria; cadastral maps were then developed and utilised as the main source of information to conduct the objective measurements.

The NWOAQ questionnaire is a self-report quantitative instrument, and although it has qualitative items, the instrument enables quantitative measurements (via a Likert scale) of the perceived environment. Moreover, it enables categorical variable measurements, which are then recorded as numerical dummy variables, such as the work status of participants. Thus, the intended quantitative variables from the application of this instrument enable the application of the ecological models of walking to occupational models, which is conceptually defined in Chapter Three (section 3.6). This mainly applies statistical analyses, such as Pearson correlation, ANOVA tests, and regression tests, to predict walking outcome variables (dependent variables) by predictors (independent variables). The random sampling method is based on a clustering sampling technique, which relies on the spatial factor (in this research, a cluster of blocks 400x400-metres) rather than the specific ratio of the population (Kish, 2004; Kish & Frankel, 1970; Kish & Frankel, 1974; Purcell & Kish, 1979). The research depends on this method because of the lack of information about the case study population. Three hundred questionnaires were distributed amongst each neighbourhood, which amounted to 900 out of approximately 1,400 housing units within the three neighbourhoods in the defined (400x400-metre) areas. This number represents approximately (64%) of the targeted houses. The participants were asked to respond to the questionnaire within typical week (Sunday to Saturday), during the total period of the study (from 1st to 20th October 2015), the first date is the first day of distributing the questionnaire and the second date is the last day of collecting the questionnaire.

Only 325 (53.8%) were returned and the number of valid participations totalled 175, which accounts for 22% of the separated formats, after applying the cleaning check criteria. The Al-Saymmar neighbourhood returned responses from 62 participants, whilst the Al-Mugawlen neighbourhood provided 58, and the Al-Abassya neighbourhood provided 52. The validity of the random sample size was computed based on the margin of error (or confidence interval) statistical method (Barlett, Kotrlik, & Higgins, 2001; Ci, 1987). In this regard, the total population is approximately computed from the average size of the Iraqi family, which is 7.7 persons per family based on Dorling's (2007) research, and the number of housing units within the sampled area (400x400m). Thus, the approximate population of the three neighbourhoods is 10,346, the number of residential units within the three neighbourhoods multiplied by 7.7, which is the average family size, which is equal to 10,364. Thus, the depended sample size in this research was 175 out of 10,364, which produced a 95% confidence interval of accuracy and a 6.2% tolerance of error ratio, based on the confidence interval of the accuracy test that was run by the SPSS software. The data sets were entered into SPSS software, where the participants (rows) were assembled into all the variables of the study (columns), including the independent (predictors, moderators, and mediators), and dependent (walking outcome) variables. Moreover, each variable was represented by its unique code. The full details regarding the data sets from the analysed questionnaires are included in Appendix 4, and represented as CD in the SPSS format (Appendix 4, as CD in SPSS format). Moreover, the objective measurement produced the determination variables (Tables 6-1 and 6-2) of this research are conducted in Chapter Six .

Integrative models are generated (section 5.5.2), where each model combines and tests several variables to address a research question and statistically evaluate the significance of their effects on the walking outcomes. In term of the mediation tests, the mediation model combines: the objectively measured walkability index (X: predictor); the perceived environment factors or belief-based measures of walking from the theory of planned behaviour TPB (M: mediators), and a walking outcome (Y: dependent variable) in order to evaluate the extent to which the tested factors mediate the direct effect of the physical environment on walking outcomes. The moderation model combines the objectively measured walkability index (X: predictor), socio-demographic factors (Mo: moderators), and a walking outcome (Y: dependent variable) to determine whether the interaction between the physical environment and the socio-demographic factors (X and Mo) have a significant effect on the walking outcomes. The determination models test the extent to which the objective measures of the physical environment predict the walking outcomes.

1.12 Summary of the findings and conclusions

The objective measures of the physical environment showed a moderate to strong predictability of meeting the recommended ≥150-minutes walking per week. In this respect, the probability that people who live in traditional neighbourhoods meet the recommended level of walking is approximately six times greater than those who live in modern neighbourhoods. However, no socio-demographic factors had a significant effect on this outcome, even for those with a significant effect on the continuous variables of walking. Moreover, only the perceived local shops' diversity and the perceived dead-end streets had a significant positive effect on achieving the recommended weekly walk minutes. Also, the effect of the beliefs-measures of walking on the ≥150 walking minutes per week showed that only the, "attitude of walking beliefs related to health benefits" and the "perceived walking control related to the proximity of destinations" had a significant positive effect on achieving the recommended level (≥150-minutes/week) of walking.

When walking outcomes were considered as continuous variables, the belief-based measures of walking produced considerable effects on walking outcomes. Thus, the Theory of Planned Behaviour (TPB), which is used as a social cognition theory to probe the beliefs of participants on walking, could be considered an efficient instrument to elicit knowledge on how human cognitions might mediate the effects of the physical environment on walking behaviour. As such, the attitudinal beliefs concerning the health benefits of walking, the social norms of walking, and the perceived control of the proximity and diversity of local shops had a significant indirect effect on walking to occupational activities in the neighbourhoods of Basra city.

When the walking outcomes were considered continuous variables, the perceived environment factors of Basra city's neighbourhoods recorded a considerable effect on walking outcomes. Thus, safety, the diversity of land use, the proximity to local shops, and the presence of cul-de-sacs have a significant indirect effect on walking to occupational activities in the neighbourhoods of Basra city. Moreover, when walking outcomes were considered continuous variables, the socio-demographic factors showed a limited moderation effect on the walking outcomes. More specifically, for income and employment, the free business types of work status have considerably and indirectly influenced walking to occupational activities in the neighbourhoods of Basra city.

The objective measures of urban planning demonstrated a considerable direct effect on walking outcomes. In this respect, the density, diversity and street design showed a moderate to strong predictability, (p<.01-.001, R^2<20% to p<.05, R^2≥20%)[5], on the walking outcomes in Basra city, as sampled in the three different neighbourhoods. Moreover, the most popular explanation for the total walking distance for occupational activities was the diversity of the retail commercial land use indicator (scale 600-meter radius, p<.001, R^2=35.1%). This overall pattern of association indicates a considerable positive determinist role on the urban planning measures of neighbourhoods in Basra city to walking outcomes. In this respect, the traditional neighbourhoods, which demonstrated a high density, high diversity, and high street connectivity, showed a considerable persuasive role in terms of walking behaviour.

The objective measures of the urban form morphology and streetscape demonstrated a less considerable direct effect on walking outcomes than urban planning measures. Also, the overall pattern of associations did not demonstrate a consistent predictability of walking outcomes. The indicators that showed a strong predictability (p<.05, R^2≥20%) between the walking distance and number of journeys showed a moderate predictability (p<.01-.001, R^2<20%) in terms of walking minutes.

[5] Where weak predictability is p<.05, R^2<20%, moderate predictability is p<.01-.001, R^2<20%, and strong predictability is p<.05, R^2≥20%.

Also, their association was mostly negative; in other words, the higher the value of the indicator, the lower the walking score. Examples of this are the Gini Coefficient of straightness (400-metre radius), and the frontage quality index of the high betweenness degree (600-metre radius). Also, the indicators that showed a moderate predictability (p<.01-.001, R^2<20%) between the walking distance and number of journeys showed a weak predictability (p<.05, R^2<20%) concerning the walking minutes. Moreover, their association was mostly negative; in other words, the higher the value of the indicator, the lower the walking score. An example for this is the pedestrian route directness ratio at a 400-metre radius.

The feedback to the master plan of Basra city (2010-2035) includes several important points:

1. In terms of the dependent unit of planning, the current master plan depends on the district, which concerns four neighbourhoods, with a total area of 100.8-hectares. This means the single neighbourhood would be 25.2-hectares. However, this thesis recommends defining the neighbourhood unit as a basic planning unit of 50.24-hectares, which is ten walking minutes;
2. In terms of the commercial land use, this research was based on evidence of walking behaviour to the occupational activities that recommends that commercial land use could be increased to 10% from the approximate 1% suggested by the current master plan;
3. In terms of the housing density, this thesis agrees with the master plan about the suggested total housing density (53%). This is because the evidence shows that the approximately 50% as a residential land coverage of the traditional neighbourhood have a significant association with walking in this model;
4. In terms of the open space, this thesis agrees with the master plan concerning the suggested total open space (30.5%). This is because the evidence shows that approximately 30% an open space of the traditional neighbourhood have a significant association with walking in this model;
5. Finally, in considering service land uses, this thesis did not produce any evidence based on this model.

1.13 Structure of the chapters

This thesis is divided into the following chapters, as described. Chapter One has provided an introduction to the study, which justified and outlined the research including the aim, objectives, research questions and hypothesis. This is followed in Chapter Two by a description of the case studies, which are based on the three neighbourhoods of Basra city. The case studies are systematically defined, and their attributes quantitatively measured, and qualitatively discussed to determine the degree of variance amongst them. The degree of variance is beneficial in two regards; firstly, it helps to establish the degree to which the urban form of Basra city was impacted by the application of the modern principles of master planning. Secondly, by identifying the variance it helps to increase the statistical potential of the independent variable in explaining the variance in the walking outcome variables.

Chapter Three provides a literature review and from this the conceptual framework of the ecological model of walking to occupational activities at the neighbourhood scale is developed. The primary inputs come from the literature concerning ecological models, and the conceptual framework is based on four levels, namely: socio-demographic information, or the individual traits of participants (level one); the active domain, which is walking to occupational activities (level two); the built environment (level three), and the government-related factors (level four), which concerns the master plan of Basra city. These four levels represent the conceptual framework of the ecologic model of this research.

Chapter Four outlines the analytic framework, which is the expansion of the conceptual framework. In this chapter, the measures and items of each level are defined and discussed based on evidence from the literature. The (NWOAQ) questionnaire is developed, and objective measures, which have a significant association with walking, are addressed and defined. Chapter Five outlines and justifies the research methodology. A mixed method is adopted based on the NWOAQ questionnaire instrument, and applies a cross-section random sampling method. The gathered data records the variables required to answer the research questions. In this regard, purposive models are generated for use during the statistical analyses.

Chapter Six outlines the objective measurement of the built environment, which provides the physical environment of this research. The objective measures are systematically applied to the case studies, and each measure is developed into multiple indicators based on three scales of measurement, namely: 400-400 metres, a 400-metre radius, and a 600-metre radius. Moreover, the objective measures are considered the determination, or prediction, variables in this research or, in other words, the source of the direct effect on walking outcomes.

Chapter Seven outlines the statistical responses to the research questions. This is broken down into three steps where the first is the normality test of the data; the second is the correlation analyses between the independent variables and the dependent variables (only the independent variables with a significant correlation were qualified for the higher level of testing). The third step involves four types of statistical analyses, which are: 1) the effect size tests on walking outcomes; 2) the mediation tests; 3) the moderation tests; and 4) the prediction tests. The last section within the chapter discusses the findings. Finally, Chapter Eight presents the final conclusions and the contributions of this research, in particular outlining feedback to the master plan of Basra city.

1.14 The importance of this research

There are two worldviews concerning human-environment relationships within behavioural and environmental psychology studies, and these are: phenomenology and positivism, which are open and closed systems, respectively. The first worldview, concerns the concept phenomenology, originally defined by Edmund Husserl (1859-1938) which sees that human beings construct the meaning of their environment (Bruner, 1990). This places importance on the context as an open system; thus, it completely excludes casual laws between individual factors in the human-environment relationship, which distinguishes it from positivism (Seamon, 1982). The second worldview of the human-environment is positivism; it completely eliminates the contextual influence and considers the phenomenon as a closed system, i.e. individual factors are considered in a cause and effect relationship (Sousa, 2010). However, the ecological models of physical activity consider the inductive and deductive levels of ‘logical positivism’ (Glanz, Rimer, & Viswanath, 2008:p.29) but at the same time consider the multiple levels of contextual influence (Luke, 2004), which reinforces the methodological stance of this research trend. This is particularly relevant to this study, where the aim is to investigate the multi-level associations of the walking behaviour to the occupational activities and the contextual factors from the individual, social and neighbourhood environments. In this regard, the relevant ecological model significantly contributed to for understanding the multiple levels of contextual effects on walking to occupational activities.

Based on the application of the ecological models of walking to occupational activities, the multilevel approach contributes on two levels, includes explanation and determination, for understanding the relationship between the neighbourhood environment and walking behaviour to the occupational activities. On the explanation aspect, the mediation and moderation factors explained for some extent how the individual and personal traits of the participants indirectly influence their walking behaviour, as they mediated and moderated the direct influence of the physical environment on the walking outcomes, respectively. This research explored the mediation role of several factors from the perceived environment and the beliefs-based measurement of walking depending on the TPB. In this regard, this research provides a greater explanation of how the planning and design of the physical environment of the neighbourhood may influence the tendency of the residents to walk. In this regard, some of the tested mediation factors explained latent characteristics of walking-physical environment relationship. Precisely, the awareness of 'health benefits' of walking, influence of 'social norms', 'perceived control of proximity, and diversity of land use', the individual perception of the neighbourhood environment related to a 'sense of safety of the neighbourhood', the 'diversity of local shops', the 'proximity of the local shops', the perception of 'dead-end streets' (or lower street connectivity), and the 'aesthetics of the neighbourhood'. Also, new knowledge is addressed in this research in term of the moderation effect of the income factor and the free-business category of work status on the relationship between the physical environment and the walking to the occupational activities.

Furthermore, in considering urban planning measures on a neighbourhood scale, the physical environment has a significant determining role in meeting the recommended level of walking, which is >150 minutes per (typical) week. Thus, based on the findings of this research, the physical environment of the traditional neighbourhood of Basra city is found to be a pedestrian-friendly environment. More precisely, this is attributed to the mixed land use, density of land coverage and housing units, and street connectivity, as measured by the node density. This confirms the theoretical premises and empirical findings of New Urbanism (e.g. (e.g. Friedman, Gordon and Peers, 1994; Handy, 1993, 1996, 2006; Hess, Moudon, Snyder, & Stanilov, 1999; Kitamura, Mokhtarian, and Laidet, 1997; Lee & Moudon, 2006a, 2006b).). Also, the morphologic and streetscape attributes, to some extent, demonstrate a significant association with walking behaviour. More specifically, this concerns the clustering of destinations and the enclosure ratio of the collector streets. These two aspects of the physical environment facilitate an understanding of how planning and the design of the neighbourhood environment affect walking to occupational activities. Such knowledge may enable practitioners and decision-makers to develop pedestrian-friendly attributes within future developments.

In addition, the NWOAQ questionnaire instrument, which is designed and tested in this research, is a quantitative instrument to inspect multiple levels related to walking to occupational activities. It is based on knowledge gained from previous instruments, namely the IPAQ and NEWS instruments of physical activity, and research activities undertaken by this study. The instrument represents a contribution to the current knowledge of the ecological models of physical activity. Moreover, it is applicable to any neighbourhood/s in the world in that it is easily adapted and analysed by users. Also, it requires the objective measures to generate the determination factors (the predictors in a statistical sense), which are required to produce the integrative model.

As discussed in section 8.2, The evidence-based feedback for the master planning of neighbourhoods in Basra city produced meaningful knowledge that could contribute to the current master plan by helping to ensure that such areas are more responsive to the real needs of Basra city residents by prioritising walkability. However, modern master planning principles, especially from a low-density stance, influence the majority of urban areas of Basra city. Thus, this evidence-based research recommends a reconsideration of the attributes of traditional neighbourhoods for future developments. Moreover, by considering the neighbourhood environment as an ecosystem, especially on the multiple scale of each case study, this facilitates an understanding of the characteristics of the walking-neighbourhood relationship by multiplying the indicators of the physical environment and defining the ranges of walking (10 and 15 minutes one-way walking).

2 Defining the case studies in Basra city

2.1 Introduction

The ecological models of physical activity is a case study trend of research (Sallis et al., 2006). Therefore, this chapter aims to define the case studies, which are three neighbourhoods of Basra city. They represent three different typologies which were found during three distinct political stages of the history of Basra city namely, Ottoman period British colonialism and Iraqi Kingdom period, and the Iraqi republic period.

The alteration of the quality of the built environment in Basra city during the 20th century creates unexplored influences on the active living of the residents. Moreover, during the first two decades of the 21st century no apparent development in these three case studies is observed. In this regard, the ecological models widely explored the community design-physical activity attributes (e.g. Frank, Andresen, & Schmid, 2004; Frank, Schmid, Sallis, Chapman, & Saelens, 2005; Giles-Corti et al., 2013; Giles-Corti et al., 2006), and the obtained consistency of association considered important for intervention plans (Sallis, Owen, & Fisher, 2015). The alteration of the characteristics of the nominated samples are fully comparatively articulated in the light of detailed information about the neighbourhoods in question; critique is addressed as the attributes were discussed to explain to what extent the urban form of Basra city was altered after applying modern master planning. The variance among the three neighbourhoods, in term of their planning and morphologic attributes, produces the variance within every independent variable which are important to explain the variance in the behavioural outcomes, from a statistical perspective. This variance is considered crucial characteristic of the ecological models to reveal the association with the behavioural outcomes (Sallis, Owen, & Fisher, 2015).

Moreover, the desired insight to improve the neighbourhoods planning and design rely on evidence from fitting between the walking behaviour and the existing community designs, which is mostly considered within the ecological models of physical activity trend of studies.

2.2 Historical overview of the urban form of Basra city

In this section, this research articulate how the urban form of Basra city was significantly altered by different stages of interventions. In this regard, the urban planning and morphologic are qualitatively and quantitatively addressed in this section.

A piece of the urban tissue of Basra city, located on the southern side of Al-Ashaar river about two miles on the west of the city centre of Basra city consisted of three neighbourhoods, is qualitatively discussed to reveal the transformation of the urban form upon the time. For this purpose, the major features included streets networks, physical configuration of blocks, and land uses, for half mile from the centre of each neighbourhood were discussed as observed and measured phenomena, in comparative manners between the three neighbourhoods, in term of the role of the historical factor in altering specific qualities of the physical environment, (Table 2-1).

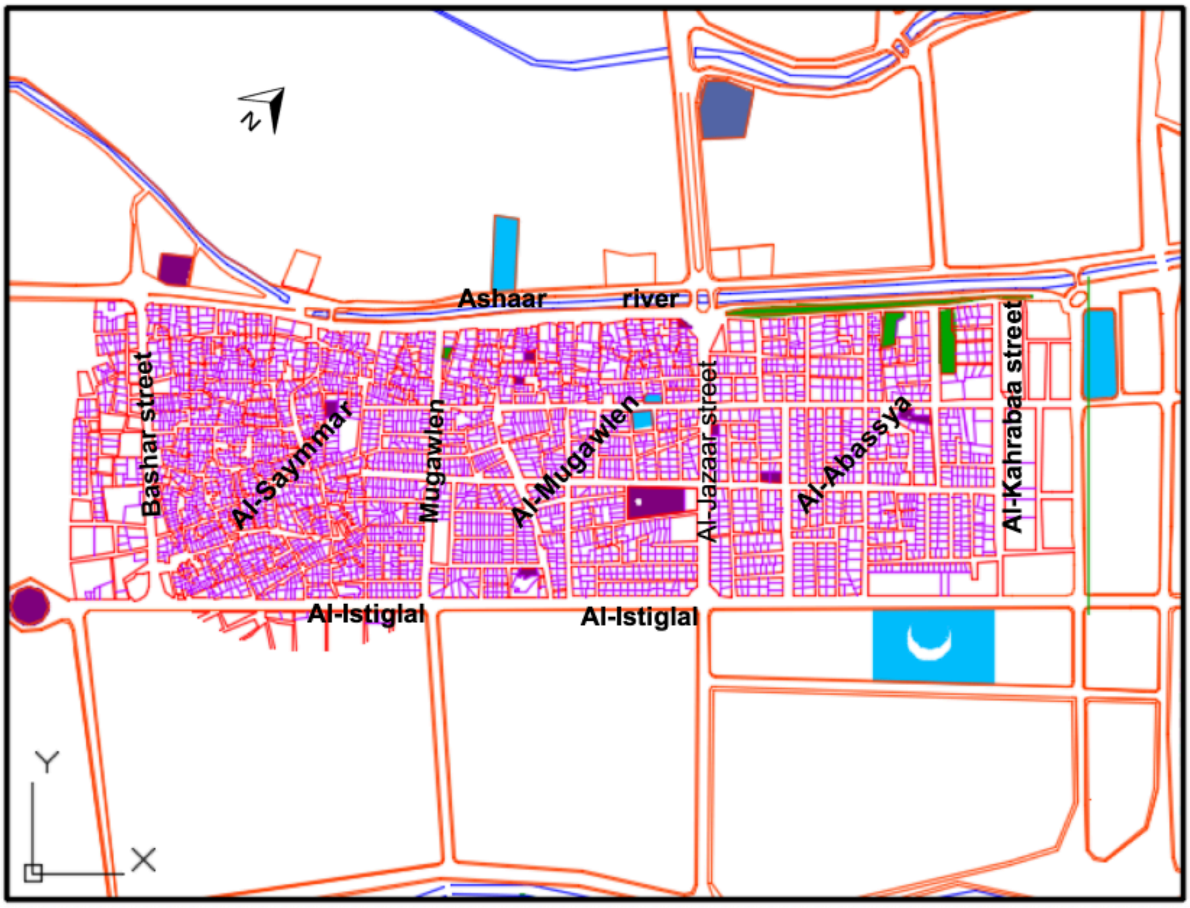

Figure 2-1: The targeted three case studies (three neighbourhoods of Basra city): (The author)

The urban form of Basra city was evolved over three distinct historical stages, include the Ottoman period (before 1916), the British colony and Iraqi Kingdome period (1916-1958), and Republic period (after 1958), (Marr, 2017). The Architecture of the city during the Ottoman colony could be split into two distinct stages. The period before (1900) which is the fenced Basra city, (Figure 2-2), while after (1900) is the time when the fenced Basra city had vanished (Al-Ali, 1973). The period (1900-1916) represented the second stage of the unplanned urban form of Basra city. It is represented in figure (2-3) in bold black dots, which is called today as the old Basra neighbourhoods, where the contemporary City of Basra with civic amenities, governmental buildings, and European Consulates had emerged. However, no official planning system was applied after the old fence was decayed. The construction material comprised on brick, local plastering, mud, timber; buildings of one or two stories; amenities comprised on houses, mosques, bazaars, governor building, which was called “*Alsarai*”. The urban structures were confined on the houses of the noble families of Ottomans and their local allies plus the government buildings and all mostly located on the banks of Al-Ashaar river. These neighbourhoods mostly still exist; however, they were bounded by arterial modern streets. They take organic shapes and courtyard houses. Although the housing units mostly still occupying the same plots, limited traditional houses still exist. Moreover, the inner organization of the neighbourhoods mostly still the same since it was found before 1916 (Wilson Arnold, 1930; L. Stephen, 1953; Khattab, 1972). However, after (1956) the courtyard housed mostly declined and the front yard, detached and semi-detached houses were strongly emerged. Moreover, the urban tissue was obviously differed from the compacted to a sprawl urban form (Khattab, 1972).

1) Tanners
2) Camel markets
3) Hays
4) Spicers
5) Weighers
6) Market
7) Fog market
8) Butchers
9) Robs
10) Fodders
11) Barbers
12) Flour shops
13) Big market
14) Ottoman market
15) Old market
16) Poets
17) Shoemakers
18) Woolers
19) Painters
20) Graveyard market
21) Market
22) Butchers

مخطط تقريبي لأسواق البصرة خلال القرن الاولى الهجرية

Figure 2-2: Fenced old Basra before 1900 (Yousef Nasir Al-Ali, 1973)

The period (1916-1958) is the British colonial period and the independent Iraqi Kingdom (1922-1958). After 1916 modern buildings, paved arterial streets, and parallel to rivers planning visions were applied into the city by the British Army engineers who designed most of the civic buildings and planned the connection streets (Longrigg, 1953). Before 1956 Max Lock was hired by the Iraqi government to make the first master plan of Basra city. This Masterplan had been embraced the automobile-oriented development, an orthogonal or grid-like or modern planning vision was applied to the city.

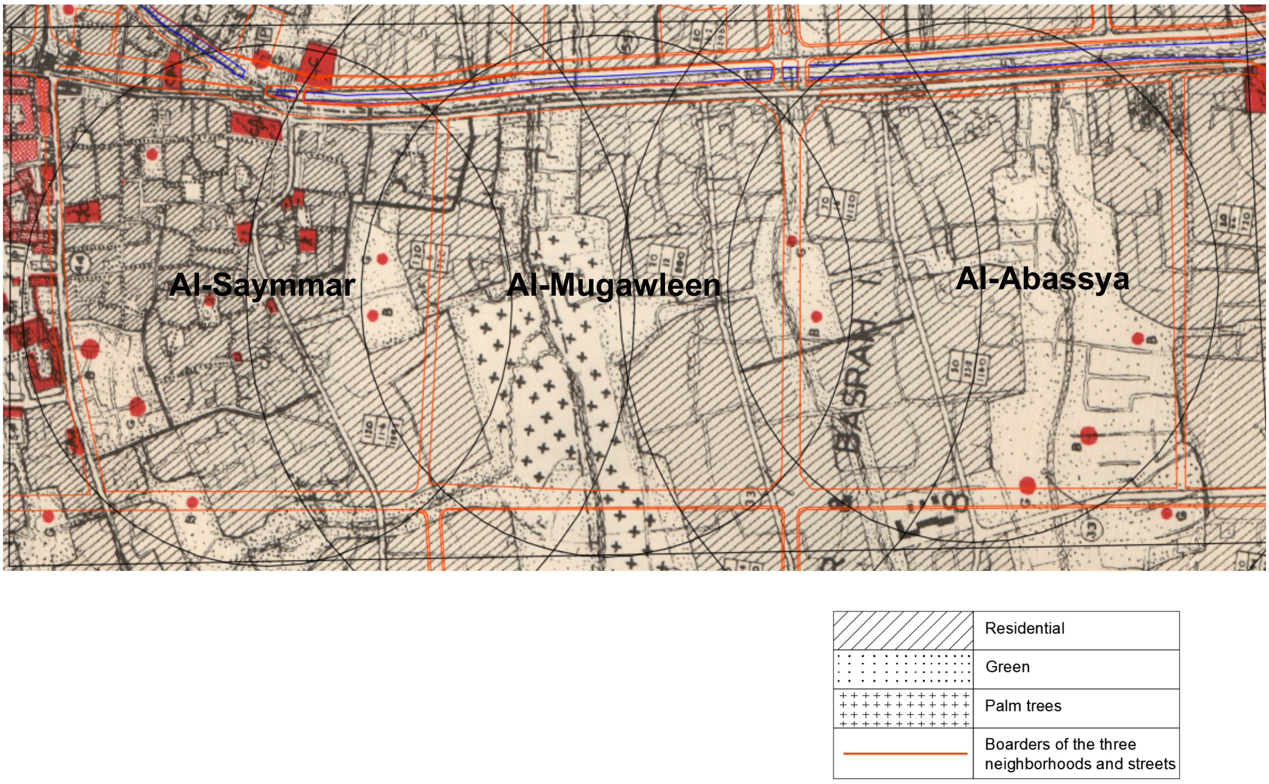

Figure 2-3: The current locations of the three neighbourhoods located over the master plan of Basra city (Lock, 1956)

The commercial land use was completely separated from the residential land use by establishing twelve commercial centres scattered across the city (Lock, 1956). Figure (2-3) illustrate the proposed land uses of the case studies of this research before and after (1956), which is the first intervention by Lock (1956). Al-Saymmar neighbourhood has mostly existed before (1956), while Mugawleen and Al-Abassya are completely proposed by the master plan by Lock (1956), they were merit palm tree farms where the hashed out rendered zones were proposed as new developments at the account of the green coverage. However, After (1956) there was a smooth process of transition from green cover of land into built form, that was not obligated to Lock's proposal; The borders in orange colour, (Figure 2-3), of the existing neighbourhoods, explain the key changes happened in the period of (1958-1969), which is also illustrated in red elapse in Figure (2-4). In this regard, Al-Mugawlen and Al-Abassya neighbourhoods habituated to residential land, Al-Istiglal street, Al-Mugawlen street, and Al-Jazaar street were found by the engineers of Basra municipality; the arterial streets of six lanes plus the walking shoulders were found, and the collector streets run through the city and directly deliver into the arterial streets, (Figure 2-1).

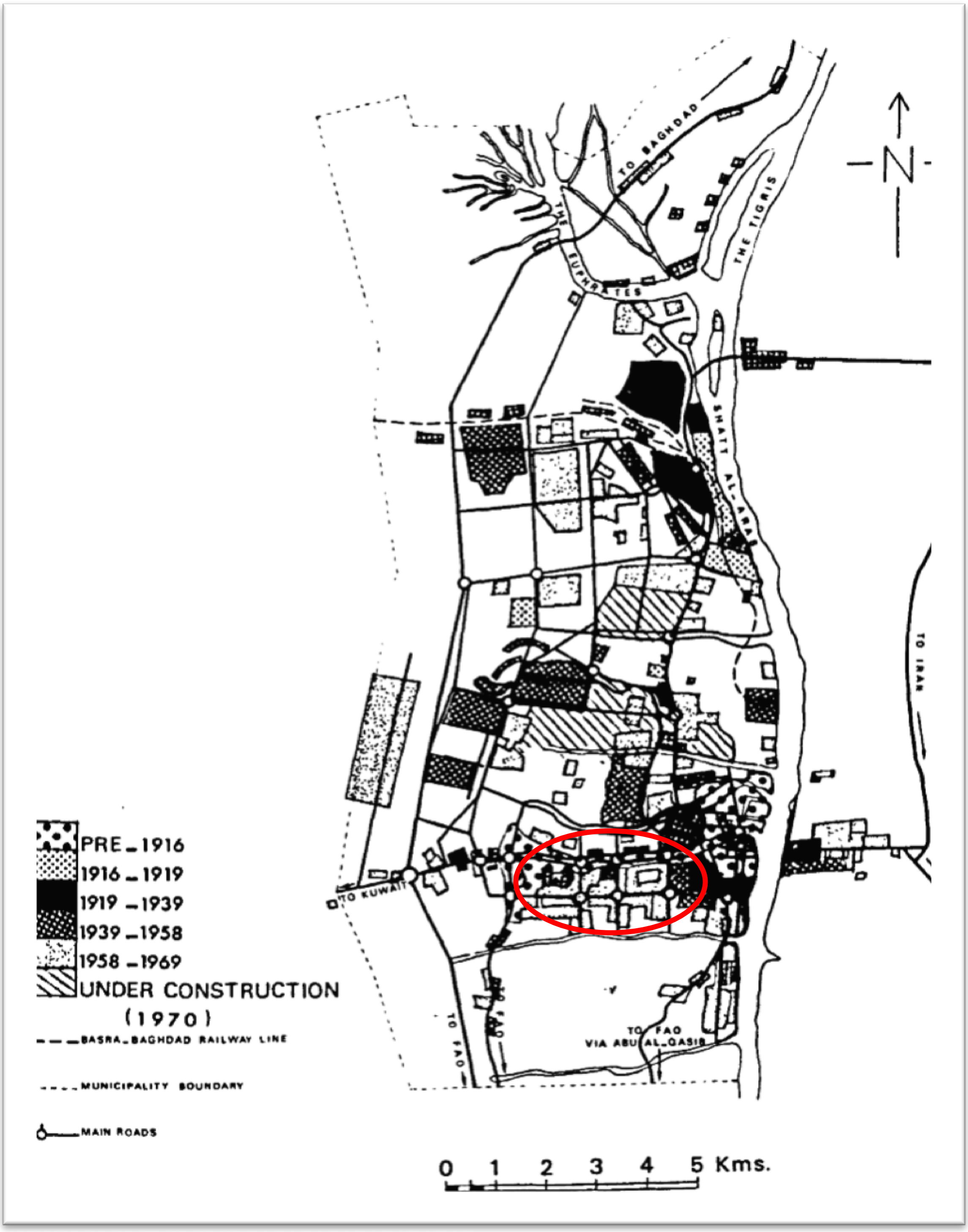

Figure 2-4: Master plan of Basra City 1900-1970, and the case studies location: (Khattab, 1972)

Also, the subdivisions of Al-Mugawlen neighbourhood followed the natural factors like rivers and legal division of the land, which was predominated by land ownership roles, who did share the ownership of agricultural lands. According to discussions with the specialists from Basra municipality, the government opened the collector streets those traverse through the neighbourhood after buying the required land from original landlords and widened some old pathways. Only the north strip of houses, parallel to Al-Ashaar street, was constructed before (1956), which is consisted mostly of courtyard houses of irregular sizes and shapes (Figures 2-2, 2-3 and 2-7); Also, in term of Al-Abassya neighbourhood, the authority and the landlord came to term on the systematic division of the land according to orthogonal streets system and lots. Unfortunately, there was no document prove these deals because during the first and second gulf war the governmental archive was burned several times.

2.3 Defining the case studies

The reviewed historical changes, that the three neighbourhoods went through, showed the role of the man-made interventions in differing the quality of the built environment of Basra city. The three neighbourhoods of the urban form of Basra are considered as three distinct residential typologies of Basra city with potential impact on the physical activity of the residents. For the purpose of conducting this behavioural study, this urban tissue systematically sampled for the application of the empirical study of this research includes the questionnaire (section 5.4), and the objective measurement (Chapter Six).

Although the boundaries of the three neighbourhoods are defined by the peripheral arterial streets, they are not identical in term of their area besides the sampling criteria in the relevant studies. Thus, this research depends, in the sampling method, on the theoretical pieces of evidence from the relevant studies. The minimum threshold of walking distance, that define the neighbourhood range, was differently defined in the human activity-environment related studies. It is mostly defined by the Euclidian distance from a certain spatial centre, either existing or postulated centre. As a general consensus, the range of walking distance falls somewhere in the range between (1/4) and (1/2) mile radius (Moudon et al., 2006), (Figure 2-5).

Although there is no consensus about the maximum range of walking distance from a certain centre, the minimum was widely depended on ten minutes of walking or 400-meter radius. The maximum threshold falls within (1-mile radius) that could be determined by the type of the study. For examples, the recreation and transportation-walking related studies depended on the (1-mile radius) as a maximum range (Lee & Moudon, 2006), destination accessibility related to neighbourhood livability studies embrace ½ mile radius from the neighbourhood centre (Tilt, Unfried, & Roca, 2007); While, the physical activity and obesity studies depended on the 15-minutes Euclidian distance or 1-kilometer network distance (Lovasi et al., 2009). In other words, the maximum range depends on the nature of the study and the requirement of the given research. Therefore, this research embraces criterion from the health-related research for moderate-intensity aerobic (endurance) physical activity for a minimum of 30-minutes walking per day for healthy active living (Haskell et al., 2007); in accordance with this criterion, if the 30-minutes represent two-way walking, then the one-way associated with this range is 15-minutes walking. Therefore, this research embraces the ranges (400-600-meters) (10-15-minutes), as optimum ranges that cover both the spatial definition of the neighbourhood and the requirements of active living lifestyle. Moreover, the urban morphology related studies sample the urban tissue as a square shape, and the sampling sizes was varied in the urban morphology studies. It was either 200x200-meter, 400x400-meter, or 800x800-meter (Remali et al., 2014). This research adopted the (400x400-meter) square sample because it is commensurate with 10-minutes walking and appropriate to sample the residential blocks, Also, this scale is utilised to sample the population. Therefore, the figure (2-5) illustrates three different borders define the sample of the urban area for this research. the first is (400x400-meter) square, that clearly defines the urban morphology of a residential core that is subject to the influence by heterogeneous factors of influence by the other two postulated ranges, 400-meter radius as minimum walking distance, and 600-meter radius as the appropriate range for 30-minute daily walking.

Thus, the (400x400-meter) is the sampled residential blocks and the population, while, the ranges 400-meter and 600-meter radius are the standard definition of the sampled walking ranges, that define the walkable neighbourhood ranges which relevant to walking structures and users (operational definition embraced by this research for the sampled neighbourhoods) (Figure 2-5), Moreover, the walking two ranges accommodates diverse of environmental features and attributes, which includes, main transportation roads, residential area, and associated commercial activities. This sampled environment represents an optimum ecosystem because it has well-defined boundaries that match human walking capacity, and the diversity of land use that has the potential to explain human activities. The centre of each neighbourhood was delimited by the intersecting of the two diameters of each square of the morph's centre (400x400-meter). Then, the defined centres were used to draw the minimum and maximum walking ranges of the neighbourhoods (400 & 600-meter radius). And, the buffer of that range is of 15-minutes walking (or 600-meter radius), (Figure 2-5).

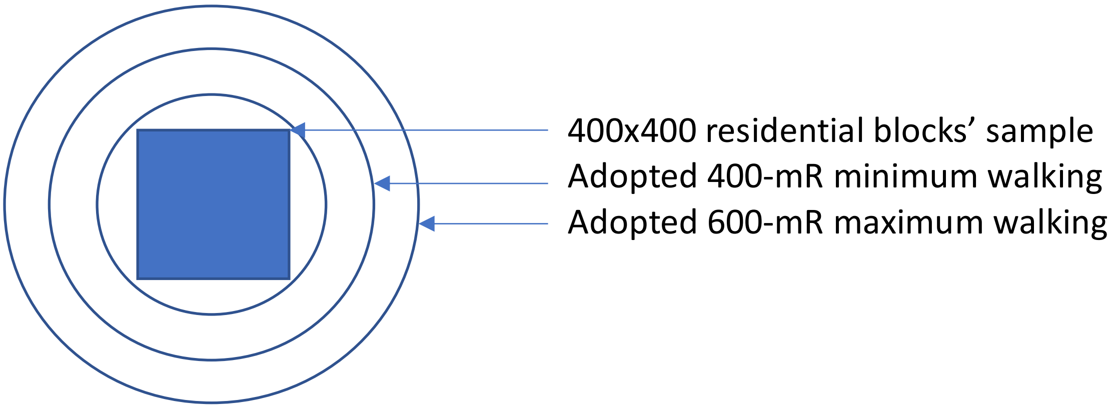

Figure 2-5: sampling criteria of the case studies: (The author)

The first step of the empirical study is to obtain maps for the neighbourhoods with around one-mile buffer from the centre of each case study. The Basra local government have satellite images and PDF maps for the whole city. However, the resolutions of the pdf maps are not valid to obtaining efficient quantitative measurement because of the low resolution and the missed information. Moreover, the google earth does not present enough information about the structural features of the selected urban areas. Thus, this research depended on the orthoimages that were obtained from the local government, which is georeferenced and geometrically corrected (orthorectified). Moreover, the image was tested with QGIS and it was spatially correctly located according to its georeferenced coordination points. The coordination of the image that was adopted by this research is (N:768546, S:3376180, UTM-WGS 1984, 38 North). The method starts by importing the image into AutoCAD Map 3D and defining its coordination points, then create a shape file extension (.shp) of the neighbourhoods in question that can be added into Q-GIS. After locating the orthorectified aerial image geographically into AutoCAD 3D map, cadastral maps are created by this research depending on the systematic survey and the original maps of the government (Figures 2-6, 2-7, and 2-8).

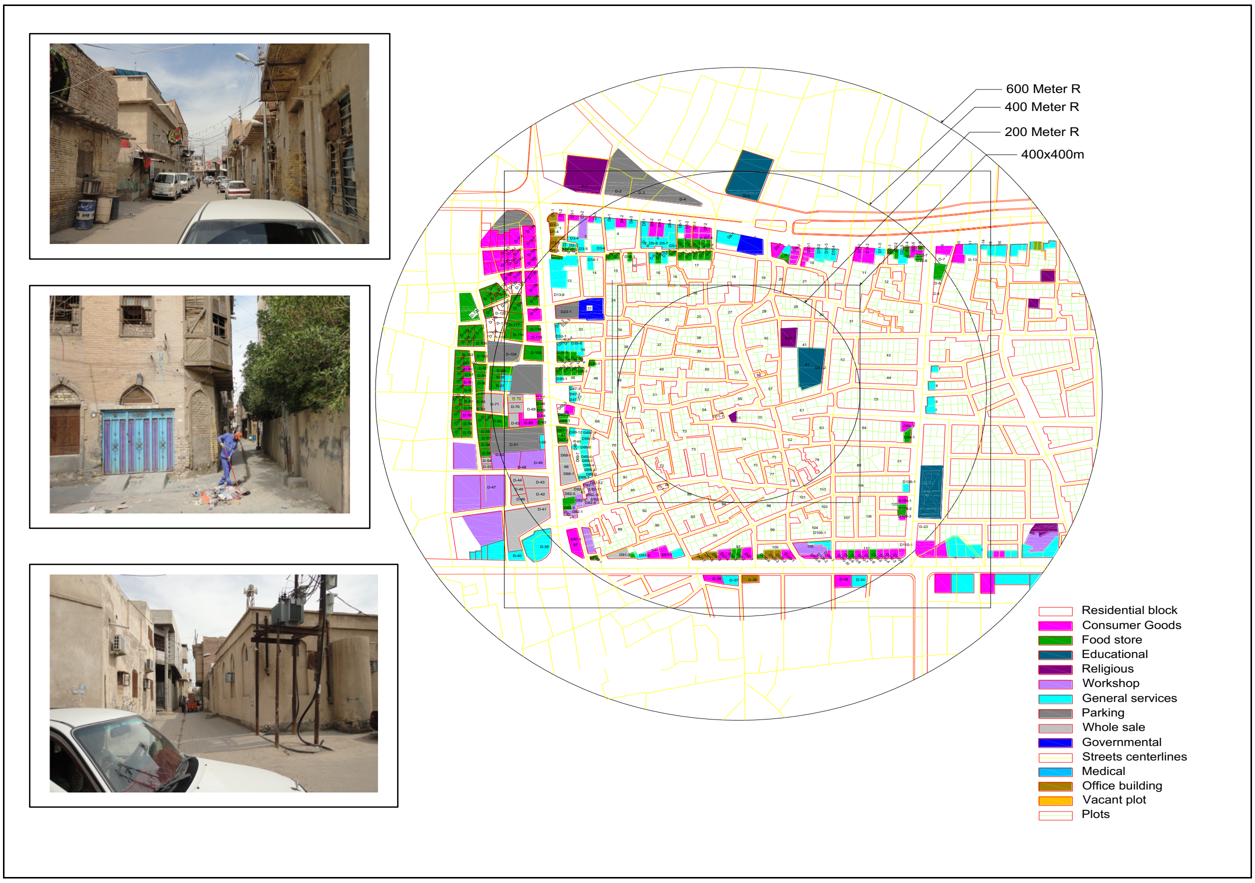

Figure 2-6: Al-Saymmar neighbourhood cadastral plan: (The author)

The processes of the survey and the drawing of the new maps were occurring together and the final maps were offered to the specialists of the governmental staff, and there was general agreement that the maps produced during this research are more accurate than the original available documents; The block survey format is used to gather information about the blocks' structures (Appendix 9). Moreover, these maps were an efficient source to create different maps of shape file extension to feed the ArcGIS or QGIS with the required informative maps. Then, the major features of the three neighbourhoods are digitalized in AutoCAD (dwg.) and QGIS (qgis.) include, streets networks as centre lines, blocks representation, and land uses (Appendix 4, DWG format). Then, the Information related to the major features of the neighbourhood were computed and uploaded into Excel sheets. Then, the objectively measured physical environment measures were computed based on the extract information in Chapter Six; the computed information of the main features and the objective measures are uploaded into Excel sheets, (Appendix 4).

Figure 2-7: Al-Mugawleen cadastral neighbourhood map: (The author)

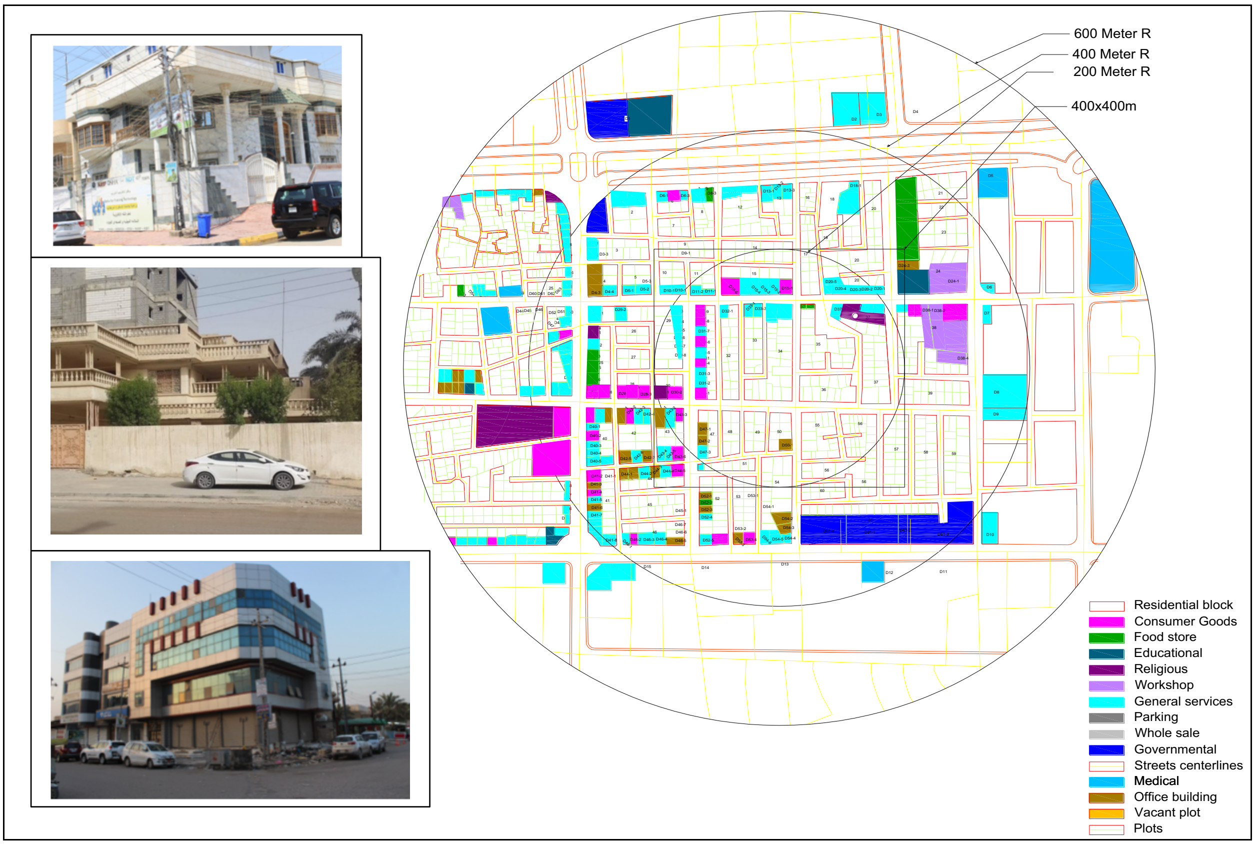

Figure 2-8: Al-Abassya cadastral neighbourhood map: (The author)

2.4 A qualitative discussion of the features of three neighbourhoods of Basra city based on their objective measurement

The three case studies, neighbourhoods of Basra city, visually tell the story of the substantial transformation of the urban form from the self-organized to grid-like planned urban form. Based on quantitative information from the cadastral maps, (Figure 2-6, 2-7, and 2-8), the three case studies qualitatively compared to reveal the extent to which the application of the modern master planning differed the quality of the built environment of Basra city as sampled in three case studies. Each neighbourhood has semi-square outline defined by the outer edges of blocks, (Figure 2-1). The area of Al-Saymmar neighbourhood is about (87.6) square acres; The area of Al-Mugawlen neighbourhood is about (80.8) square acres; And, the area of Al-Abassya neighbourhood is about (91.2) square acres. The boundaries of the three neighbourhoods are adjusted into the arterial streets patterns outside the neighbourhoods. The built-up blocks on the boundaries were fully adjusted for those streets. The boundaries of the buildings to large extent are mixed land use because they often have different types of commercial uses, and limited housing units, (Figures 2-6, 2-7, and 2-8). However, the internal land uses are residentially dominated, with limited non-residential land use, like schools, mosques, and retails. The three neighbourhoods are bounded from the north by Al-Ashaar commercial street approximately (80-m Width); from the south by Al-Istiglal commercial street approximately (30-m W); from the east by Al-Kahrabaa collective street within residential area, and from the west by Bashaar commercial street (20-m W); The street between the Al-Saymmar neighbourhood and Al-Mugawlen neighbourhood is a collector street, within residential area, approximately (20-m W); the street between Al-Mugawlen and Al-Abassya areas is an arterial commercial street, that is called Al-Jazaar street approximately (25-m W), (Figure 2-1).

In the next sections of this chapter, an intensive qualitative discussion is conducted about the structures of the three neighbourhoods, include blocks, streets networks, and land uses, to find the influence of altering the urban form on three important aspects of urban form morphologic and planning perspectives; namely, housing layout, land coverage, land use, and streets networks. The three defining borders of the case studies are useful and influential selecting process of the required information in this research, (Figure 2-5). In this regard, the square boundaries define mostly residential urban tissues of the neighbourhoods in question, the 400-m radius border includes, residential, non-residential land use related attributes, streets networks related attributes, and the 600-meter radius border defines non-residential land use related attributes, streets networks related attributes. Thus, each border serves different objective measures of the physical environmental in this research, (Table 2-1).

Table 2-1: Selecting the physical environment attributes based on the three scale

Three scales of resolution	3 levels of attributes	Residential block attributes	Mixed land use attributes	Streets network related attributes
400x400m square		X	X	-
400-m radius border		-	X	X
600-m radius border		-	X	X

2.5 The housing layouts

Al-Saymmar as an organic urban morphology demonstrated high intensity of houses units (41.87/hectare), (Table 6-2), with small to large sizes approximately (100-400m^2), (Figure 2-9), and of rectangular and square shapes, and mostly courtyard houses that have building boundaries identical with the shapes of the plot, or as called attached housing typology, with central courtyard, (Figure 2-9). In the second stage, Al-Mugawlen neighbourhood of medium intensity housing units (25/hectare), (Table 6-2), with small to large sizes approximately (100-400m^2), (Figure 2-10), and of rectangular and square shapes, mostly front-yard houses that have building boundaries aligned into the back of the plot with front-yard gardens. Moreover, with this neighbourhood the buildings are aligned with each other in different manners, attached, semi-detached, and detached units. And the latest stage, (Figure 2-11). While, Al-Abassya neighbourhood of low intensity of housing units (17/hectare), (Table 6-2), with medium to large sizes of plots approximately (250-400m^2), (Figure 2-9), with mostly rectangular shapes, and mostly front-yard houses that have building boundaries aligned into the back of the plot with front-yard gardens, and the buildings are aligned to each other in different manners include, attached, semidetached, and detached units, (Figure 2-11). Moreover, the number of floors of the single-family housing typology in the three neighbourhoods is one or two floors, and very limited with more than two floors, see the pictures with figures 2-6, 2-7, and 2-8.

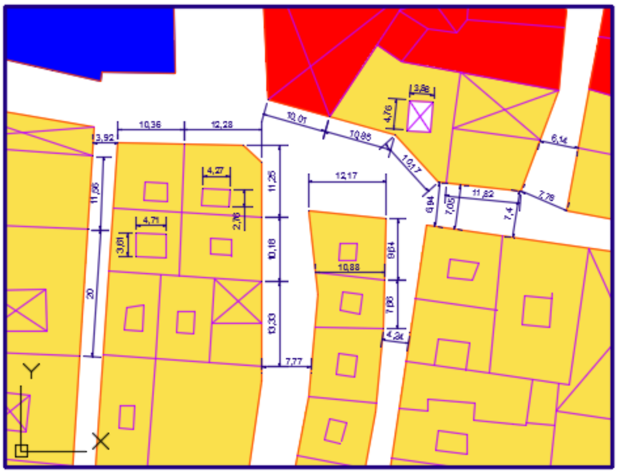

Figure 2-9: Al-Saymmar housing layout example: (The author)

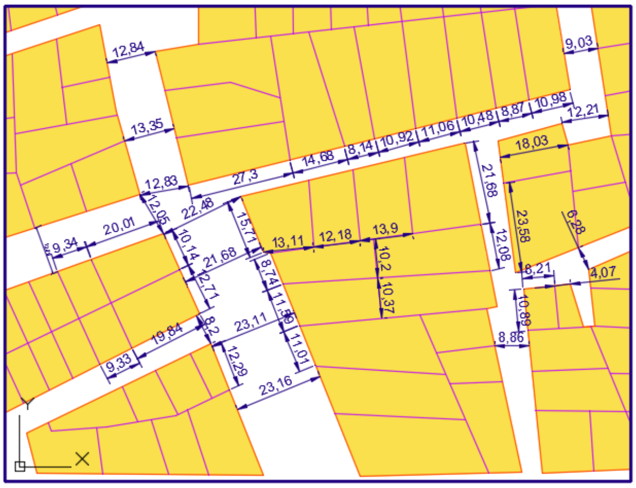

Figure 2-10: Al-Mugawlen housing layout example: (The author)

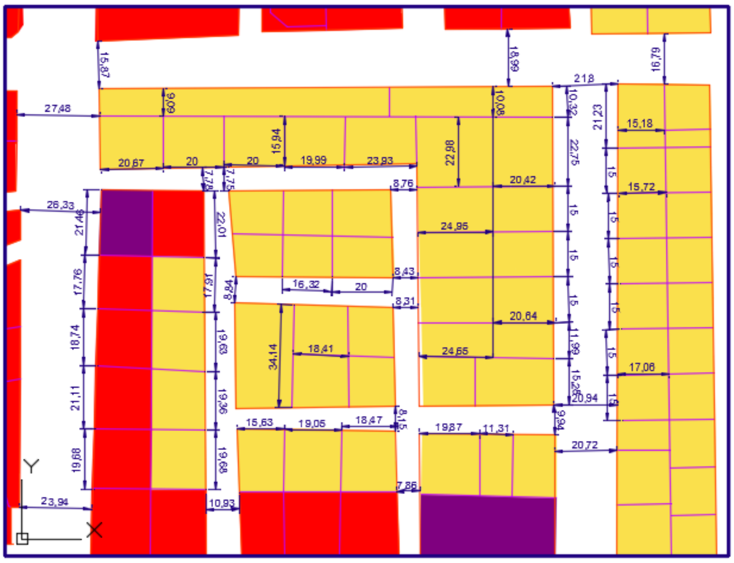

Figure 2-11: Al-Saymmar housing layout example: (The author)

Table 2-2: Urban morphology analysis for the three neighbourhoods

	Scale 400-meter Radius											
	Al-Saymmar				Al-Mugawlen				Al-Abassya			
Units	Total Area m^2	Length	No.	%	Total Area m^2	Length	No.	%	Total Area m^2	Length	No.	%
Blocks area	337,497			67.2	341,401			68	335,355			66.8
Streets Network		19433				16267				13400		
Number of streets segments			446				315				214	
X intersection			38		30		30				32	
T intersection			171		115		115				70	
Col-de-sac			30		16		16				9	
Total intersection			239	1.9			161	1.3			111	0.9
Destinations			258				224				193	

2.6 Streets patterns

The transformation of the streets pattern toward the complete grid shape is apparent according to historical alteration of the three neighbourhoods. Al-Saymmar has mostly curve-line, crescents, and cul-de-sac streets shapes, (Figure 2-9). Al-Mugawlen neighbourhood represents a case between the organic streets layout and orthogonal emerging system, (Figure 2-10). The northern strip above the traverse west-east street is with organic streets network and it is indicating the period of the emergence of this part of the neighbourhood, which is before the British colony (1916). Whereas the beneath of the traverse west-east street part has orthogonal streets, but yet to be grid system (Figures 2-1, and 2-7). Al-Abassya was mostly laid out on orthogonal pattern close to the grid system of streets, with medium to big block-sizes of single-family houses units, (Figure 2-1, and 2-8).

In term of vehicles movement, Al-Mugawlen and the Al-Abassya neighbourhoods have clear traversing collector streets, which connecting the internal of the neighbourhood to the external arterial streets, however, Al-Mugawlen north-side (parallel to Al-Ashaar river street) is a traditional strip of traditional houses which isolates the internal of the neighbourhood of the northern side, Al-Ashaar street. With the same respect the Al-Saymmar neighbourhood has no obvious internal collector streets, but one curve-line street traverse between the north and the south sides of the neighbourhood, however, it is kind of mixed-use street between vehicles and pedestrians, with irregular width ranges between (4-meter) and (8-meter). Thus, the automobile access into Al-Abassya neighbourhood is unlimited, the access into Al-Mugawlen neighbourhood is limited from the north side and good from the other three orientations, while the access into Al-Saymmar neighbourhood is limited. Then, the situation is sharply different between the old neighbourhood (Al-Saymmar) and the latter two neighbourhoods, slightly different between Al-Mugawlen and Al-Abassya neighbourhoods, in term of automobile accessibility into the neighbourhoods. However, with respect to the pedestrians' movement, the walking opportunities in Al-Abassya is equivalent to the driving opportunities, because all the streets have separated walkways of the driving lanes. In Al-Mugawlen neighbourhood the streets pattern provides equal opportunities to access for drivers and walkers from the east, south, and west directions because the street mostly has separated paths for vehicles and pedestrians. However, Al-Mugawlen neighbourhood has walking paths to access the neighbourhood from the north side but no vehicle can access from it. Although Al-Saymmar neighbourhood showed limited accessibility by vehicle, the pedestrians access to the neighbourhood is unlimited from all direction. In other words, has high external connectivity represented by the high quantity of intersections, (Table 2-2).

The quantitative analysis of streets network's morphology produced significant differences among the three typologies. The overall attributes of streets within the (400m radius) scale in Al-Saymmar neighbourhood is (19.433) kilometre length with (446) segments, Al-Mugawleen neighbourhood is (16.267) kilometre length with (315) segments, and Al-Abassya neighbourhood is (13.4) kilometre length with (214) segments. With that respect, around 3-km reduction in streets lengths in Al-Saymmar of Al-Mugawleen, 3-km reduction in Al-Mugawlen of Al-Abassya, and 6-km reduction in Al-Saymmar of Al-Abassya. Worth to mention, that the lengths were measured based on the centreline, (Table 2-2).

The total number of the intersection was decreased jointly with the streets lengths' reductions, and vice versa; in other words, the more segments the more intersections presence. The intersections in the three neighbourhoods vary of four legs intersections (X-shape), three legs intersections (T-shape), and cul-de-sac (dead end street). The highest number of intersections was noticed with Al-Saymmar; the active intersections types X, and T were 38 and 171, respectively, with 30 dead ends streets, (Table 2-2); relatively to Al-Abassya typology, which have lower ratios of intersections number associated with the number of streets segments; the active intersections type X, and T were 32 and 70, respectively, with 9 dead ends. Al-Mugawlen illustrated a moderate quantity of intersections; the active intersections types X, and T were 30 and 115, respectively, with 16 dead ends, (Table 2-2). Moreover, the route option has widely differed from Al-Saymmar neighbourhood to the other two typologies status. It provides wider options for routes to the walkers because of the high density of streets, intersection, and external entrances for pedestrians. While, the other two typologies provide lower options of routes because of the lower density of streets, intersections, and external entrances. However, Al-Saymmar neighbourhood has the highest ratio of cul-de-sac streets typology, 30 dead ends streets, (Table 2-2), than in the other two typologies, which is considered of negative impact on users activity (Remali, Porta, & Romice, 2014; Remali, Porta, Romice, & Abudib, 2015).

2.7 Blocks structure

The outline of the blocks has sharply differed among the three neighbourhoods' typologies. The regularity of geometric form of the blocks of Al-Saymmar neighbourhood is un-capture-able. Also, sizes of the blocks are highly varied from small to supersize blocks. Moreover, the plots within the blocks were sharply varied in term of shape and size. The shapes of the blocks of Al-Mugawlen neighbourhood are less irregular than Al-Saymmar situation. However, they still undefinable with a unified shape of blocks. Examples for the shapes of blocks are rectangular, L-shape, square, and irregular shapes. Also, the sizes of the blocks were less varied than Al-Saymmar situation. Thus, no unified block size can be defined of this urban form typology. On the other hand, the block shapes and size of Al-Abassya neighbourhood are more regular than the other two neighbourhoods. The shapes were noticed are: rectangular, L-shape, and only two irregular L-shape blocks, with well-aligned blocks onto the orthogonal streets' edges. Although the internal subdivision of the lots was not standardized across the whole neighbourhood, the individual plots were mostly having orthogonal shapes, square and rectangular shapes, (Figure 2-9, 2-10, and 2-11).

Each of the three neighbourhoods is sampled in scale (400X400-meter), (Figure 2-12), the blocks occupied (78.4%) of the sampled area of Al-Saymmar neighbourhood and they are completely irregular shape blocks with no defined orientation, (Table 2-3). The blocks occupied (74.8%) of the sampled area of Al-Mugawlen neighbourhood and they mostly have irregular shapes of blocks, (Table 2-4). And, the blocks occupied (70.5) of the sampled area of Al-Abassya neighbourhood and they are mostly rectangular like blocks, which are north-west and south-east side oriented blocks,

(Table 2-5). Although the coverage ratio has slightly differed between the neighbourhoods, the number of blocks was sharply differed, (70) blocks, (Table 2-3), (50) blocks, (Table 2-4), and (32) blocks, (Table 2-5), respectively. Also, Al-Saymmar 's blocks have relatively low open spaces area (21.59), (Table 2-3); Al-Mugawleen has relatively moderate level of open spaces area (23.17%), (Table 2-4); While, Al-Abassya relatively have a higher ratio of open spaces (28.49), (Table 2-5).

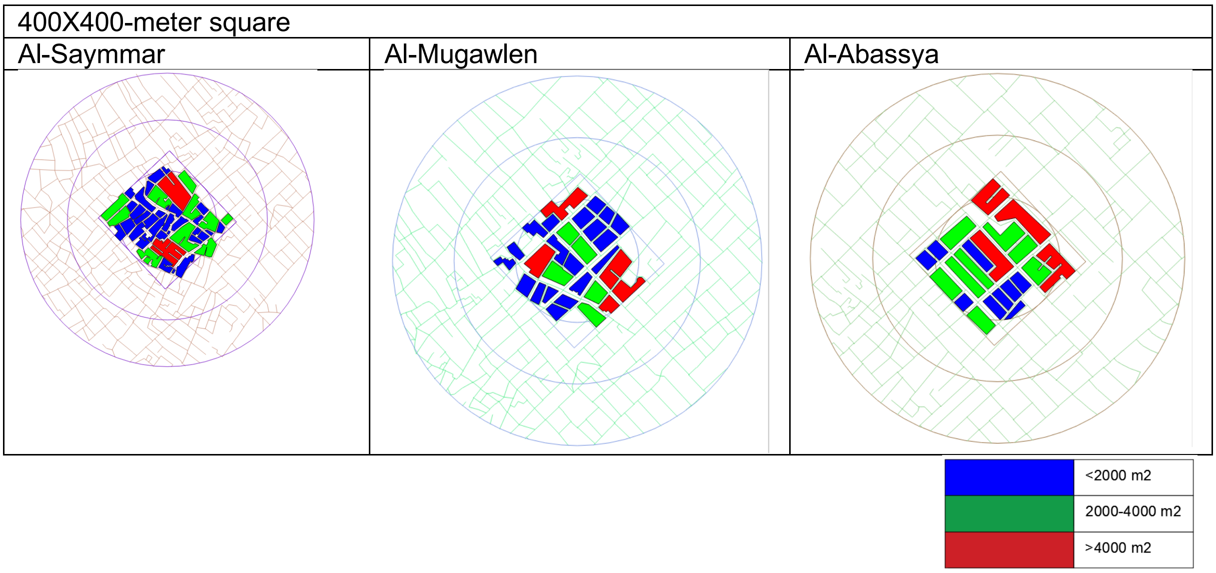

Figure 2-12: Block size categories (blue: <2000m²), (green: 2000-4000m²), and (red: >4000m²).

A typo-morphologic analysis by QGIS of the blocks' areas of the three neighbourhoods, showed that the areas of blocks fall between (200m^2-9000m^2), as minimum and maximum areas respectively. This range was divided into three categories include the small size block category, (<2000); the medium size block category, (2000m^2-4000m^2); and the supper size block category, (>4000m^2), (Figure 2-12). Those three categories are found in all the neighbourhoods but in different proportion. In Al-Saymmar the first, the second, and the third categories were of 70%, 24%, and 6% respectively; In Al-Mugawlen neighbourhood the first, the second, and the third categories were of 36%, 43%, and 21% respectively; In Al-Abassya neighbourhood the first, the second, and the third categories were of 43%, 38%, and 19% respectively. Moreover, the Gini coefficient values of the three neighbourhoods were .44, .24, and .28 respectively, (The definition of the Gini Coefficient in section 4.7. 10.3). The Gini coefficient explains that the best distribution of land among the block happens with Al-Saymmar neighbourhood (.44) because the majority of small size blocks occupied the majority of land (70%), while Al-Mugawlen and Al-Abassya showed approximately similar Gini of coefficients .24, and .28 respectively, because the majority of land was occupied by the medium and supper size of blocks while the small size represents less than 50%, (Figure 2-12). Moreover, the Gini coefficient computed by QGIS software (Appendix 4, CD, QGIS file format).

2.8 Land use

The survey that was conducted for this research depended on three types of criteria to label the land use of the spatial structures. If the block has one typology of land use, then it was completely labelled with its indicating colour, for example, residential or commercial. If the plot has one land use typology, then it was labelled completely with its appropriate indication, that distinct it of its block. And, if different types of retails were existing in a plot, then only the dominating type of retails were considered to label the plot with its indicating colour. In this section, this research comparatively reflects on the quantitative and qualitative differentiation of land use among the three neighbourhoods, on two scales. The addressed tables (2-3, 2-4, and 2-5) explain the statistical analysis of the land uses of the case studies. The main principle of this analysis is to find out the basic differences among the neighbourhoods in term of residential, and non-residential land uses. Then, concentrate on the commercial portion, because it thought to be more influential on walking behaviour.

On the scale of (400x400-meter), the overall coverage percentage ratio of Al-Saymmar and Al-Mugawlen neighbourhoods was (78.4%) and (74.8%), respectively, and Al-Abassya neighbourhood (70.5%), which shows a significant difference between the former and the later typologies in term land use coverage. Additionally, the residential is the dominating land use category in all the three neighbourhoods' typologies; It represents (75.97%) of Al-Saymmar neighbourhood, (70.17%) of the Al-Mugawleen neighbourhood; And far less, (59.47%) of Al-Abassya neighbourhood, out of the total built-up areas. On the same scale, the none-residential land use was considerably differed, as well. Al-Abassya neighbourhood clearly demonstrated the presence of commercial land use in the residential core (10.88%), Al-Mugawleen neighbourhood has a modest ratio of commercial land use on this scale (2.13%), out of the total built-up areas, (Tables 2-3, 2-4, and 2-5). However, Al-Saymmar neighbourhood showed no commercial land use on this scale. Moreover, the religious and the educational land uses are the common non-residential land uses of the three neighbourhoods on this scale.

Table 2-3: Al-Saymmar neighbourhood overall land uses

Al-Saymmar Neighbourhood Land use and density				
Land use (m^2)	400x400m	Ratio %	400-m Radius	Ratio %
Residential	121,552.00	75.97	265,649.00	52.88
Governmental	-	-	2,292.00	0.46
Educational	3,009.00	1.88	5,290.00	1.05
Religious	900.00	0.56	1,083.00	0.22
Commercial	-	-	69,550.00	13.84
Health	-	-	-	-
Vacant	-	-	12,633.00	2.51
Total built up area	125,461.00	78.41	356,497.00	70.96
Open space	34,540.00	21.59	164,903.00	32.82
Number of blocks	70			
Blocks Gini Coefficient	.44			
Total area of the sample	160,001.00		502,400.00	

On the scale of (400-meter radius), there is approximately 5% difference, in term of the ratio of the built-up area to the total area, between Al-Saymmar neighbourhoods and the other two neighbourhoods; It represents (71%) of Al-Saymmar neighbourhood, (65%) of the Al-Mugawleen neighbourhood, and (66.4%) of Al-Abassya neighbourhood. On this scale parts of the arterial streets were included into the three the neighbourhoods, which caused an increase of the open space at the account of the built portions (Figures 2-6, 2-7, and 2-8). The residential land use is the dominating land use, at the expense of the non-residential parts, and the overall open-space. It represents (52.88%) of Al-Saymmar neighbourhood, (44%) of Al-Mugawlen neighbourhood, and (38.2%) of AL-Abassya neighbourhood. The remaining lands were divided between the non-residential and open-spaces usages. With that respect, Al-Abassya neighbourhood has the highest ratio of open space, which mostly presented as streets of wide strips, or automobile-oriented trend of planning (34%). Al-Mugawlen neighbourhood has only three wide strip streets, which function as collector streets of the smaller scale streets and transit the internal movement into the surrounding arterial streets (35%). Although the open-space in Al-Saymmar neighbourhoods is mostly streets, similar to the other two typologies (32.8%), the area was distributed among longer length of streets network. In other words, the total area of the open spaces is approximately similar to the other two typologies but it is divided into more number of streets. The ratio of the built-up area out of the total area has slightly differed, Al-Saymmar neighbourhood 67.9%, Al-Mugawleen neighbourhood

66.95%, however, Al-Abassya neighbourhood was 65.05%, (Tables 2-3, 2-4, and 2-5). Thus, changing the scale of sampling results in changing the degree of differentiation among the three neighbourhoods in term of land coverage.

Table 2-4: AL-Mugawlen neighbourhood overall land uses.

Al-Mugawleen Neighbourhood Land use and density				
Land use (m2)	400x400m	Ratio %	400mR	Ratio %
Residential	112,271.00	70.17	220,770.00	43.94
Governmental	-	-	10,760.00	2.14
Educational	-	-	14,915.00	2.97
Religious	4,600.00	2.88	6,550.00	1.30
Commercial	3,400.00	2.13	71,136.00	14.15
Health	2,650.00	1.66	3,000.00	0.60
Vacant	-	-	9,270.00	1.85
Total built-up	122,921.00	76.83	326,501.00	64.99
Open space	37,079.00	23.17	175,899.00	35.01
Number of blocks	50			
Blocks Gini Coefficient	.24			
Total area of the sample	160,000.00		502,400.00	

The presence of kinds of commercial land uses was similar in all the neighbourhoods, however, the presence of the workshops and the wholesale land uses in the Al-Saymmar neighbourhood distinct it from the other two typologies, (Tables 2-6, 2-7, and 2-8). This indicates a higher level of land use's diversity in Al-Saymmar than it is in the other two typologies.

Table 2-5: Al-Abassya neighbourhood overall land uses

Al-Abassya Neighbourhood Land use and density				
Land use in (m2)	400x400m	Ratio %	400mR	Ratio %
Residential	95,150.00	59.47	191,725.00	38.16
Governmental	-	-	40,650.00	8.09
Educational	-	-	1,975.00	0.39
Religious	1,870.00	1.17	3,675.00	0.73
Commercial	17,400.00	10.88	72,970.00	14.52
Health	-	-	7,435.00	1.48
Vacant	-	-	15,225.00	3.03
Total built-up	114,420.00	71.51	333,655.00	66.41
Open space	45,580.00	28.49	168,745.00	33.59
Number of blocks	32			
Blocks Gini Coefficient	.28			
Total area of the sample	160,000.00		502,400.00	

2.9 Commercial Land use

The main three types of the non-residential land uses were observed and documented in this research include, the retail shops, the wholesale stores and workshops, and the civic or services buildings. The retail shops have diverged into food-related shops, consumer goods related shops, and general services. The observed food shops are restaurants, butchers, fish markets…etc. The consumer goods are the shops that sell things like furniture, clothes, or even electrical equipment…etc. The general services might be barbers, telephone maintenance, or coffee-shop…etc. The second type is the wholesale stores are bigger store sometimes it takes a whole single or multiple floors of a building, and some time it takes a bungalow form of a wide space of ground floor. Although these types of land uses take larger areas than the retails, they are a fewer number of destinations than what the retails are, (only 12 of wholesale stores, and 8 of workshops were observed in Al-Saymmar neighbourhood), (Figure 2-6). Moreover, the products that are sold in the wholesale stores, either food related or consumer goods, are related to what the retails sell. This type of land use needs to be connected to wide streets for the purpose of loading and unloading. And, the third type of commercial land use is the workshops. This is a kind of small industrial craftsmanship practices in zones close to the residential areas since decades in Basra city. Examples of the materials were made in these workshops are the gas ovens locally called *Tanoor*, wooden doors, and mattresses. In this thesis, the non-residential land uses are clustered into three bundles. The first bundle is all the commercial land use, the second is the commercial land use without parking, workshops, and wholesale or the retail bundle, and the third included all the non-residential land uses, which are the commercial plus the civic buildings, like schools.

Table 2-6: Commercial land use of Al-Saymmar neighbourhood

Al-Saymmar Neighbourhood Land use and density				
	400x400m	Ratio	400m Radius	Ratio
Food stores	-	-	12,570.00	2.50
Consumer goods	-	-	14,706.00	2.93
General services Shops	-	-	14,925.00	2.97
Wholesale	-	-	7,127.00	1.42
Workshops	-	-	6,238.00	1.24
Offices	-	-	2,245.00	0.45
Parking	-	-	11,700.00	2.33
Total commercial area	-	-	69,511.00	

Table 2-7: Commercial land use of Al-Mugawlen neighbourhood

Al-Mugawleen Neighbourhood commercial land use				
	400x400m	Ratio	400mR	Ratio
Food stores	-	-	5,259.00	1.05
Consumer goods	-	-	19,908.00	3.96
General services Shops	2,000.00	1.25	39,991.00	7.96
Wholesale	-	-	-	-
Workshops	-	-	1,050.00	0.21
Offices	1,400.00	0.88	9,930.00	1.98
Parking	-	-	-	-
Total area	3,400.00		76,138.00	

The locating of the retails and other commercial land uses into the structure of the neighbourhood produced a common identity of the three neighbourhoods, which is the surrounding strip of mixed land uses that is adjacently aligned into the arterial streets, with an obvious residential core of the three neighbourhoods. Also, the alignment of the retails into the individual building structures was similar; the retails are aligned into the frontage of the plots with different depths. The presence of the commercial land use on the (400x400-meter) scale in Al-Abassya neighbourhood represents the most distinctive attribute of the strong grid streets system, (Figure 2-8). Also, Al-Mugawlen has far less commercial land use on this scale, (Figure 2-7). However, Al-Saymmar showed no commercial land use on this scale, (Figure 2-6).

Table 2-8: Commercial land use of Al-Abassya neighbourhood

Al-Abassya Neighbourhood Land use and density				
	400x400m	Ratio	400mR	Ratio
Food stores	-	-	1,513.00	0.30
Consumer goods	8,600.00	5.38	15,491.00	3.08
General services Shops	7,250.00	4.53	37,084.00	7.38
Wholesale	-	-	-	-
Workshops	-	-	8,430.00	1.68
Offices	1,550.00	0.97	9,347.00	1.86
Parking	-	-	1,106.00	0.22
Total area	17,400.00		72,971.00	

On the scale of (400-meter) radius, the structural formation of the three neighbourhoods is similar for a large extent based on two criteria, the residential and non-residential compositional relationship, and the availability of certain land uses kinds. However, the proportionating of the commercial land use, among the three neighbourhoods, has strongly differed on this scale. Al-Saymmar area is the only neighbourhood that showed the presence of all the land use kinds, Al-Mugawlen included all the kinds but the wholesale kind, and Al-Abassya accommodated all kinds but the wholesale and the parking. In term of food shops, Al-Saymmar neighbourhood has the highest ratio (2.5%) out of the total area of the 400-meter radius, Al-Mugawlen illustrated less than a half of Al-Saymmar score (1.05%), while Al-Abassya showed far less ratio of food shops (0.3%). The shops of consumer goods, the three neighbourhoods were approximately having similar ratios of this kind of land use with relative overtaking in the second neighbourhood, (2.93, 3.96, and 3.08), respectively; The general services shops, Al-Mugawlen and Al-Abassya neighbourhoods were slightly different of each other (7.96%) and (7.38%), however, Al-Saymmar had far less ratio of this kind of land use (2.97%) out of the total sampled area (400-meter radius); The wholesale kind of land use are existing only within Al-Saymmar neighbourhood (1.42%) out of the total sampled area; workshops kind of land use is existing in all the three neighbourhoods, and the highest ratios were observed in Al-Abassya and Al-Saymmar area (1.68%) and (1.24%), respectively, the lowest ratio was observed of Al-Mugawlen area (0.21%); the office building kind of land use is existing in all the three neighbourhoods, and the highest ratios were observed in Al-Mugawlen and Al-Abassya areas (1.98%) and (1.86%), respectively, however, this type of land use is far less in Al-Saymmar area (0.45%); Although the car parking lots are existing in Al-Saymmar and Al-Abassya neighbourhoods (2.33%) and (0.22%), respectively, the available areas were extremely different; on the other hand Al-Mugawlen neighbourhood illustrated no parking lots on this scale, (Tables 2-6, 2-7, and 2-8).

2.10 Summary of the defining the case studies chapter

In this chapter four topics related to the case studies were elaborated and articulated include, the historical review, the systematic definition of the case studies, the structural analysis, and land use analysis. On the historical level, most of Al-Saymmar neighbourhood was exist before (1916) and within the proposal of Lock's master plan (1956), (Figure 2-3), include Al-Ashaar street and Bashar street, (Figure 2-1), which indicates the historical value of the neighbourhood. However, Al-Istiglal and Al-Mugawleen streets had found after (1956), (Figures 2-1, and 2-7), which means that even Al-Saymmar was subject to partial modern interventions. Al-Mugawleen neighbourhood mostly a product of modern master planning except for the northern strip which found before (1916), and Lock (1956) suggested to transform part of this strip to a green belt but it still the same till today. And, Al-Abassya is completely a product of modern master planning, (Figure 2-1, and 2-8). The second topic of this chapter, which is the systematic definition of the case studies, systematically produced the cadastral maps for each case study, and defined three scales of measurement for every case study. They represent the main source for the row information that re required to compute the objective measures in this research, (the objective measures defined in chapter four and computed in chapter six of this research). The structural and land use analyses were conducted in this chapter, significantly revealed the extents to which the three case studies are differentiated of each other in term of urban planning and morphologic aspects. Revealing this discrimination justify exploring the impact of this variance on walking. Therefore, the first and the second objectivities of this research are achieved in this chapter.

3 Literature Review of the Ecological Models

3.1 Introduction

With the aim of developing an ecological model of walking to occupational activities, this research proposes a conceptual framework elicited from the following literature review concerning ecological models of physical activity. In this regard, different types of study were reviewed, including literature reviews, ecological models of physical activity, intervention models of physical activity (based on social cognition theories), and integrative ecological models of physical activity (Table 3-1). The literature review defines that the ecological models test multiple levels of social and physical environmental influences on physical activity and specifies four levels that include the individual, social, built environment, and governmental (specifically policy) (Ding, Sallis, Kerr, Lee, & Rosenberg, 2011; Ding et al., 2012; Sallis et al., 2006; Sallis, & Kerr, 2012; Sallis, Owen, & Fisher, 2015). Therefore, from the reviewed literature, this research will identify the factors within the four levels that, having been tested, showed a significant association with physical activity; which physical activities were investigated, and what methodologies were adopted to achieve these aims (Tables 3-2, 3-3 and 3-4). Then, the findings are synthesised based on the four defined levels, and the conceptual framework of this research benefited from the synthesised levels.

Table 3-1: The reviewed literature concerning the ecological models

	Studies	Type of the study
	Review of literature	
1	Humpel, Owen, & Leslie, (2002)	Ecological models
2	Saelens, Sallis, & Frank, (2003)	
3	Duncan et al. (2005)	
4	Bauman, Sallis, Dzewaltowski, & Owen, (2002)	
5	Ding, Sallis, Kerr, Lee, & Rosenberg, (2011)	
6	Sallis, Floyd, & Rodríguez, (2012)	
7	Sallis, Owen, & Fisher, (2015)	
8	Rhodes & Pfaeffli, (2010); Rhodes & Nigg, (2011)	Review of Integrative model, section 3.3.3
	Ecological models	
1	De Bourdeaudhuij, Sallis & Saelens, (2003)	Ecological models
2	Frank, Schmid, Sallis, Chapman, & Saelens, (2005)	
3	Ding et al., (2012)	
4	Ball et al., (2007)	
5	Ding et al. (2013)	
6	Eves, Hoppéa, & McLaren (2003)	Intervention model
7	Darker, French, Longdon, Morris, & Eves, (2007)	
8	Maddison et al., (2009)	Integrative model
9	Giles-Corti & Donovan (2002)	
10	Rhodes, Brown, and McIntyre, (2006)	
11	Ryan E. Rhodes, Kerry S. Courneya, (2007)	
12	Lee & Shepley, (2012)	

3.2 Literature reviews on the ecological model

The early literature reviews of ecological models of physical activity examined the association between the physical activity and perceived environment factors (Duncan et al., 2005; Humpel, Owen & Leslie, 2002), and the objectively measured environmental factors (Saelens, Sallis, & Frank, 2003). They inspected the significant associations between the environmental factors and physical activity. The perceived factors were categorised into five types: “accessibility of facilities, opportunities for activities, weather, safety, and aesthetic attributes” (Humpel, Owen & Leslie, 2002). The reviews by Duncan et al (2005), and Humpel, Owen and Leslie (2002) reported a limited significant influence amongst the accessibility, opportunities, and aesthetics variables, whilst the safety and weather variables demonstrated outcomes on the physical activities. However, a review by Saelens, Sallis, & Frank (2003) highlighted the main objectively measured attributes; including density, the distance of facilities, walking infrastructure, access to facilities, and access to local shops. It reported evidence of a significant association with transportation modes, walking and cycling, and the objectively measured urban planning and urban design attributes.

The study addressed a conceptual model for governmental initiatives to improve physical activity, and the objective attributes of the physical environment to improve physical activity (Saelens, Sallis, & Frank, 2003). Thus, the early literature reviews on ecological models mainly focused on the association between physical activity and the perceived environment, with limited consideration of the objective measures. Furthermore, they only provided limited evidence of any association with physical activity and a higher significance of association with the objective measures (Saelens, Sallis, & Frank, 2003).

On the contrary of the previous two types of reviews, the thesis by Bauman, Sallis, Dzewaltowski, & Owen (2002) posits the mechanisms, or ecological processes, of the ecological models of physical activity. They state that they include determination by determinants, or mediation by mediators, and moderation by moderators, whilst some variables may behave as confounders (Figure 3-1). In other words, these mechanisms define the dimensions of the causal relationship between human activity and the environment. Moreover, the same study explained in detail the definition of each factor, as outlined below:

- The **determinants** or correlates are the independent factors that have a causal relationship. The differences in these variables are associated with parallel variations in an outcome or dependent variable.
- **Mediators** are intervening causal variables. The mediator has a causal pathway between an intervention determinant and an outcome. Moreover, this could be a single mediator or a series of cascading mediators (M1, M2 …. Mi). For example, for mediators include, “social support, perceived physical competence, or use of behaviour change strategies” (p.7).
- **Moderators** or “effect modifiers” are the factor that strengthens the relationship between an independent variable of effect and an outcome, through the interaction with the independent variable (Mo1, Mo2 …. Moi)).
- **Cofounders** are independent variables. The cofounder has an association with both the independent variable and the outcome variable.

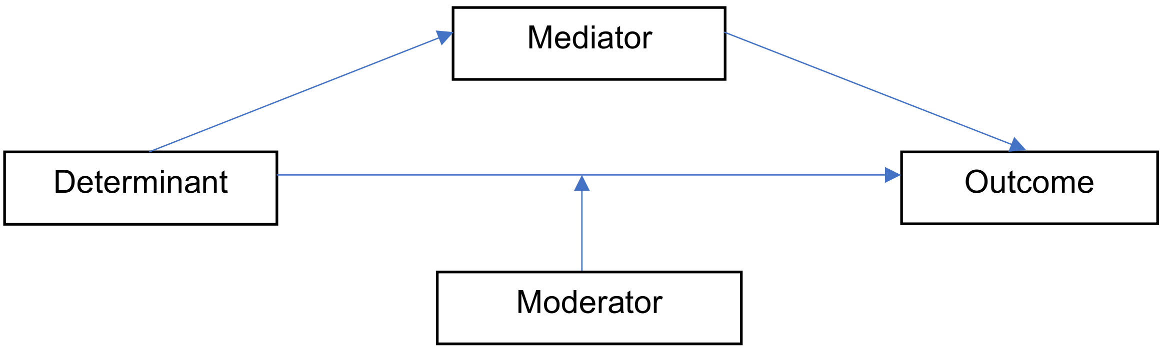

Figure 3-1: Processes of ecologic models: (Bauman, Sallis, Dzewaltowski, & Owen, 2002)

Recent literature reviews by Ding, Sallis, Kerr, Lee and Rosenberg (2011), Sallis, Floyd and Rodríguez (2012), and Sallis, Owen, and Fisher (2015) provided more thorough reviews than the earlier studies. Ding et al. (2011) reviewed studies related to neighbourhood environment influences on physical activity amongst youth. They found that the objectively measured environmental influences tended to be more credible than the perceived factors. The studies that consistently targeted children showed a significant association between physical activity and, “access to recreation facilities, land-use mix, residential density, walkability, walking/biking facilities, traffic speed/ volume, pedestrian safety structures, incivilities/ disorders, and vegetation” (p.550). Also, data from adolescents consistently showed a significant association between physical activity, the residential density and a land-use mix. However, this study reported limited evidence concerning any association between physical activity and the perceived environmental factors, which included social indicators, walking/biking facilities, traffic speed/volume, unspecified traffic safety, and access to recreation facilities (Ding et al., 2011). However, this study did not report nor reflect on other aspects of ecological models, like methodology or processes of interaction between the multilevel characteristics of the models.

Sallis, Floyd and Rodríguez's (2012) review, which adopted the general ideas concerning ecological models from a previous review (Sallis et al., 2006), classified: the multilevel to individual (biological and psychological factors); social and cultural factors (social support, social norms, and media models); built environment (urban planning, urban design, public facilities, and home design), and policies related to the built environment. The study reported patterns of evidence pertaining to each of these levels and addressed a cumulative conclusion from the studies, that the decline in built environment qualities is combined with the significant reduction of physical activities, especially those associated with the active transportation domain. The most influential characteristics indicated were: the land-use intensity and the location of destinations, the connectivity of streets, and the aesthetics of the built environment. Also, the proximity and diversity of the destinations are positively associated with walking and biking. Moreover, transportation facilities affect the active transportation domain outcomes because they affect how destinations and residential units are connected. For example, when streets and walkways of a neighbourhood are well lit, people often walk more. Using evidence from the reviewed studies, Despite the fact that some reviewed studies reported an inconsistent correlation, Sallis et al. (2012) concluded that the walkability index, which is the product of density, land-mix use, and street connectivity, showed a consistent significant association with walking and BMI at the neighbourhood scale. The recommendations of the study emphasised the combination between the contexts experienced in everyday life and an active domain for physical activity; for instance, neighbourhood walking. Subsequently, this review-based-study recommended strategies that could contribute to physical activity within the four domains, which required the necessary resources, means, and facilities, such as changes in land use policies (Sallis et al., 2012). However, this study did not report nor reflect on other aspects of ecological models, like the methodology or interaction processes between factors from the multiple levels, which may contribute to the targeted conceptual framework of this review.

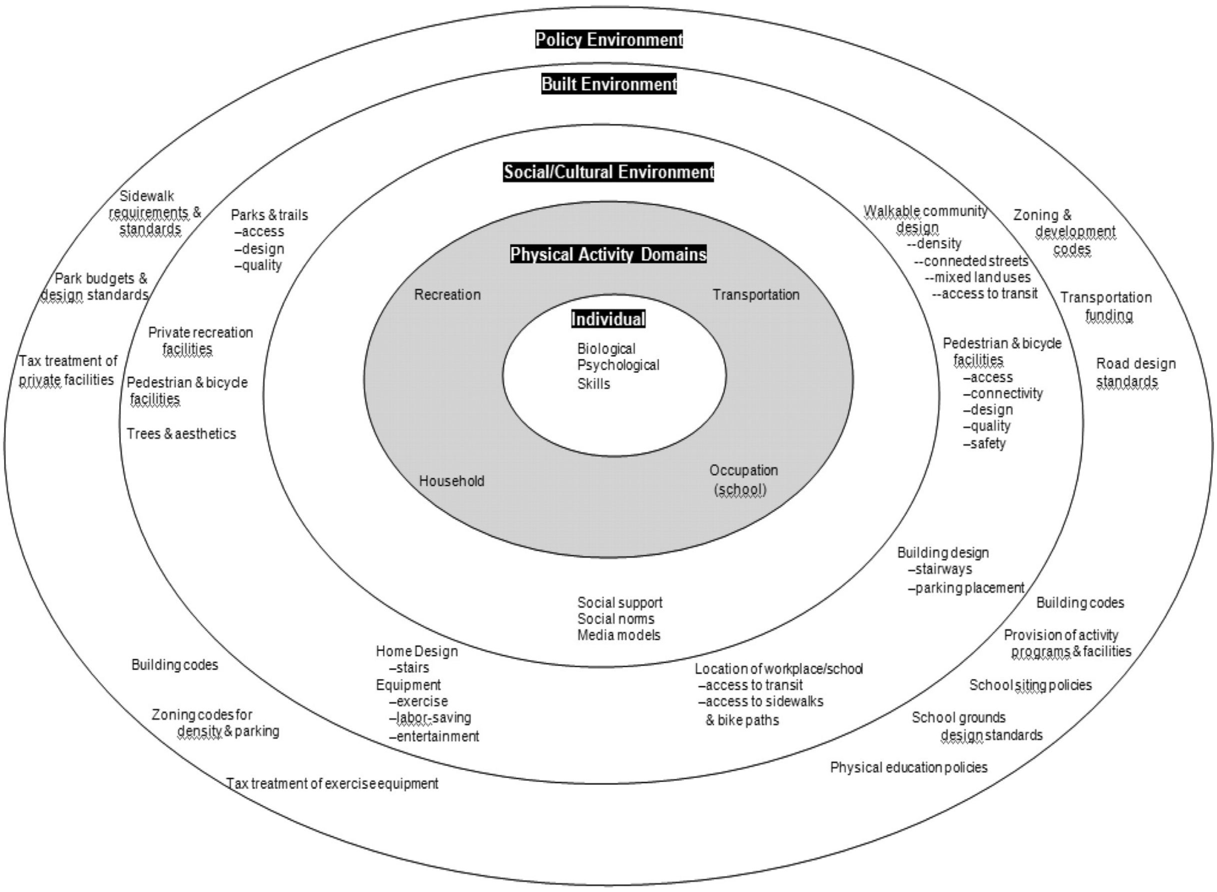

Figure 3-2: An ecological model of the four domains of physical activity (Sallis et al., 2006, 2012)

The latest review of ecological models, conducted by Sallis, Owen, & Fisher (2015), addressed a more holistic and critical review of the models that were relevant to healthy behaviour. The study highlighted both theoretical and empirical evidence, and the intervention aspects of the ecological models reviewed. They defined “the intrapersonal, interpersonal, organizational, community, and public policy levels” (p.466) as the main levels of influence on healthy behaviour and included physical activity. The second important issue was defined as the ‘between levels interaction’ (p.505). This means that the factors of influence could interact and create a synergic factor of influence. For example, the high motivation, individual factor of avoiding weight could be tested interactively by driving near fast food restaurants. In this respect, they reported very few ecological interaction factors of influence (e.g. Rhodes, Brown, & McIntyre, 2006; Ding et al., 2012). Moreover, they suggested that the interaction of personal, social, and community could be considered within intervention plans, based on evidence from multilevel statistical tests between the behavioural outcomes and individual factors, like neighbourhoods characteristics. However, these must have a level of variance that statistically helps to explain the difference in the outcome variables (Sallis, Owen & Fisher, 2015).

Besides the importance of the multilevel ecological models in improving health behaviour, especially through physical activity, this review asserted the importance of the interaction between environmental and community factors, and the individual factors, like the psychological aspects. Based on multilevel factors, these were significant for the intervention plans. Similar to the first three reviews, this publication omitted to analyse the methodological and statistical aspects of the reviewed ecological models.

Thereafter, reviews have mostly highlighted the four important aspects of ecological models, namely: (1) the active living domain, which includes physical activity; (2) the targeted category of participants; (3) the multiple levels of the models, namely individual, social, and physical environments, as the correlated sources of the tailored models, and the degrees of their association with the behavioural outcomes, which encourages participants to achieve higher levels of physical activity. In this respect, they support the ecological approach theorised by Sallis et al., (2006), which stated that “multilevel interventions based on ecological models and targeting individuals, social environments, physical environments, and policies must be implemented to achieve population change”. The final important aspect of the ecological models, is: (4) the reported findings about the association between physical activities and multiple levels differed from the tests, which yielded evidence concerning the importance of the physical environment for activity; this was particularly significant when objectively measured. Moreover, one study recommended an interaction between the environmental and psychological factors (Sallis, Owen, & Fisher, 2015). However, this review tended to omit the methodological aspects, like the sampling methods and the statistical analyses. Therefore, for the purpose of developing a comprehensive ecological model of walking to occupational activities, which is the main concern of this research, this study aims to explore the more precise dimensions of the ecological models of physical activity.

3.3 Review of the ecological models of active living

Twelve existing ecological models of physical activity are reviewed in this thesis to define the dimensions of such models. Three types of model are pertinent to the physical activity reviewed, and include: the ecological models of physical activity, the intervention models of physical activity that are based on social cognition theories, and the integrative ecological models of physical activity (Table 3-1). The recent reviews are based on key concepts from the previous ecological model literature reviews and subsequently define six criteria. These criteria include: (1) the domains of active living, which include physical activity; (2) the targeted category of the participants; (3) the multiple levels of the ecological models, and (4) the findings of the models. As well as the above, the literature review for this research aims to highlight; (5) the methodological aspects, like the sampling methods and the statistical analyses, and (6) the interaction of the environmental and psychological factors, as recommended by Sallis, Owen and Fisher (2015). After reviewing three types of physical activity model, the indicators that showed a significant association with a physical activity are synthesised based on the multiple levels of the ecological models. These levels include: the policy level, the active living domain level, the social and physical environments level, and the level of individuals. On each level, the evidence is discussed in the light of its strengths and weaknesses, and the possible gaps that remain in the body of knowledge.

3.3.1 Review of ecological models

De Bourdeaudhuij, Sallis and Saelens (2003) developed a thorough tool to investigate environmental qualities in terms of their influence on adult physical activity. Two built environment levels were considered in the study; neighbourhood design and recreational environment determinants. Environmental variables that were considered in this study related to the perceived environment, and included neighbourhood aesthetics, perceived safety from crime, perceived safety from traffic, satisfaction of neighbourhood services, perceived residential density, perceived land use diversity, perceived access to local shops, ease of walking to public transport, self-report availability of sidewalks, and bike lanes. The moderate intensity of the physical activity was explained by the access to local shops and neighbourhood satisfaction. Moreover, a supportive work environment correlated with more physical activity. However, no demographic information was able to explain the difference in physical activity variables (De Bourdeaudhuij, Sallis & Saelens, 2003) (Table 3-2).

Also, an ecological model by Frank et al. (2005) tested multilevel associations between physical activity and objectively measured walkability. In this respect, the environmental factors played a considerable determining role in the physical activity. The model developed a method for the objective measurement of the built environment, called the walkability index. This is an index that combines the main three dimensions of urban planning, including density, land-use mix, and street connectivity. This index could give different weights of the indicators of the urban planning, and must be empirically tested to identify the index that has the best association with the behavioural outcome in question. The study justified this procedure to the inherited synergic influence of these three measures, which contribute to the walkability of urban areas. The hypothesis of this model is that the higher the mixed-use urban areas and the greater the street connectivity, the higher the residential density. On the other hand, the accelerometer was used for objectively measuring physical activity, and the outcome variables were the total minutes of walking per week plus the frequency and the number of steps. The study embraced different statistical analysis tests between the independent and dependent variables, including correlation, regression, and quartiles.

The findings of the study suggested that the walkability index significantly explained the variance in walking outcomes; thus, the more walkable the neighbourhood, the higher the probability that people meet the recommended walking criteria (which is ≥30-m/≥1-hr in 2-days). In other words, the greater the density, mix of land-use, and street connectivity, the more moderate the type of physical activity. However, it is difficult to grasp the association between adult physical activity and the environment because the land-use variables are inter-related. As such, this study found out that the walkability index is significantly associated with a moderately-intense physical activity. Therefore, the built environment ingredients are flexible correlates of physical activity and should be included in the tailoring and targeting criteria of physical activity interventions (Frank et al., 2005) (Table 3-2).

Moreover, another ecological model by Ding et al. (2012) expanded the scope of the ecological models addressed by the previous two models. The model by Ding et al. tested the interactive effects of the built environment and psychosocial determinants based on a multilevel regression analysis. The determinants, or the independent variables, included an objectively measured walkability index and the perceived environment included the aesthetics of the neighbourhoods, and the dependent variable related to the physical activity outcomes that were either objectively measured or self-reported, like moderate-to-vigorous physical activity, leisure-walking and self-reported walking to transportation. Moreover, the psychosocial variables included self-efficacy, social support, enjoyment, perceived benefits and perceived barriers (Table 3-2).

Table 3-2: Characteristics of the ecological models of physical activity

The study	Domain of physical activity	The methods		The multilevel of the EM of PA		
		methodology	Analytic method	Built environment factors	Sociodemographic factors and BMI	Social cognition factors
(De Bourdeaudhuij, Sallis & Saelens, 2003)	Moderate intensity physical activity (walking)	Adults (18-65), cross-section, random sample, IPAQ	Regression analysis	Perceived environment	Gender, age, education, working and BMI	-
(Frank, Schmid, Sallis, Chapman, & Saelens, 2005)	Moderate intensity physical activity (walking)	House hold adults living in 1 kilometre radius, (≥30-m) of (≥1-h) per (2-days); Objective measurement of physical activity and physical environment	Regression analysis Odd ratio R2	Mixed land use Residential density Streets connectivity Walkability index	Gender Age Education Ethnicity BMI	-
(Ding et al., 2012)	moderate-to-vigorous physical activity, transport walking, leisure-walking	Median outcome households, 32 Neighbourhoods of two cities, cross-section sampling, objective measurement of physical activity by Actigraph accelerometers, self-report of walking by IPAQ	Regression models, intraclass correlation coefficient (ICC)	Mixed land use Residential density Streets connectivity Walkability index	Age, gender, education attainment, family household income, ethnicity/race, marital status, and the number of vehicles.	Self-efficacy, social support, enjoyment, benefits, barriers.
(Ball et al., 2007)	leisure-time walking and walking for transport	Women (18-65), 45 neighbourhoods, min 10 minutes walking; Self-reported education levels, IPAQ; Perceived environmental aesthetics, Perceived safety,	Multilevel logistic regression analysis	the total area of free access public open space, the total length of walking tracks, the number of intersections	Age, marital status, presence of children in the home and pregnancy.	Self-efficacy, enjoyment, barriers, intentions, Social support,
Ding et al. (2013)				Density, land mixed use, streets connectivity, and walkability index		

The finding of this study showed that most of the tested built environment qualities showed a significant effect on the self-reported walking to transport and to leisure. Meanwhile, limited associations were reported between the interaction factors and the walking outcomes, which in this regard, was the tested interaction effect between the built environment and the psychosocial determinants. None of the interaction variables had a significant effect on the objective moderate-to-vigorous behavioural outcomes, including the walking outcome (ICC=.10). Only the walkability index benefits were significantly associated with the moderate-to-vigorous behavioural outcomes that included leisure-walking (β=-.05, p=.047, ICC=.02). Moreover, only seven recreation facility variables showed a significant association: with a self-efficacy outcome (β=−.04, p=.006), with benefits (β=-.07, p=.003), with barriers (β=.06, p=.006), with benefits (β=-.09, p=.001), and with barriers (β=.07, p=.017). Also, the outcome for walking/cycling facilities showed a significant association with social support (β=−.14, p=.049), and the perceived environment of neighbourhood aesthetics with enjoyment outcome (β=-.19, p=.036). Moreover, the people with a lower psychosocial factor score also showed a lower walking rate.

The study empirically supports the synergic environmental effects of the paired variables on physical activity. However, a consistent association was only reported with the lower psychosocial factor score and the built environment with walking. Therefore, a built environment intervention plan could be effective (Ding et al., 2012) (Table 3-2). Thus, this study showed the importance of the interaction factors in revealing the physical activity attributes, and particularly the interaction factors between the psychological and environmental factors. Moreover, on a methodological level, the regression models and intraclass correlation coefficient (ICC) statistical analyses sufficiently revealed the associations between the independent and dependent behavioural variables (Table 3-2).

Another study by Ball et al. (2007) benefited from advances in the theoretical posits of the ecological models in terms of their ecological processes. The study applied a multilevel ecological model of personal, social and environmental factors to test their ability to mediate the educational inequality of women and their walking outcomes to leisure-time and transport. Mediation analysis was conducted to explain the leisure-time walking of women, which employed explanatory factors from multiple levels, including women's local neighbourhoods, coastal proximity, streets connectivity, and social support from family. The sample of 1554 women from 45 neighbourhoods in Melbourne was randomly recruited to answer the IPAQ-L questionnaire instrument, and produced 14 mediating variables of four aspects. These aspects were: 1) personal, which included self-efficacy, enjoyment, barriers, and intention; 2) social mediators, which included social support, membership of a sports team, exercise with a group, and whether if she has a dog; 3) environmental mediators, which included the perceived environment variables, and objectively measured environment variables; and 4) the covariate variables, which included the age, marital status, and number of children. However, none of the covariates showed a significant correlation with the outcome variable; instead, they were omitted from the multilevel analysis (Table 3-2). Moreover, the association between the predictor (exposure) and the outcomes was measured by logistic regression analysis to determine the odds ratio (OR), in four models. This combined leisure-time walking on educational level predictors with/without mediators to calculate the odds ratio (OR), and four other models, which combined transportation-related walking with educational level predictors with/without mediators to calculate the OR. The overall pattern of association demonstrated that, after adding them to the models, the tested mediators reduced the OR; this means that the social and perceived environmental factors have a significant mediation effect on walking behaviour (Ball et al., 2007) (Table 3-2).

A study by Ding et al. (2013) examined the effect of a changing country on the relationship between the perceived neighbourhood environment and physical activity. The environmental qualities investigated were the: residential density, shops near home, transit stops near home, sidewalk presence, bicycle facilities, low-cost recreation facilities, and safety from crime. The land-mix use showed significant effects on physical activity across different countries (p<.05), whilst the presence of sidewalks was a significant influential factor on physical activity (p<.05). However, the presence of bicycle facilities was an influential factor on walking in Hong Kong and Japan but not in Europe (p<.05). Although the transit's access was a less frequently investigated factor in relation to physical activity, it showed a fluctuation in the rates of significance between countries. Moreover, access to recreational facilities and safety from crime showed nonsignificant associations with physical activity (Ding et al., 2013) (Table 3-2).

3.3.2 Review of social cognition models of intervention

The tailored, theory-based models of intervention, which aim for behavioural change depend on sound evidence from related theoretical sources (Michie & Abraham, 2004). In this respect, Hardeman et al. (2005) emphasised the need to develop causal models, which are justified by theory-based evidence, to explain how the intervention process takes place in the pattern of inter-dependent determinants of behaviour (Campbell et al., 2000). Moreover, the required causal models tend to explain the mechanism of intervention that accounts for the change of behaviour in question (Darker, French, Eves, & Sniehotta, 2010). In this respect, the Theory of Planned Behaviour (TPB) is pertinent to physical activity intervention models for behaviour change for different reasons. Firstly, the TPB defines the apparent constructs and determines the behaviour's incidence. Secondly, a meta-analysis of reviews demonstrated that TPB empirically contributed to the prediction of behavioural outcomes (Armitage et al., 2001; Conner & Sparks, 2005 as cited in Darker et al., 2010). Thirdly, the theory was widely used within health psychology, especially for physical activity, and within interventions related to behavioural change (e.g. Darker et al., 2010; Hardeman et al., 2005; Williams & French, 2014). Fourthly, the TPB was utilised to examine physical activity change, including walking within ecologic models, which involves the environment factors including the physical environment (Rhodes & Nigg, 2011).

Moreover, the TPB has been, on different occasions, utilised to produce integrative models of physical activity, to examine the causal effect of environmental and individual factors on behavioural outcomes. The TPB addressed three beliefs as determinants of behaviour, which include, behavioural attitude (BA), subjective norms (SN), and perceived behavioural control (PBC) (Ajzen, 1991). Such an approach is about predicting behaviour occurrence throughout its proximate intention. The intention to act is postulated as equivalent to the will (volition) to behave. The intention is considered a measurable construct by the theory, either directly or indirectly by its determinants. Furthermore, the greater the intention a person has to act, the more likely that the behaviour will occur. The intention could be defined by the three factors, which were considered determinants of its strength, namely: attitude, subjective norms, and perceived behavioural control. An individual's attitude to behave reflects in the belief about the extent of interest to them, and thus, their desire to do it. A subjective norm construct measures the perceived pressures of people to undertake an action. PBC is defined as the beliefs toward the availability of resources that determine the perceived control and the person's self-assessment to perform the behaviour (Ajzen, 1991). As a general rule, the more favourable the attitude and subjective norm and the greater the perceived control, the stronger the person's intention, and thus, the more likely they are to perform the behaviour in question. Finally, by giving a sufficient degree of control over their behaviour, people are expected to carry out their intentions when the opportunity arises. Therefore, intention is assumed to be the immediate antecedent of behaviour. However, because much behaviour poses difficulties for execution, which may limit volitional control, it is useful to consider perceived behavioural control in addition to intention. To the extent that perceived behavioural control is correspondent to the reality, it can serve as a proxy for actual control and contribute to the prediction of the behaviour in question (Ajzen, 2006).

Moreover, Ajzen described two suggested roles of the Theory of Planned Behaviour within the walking-environment relationship. The first is the mediation role where the TPB addresses a proximal construct of real behaviour. Thus, these constructs might mediate the relationship between the 'external' variables and the behavioural outcomes. In other words, the theory postulates that the environmental qualities affect real behaviour through the influence of individual beliefs related to particular behaviour, namely, attitude, subjective norms, and perceived behavioural control. The second role is moderation, where the constructs of the TPB moderate the effects of the external factors and the intention to walk (Ajzen, 1990 as cited in Rhodes & Nigg, 2011); for example, if the attitude to walk moderates the effect of the walkability index on the intention to walk (which is the fourth construct of the theory).

Table 3-3: Characteristics of the social cognition models of the physical activity

		The methods		The multilevel of the EM of PA		
The study	Domain of the PA	Methodology	Statistical Analysis	Built environment factors	Socio-demographic	Individual level
Eves, Hoppéa, & McLaren (2003)	Physical activity, Walking, cycling	Longitudinal of one month targeted adults	Regression analysis	-	Demographic information	The TPB constructs
Darker et al. (2007)	Physical activity, Walking, cycling	Longitudinal of one month targeted adults	Regression analysis	-	Demographic information	The TPB constructs

A study by Eves, Hoppéa and McLaren (2003) explained that, among the three constructs of the Theory of Planned Behaviour, only perceived behavioural control (PBC) significantly predicted walking change. The study demonstrated that "One item clearly cannot capture the complexity of physical activity, particularly when different frequencies of each behaviour are involved" (p.79) and different contributions of the different constructs of TPB might be created for different physical activities. Compared with other activities, walking was better explained by the TPB constructs, as 40% and

64% (based on the determination coefficient R^2), respectively. In general, the study found that the TPB constructs contributed differently to explain the variance of different behaviours. The behavioural attitude BA and PBC determined intention, and intention determined behaviour in terms of generic exercise. However, walking was less predicted, with no contribution of attitude to the intentions for walking (Eves, Hoppéa, & McLaren, 2003) (Table 3-3).

Another social cognition study of walking, by Darker et al. (2007), found that the order of the constructs of the TPB was not biased by changing the order of the constructs (attitude, social norms, PBC). They asserted that affective/instrumental factors of attitude toward walking ought to consider, as called “targeting affective beliefs”, such as the expected health affect beliefs. In this regard, a significant effect of the beliefs was noticed on the physical activity, (p<.001) (Darker, French, Longdon, Morris, & Eves, 2007) (Table 3-3).

3.3.3 Review of integrative ecological models of physical activity with the TPB

The integrative models trend is a trend of ecological models of physical activity that integrates the first trend, which concerning the social and physical environment, to the Theory of Planned Behaviour from social cognition trend of intervention of physical activity. It mostly relies on the TPB to build integrative ecological models, which combine the environmental qualities with the behavioural outcomes through the constructs of the theory (Rhodes & Nigg, 2011). The theoretical bases for such claims come from the potential of the TPB, as outlined by Ajzen (1985, 1991). In this regard, two studies (a review and an update) by Rhodes and colleagues (Rhodes & Pfaeffli, 2010; Rhodes & Nigg, 2011) reviewed particular prominent social cognitive theories in terms of their utility in the domain of physical activity. Three theories were reviewed in this regard: the Theory of Planned Behaviour (TPB), Self-Efficacy Theory (SET), and the Trans-Theoretical Model of Behaviour Change (TTM). In terms of the TPB, the study explained that the conversion of a worldview from the individual to the socio-ecological conception of a human-environment interaction phenomenon drew the attention to the TPB. This is because of the embedded connection of its personal traits constructs to social and physical environments. Various levels of physical activity were examined with the TPB through particular physical activities, at sedentary, moderate and vigorous levels. Generally, the evidence from past studies showed that the subjective norms construct and behavioural attitude construct are the weaker predictors than perceived behavioural control and intention. The reviews asserted the importance of an integrative model for physical activity because this facilitates the combination of the personal traits with the external factors, such as neighbourhood factors, to predict targeted physical activity (Rhodes & Nigg, 2011; Rhodes & Pfaeffli, 2010). In other words, the tailoring of the ecological models was based on the structure of the TPB.

Table 3-4: Characteristics of the integrative models of physical activity

The study	Domain of the PA	Methodology	Statistical Analysis	Built environment factors	Sociodemographic and BMI	Individual level
(Maddison et al., 2009)	moderate-to-vigorous physical activity	Adolescents (12-17) of two metropolitans, objective measurement of physical activity by Actigraph accelerometers, self-report of walking by IPAQ-A	SEM, and R^2	Walkability index, access index to physical activity facilities	Gender, age, ethnicity, body composition, and deprivation index.	The TPB constructs
(Giles-Corti & Donovan, 2002)	Vigorous, light to moderate activity, walking for recreation and transport; The metabolic equivalent of each physical activities (MET)	Healthy workers and home-makers, (adults 18 to 59-yrs) living in a 408 km2 area of metropolitan Perth and Western Australia, and two weeks duration	Multilevel logistic regression analysis, and R^2	Spatial access to recreational facilities	age, gender, number of children in the house hold under 18 years, work outside the home, household income, and education	The TPB, and the TT
Rhodes, Brown, and McIntyre, (2006)	Leisure-time walking	Adults living in a district, NEWS, IPAP-SEM, and GLTEQ	Bivariate correlation, R^2, and SEM	Perceived environment	Age, education level, job, income, martial, health status, and ethnicity	The TPB constructs
Ryan E. Rhodes, Kerry S. Courneya, (2007)	Leisure-time walking	Adults living in major city, NEWS, IPAP-SEM, and GLTEQ	Bivariate correlation, The standard fit indices, R^2 and SEM	Perceived environment	Age, education level, job, income, martial, health status, and ethnicity	The TPB constructs
Lee & Shepley, (2012)	Last 30 minutes leisure-time walking per a week	Korean adults (>18 years old), PAQLQ	Chi-square, Pearson correlation, and SEM	Perceived environment	Age, gender, martial, and education level	The TPB constructs

A study by Madison et al. (2009) suggested an integrative model of built environment qualities, either perceived or objectively measured, and physical activity outcomes to the TPB constructs. The model was applied to adolescents in New Zealand. The objective measures of the physical environment were: accessibility, walkability, and the Deprivation index (NZDep). The subjective measures of the physical environment were based on the Neighbourhood Environment Walkability Scale (NEWS) instrument. The behavioural outcomes that were related to the physical environment were the minutes walking (30 minutes per day for weekdays), and the step count, measured by an Accelerometer. These were measured by the Physical Activity Questionnaire for Adolescents (PAQ-A). The TPB constructs were measured by Likert scales, in accordance with Ajzen's criteria (1991). The resulting model depended on a structural equation to bring the different variables together. The study reported a significant correlation between different paths of analysis. The perceived variables of the physical environment have no correlation with the Moderate to Vigorous Physical Activity (MVPA), and the GIS-based measures (walkability and accessibility) showed no significant correlation with the MVPA. The MVPA minutes significantly correlated to the PAQ-A (r=0.05, p<0.0001). The dependency of the PAQ-A variables on the perceived behavioural control (PBC) and the intention (as independent variables) was significant (p<.0001), and the model counted for 43% of the variance on the physical activity outcome. Also, the MVPA as a dependent variable on the perceived behavioural control (PBC), and intention, as an independent variable, were both significant (p<.0001); furthermore, the model counted for 13% of the variance of the MVPA. The overall results reported that the constructs of the TPB variables were "the most proximate determinants" of both subjectively and objectively measured physical activity.

It is thus the perceived control of accessibility to the recreation equipment that encourages participants to undertake physical activity (Madison et al., 2009). Perceived safety was related neither to the TPB constructs nor to physical activity. On the other hand, in contrast to previous studies (e.g. Frank et al., 2005), the walkability index was neither correlated to the self-report nor objectively measured to the physical activities. The study attributed this to the free play lifestyle of adolescents and the small sample. The accessibility index had no association with either measures of physical activity. The study concluded that the integrative model was modest (at best) in predicting behavioural outcomes. Moreover, the structural equation model, based on the TPB, had the potential to explore the complex interdependence between the different variables of the person-environment outcomes in terms of physical activity (Maddison et al., 2009) (Table 3-4). Thus, this study, in contrast to most other studies in this field, supports the subjective measures in predicting physical activity, and not the objective measures of the physical environment.

Another study by Giles-Corti and Donovan (2002) was concerned with testing environmental and individual determinants of physical activity. The study postulated that it was essential to determine the level of use of the facility, and the streetscape quality in terms of motivating individuals to walk. Thus, the aim was to identify the influence of the individual, social, and physical environment on the physical activity of participants, particularly in relation to recreational walking. Moreover, the interaction effect on outcome behaviour was examined between the individual traits and the physical environment. The individual factors were based on the TPB by Ajzen (1991) and the Theory of Trying (TT) by Bagozzi and Warshaw (1990). Specifically, these were the perceived behavioural control from the Theory of Planned Behaviour, and the conceptualisation of behavioural skills from the Theory of Trying. The distance-based accessibility, which was based on the distance decay principle (Hansen, 1959) and considered as a good predictor of behaviour (Teraslinna, Partanen, Koskela, and Oja, 1969), was utilised as the main physical environment factor in the study. It is thus hypothesised that the spatial factor influences the desires and abilities of users to undertake a trip (Giles-Corti & Donovan, 2002).

The logistic regression analysis, between the outcome behaviour related to the use of the facility and the level of accessibility, showed a significant effect ($p<.05$) on the access level. This included access to the beach, river, golf course, swimming pool, and tennis court. Moreover, the TT behavioural skills variable showed a significant association ($p<.05$) with an increase in the level of exercise, whilst the perceived behavioural control variable showed a significant effect on the level of exercise, and the intention variable showed a significant effect on the level of exercise. However, participants with a higher Social Norm level were less likely to exercise (Odd Ratio=0.72). The social environment variables predicted the exercise outcome, where the more people engaged in the activity with the participant, the more frequently the exercise was practised by the individual ($p<.001$). Additionally, sports members were approximately 2.5 times more likely to engage in and achieve physical activity than the recommended level (OR=2.45).

After adjustment to the other variables, the relative influence of the individual, social and physical environment correlated; whilst the strongest association was noticed between individual correlates and the outcome of the exercise. This was more so than an association with the social and physical environments. Thus, those with a higher level of individual determinants of walking were more likely (by 8.14 times) to meet the recommended level (OR=8.14). This is approximately twice as high as the influence of the highest score on the social environment correlates, (OR=3.72), and five times higher than the influence of the highest score on the physical environment correlates, (OR=1.43) (Table 3-4). However, the study omitted the interaction effects between the levels as independent variables.

The study concluded that accessible facilities are necessary to enhance physical activity. Moreover, the new modification may yield better results to the recommended level of the physical activity, which was called the “gold standard” of behaviour. The second important conclusion was that the social ecology approach accommodates empirically and theoretically important variables, which have the potential to enhance methods to study the physical activity discipline. Similar to other studies, the PBC and behavioural skills are considered determinants of physical activity behaviour. Meanwhile, attitude was not included in the social ecological model because it was weakly associated with the behavioural outcome. Therefore, the social ecological model has a weak contribution to the physical activity model, which contrasts with its contribution to accessibility (Giles-Corti & Donovan, 2002).

Also, Rhodes et al. (2006) used an integrative model with the TPB amongst adults in Canada to predict leisure time walking. This model relied on independent factors from: the perceived neighbourhood environment, personality, and planning factors. The causal model of the Theory of Planned Behaviour was adopted to determine whether it mediates the environment-walking relations, and whether the environmental factors moderate the TPB-walking relationships. The first integrative model of the perceived environment variables and TPB only depended on the land-mix use and the neighbourhood aesthetic variables. This was because of its significant correlation with the outcome variable of walking. Based on the determination coefficient (R^2), the land-mix use determinant showed a significant effect on all the TPB determinants of physical activity (affective attitude r^2=.21, instrumental attitude r^2=.21, SN r^2=.16, and PBC r^2=.19). Meanwhile, for neighbourhood aesthetics, the effect was only significant on the affective attitude (r^2=.15), and the instrumental attitude (r^2=.18). However, the effect of neighbourhood aesthetics was not significant with either the SN or the PBC. The final conclusion was related to the mediation tests and reported the possible indirect effect of the physical environment on physical activity through the mediation effect. For example, the perceived neighbourhood aesthetic and land-mix use may influence the intention-walking relationship. The moderation role of the environmental factors was significant for the sense of safety (crime) (r^2=.01, or 1%). Also, the land-mix use significantly moderated the intention-walking relationship (p<.01) (Rhodes, Brown, & McIntyre, 2006) (Table 3-4).

Another model, by Rhodes and Courneya (2007), aimed to integrate the perceived environment, individual traits and planning measures to the Theory of Planned Behaviour. Only the neighbourhood aesthetic, the quality of the infrastructure, and the proximity to retail were used with the regression analysis and this was because of their significant correlation with the outcome variables. Only the variables that had a significant correlation with the dependent variables of walking were to be integrated into the TPB variables. This aimed to predict walking from the multiple levels of determinants.

Thus, for the purpose of predicting walking outcomes, the integrative model includes these three perceived environment variables in the Theory of Planned Behaviour and the variables of planning. The following standard fit indices were adopted: chi-square (X^2), Confirmatory Fit Index (CFI,) and the Root Mean Square Error of Approximation (RMSEA). Thus, a moderate fit was obtained for the model (χ^2(183)=716.32; p<.01; CFI=95; RMSEA=.08). Results from integrating the perceived environmental variables showed a significant effect of the proximity to retail on walking outcomes (r^2=.18 or 18%, p<.05). Furthermore, significant effects were also demonstrated between: the infrastructure quality on affective attitude (r^2=.2 or 20%, p<.05), on instrumental attitude (r^2=.25 or 25%, p<.05), and on SN (r^2=.19 or 19%, p<.05). Also, the significant effect of the aesthetic factor on both affective attitude (r^2=19 or 19%, p<.05), and on Social Norm (r^2=.12 or 12%, p<.05) was reported. The perceived environmental factors added approximately 2% to the explanatory power of the TPB construct ($\Delta\chi^2$ (3)=18.90; p<.01), to explain the variance in intention. From the perceived environment factors of the neighbourhood, only three factors moderated the intention-walking relationship: the perceived proximity of retail (r^2=.17); the condition of the infrastructure (r^2=.17), and the neighbourhood aesthetic (r^2=.14) (Rhodes & Courneya, 2007) (Table 3-4).

In contrast to the theoretical tenets of the Theory of Planned Behaviour, (Rhodes & Courneya's results do not support the full mediation of the TPB construct to the external influences on the behavioural outcomes. This echoes the claim by Fishbein (2000, as cited by Rhodes & Courneya, 2007), that the influence of the environment on behaviour may occur independently of social cognition constructs.

A study by Lee & Shepley (2012) with Korean adults addressed a framework proposed from the TPB to examine the relationship between leisure-time walking and several other factors, including the personal, social, and perceived environment. The main purpose of the study was to inform architects, urban planners, and urban designers about the importance of personal traits in predicting the relationship between the built environment and walking for leisure. The study used a questionnaire to conduct a cross-sectional survey of the perceived neighbourhood environment, the TPB, and leisure-walking behaviour. All the statistical tests compared the walkers and non-walkers (with the criteria being a self-reported 30-minutes/5-days walking behaviour) in terms of several variables from three major domains: the perceived environment, physical activity, and the constructs of the TPB (Table 3-4).

Based on the behavioural outcomes, participants were categorised as walkers or non-walkers. Thus, the *t*-test was conducted to assess the association between the independent variables and the behavioural outcomes of the two categories. The results of the study only showed a significant influence between the aesthetic qualities ($p<.05$) on the perceived environment qualities; however, the influence of traffic safety, crime safety, and convenience variables showed a non-significant influence on the leisure-walking variables ($p>.05$). The perceived control and intention constructs of the TPB significantly differed between the two categories, ($p<.001$), but the attitude and Social Norm were not significant ($p>.05$). In other words, the walkers expressed a higher level of perceived behavioural control and intention than non-walkers.

The integration between the TPB variables and environmental variables were correlated with walking as a continuous variable. The correlation between walking and intention was significant ($r^2=0.27$, $p<.01$), with PBC recorded as significant ($r^2=0.19$, $p<.01$), and the perceived crime safety found to be significant ($r^2=0.15$, $p<.05$). The environmental variables included, perceptions of the neighbourhood aesthetics ($r^2=0.19$, $p<.01$), traffic safety ($r^2=0.15$, $p<.05$), and crime safety ($r^2=0.15$, $p<.05$), which all significantly correlated with intentions.

The model of the TPB was conducted by AMOS software and showed a "modest fit of data, [x^2=0.134, p=.94; Normed Fit Index (NFI)=1.00; RMSEA=.00]". Within the integrative model, the intention showed a greater direct effect on walking (r^2=.37), than PBC (r^2=.01). Following the identification of this finding, the perceived environment variables were added to the model to determine the contribution of environmental information to the predictability of the model. Only the perceived safety from crime was added because it was the only correlated variable with walking. Again, the overall model showed a "modest fit of data, [x^2=2.372, df=5, p=0.796; Normed Fit Index (NFI)=.99; (RMSEA) =.00]". The intention factor was predicted with a 45.6% variance, and the walking outcome with a 19.4% variance was also explained. Moreover, perceived crime safety has a direct standardised effect on attitude (r^2=.13), on subjective norms (r^2=.08), and on PBC (r^2=.14). Whilst, the intention factor has a direct standardised effect on walking (r^2=.427) (Lee & Shepley, 2012).

The major conclusion of the study suggested that the higher the beliefs' scores (in terms of BA, SN, and PBC) that a person holds about walking, the greater the walking behaviour yielded. Moreover, the safety and aesthetics of the neighbourhood environment are considered important qualities in terms of encouraging walking (Lee & Shepley, 2012).

3.4 Synthesis of the findings from the reviewed literature

All types of the reviewed studies (Table 3-1) agreed that ecological models concern the multilevel association between physical activity and the individual traits, social environment, physical environment, and policy intervention. However, the reviewed studies dealt with these levels differently. In other words, each study considered some levels at the expense of others. Only three studies (Bauman, Sallis, Dzewaltowski & Owen, 2002; Sallis et al., 2006; Sallis, Owen, & Fisher, 2015) holistically addressed theoretical theses and empirical evidence, and their theoretical posits agreed with the notion of four level ecological models, which are outlined as follows.

3.4.1 Policy and governmental regulations (level - 1):

As recommended by the ecological models, the interventions are confined to changes in policies related to the built environment in order to improve physical activity and prevent obesity. Governmental strategic plans to improve the built environment focus on the urban structures, like transportation, walkways, recycling, and recreation facilities. Moreover, a second aspect is policy intervention, which can be exemplified by new management plans, like the use of public facilities. Also, new development-related interventions might come as a criterion of land density, mixed land use, diversity of users, and design guidance.

However, the lack of recommendations was noted amongst previous ecological models in terms of any built environment change and policy intervention to improve physical activity (Bauman, Sallis, Dzewaltowski, & Owen, 2002; Sallis et al., 2006; Sallis, Owen, & Fisher, 2015). Policy intervention includes the master planning of cities, which develops founding plans of built environments, especially in planned cities and metropolitan areas. Moreover, education could directly influence physical activity through greater awareness about urban structures (Sallis et al., 2006). However, no previous studies utilised factors from this level as determinants of physical activity. Instead, their use within some existing ecological models is confined to receiving feedback based on evidence for the purpose of intervention (e.g. Sallis et al., 2006; Sallis, Owen, & Fisher, 2015). Nevertheless, no previous publication has applied an empirical study comprised of two phases, namely before and after an intervention.

3.4.2 Active living domains (level - 2):

Sallis et al. (2006) classified human activities in the built environment into four domains of active living, including active recreation, active transportation, household activities, and occupational activities. However, based on the reviewed studies, the body of knowledge of ecological models covered limited active living domains. In this regard, the reviewed studies mostly covered walking to transport, recreation, and leisure, which tended to be significantly associated with the environmental factors and less significantly associated with individual factors, like the Theory of Planned Behaviour constructs. Thus, there are several active living domains that currently have no ecological models, like household and occupational activities.

3.4.3 The social and physical environmental level (level - 3):

Based on the reviewed literature, social support for physical activity has a limited intention amongst the applied ecological models compared with the built environment. In this regard, both social cognition theories and psychological theories were utilised. For example, the SN construct of the Theory of Planned Behaviour probed the dependence of physical activity on social norms and demonstrated an inconsistent association (Giles-Corti & Donovan, 2002; Lee & Shepley, 2012; Maddison et al., 2009;

Rhodes, Brown, & McIntyre, 2006; Rhodes & Courneya, 2007). Moreover, the Theory of Trying, which was used to probe the dependence of physical activity on social support, showed a significant association (Giles-Corti & Donovan, 2002). Moreover, the social environment indicators were completely based on a self-report method.

In terms of the physical environment, evidence for several studies showed that changes in physical activity occur alongside changes in the built environment (Sallis & Kerr, 2006). Another study by Sallis et al., (2012) demonstrated uneven evidence concerning the influence of the built environment on physical activity. However, the study concluded that the decline in built environment qualities means a subsequent reduction in physical activity, especially in relation to transportation activities (Sallis, Floyd, Rodríguez, & Saelens, 2012). In other words, the reported consistency of a positive association between the physical environment attributes and physical activity (e.g. Saelens, Sallis, & Frank, 2003; Sallis, Floyd and Rodríguez's, 2012; Sallis, Owen & Fisher, 2015) support the importance of the physical environmental factors in the ecologic models.

From the reviewed studies (Table 3-1), the physical environment attributes were either subjectively or objectively measured, like the data sets related to the GIS (Brownson et al., 2009). The subjective measurement was applied to the perceived environment indicators (Brownson, Ross, Hoehner, Day & Forsyth, 2010), whilst the objective measurement was mainly applied to the urban planning measures (Saelens, Sallis & Frank, 2003), such as when utilised to create the walkability index (Frank et al., 2006; Frank et al., 2010). Also, the accessibility index based on distance measures was used on only one occasion with the reviewed studies (Giles-Corti & Donovan, 2002). When assessing the built environment, ecological models regularly consider the walkability index (which is the product of density, land-mix use, and street connectivity). In other words, when the walkability index was applied to certain studies, it yielded a significant correlation with the walking outcomes (Sallis & Kerr, 2006).

However, the perceived environment indicators had a less significant association with physical activity (Duncan et al., 2005; Humpel, Owen & Leslie, 2002). In this regard, the most influential characteristics indicated were: land mixed-use, intensity, proximity and destination accessibility, connectivity of streets, neighbourhood aesthetics, and the sense of safety related to traffic. These qualities play a determining role in terms of the physical activity. Indeed, Sallis & Kerr (2006) explained that transportation facilities effect the active transportation domain outcomes because they impact on the connection between destinations and residential units. For example, when neighbourhood streets and walkways are well-lit, people often walk more.

Nevertheless, previous studies only tested a limited range of physical environment attributes, especially focusing on the objectively measured morphologic and urban design attributes of the urban form, like the quality of blocks, edges, and facades. In contrast, the phenomenological models, like studies related to the New Urbanism movement, particularly focused on the neighbourhood walkability, and covered a wider area of attributes (e.g. Ewing, Handy, Brownson, Clemente, & Winston, 2006; Handy, 1996; Lee & Moudon, 2006a, 2006b, 2008; Moudon et al., 2007). Although only a few of the reviewed studies tested the interaction factors between the social and physical environments (e.g. Ding et al., 2012), these factors were highly recommended (Sallis, Owen, & Fisher, 2015).

3.4.4 The level of individuals (level- 4):

3.4.4.1 Socio-demographic information:

The reviewed studies (Table 3-1) frequently used demographic variables to determine environment-activity relationships, including: gender, age, working situation, income, disability, height and weight (calculating the body mass index (BMI) as kg/m). Conversely, relevant family information was constructed in terms of: living conditions, family size and children (with/without), children under the age of 16, house ownership, and whether the participant practiced sport or exercise. Sallis et al., (2009) also supported this summary.

3.4.4.2 Body Mass Index BMI:

Saelens, Sallis, & Frank (2003) explained that the evidence-based relationship between the built environment and obesity revealed fluctuating results amongst adults. Some studies concluded that a walkable neighbourhood could prevent individuals from becoming overweight and obese. However, other studies reported an inconsistent association between the physical environment’s qualities related to walking and rates of obesity/overweight. Moreover, they explained that longitudinal studies could generate more efficient results than cross-section studies because the fat in the human body accumulates over a long time. Thus, a longer time of observation could enable more sound conclusions. However, a cross-sectional study of a large sample showed a significant association between neighbourhood walkability and obesity. The study concluded that longitudinal studies must run alongside longitudinal changes in the qualities of the built environment in order to detect any relationship with BMI changes (Saelens, Sallis, & Frank, 2003).

3.4.4.3 Social cognition theories (including TPB, SET, and TT):

The reviewed studies concerning the integrative trend amongst ecological models mainly depended on the basic structure of the Theory of Planned Behaviour (Table 3-4). However, several theories were considered as potentially important to physical activity (Rhodes & Nigg, 2011; Rhodes & Pfaeffli, 2010) including: the Theory of Planned Behaviour (TPB), Self-Efficacy Theory (SET), and the Trans-Theoretical Model of Behaviour Change (TTM).

The two reviews (Rhodes & Nigg, 2011; Rhodes & Pfaeffli, 2010) explained that the conversion of the worldview from an individual to a socioecological conception of the human-environment meant that the Theory of Planned Behaviour was significant. This was due to the embedded personal trait constructs within the social and physical environments. Moreover, the TPB constructs were: attitude, subjective norms, perceived behavioural control (PBC), and intention (Ajzen, 1991).

The studies reviewed by this research (Table 3-4) examined the influence of various environmental factors and individual traits based on the TPB constructs concerning physical activity. Generally, the patterns of evidence from past studies showed that the subjective norm constructs and behavioural attitudes are weaker predictors than perceived behavioural control and intention. The PBC and the intention constructs of the TPB were consistently associated with the physical activity in question, which accord with the primary posits by Ajzen (1991), who considered the TPB constructs as proximates of real human behaviour. Thus, the reviewed studies asserted the importance of integrative models of physical activity, because they facilitate the combination (namely the tailoring of ecological models) of external factors with personality traits, like neighbourhood factors, within a targeted physical activity. These views support the literature review conclusions by (Rhodes & Nigg, 2011; Rhodes & Pfaeffli, 2010). Therefore, the theory can be considered a multi-dimensional instrument that brings the individual internal factors in line with their external context, like the neighbourhood. The theory played a major role in creating the integrative ecology models trend. This was due to the primary representational structure of the TPB, and the potential of the Structural Equation Model SEM, which is already utilised with the

TPB, to compute the size of effect between the involved determinants of the hoped integrative model of the physical activity.

Based on evidence from the reviewed literature (Table 3-3) about the significant association between physical activity and the Theory of Planned Behaviour constructs, this research argues that the importance of the TPB lies in its consideration of the external stimulus of walking. Therefore, the theory has the potential to concretise the cognitive gap between the external circumstances and the actual human actions. This potential serves a major aim of this research concerning the development of a multilevel analytic instrument concerning activity-environment in Basra city; this is because it can be considered a holistic instrument that combined varied factors of influence.

3.5 Methodological considerations based on the reviewed literature

The reviewed literature in this research (Table 3-1) addressed important methodological dimensions of the ecological models. The reviewed models were completely cross-sectional and from randomly sampled populations. The adopted questionnaire instruments mostly were close-ended questionnaires, which produced quantitative variables (e.g. the International Physical Activity Questionnaire IPA). However, some models included interviews with open-ended questions (e.g. Eves, Hoppéa, & McLaren, 2003; Darker et al., 2007). The statistical analyses completely depended on the regression analyses of multiple independent variables and one dependent variable, which was the behavioural outcome. In this regard, different types of regression analyses were applied, including: the logistic regression analysis (considered when the variables are categorical), and the hierarchical regression analysis (considered when the models are composed of several levels). Also, the SEM was considered in several methods to check the fit of the models, including: chi-square (X^2), Confirmatory Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA) (e.g. Lee & Shepley, 2012; Rhodes & Courneya, 2007). The variables of the models were either independent or dependent variables. The independent variables included determinants, moderators and mediators, as defined by Bauman, Sallis, Dzewaltowski and Owen (2002).

3.6 The conceptual framework of this research

Based on literature related to ecological models, which are strongly asserted a multi-disciplinary approach with the aim of promoting/improving active life-styles (e.g.

Sallis et al., 2006; Sallis et al., 2015), a conceptual framework for this research is developed, which involves the necessary individual, social, and physical environment levels to explain the walking to occupational activities in Basra city's neighbourhoods. Thus, the conceptual framework of this research (Figure 3-3) is informed by the synthesised multiple levels of the reviewed models (section 3.3). This conceptual framework is a main objectivity of this research (objectivity 2, section 1.6.2) that serve its aim in promoting the active living style based on the obtained evidence-based feedback for the planning and design of the neighbourhoods of Basra city.

The conceptual framework represents the requirements of a cross-disciplinary (or multilevel) approach of a walking-neighbourhood relationship that also guides this research. The first level includes the target level of the inspection, which are from two active living domains namely, occupational activities and walking as a mode of transport. Aside from its importance for public health, walking is important because it is the most interconnected domain with all four other domains. The second level represents the social and physical environments, which are objectively and subjectively measured. The third level represents the individual, and includes the personal information and TPB constructs. Finally, the fourth level is the master planning of Basra city, which is utilised as the intervention level.

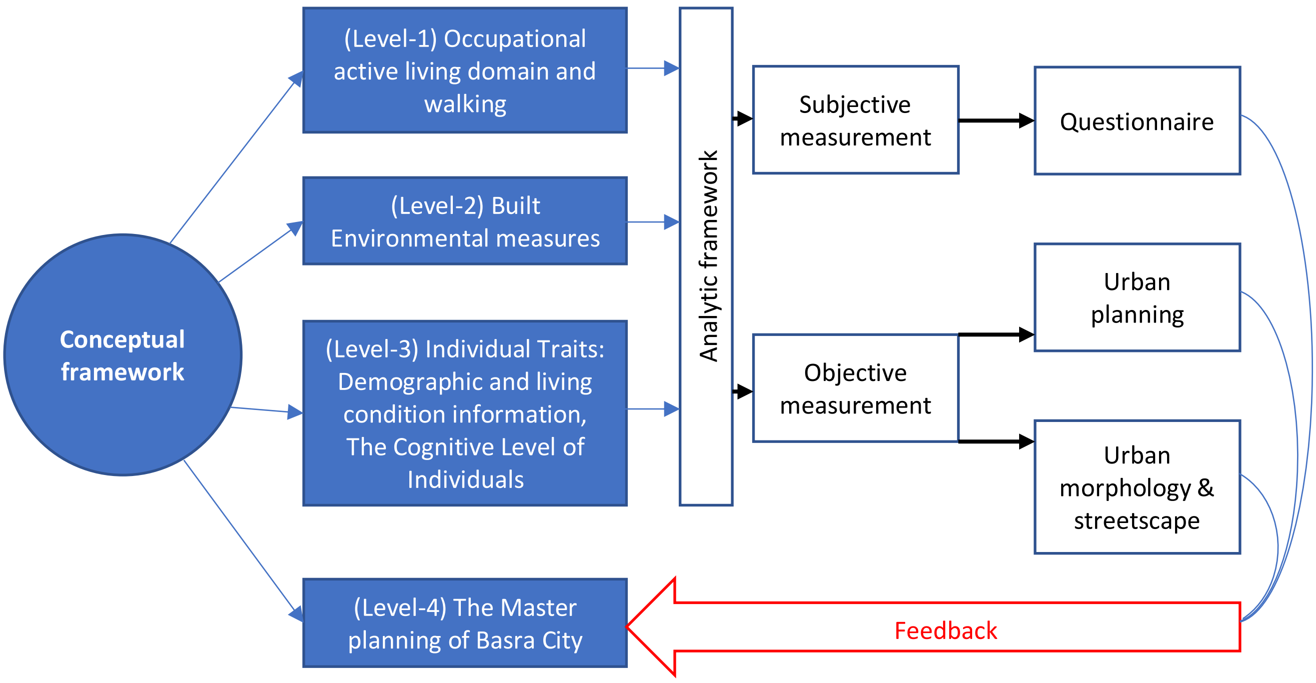

Figure 3-3: Conceptual framework of walking-neighbourhood relationship

3.6.1 (Level-1) The occupational active living domain and walking:

Although there is a substantial body of literature on the ecological models of physical activity that are concerned with transportation and recreation, none of the existing models are concerned with occupational activities and walking. This research adopted the occupational active living domain with a walking transport mode, because of the substantial consensus amongst scholars that walking is the most important physical activity, and it is particularly vulnerable to environmental change and decisions by urban design and planning. Also, there is general emphasis amongst contemporary trends of research, namely social ecology and New Urbanism, and by international organisations, like WHO (2012), about the importance of pedestrian-friendly neighbourhoods for public health and prosperity. Thus, this research employs the literature review concerning existing ecological models of physical activity to develop the main structure and the components in a study on the domain of walking to occupational activities.

Although active living domains and transportation are two different entities, the reality of everyday life in a built environment indicates that these two topics are highly interrelated due to, for example, common facilities and considerations regarding the activities. This is because an individual journey (regardless of whether on foot or in a vehicle) is undertaken to satisfy the need for a certain activity and will always involve a mode of transportation. However, no study has as yet dealt with the topic of active living in Basra city. Also, no study has yet been conducted into the quality of the built environment in Basra, especially in terms of its influence on human life. Although, within Iraq, there are limited unpublished studies related to the 'livability' of its built environment, no study has yet been conducted about the physical activity of its residents.

3.6.2 (Level-2) Built environment measures:

The literature review identified the adoption of two methods, namely subjective and objective, to inspect the quality of the physical environment. The research specifically focuses on the qualities that were emphasised by both the ecological models of physical activity and the studies concerning with the walkability of the built environment. The objective aspects of the physical environment rely on indicators from urban planning, urban design, and composite indexes, like walkability, which is the product of density, land-mix use, and street connectivity. Due to the cumulative effect of such components, these are considered important factors within ecological models in assessing the built environment. Also, there are the perceived environmental indicators of the physical environment, which are widely considered in the reviewed ecological models by this research.

Moreover, Based on Handy (2006), the indicators of the physical environment were also called the community design, which is used to express three aspects of the built environment: the spatial distribution of land uses, the transportation system that connects the designated activities, and the design of the edges and public realm of built environment. Thus, the indicators adopted in these studies related to how it was used and perceived by the community (or research population), such as through access to amenities and perceived safety (Handy, 2006). However, the urban form syntax (or morphology of the urban form attributes) was very rarely used to predict the physical activity (e.g. Van der Westhuizen, 2010), and this included: the distribution and clustering of destinations, street network configurations, block attributes, edges, and other neighbourhood design aspects. Thus, this research considers both aspects as attributes of a behavioural setting, which will be applied in the defined case studies, namely the three neighbourhoods of Basra city.

3.6.3 (Level-3) Individual traits:

3.6.3.1 Demographic and living condition information (socio-demographic factors):

Based on the frequently used demographic variables in the reviewed studies (Table 3-2), this research adopts a group of demographic factors, namely: gender, age, working situation, income, disability, height and weight (the body mass index (BMI) was calculated as kg/m). Moreover, the second set of social information related to living conditions, include the family size and children (with/without), children under the age of 16, house ownership, and whether the participant practices sport or exercise. The total number of questions requesting personal information is 14, and one further question is included about disability.

3.6.3.2 The cognitive level of individuals:

The reviewed literature (Table 3-4) widely considered the Theory of Planned Behaviour constructs in the ecological models in order to develop knowledge about individuals' cognitions that may influence their physical activity. In this research, a belief-based measurement of walking, based on the TPB constructs, is considered to identify how beliefs about walking might influence walking outcomes.

3.6.4 (Level-4) The master planning of Basra City:

The reviewed literature (Table 3-1) asserted the importance of government policies and initiatives to improve the quality of the built environment, as appropriate intervention methods can improve the physical activity of users (Bauman, Sallis, Dzewaltowski, & Owen, 2002; Ding, Sallis, Kerr, Lee, & Rosenberg, 2011; Sallis, Floyd, & Rodríguez, 2012; Sallis, Owen, & Fisher, 2015). In this regard, master planning is one of the most obvious government initiatives that this study considers as the policy level. The current Master Plan of Basra city was approved in 2015 by the government of Basra city, and was proposed by a local company, called Snafy Company. In Chapter Eight of the approved Master Plan of Basra city (Basra, L. G., 2015), the planning criteria for the districts were addressed (Table 3-5). This is subject to the feedback from this research, and will be based on evidence concerning the ecological model of walking to occupational activities suggested by this study. Thus, the Master Plan is the only official intervention plan by the government of Basra city to improve the built environment, and, except for some maintenance plans of existing neighbourhood structures, there are no other plans or policies (like local initiatives) considered by the government.

Table 3-5: Residential quarter land use of Basra Masterplan 2015-2035: (Basra G., 2010)

Land use	Quantity	area	unit	percentage
1) Commercial centers	2	1	hectare	.99%
2) Retail shops	N/A	1	hectare	.99%
3) Religious centers	2	1	hectare	.99%
4) Health and social centers	2	1	hectare	.99%
5) Nursery	7	2.5	hectare	2.4%
6) Primary schools	4	2.2	hectare	2.2%
7) Middle schools	4	3.8	hectare	3.7%
8) Secondary schools	4	4.4	hectare	4.3%
9) Play grounds	N/A	2	hectare	5%
10) Local parks	N/A	3.5	hectare	5%
11) Roads and open spaces	N/A	25	hectare	25%
12) High density housing	N/A	2	hectare	10%
13) Medium density	N/A	12	hectare	12%
14) Low density	N/A	39.5	hectare	39%
Total area		100.8	hectare	

The partition of the district's statement and current masterplan criteria for Basra city (2015-2035) is discussed in this research to identify its possible urban policy, planning and design consequences. This level of the conceptual framework is postulated as the targeted core of knowledge that needs to be informed by the evidence from this study. Therefore, it was considered in terms of feedback to the plan rather than any influence on the study (Figure 3-3). In other words, the other three levels of the conceptual framework might influence each other, and the result of these associations will create feedback at the master planning level. This notion was adopted from social ecology research by Grimm, Grove, Pickett and Redman (2008); that an ingredient of a socio-ecological system can either have influence on or provide feedback to relationships.

The new Master Plan of Basra city revealed a joint problem, namely the shortage of residential units and the shortage of land for new development. Thus, according to the status quo, urban intensification is an appropriate solution. However, this strategy requires long-term plans. Moreover, the available vacant lands for intensification development are limited and not sufficient for the required number of residential units, which is 61,000-93,000 between 2015-2020, and 93,000-180,000 between 2020-2035. The residential units planned are 11,000-37,000 by 2020, and the total units required by 2020 is 56,000. Moreover, by 2035, 143,000 will be required, and 19,500 residential units need to be changed. The proposed new development includes the areas that contain several land-uses, namely residential, mixed-use, open space, and services (Basra, L. G., 2015).

At the residential level, the Master Plan operates at the quarter, not the neighbourhood, and three residential typologies are proposed within each quarter: high density, medium density, and low density. The Master Plan explains the requirements of each residential quarter, and the estimated population or residents in each quarter is 15,000 persons. The total number of residential units is 2,140 and each of the three residential typologies has a different percentage of the total area. The high density type is 100-unit/hectare, comprising 10% of the total residential units and 2% of total area. The medium density type is 45-unit/hectare, comprising 25% of the total residential units and 12% of the total area. Finally, the low density type is 35-unit/hectare, comprising 65% of the total residential units and 39% of the total area.

The urban structures of the residential quarter include, two commercial centres (1 – hectare), retail shops (1 – hectare), two religious centres (1 – hectare), health and social centres (1-hectare), seven nurseries (2.5 – hectare), four primary schools (2.2 –

hectare), four middle schools (3.8 – hectare), four secondary schools (4.4 – hectare), playgrounds (2 – hectare), local parks (3.5 – hectare), roads and open spaces (25.2 – hectare). Thus, the total area of the quarter is 100.8 – hectare, the overall housing density is 22 units/hectare, and the residential density is 153/hectare, (Table 3-5), (Basra, L. G., 2015).

However, according to the criteria of the Ministry of Housing in Iraq this Master Plan does not discriminate the quarter into neighbourhoods, but defines the residential quarter as the integration of four neighbourhoods and each neighbourhood has a distinct identity in terms of its housing typology and density. Accordingly, the differentiation of the residential quarter into neighbourhoods is not defined by the new Master Plan of Basra city. Thus, the planning and designing of the neighbourhood scale of future developments in Basra city needs to be theoretically and empirically informed. The integration of two criteria, Basra's Master Plan and the Federal Ministry of Housing in Iraq, has influenced the division of the proposed residential quarter structures by four to determine the structural components of a neighbourhood. Nevertheless, this still insufficient and thus the guidance will remain incomplete.

3.7 Summary of this chapter

The conceptual framework is developed in this chapter based on literature concerning ecological models of physical activity. The reviewed literature is categorised into four types, and the defined levels of the ecological models cover four levels. The information about each level is based on its significance in the reviewed models, and was synthesised in individual headings for each level. From this, the conceptual framework related to walking to occupational activities is addressed in parallel to the synthesised four levels. Also the addressed in this chapter, the conceptual framework roughly defines the dimensions of the ecological model of this study; also, in order to be empirically considered, an analytical framework is developed in the next chapter of this research. Therefore, this chapter contributes to achieve the first part of the third objectivity of this research; In term of developing the conceptual framework.

4 Analytic Framework

4.1 Introduction

In this chapter, the proposed conceptual framework is developed into an intensive analytic framework (Figure (3-3) to examine the walking to occupational activities on the neighbourhood scale. This involves specific measures that relate to the multiple levels of the conceptual framework. The literature review in Chapter Three of this study identified two categories of measurement amongst the reviewed ecological models of physical activity, namely objective and subjective methods (Brownson et al., 2009; Brownson, Ross, Hoehner, Day, Forsyth, 2010). In this chapter, the subjective measures are concerned with the occupational activities and walking, personal traits, the perceived environment, and the beliefs-based measures of walking (based on the TPB); these all form the ingredients of the questionnaire. Meanwhile, the objective measures are concerned with measuring the physical environment according to the correlates or measures from urban planning and urban design, (Figure 4-1).

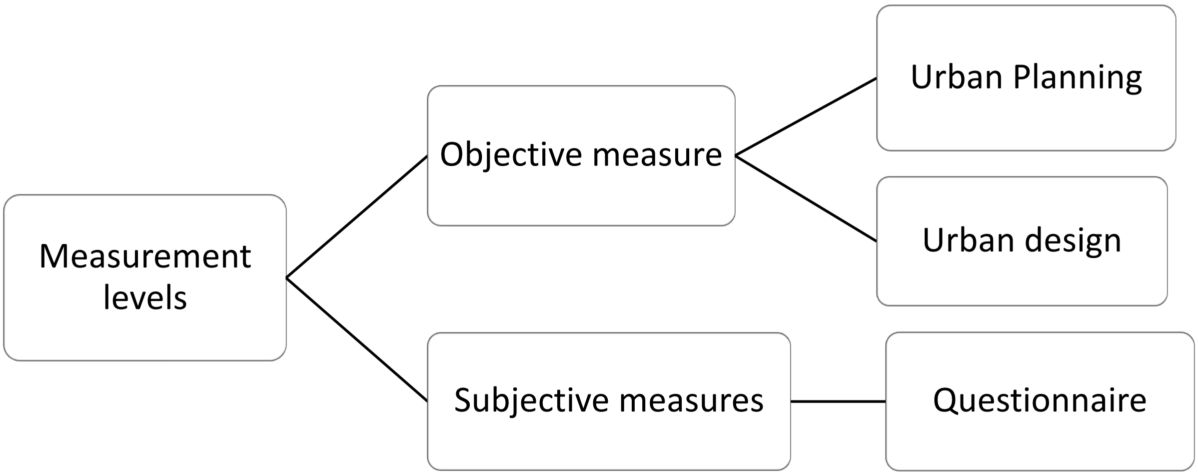

Figure 4-1: Measurement methods: (the author)

In terms of the subjective measurement, the current self-report instruments of physical activity (e.g. IPAQ, NPAQ) are not active living domain specific instruments; on the contrary, they are designed to measure different levels of physical activity, from moderate-to-vigorous. Therefore, a specific instrument of physical activity for walking to occupational activities is required. Moreover, the instruments currently available are designed according to lifestyle, level of education, experience, and availability of resources, such as public facilities and transportation. These living conditions are different for the people of Basra. For example, houses have no designated addresses, and there are no well-defined transportation stations available. Thus, this research argues that the current instruments are not suitable for use within Basra city.

Moreover, developing a new instrument it will be possible to benefit from the thematic concepts amongst current instruments of physical activity (e.g. IPAQ, NPAQ). In this regard, as an objectivity of this research; it targets to develop a new instrument of physical activity.

4.2 The review of the measurement instruments of the physical activity

Several instruments were used by different studies, but the most prominent tool has been the International Physical Activity Questionnaire (IPAQ) that was developed by the World Health Organization (WHO) and the Centres for Disease Control and Prevention (CDC) (Booth, 2000), to obtain physical activity monitoring data. Moreover, the validity and reliability of its results within 12 countries show that the instrument is valid and reliable for self-report. It has therefore been widely embraced by previous ecological models and considered highly reliable with valid results, (*p*-value=0.3 for criteria validity) (e.g. De Bourdeaudhuij, Sallis & Saelens, 2003; Booth et al., 2003). It is designed to investigate seven days of physical activity for amongst a specific sample by multiple methods of interview, telephone interview and questionnaire. The participants provide the studies with information about their physical activity as they recall it, rather than as the activity occurs. The activities were addressed in different domains and different intensities could be specified for each activity. The levels of activity included: household, occupational, use of a personal car, and leisure-time physical activities, while the intensities included, walking, vigorous, moderate, and sedentary. The activities were classified into walking, light, moderate, vigorous, and sedentary according to their load on the human body; each activity was measured by frequency per week and the total time per week. Moreover, the model was categorised into two types of IPAQ models, namely long and short-term.

For example, a study of physical activity by Cerin et al. (2007) depended on the International Physical Activity Questionnaire–Long Form (IPAQ). The study consists of one-hour/seven days of self-report-individual-level, and participants used “Actigraph accelerometers” during walking for the direct measurement of seven successive days. Three types of activity were classified into sedentary, light, and moderate-to-vigorous intensities, and an accelerometer was used with the IPA to objectively measure the walking distance, the minute counts, and the average activity hours per day.

Furthermore, a regression analysis was used to associate the physical activities with medical treatment.

Based on the reviewed literature in Chapter Three (Tables 3-2, 3-3, and 3-4), most of the ecological models of physical activity depended on IPAQ as the main self-report instrument. The second and third instruments used amongst the reviewed studies to inspect physical activity on the neighbourhood scale are called the Neighbourhood Physical Activity Questionnaire (NPAQ) (Giles-Corti et al., 2006) and the Neighbourhood Environment Walkability Scale (NEWS) (Saelens, Sallis, Black & Chen, 2011). These two instruments aim to develop context-specific questionnaires of physical activity on a neighbourhood scale; these are similar to IPAQ, but conducted on a short-term basis. Three types of walking guide these questionnaire instruments: within and outside the neighbourhood, and recreation. Participants were asked to complete the duration and frequency of each activity, and to do so by recall rather than as the activity occurred. These instruments depend on different methods to test their reliability, which includes the intraclass correlations coefficient (ICC), Cohen Kappa statistic tests, or Cronbach's alpha. The results of all questions showed a fair to excellent agreement between the test and retest according to both the Kappa and ICC test.

The NPAQ was designed to inspect both the walking activity and the characteristics of the neighbourhood environment. Therefore, it considers studies related to urban design. As the context factor to apply the instrument, the neighbourhood is defined as 10-15-minutes of walking activity, following the 400-metre radius (Pikora et al., 2002, 2006), and less than a one-kilometre radius (Frank et al., 2004). Thus, from the review of these types of questionnaires, the thematic dimensions of the International Physical Activity Questionnaire (IPAQ) and the Neighbourhood Physical Activity Questionnaire (NPAQ), could be summarised as follows:

1. The domains of the physical activities relate to what people do in everyday life, and fit a mode of transportation, namely: walking, biking, or using an automobile.
2. According to the level of load on the human body, the activities could be classified into different intensities including, walking, light, moderate, vigorous, and sedentary. Moreover, walking could always be considered as a moderate intensity physical activity.

3. They depend on the self-report approach as a reliable method to probe the physical activities of participants, who complete the format either by recall or as the activity occurs.
4. A typical weeklong period is the most commonly agreed duration to probe the physical activity of the participant.
5. Types of variables include: duration in minutes, number of steps, distance, and the frequency of the activity (Matthews, 2002).
6. The minimum period of activity is 30 minutes per day for walking, which was considered appropriate for a healthy active lifestyle. Also, national and international organisations considered ≥150 minutes per week a good rate for a healthy lifestyle.
7. The statistical analyses depended on the aims of the study; however, if the outcomes were defined as categorical variables, a logical regression analysis was predominantly used with the duration outcome variable to test the odds ratio (OR).
8. Besides the subjectively measured physical activity (IPA and NPAQ), studies used “Actigraph accelerometers” to objectively measure physical activity. However, this research utilises Q-GIS to objectively measure the walking distance instead of depending on the “Actigraph accelerometer” device to measure the walking distance.

4.3 Subjective measurement (questionnaire)

Spector (1994) stated that the self-report (questionnaire) is a reliable method that is widely used in behavioural studies. It relies on people to report certain variables of the study, and this is especially used to gather information that cannot be objectively gathered (Spector, 1994). The previous studies concerned with physical activity used self-report and direct measurement methods to quantify: walking, biking for transportation and recreation, and several other activities (Cerin et al., 2007; Giles-Corti et al., 2006; Lee & Moudon, 2006a; Moudon et al., 2006c; Owen et al., 2007). Although there are several subjective instruments of physical activity (e.g. IPA-Q, and NEWS), there is no subjective instrument for walking to occupational activities. Therefore, this research will design a new questionnaire instrument, which is close-ended, and obtains four types of information, including: personal information, the perceived environment, the occupational activity and associated walking, and the beliefs-based measures of walking from the TPB. These form the levels of the questionnaire instrument, which is called the Neighbourhood Walking and Occupational Activities Questionnaire (NWOAQ) (Appendix 2).

4.4 Defining the occupational activities and walking

The occupational active living domain is one of four active living domains that was defined by Sallis et al. (2006). However, there is no published specific model from this study to measure the occupational activities. Hence, designing and testing a specialised instrument to probe the occupational active living habits of participants is considered one contribution of this thesis. The instrument is required to build an informative data set of quantitative variables that concern walking to occupational activities in Basra city's neighbourhoods. Sallis et al. (2006) defined the occupational domain of activities as including all human activities related to everyday routines, such as going to work or shopping. However, no existing study has yet defined the sub-domains of these occupational activities. Thus, the interview method was selected for this study to help define a set of precise everyday activities on the neighbourhood scale in Basra city concerning the occupational domain.

One question is used to interview nine participants: three participants were from each neighbourhood, and three specialists have Ph.D. degrees and were amongst staff within the architecture department of Basra University, who have experiences in and practiced urban design in Basra city but they don't inhabit in the specified areas. The snow-ball method was adopted for this purpose, which enabled the recruitment of six males and three females, aged between 22 and 45 (with a mean age of 33.5 years). This sampling method depended on the researcher to identify and approach both types of participant (Henry, 1990). The participants were individually interviewed in private within the first phase of this thesis (from 19st September to 22th September 2015). One question was posed: "what are the main activities that you daily do in your neighbourhood?". The interviewer then let the individual talk for 20 minutes without interruption, and took notes as the participant spoke. Moreover, the purpose of the interview was explained before the interview, before the interviewer was asked the participant to sign their consent to participate. Then, the urban specialists were interviewed after those from the residents.

The transcripts were analysed line-by-line, focusing on and highlighting the precise names of the activities mentioned by the interviewees. As a primary scan of the responses, information about the types of activity was thematically patterned into four topics that included: shopping, leisure, services, and work. Then, a line-by-line scan about more precise activities was conducted to identify the activities of each topic. After this, a clustering process was conducted to align them with the main four topics, and an analytic table was generated based on the defined activities, (Table 4-1).

The eight elicited activities included: go to work (6.45%); study or attend a training course (3.23%); practice a type of sport or go to the Gym (3.23%); meet with friends (16.13%); go food shopping (38.7%); shop for consumer goods (6.45%); visit a doctor (6.45%), or conduct personal business (16.13%). Thus, the most common neighbourhood activity amongst the interviewees was to go shopping for food, (38.7%). These activities are commensurate with the definition by Sallis et al. (2006), who stated that the occupational activities include human activities in the built environment, for example, work, study, shopping, meeting friends or colleges (Sallis et al., 2006).

Table 4-1: Analysis of the interviews based on the defined activities

		Work		Leisure		Shopping		Services	
		Go to job	Training or study	GYM or Practice a sport	Meet with friends	Food	Consumer goods	Doctor	Personal business
1	Participant	+	-	+	+	+	-	-	-
2	Participant	-	-	-	-	+	-	-	-
3	Participant	-	-	-	-	+	-	-	+
4	Participant	-	-	-	+	+	+	-	+
5	Participant	-	-	-	+	+	-	+	-
6	Participant	-	+	-	-	+	-	-	+
7	Participant	-	-	-	-	+	-	-	-
8	Participant	-	-	-	-	+	-	-	-
9	Participant	-	-	-	+	+	-	-	+
10	Participant	-	-	-	+	+	-	-	-
11	Participant	-	-	-	-	+	+	-	-
12	Participant	+	-	-	-	+	-	+	+
	Total	2	1	1	5	12	2	2	5

+ :positive, the activity is mentioned by the participant.
- :negative, the activity is not mentioned by the participant.

4.4.1 Designing the instrument of the walking and occupational activities

The self-report questionnaire instrument (NWOAQ) is specific to: the neighbourhood context, the occupational active living domain, and walking. It subjectively inspects walking to seven occupational active living domains, namely: undertaking work and study; practising a type of sport; going to the Gym; meeting with friends or equivalents; shopping for food; shopping for consumer goods; visiting a doctor, and conducting personal business. These were defined in the context of Basra city concerning the everyday life activities (between 7:00am-12:00am) that were conducted on a neighbourhood scale.

Similar to the ecological models reviewed in Chapter Three, the postulated time scale of this study is a typical one-week period. Moreover, because the instrument is context-specific, the definition of context depends on the definition of neighbourhood within existing urban design studies, which is a 10-minute walking distance (400-metre radius); furthermore, a 15-minute range and 600-metre radius, is the required distance to meet the required (30-minutes) recommended walking activity criterion for an active lifestyle (WHO, 2010). Moreover, the intensity levels of these activities were omitted in this research because the study is concerned with walking activity, which is considered of moderate intensity.

The design of the instrument posits a simple arrangement of the variables in a table of four columns that relates to information about the type of activity, the address of the daily activities, the time duration (5-30 minutes), and whether the transport mode is walking or not. The daily time span of the activities required, is from 7:00 am until 12:00 midnight. Each activity must be explained by the address of the destination, and an attached map of the participants' neighbourhood was provided to help them choose the block-based address of his/her house and the destination address (Table 4-2). Thus, partition (E) of the questionnaire is the map of the neighbourhood where the block of participant's address for each residential area is labelled as (Bi)[6] and the destinations in each case study are labelled as (Di)[7], (the final questionnaire is listed in the Appendix 2).

Moreover, a description and justification of the methodology that addresses the application of the instrument and the techniques used to analyse the gathered data is explained in Chapter Five of this thesis.

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[6] Bi is the block number where participant lives.

[7] Di is the destination number where the participant went to undertake their activity.

Table 4-2: The walking to occupational activities instrument: (The author)

Where did you go? Sunday - Saturday	Destination Address	Count of minutes you walked						Walk	
		10	15	20	25	30	≥30	Yes	No
To work/study		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
To do personal business		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
For shopping goods		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
For shopping food		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
To meet with people in public places		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
To the GYM or to play a type of sport		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
To see the doctor		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
		○	○	○	○	○	○	○	○

4.4.2 Perceived environment

Studies related to human activity in the built environment examined the effect of the perceived physical environment on participants' physical activity outcomes. For example, Ding et al. (2013) examined the effect of changing the country on the relationship between the perceived neighbourhood environment and the physical activity. The environmental qualities investigated by previous studies were the: residential density, shops near home, transit stops near home, sidewalk presence, bicycle facilities, low-cost recreation facilities, and safety from crime (Ding et al., 2013). Another study examined the association between perceived social and physical environments and physical activity (Addy et al., 2004). Thirteen items concerning the perceived physical environment of the neighbourhood were defined, which included: sidewalks, recreation facilities, public recreation facilities, streetlights, a pleasant neighbourhood for walking, and neighbours' physical activity (Addy et al., 2004). Besides aspects related to the physical activity, the Neighbourhood Environment Walking Scale (NEWS) instrument (De Bourdeaudhuij, Sallis & Saelens, 2003; Saelens, Sallis, Black, & Chen, 2011) is designed to inspect two levels of the built environment: neighbourhood design and recreational environment determinants. Environmental variables were considered in this study that related to the perceived environment; this includes the neighbourhood aesthetics, perceived safety from crime, perceived safety from traffic, satisfaction with neighbourhood services, perceived residential density, perceived land use diversity, perceived access to local shops, ease of walk to public transport, self-report availability of sidewalks, and bike lanes. Thus, for this research (12) items concerning the perceived environment were adopted from the NEWS instrument, and these were based on evidence concerning their significance within previous studies (e.g. Cerin et al., 2013; De Bourdeaudhuij et al., 2003). For this study, the item (question) number (13) is developed from several items in NEWS that relate to the condition of buildings. The thirteen items are provided below.

1. This question is about the perceived aesthetics of the neighbourhood:
   "There are many attractive things to look at while walking in my neighbourhood"
2. This question is about the sense of safety within the neighbourhood:
   "My neighbourhood is a safe enough so that I would let a 10 year-old boy walk around my block alone in the daytime"
3. This question is about the perceived diversity of local shops:
   "I can do most of my shopping within my neighbourhood"
4. This question is about the perceived proximity of the local shops:
   "Local shops in my neighbourhood are within easy walking distance of my home"
5. This question is about the perceived ease of movement in the streets of the neighbourhood:
   "The sidewalks in my neighbourhood are well designed for walking"
6. This question is about the ease of movement through the streets of the neighbourhood, with the presence of dead-end streets:
   "The streets in my neighbourhood do not have many cul-de-sacs"
7. This question is about the connectivity of the streets within the neighbourhood:
   "There are many alternative routes that enable me to move from place to place in my neighbourhood"
8. This question is about how well pedestrians and traffic are designed for in terms of safety:
   "The busy traffic in my neighbourhood makes it an unsafe place to walk"
9. This question is about safety from crime:
   "The low crime rates in my neighbourhood makes it safe place to walk"
10. This question is about the availability of general services:

"In my neighbourhood, there are many places within easy walking distance from my home", like parks, mosques, gyms, cafes, playgrounds

11. This question is about the influence of the social community on walking outcomes:

"I see and speak to other people when I am walking in my neighbourhood"

12. This question is about the effect of parking cars in the neighbourhood streets on pedestrian movement:

"Parking cars in the streets of my neighbourhood impedes my walking"

13. This question is about the perceived overall condition of buildings in the neighbourhood:

"Considering the overall condition of houses in my neighbourhood, I am satisfied with living in it"

Each question was followed by an agreement Likert scale of 5 points and participants were asked to choose the number that represents their satisfaction with the statement. This instrument represents section (C) of the questionnaire, (Appendix 2).

4.4.3 Individual traits level of measurement

Two sections of the final questionnaire relate to the individual trait measurement levels. The first concerns personal traits (partition A of the questionnaire) and has fourteen items about the demographic and social status of the participant. The second concerns the individual beliefs about walking (partition D of the questionnaire, Appendix 2), which is based on the Theory of Planned Behaviour TPB and measures the beliefs of participants in relation to walking.

4.4.3.1 Socio-demographic information

The personal traits level included three types of information, including: demographics, social condition, participant height, and participant weigh, which is based on frequently used personal information in the ecological models from physical-activity studies, which are explained in tables (3-2, 3-3 and 3-4). In this regard, the analytic framework depends on two types of item. The first is the demographic and includes gender, age, working situation, income, disability, height, weight (for body mass index BMI, calculated as kg/m). The second is related to living conditions and includes family size and children (with/without), underage children (under 18-yrs), house ownership, and whether the participant practices sport or exercise. Fifteen items comprise partition (A), and are based on personal information (Appendix 2). They are as follows:

1. This item aims to define whether the participant has a disability that prevents their ability to walk.
2. This item is about the gender of the participant, as past studies showed that gender is an important effect factor on the opportunities that an individual may have in terms of physical activity.
3. This item is about the age of participants and its effect on the physical activity opportunities of each individual. Past physical activity related studies have been greatly concerned with this factor.
4. This item is about the approximate monthly income of the participant. In past studies, the income factor was considered influential on the physical activity of adults. Moreover, the options related to this question consisted of six categories, which were based on information from the local government of Basra city about the income ranges of its citizens.
5. This item is about the status of the participant's employment. This question was used in transportation and physical activity studies to define its effect on participant choices in terms of transport mode and the level of the physical activity, respectively. The options entailed with this question are employed, unemployed, self-employed, housekeeper and student.
6. This item is about the marital status of the participant.
7. This item is about whether the participant regularly practices a type of sport because this is an additional factor to consider regarding fitness.
8. This item is related to BMI (Body Mass Index); the participants were asked to supply in number their height and weight in metres and kilograms, respectively. This indicator was used widely in physical activity related studies.
9. This item is about the size of the family or the number of family members. It has the potential for interpretation regarding the individual's social conditions.
10. This item concerns the number of individuals who are aged 18 years and under who form part of the participant's family.

11. This item is about the number of cars used by the family of the participant. This question was used in transportation-related studies to define its effect on the choices of the participant in terms of transportation mode.
12. This item is about the period that participant has lived in their current property. This factor was used in transportation and neighbourhood choice studies, and it has potential to probe the effect of neighbourhood typology on the period of inhabitation.
13. This item is about the number of bedrooms within the participant's house. This factor has two potentials: the first is the social class of the participant and the second relates to the physical typology of their house.
14. This item is about the participant's housing typology.
15. This item is about the type of house ownership, whether family-owned or rented. This question has potential social and economic impacts on the participant's life.

4.4.3.2 TPB-related to walking behaviour measures

Based on the reviewed literature concerning ecological models, the Theory of Planned Behaviour (TPB) is widely considered to examine the individual's cognitions in term of walking (e.g. Brown, and McIntyre, 2006; Courneya, 2007; Giles-Corti & Donovan, 2002; Maddison et al., 2009; Rhodes, Ryan E. Rhodes, Lee & Shepley, 2012). This is based on the four constructs of the theory, which are: behavioural attitude (BA), social norms (SN), perceived behavioural control (PBC), and intention. In this regard, the PBC and the intention constructs showed show a consistent pattern of association with the behavioural outcomes. Thus, this research considered the theory part of the self-report instrument (questionnaire). However, the questions related to this theory and designed for this study are based on the original thesis by Ajzen (2006).

4.4.3.2.1 General concepts about belief-based measurement

The measurement of beliefs follows the principles of measuring a latent variable in that cannot be directly measured because they are unobservable (Ajzen, 2006). Ajzen (2006) defined the TACT elements, which stand for Target, Action, Context, and Time, as a means to measure certain behaviour; for example, an athlete <u>exercises</u> (A) on a <u>racetrack</u> (T) in a town's <u>sport-yard</u> (C), for <u>30-minutes,</u> <u>on daily basis</u> (T). However, Ajzen (2006) states that, regardless of how the TACT elements are defined, two principles must be assured and these are "compatibility" and "specificity". In terms of compatibility, a statement question addressing the three constructs (BA, SN and PBC) ought to be defined by compatible elements. Moreover, in terms of specificity, the TACT elements must be quite specific, although it is possible to be general to a certain extent. However, the instrument must achieve “internal consistency” and ensure that it probes the implied beliefs about the behaviour in question (Ajzen, 2006).

Moreover, there are two types of measurement of intention toward behaviour: direct and indirect. The former depends on measuring the intention of a person directly, whilst the latter is when the intention toward a behaviour is the product of the three types of beliefs: BA, SN and PBC (Ajzen & Fishbein, 1988). Ajzen (2006) defined the three beliefs as the indirect measurement of the behaviour, and thus called this the “belief-based measures” of behaviour. Although the indirect is not an alternative to the direct measurement, it helps to understanding the “cognitive foundation” of certain behaviour. Also, the consistency between indirect and direct measures of certain behaviour indicates the reliability and validity of both modes of measurement (Ajzen, 2002, 2006).

4.4.3.2.2 Belief-based measurement of walking

For each construct, there are instrumental beliefs and affective beliefs that moderate the instrumental one. According to Ajzen (1991), both affective and instrumental beliefs result in the attitude; the affective belief is the expectation of the person to act, which could be considered as the evaluating of the judgment (the instrumental beliefs) of the person, while the instrumental belief measures the expected benefit (judgment) of doing the behaviour in question (Ajzen, 1991). In this regard, attitude is dictated by the behavioural beliefs and the expected results of doing the activity, whilst weighted by the evaluation of the expected results (Ajzen & Fishbein, 1980). Subjective norms are dictated by normative beliefs, namely the importance of the socially predicted consequences of the activity, whilst weighted by the motive of the person to agree with the recommended beliefs by people (Ajzen & Fishbein, 1988). PBC is dictated by control beliefs, which means the participant’s assessment of the condition that makes performing the behaviour possible, whilst weighted by the perceived power that makes the participant capable of the behaviour (Ajzen, 1991).

In this thesis, the questionnaire on beliefs related to walking behaviour was modelled in accordance with Ajzen’s procedure (Ajzen, 2006, 2012). The walking behaviour beliefs assigned to measure the walking attitude are related to health, safety, environment, fresh air and time, and a moderator weights each item. Thus, five instruments and five moderators were designed to measure the attitudinal beliefs of walking, (Table 4-3), items 1 to 10. The normative beliefs assigned to measure the subjective norms construct were related to people, family, and doctors, and a moderator weights each item. Thus, three instruments and three moderators were designed to measure the subjective norms, (Table 4-3), items 10 to 16. The control beliefs assigned to measure the perceived control beliefs are related to the proximity of destinations, the ease of movement in the streets, the diversity of destinations, the crowd of people in the streets, and the intensity of houses; furthermore, a moderator weights each item, Thus, three instruments and three moderators were designed to measure the PBC, (Table 4-3), items 17 to 26. A Likert scale measures participant beliefs, and the affect factor (that moderates the behavioural belief) can be measured on any scale but must be similarly applied to all the constructs. In this research, the instrumental beliefs are measured by the Likert scale and range from 1 (disagree) to 7 (agree). The evaluation is as follows: (1) when the consequences are considered as affective (to some extent); (2) when the consequences considered as affective (for a large extent); (3) when the consequences considered as affective (to a very large extent); (4) when the consequences considered as affective (to an extreme extent). Each instrument was multiplied by its motive factor to produce the score of the beliefs construct. This is related to walking behaviour for 30-minutes on the neighbourhood scale. The final list of 27 questions comprised the following: ten questions for attitude (five beliefs and five moderators); six questions for subjective norms (three beliefs and three moderators; ten questions for PBC (five beliefs and five moderators), and one question for the direct measurement of the intention to walk (Table 4-3). The 27 items on belief-based measures of walking form partition (D) of the questionnaire (Appendix 2).

Table 4-3: Beliefs-based measurement of walking: (developed in this research)

	Attitude to questions:
Instrument	**1.** I aim to walk for 30 minutes each day within my neighbourhood because it is healthy. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__ Agree
Moderator	**2.** I think walking is healthy. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
Instrument	**3.** I aim to walk for 30 minutes each day within my neighbourhood because the environment is pleasant. Disagree: __1_: __2__: __3__: __4__: __5__: _6__: __7__ Agree
Moderator	**4.** I think walking is entertaining. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
Instrument	**5.** I aim to walk for 30 minutes each day within my neighbourhood because it is safe. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__ Agree
Moderator	**6.** I think walking is harmful. ◯ to some extent, ◯ to a large extent, ◯ a very large extent, ◯ an extremely large extent
Instrument	**7.** I aim to walk for 30 minutes each day within my neighbourhood because of the fresh air. 8. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__ Agree
Moderator	**9.** I think walking is an opportunity to breathe fresh air. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
Instrument	10. I do not want to walk for 30 minutes each day within my neighbourhood because it waste my time. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__ agree
Moderator	**11.** I think that walking wastes time. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
	Subjective norms questions:
Instrument	12. People encourage me to walk daily within my neighbourhood. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
Moderator	13. I do consider the opinion of others. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extreme extent
Instrument	14. Family encourage me to walk daily within my neighbourhood. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
Moderator	15. I do consider my family's opinion. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extreme extent
Instrument	16. Doctor encourages me to walk for at least 30 minutes daily within my neighbourhood. Disagree: __1__: __2__: __3_: __4__: __5__: __6__: __7__: agree
Moderator	17. I do consider his opinion. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extreme extent
	Perceived behaviour control:
Instrument	18. I find the proximate destinations in my neighbourhood are walkable in 15 minutes. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
Moderator	19. I think that proximate destinations facilitate walking. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
Instrument	20. I find that it is easy to walk in the streets of my neighbourhood for 30 minutes daily. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
Moderator	21. I think the design of the streets in my neighbourhood facilitate walking. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
Instrument	22. I am capable of walking to different destinations in my neighbourhood. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
Moderator	23. I think the diversity of destinations facilitates walking ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
Instrument	24. I find crowds in the streets of my neighbourhood do not impede my walking for 30 minutes daily. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
Moderator	25. I think that crowds in the streets of my neighbourhood impede walking. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent

Instrument	26. I find the density of buildings in my neighbourhood does not impede my walking for 30 minutes daily. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
Moderator	27. I think the density of buildings impedes my walking. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
	Intention:
Instrument	28. I intend to walk for 30-minutes daily in my neighbourhood. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__: agree

4.4.3.3 The BMI

According to the World Health Organization's (WHO) International Obesity Task Force (2014), the average body mass index of Asians is 25 kg/m^2. WHO's criteria demonstrates that between 18.5 and 24.99 is considered a normal BMI; a BMI of 25 is considered overweight whilst a BMI of 30 is considered obese. In this research, these values were considered as thresholds to categorise the participants (WHO, 2016). The following shows the calculation to determine the BMI of participants.

Equation 4-1: The Body Mass Index equation (WHO, 2014)

BMI = W (kg) / H (m^2)W weight in kilograms

H height in metres

[8]

4.4.3.4 Experimental application of the NWOAQ

The questionnaire had been applied experimentally to 20 of people in the Al-Mugawleen neighbourhood; this was based on cooperation between the researcher and the Imam of the central mosque in Al-Mugawleen. The aim was to determine the extent which individuals could understand the questionnaire. Initially, the Imam did not cooperate for security concerns, but after the researcher was approached by an acquaintance who lives in the neighbourhood, the Imam allowed the researcher to talk to people who were willing to contribute to the study. The researcher provided two different arrangements of the questionnaire. Partition B in the first version of the questionnaire tended to be misunderstood. In one version, the questionnaire split the activities from the table and the activities were listed as options A to G (Figure 4-2).

[8] The final English language questionnaire is attached as Appendix (2), and the final Arabic language questionnaire is attached as Appendix (3).

Meanwhile, the second version included both the activities and the targeted variable (the walking minutes and the address of the destination) in one table. Based on the analysis of the twenty experimental questionnaires, it was concluded that the activities should be included in the table and, instead of listing them as options under the table of the walking minutes; In other words, the activities should be directly resemble to the possible minutes of walking. Otherwise, all other questions were clearly understood. Moreover, the researcher did not consider the outcomes of this experiment as evidence for this research; this was because its purpose was to reassure the researcher of instrument's ease of use.

B:

Day (Monday – Sunday)
Address:

Go to the attached map and choose the block code where your house is part of and put it as your address.

Where did you go (Sunday to Saturday)	**Destination Code**	**Start**	**End**	**Walking**	
				Yes	**No**
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		
		:	:		

Code of activity	**Type of activity**	**Code of activity**	**Type of activity**
A	Go to work	E	shopping consumer goods
B	practicing type of sport or go to the GYM	F	visit a doctor
C	meet with friends	G	Do a personal business
D	shopping food	H	

Note:

1. **Choose the code that match your behaviour and locate it in the right time in the column called "What you were doing".**
2. **Go to the attached map and choose the "destination code" where your activity took place, and locate the right code in the column called "Destination Code".**
3. **Start and end are the times of your activity either AM or PM, estimate the span time of your activity.**
4. **The last three columns are transportation methods that you use to go to do your activity, tick ☑ into the cell that you used.**
5. **Use the attached map and a pen to mark the rout that you used for each trib.**

Figure 4-2: Experimental version of the occupational activities' questionnaire partition (B): (the author)

4.5 The objectively measured physical environment attributes

The literature review concerning the ecological models of physical activity addressed the significant contributions of the physical environment on the physical activity (e.g. Ball et al., 2007; Ding et al., 2012; Ding et al. 2013; Frank, Schmid, Sallis, Chapman & Saelens, 2005). In this regard, the physical environment is understood to be an essential level of the reviewed models. Thus, this section focuses on the physical environment characteristics that are considered effective on physical activity in the built environment; these characteristics are adopted from the reviewed literature. Moreover, this thesis borrows, elicits, and determined the reliable physical environment measures from the reviewed studies; these are either perceived or objectively measured qualities. Moreover, the objective measures in this research are intensively reviewed in terms of three aspects, which include: **(1)** defining the indicator, **(2)** illustrating its influence on physical activity as utilised in previous studies, and **(3)** determining how to compute its value.

Urban planning measures within the built environment include density, land use mix, and the connectivity of streets. Moreover, the walkability index is a compositional factor based on these three urban planning measures. It was considered an influential factor on human activity in the built environment (Frank et al., 2005). According to the reviewed ecological models, urban design qualities were considered influential attributes and classed as perceived factors (e.g. Ding, et al., 2011; Owen, et al., 2004; Sallis, et al., 2003). However, in this research the urban design qualities are objectively measured based on the morphologic attributes of the urban form and streetscapes measures in order to expand the scope of the ecological model of the physical activity. This is because the objective measurements tend to show a greater association than the subjective measurements, which is confirmed by the reviewed models in this research (e.g. Saelens, Sallis & Frank, 2003). Thus, this research depends on a group of objectively measured attributes of the physical environment that were adopted to determine their contribution to physical activity. The measures are defined in this chapter and empirically applied based on raw information from the cadastral maps (from Chapter Two) in Chapter Six of this thesis.

4.6 Urban planning measures of the physical environment

A proponent study by Cervero and Kockelman (1997), addressed three dimensions that are considered responsible for travel demands in the built environment; these include density, diversity, and design, and called the 3Ds. Their study showed how these three dimensions contributed to an increase in the number of walkable streets in San-Francisco (Cervero & Kockelman, 1997). The density, land mix use, and street connectivity have much to do with transportation and physical activity (Leslie et al., 2005; Saelens, Sallis & Frank, 2003). Additionally, the New Urbanism movement widely admired the compacted urban form and embraced the density of urban form, mixed land use (diversity), and walking oriented streets (connectivity) as landmarks of more liveable neighbourhoods (Calthorpe & Poticha, 1993; Duany, Plater-Zyberk & Speck, 2001). Also, the studies concerning ecological models of physical activity depend on urban planning measures as a major factor of influence on physical activity (e.g. Bauman et al., 2002; Ding et al., 2012, 2013; Frank et al., 2005; Sallis et al., 2009).

4.6.1 Density

The intensity of users in urban areas is associated with the concentration of built-up urban developments. Density influences how well human activity and place are related because it influences the available urban space. Moudon et al. (2007) demonstrated that density and walking are strongly associated and the higher density areas are more vibrant and walkable (Moudon et al., 2007). Although, the locations of destinations are defined by the distance factor, the density of the urban area are influences the locations of activities. This is because the geometrical relationship among components of a higher density area imposes closer distances. Moreover, Frank et al. (2005) demonstrated that the residential typologies and their physical layouts could provide a conception of population density. For example, a high-density place could include multi-family housing, apartments, and small residential lots. Moreover, high density is defined as >6 housing units per acre, and low density is defined as <3 units per acre, whilst a medium density falls between these values (Frank, Schmid, Sallis, Chapman & Saelens, 2005). Therefore, density could be rather a parametric concept that abstractly defines the neighbourhood typology. Although density is a reliable measurement in urban planning, there is no particular level of acceptance concerning density. It shifts according to different factors, like social, and cultural contexts. For example, what could be considered as high density in Western countries could be seen as low density in China or India.

Studies related to walking and the built environment computed the density as the ratio of built-up blocks to the total area (Frank et al., 2005; Frank et al., 2010). Moreover, in this research, two types of indicators were depended, namely block density and the intensity of residential units per area. The total number of houses depends on the number of plots because, in the single-family housing typology in the case studies, every single plot is used to build a single house, and a very limited number of plots accommodate several houses.

Equation 4-2: Block density equation (Frank et al., 2005)

Blocks density = B_{tot} / A_{tot}

B total area of blocks, includes the open space inside the block

A total area measured by square metre

Equation 4-3: Housing unit density equation (Frank et al., 2005)

Housing Density = H_{tot} / A_{tot}

H total number of housing units

A total area measured by square hectare

4.6.2 Mixed land use

The mix of land use measure is the degree of difference between the land uses that occupy a certain urban area. In other words, this means the degree of proportionating between different types of land use areas within the total area. Similar to density, the mix of land uses is considered to be associated with the increase of walkers in urban areas. In other words, when a place has diverse facilities or destinations, this will encourage users to walk (Cervero & Kockelman, 1997; Frank et al., 2005; Handy & Clifton, 2001). The impact of land use diversity on users manifests in the way in which a user associates themselves with their neighbourhood or with the wider urban area of the city. This is because it provides them with more opportunities. Also, it facilitates their imagination, in accordance with the notion of a cognitive map, as posited by Kevin Lynch (1968). Thus, diverse land use adds to the experience of people providing more motives and resolutions, which encourage walking. Furthermore, studies used a mix of land use as a criterion of the 3Ds to probe the quality of place in term of its walkability and transportation, and positive correlations were widely noted amongst several studies (e.g. Burke & Brown, 2007; Handy, 1996; Lee, Moudon & Courbois, 2006; McCormack, Giles-Corti & Bulsara, 2008; Moudon et al., 2007).

The method to compute land use diversity is addressed by Frank et al. (2005, 2007). It adopts a mathematical equation to compute the entropy of land use division to a group of land usages, from a baseline of equality between the different portions (Frank et al., 2005; Leslie et al., 2007).

Equation 4-4: Land use diversity (Frank et al., 2005)

$$= -\frac{\sum_k (pk \ln pk)}{\ln N}$$

K an individual category of land use

P the proportion of total land use

N the total number of categories

4.6.3 Streets connectivity (node density)

Street connectivity is considered the third indicator in urban planning studies. It is based on the notion that a greater flow of movement highly depends on how easily people and cars can gain access within/through urban areas. Thus, the more accessible attractions require more connectivity of streets and walkways. Cervero and Kockelman (1997) outlined design dimension as the shape and number of streets and nodes. Streets could be a grid or curve-lined shapes, and the intersections are nodes of four or three legs. Additionally, the more that connections resemble a grid, the more nodes are required and the more the accessible area and destinations. Regarding the quality of the streets, studies depend on street design criteria as a parametric measure to assess their contribution in terms of walkability and transportation (Frank et al., 2005a; Lee, Moudon & Courbois, 2006; Moudon et al., 2007). Connectivity and smaller and denser blocks and streets decrease travel distances and encourage users to walk or cycle. Consequently, they increase place accessibility (Duany et al., 2001). New Urbanism supported this finding, proposing that more connective and compacted urban forma are generally more accessible and with lower land consumption. Thus, the pedestrian-oriented areas designed with highly connected streets and a lower ratio of wasted lands are not just more walkable but safer; as such, these could also be considered sustainable areas (Calthorpe & Poticha, 1993; Duany et al., 2001).

Both streets and intersections are useful tools for engineering urban tissue, which are also its key urban characteristics. Moreover, many researchers emphasised the importance of these two components in measuring people's movement (e.g. Handy, Boarnet, Ewing, & Killingsworth, 2002; Peponis, Bafna, & Zhang, 2008; Peponis, Allen, French, Scoppa, & Brown, 2007). In this regard, several forms of measurement were addressed by different scholars, such as: (1) the intensity of nodes per area (Frank et al., 2005a); (2) the external connectivity, which depends on the number of entrances (related to length in metres) into a certain urban area (Song & Knaap, 2004); and (3) the number of street segments normalised by the number of accommodated intersections (Handy et al., 2003). However, the node density was more commonly used amongst urban planning measures of ecological models.

The density of intersections per area was considered a measure of the streets' network connectivity, whereas the presence of three legs intersections or more indicate a greater connectivity, and thus more accessible place (Frank et al., 2005 ; Cervero and Kockelman, 1997). However, different formulas were applied to measure the density of intersections. The first formula was by urban planners, and depends on the ratio of the aggregated number of 3 & 4 legs intersection to the total area in question (Frank et al., 2010).

Equation 4-5: Intersection density (Cervero and Kockelman, 1997)

Intersections density = N_{tot} / A_{tot}

N total number of T and X intersections

A total area measured by hectare

4.6.4 Walkability index

The walkability index is a compositional index of the objectively measured physical environment. It depends on urban form planning measures as ingredients of the equation (Frank et al., 2005, 2006, 2010): (walkability index = (2xnodes density) + diversity of commercial retail shops + block density). The index was frequently used within studies on ecological models of physical activity (e.g. Sallis et al., 2005, 2006, 2009, 2013), and showed a significant association with an increase in physical activity. Moreover, the measures of the urban planning were transferred into z-scores before aggregation, because their original units of measurement were different. Therefore, this index is widely considered within community design, which completely depends on the 3D measures of urban planning.

Equation 4-6: Walkability index (Frank et al., 2005, 2010)

Walkability index = (2xnodes density) + diversity of commercial retail shops + block density

4.7 Urban morphology and street scape measures

In addition to the urban planning measures, studies relating to human activity in the built environment utilised measures from the urban morphology discipline to probe the potential of the physical environment for the physical activity. Urban morphology, according to Cozen (1969), is the discipline concerned with the physical dimension of human settlement that takes into consideration its historical evolution. Within urban morphology, the basic components of urban tissue consist of land use, blocks, plots, and streets (Cozen, 1969). Urban design was utilised from the representation power of urban morphology domain, with respect to physical structures of the city, because it can define the conditions of the built environment that users are exposed to. It could be said that urban morphology describes the hard and topologic dimensions of the urban form; whereas, urban planning defines the structural dimension of urban form that is necessary for a certain area, like in a neighbourhood or urban quarter. Thus, urban morphology and urban planning reciprocally construct the physical dimensions of the urban form that is necessary for the livability of urban areas. Moreover, the topologic relationships between two or more of the morphologic components can be patterned (Alexander, 1977) and used as measures or indicators that might have similar offsets of human response in the built environment. Thus, this research adopts twelve morphologic and streetscape measures related to the urban form components, which could be sorted in three categories: (1) street measures, (2) block measures, and (3) land use measures.

4.7.1 Street densities

The total length of streets included in a certain urban area, as normalised by the total area, was considered a measure of connective urban tissue (Handy et al., 1998; Mately et al., 2001; Remali et al., 2014). Thus, the denser the streets per area, the more connective, and thus accessible, the place.

Equation 4-7: Street density (Handy et al., 1998)

Street density = L_{tot} / A_{tot}

L total length to street segments

A total area measured in hectare units

4.7.2 Link-node ratio

During his study on USA cities, Handy (2005) used this ratio to express the extent to which the urban area is connected. The number of street segments per area represents the number of links between the nodes divided by the total number of 3 and 4 leg-intersections, which represent the nodes where the flow of movement occurs.

Equation 4-8: Link node ratio: (Handy, 2005)

Link node ratio = LN_{tot} / N_{tot}

LN the total number of links

N the total number of nodes

4.7.3 External connectivity

The ratio of Ingress/Egress (access) points of the neighbourhood to the total length of peripheral streets reveal the extent to which the neighbourhood is connected to external urban areas; thus, the greater the distance, the poorer the external connectivity (Song & Knaap, 2004; Song & Quercia, 2008).

Equation 4-9: External connectivity (Song & Knaap, 2004)

External connectivity = L_{tot} / E_{tot}

L total length of peripheral boundaries of the neighbourhood

E total number of entrances into the neighbourhood

4.7.4 Block compactness

Having an idea about the size of the blocks in a particular area helps to understand its connectivity. The structure of a block is an important indicator that impacts traffic and pedestrian movement. Jacobs (1961) stated that longer blocks hinder permeability but the shorter blocks facilitate movement and motivate street liveability. Urban morphology studies assert that smaller urban blocks are important for better street connectivity, which leads to more walkable and accessible urban areas (Carmona, 2010; Montgomery, 1998; Moudon, 1997; Song and Knaap, 2004).

The structure of a block concerns three dimensions: area, diameter, and height. These dimensions are expressive because they explain how well the block geometry is compacted, which contrasts with the super block that has long elevations and thus longer street segments. In other words, two blocks of two different degrees of compactness have different associated streets lengths, and thus different impacts on pedestrian activity. The ratio of the real area of the block to the hypothetical circle area is defined by the longest diameter of the block. A greater ratio (closer to 1) means that the block has the optimum coverage of a certain area, which is defined by its diameter, and vice versa when the ratio is closer to 0.

Equation 4-10: Block compactness (Moudon, 1997)

Block compactness = A_{real} / A_{circle}

A_{real} total area of a block

A_{circle} total area of the circle defined by longest diameter of the block

4.7.5 Pedestrian Catchment Area (PCA)

The Pedestrian Catchment Area (PCA), which is the accessible area via the street network, assesses the efficiency of the street network to serve certain destinations or built up urban areas within an acceptable Euclidean walking distance, such as a 200, 400, or 800-metre radius, from a given point or important facility, like a transport station (Remali, 2014; Rights, 2005; Schlossberg, 2004). Furthermore, the PCA ascertains that, measuring the extent to which the street network serves blocks, demonstrates a certain level of accessibility into the built-up area, as sampled by a circle (e.g. 200-metres radius). The centre of the circle is hypothetically considered as the pedestrian departure point and a 200-metre radius ring is the proposed walkable shed. Thereby, the total accessible built-up area in a 200-metre network distance that is normalised by the total built-up area inside the circle, indicates the efficiency of the street network defined by the sampling circle. Moreover, in some research, this is called the Pedshed ratio in other studies (e.g. Remali, 2014).

Equation 4-11: Pedestrian Catchment Area (PCA) (Ramali, 2014)

PCA = AA_{tot} / A_{tot}

AA total accessible area.

A total built-up area of the sampled urban tissue.

4.7.6 Destination related measures

The design of destinations across the urban area is not co-founded on the planning dimensions that influence those destinations but on the compositional status that facilitates the accessibility of a place. Additionally, several scholars have asserted that the more accessible places depend on how such destinations are located. The term accessibility was used to explain how street connectivity and destination locations together function as a place (Handy, 1996c; Handy & Niemeier, 1997). Designing the physical environment is about making destinations accessible. For the same reason, Lee and Moudon (2006b) added R (length of route to a destination) to the 3Ds (density, diversity, design) developed by Cervero (1997). Moreover, they concluded that the distance to destinations and the 3Ds mutually effect walking. In this respect, several measures claimed to be effective tools in revealing the extent to which the design of destinations across an urban area influence walking.

4.7.7 The number of destinations

This measure captures the accessibility of certain destinations within walking distance in urban areas, regardless of the urban planning and topologic aspects. Significantly, a higher walking distance was noticed when a sufficient number of destinations are available in the neighbourhood (Lee & Moudon, 2006b, 2008). In this research, the total number of destinations is considered an independent variable that could help to predict different aspects of human activity and walking behaviour outcomes in urban areas. In this respect, one destination typology is considered in the thesis, which is the retail shops that are located on two scales: within a 400-metre radius and a 600-metre radius of the three neighbourhoods.

4.7.8 Pedestrian route directness ratio (PRDR)

Proximity was frequently used in accessibility and transportation related research. It is about the distance, either aerial or real, between a resident's house and the destination (calculated in walking distances, e.g., ¼ mile, ½ mile, and 1 mile). This was considered an influential factor in facilitating the activity of users, especially walking to the nearest destinations (Burke & Brown, 2007; Cerin et al., 2007; Handy & Clifton, 2001; King et al., 2003; Lee & Moudon, 2006a; Lee & Moudon, 2006b; McCormack et al., 2008; Moudon et al., 2006c; Frank et al., 2004; Frank et al., 2005a). Moreover, Randal and Baetz (2001), developed the pedestrian route directness ratio (PRDR), which is the ratio between the aerial distance to the real distance. It is an expressive formula because it explains the ease or probability to access certain destination/s located in a certain distance-range of residences. Thus, the higher ratios (up to 1) represent the best proximate relationships between origin and destination. In this research, the ratio was adopted to express the proximity caused by the street network design, and the number of destinations measure was considered in different measurement levels.

The Pedestrian Route Directness Ratio (PRDR) measure was considered on the neighbourhood level of measurement, from the equation (PRDR= Euclidian distance/network length of a route), and the numerical range of this ratio is ≤1. The 1 value represents an optimum relationship that has identical aerial and real distances; whereas, a smaller ratio illustrates that the real route is longer than the aerial distance. In streets, network routes relate between two points, the user's departure station and contextual locations or destinations; meanwhile, the Euclidian distance is the aerial distance between the two points. In this thesis, a certain number of destinations and one origin are defined for each case study, where the origin is the postulated departure point and the destinations are defined by the survey.

Equation 4-12: PRDR (Randal & Baetz, 2001)

(PRDR= Euclidian distance / network length of a route)

4.7.9 The clustering coefficient of destinations

The clustering of destinations suggests that people perceive this as more than a single destination because each cluster provides a range of options. Thus, the cluster has a greater chance of meeting users' needs than an individual destination (Handy & Clifton, 2001; Moudon & Hess, 2000). Thus, a cluster of destinations is a design process that serves the proximity by compromising the distance and geometrics of destinations; thus, users maintain a cognitive map of the proximity of their houses to non-residential clusters. However, there is no study that validates any standard measures of a cluster; instead it is simply perceived as a group of destinations proximate to each other to which people take themselves. Each cluster accommodates a bundle of different types of uses instead of single type of land use. The depending bundle criterion was devised by Canter and Tagg (1975), and defines how many clusters serve a particular urban area.

The clustering coefficient is a graph-based measure, developed by Watts and Strogatz (1998), to calculate social networks, which were considered ‘small world’ networks. If a group of destinations is represented as nodes and a graph was made through connecting the nodes by hypothetical links, then the clustering coefficient is the number of links between all the nodes divided by the total number of links that was postulated as a rational relationship amongst the nodes. Also, the coefficient represents the degree to which a group of nodes are clustered, by normalising the number of observed likes to the number of possible links among the same group of nodes. The implication of a *small-world phenomenon,* as called by the network theorists (Watts and Strogatz, 1998), to measure the degree of proximities between a group of destinations is promising because there is no equivalent topological measure to represent the relationship among a group of proximate destinations. However, there is no available method to produce a standard measurement of accessibility from this coefficient. In this respect, Diaan (2010) used the ratio of a number of realised links between destinations, normalised by the number of possible links, and reported the significant influence of walking.

In this thesis, case study destinations are defined within two scales, namely 400-metre radius and 600-metre radius (10-minutes and 15-minutes walking Euclidian distance from the neighbourhood centres), which were considered appropriate to create the clusters, and thus their coefficients. The aerial distances between the destinations represent the links, while the destinations represent the nodes of the *small-world* network, and the clustering coefficient is the product of the number of observed links divided by the number of possible links between the same destinations. For this research, the quantity of observed links depends on a 200-metre radius around each destination, which represents a tolerance range to determine links with other destinations over the shortest walking distance (5-minutes); this is the numerator. Thus, higher ratios mean a higher clustering of the destinations; in other words, a lower number of journeys that can satisfy more human needs.

Equation 4-13: Clustering coefficient (Diaan, 2010)

Clustering Coefficient = observed links / possible links $(n^2-n)/2$[9]

[9] The formula $((n^2-n)/2)$ to compute the possible number of links among n nodes is addressed by this research because the original reference did not mention this part.

4.7.10 Centrality measures of streets network

This research explains different measures, which highlight the efficiency of street networks in terms of the accessibility and liveability of the urban area. The importance of the centrality measures stem from a consideration of all the network components, including the nodes, edges, and lengths of segments. This stands in contrast to a generic perspective of space syntax (Porta, Crucitti, & Latora, 2006b). Also, the study of street networks by centrality measures reveals their potential in terms of connectivity, and thus, the liveability of an urban area.

4.7.10.1 Betweenness centrality

Betweenness is a centrality measure; it calculates the extent to which street segments can be traversed from other two non-connected streets segments. In other words, the degree (out of one) that represents the level of connectivity of a single street segment between another two street segments is known as the degree of betweenness (Porta, Crucitti & Latora, 2008). Moreover, according to Porta (2006, 2008) the degree of betweenness expresses the accessibility of the street as a place, and he refers that to what accessibility means in transportation planning. The most significant application of the measure was to discriminate between self-organised urban morphology and designed urban forms. Moreover, by using multi centrality assessment software (MCA), Porta et al. (2008) demonstrated that spatial cognition and collective behaviours showed a significant association with the computed measures of centrality.

Equation 4-14: The degree of betweenness (Porta, Crucitti & Latora, 2008)

$$C_i^B = \frac{1}{(N-1)(N-2)} \sum_{j,k \epsilon Ni, j \neq k;\ j,k \neq i} \frac{njk\ (i)}{njk}$$

njk (*i*) number of routes between two split nodes (*j* and *k*) throughout the node in question

njk the total number of routes which include the node in question

N the total number of nodes in the street network that n belongs to

Thus, the betweenness centrality of each node is a value allocated between 0 and 1.

4.7.10.2 The straightness centrality measure

Porta et al. (2008) argued that a greater degree of street straightness means more centrality than amongst streets with a lesser degree of straightness. As such, the accessibility of a place is calculated by the mean of straightness; Indeed, by using multi centrality assessment software, Porta et al. (2008) stated that spatial cognition and collective behaviours showed an association with the computed straightness centrality.

Equation 4-15: the degree of straightness: (Porta, Crucitti & Latora, 2008)

$$C_i^{S} = \frac{1}{(N-1)} \sum_{j \in N;\, j \neq i} \frac{dij\ (Eucl)}{dij}$$

dij (*Eucl*) total Euclidian distances among a group of nodes

dij the total real distance among the same group of nodes

N the total number of nodes in question

Moreover, this research depends on the MCA software to compute the betweenness and straightness centrality, as similarly used in other studies (Porta, Crucitti, & Latora, 2006a; Porta et al., 2008; Remali, 2014).

4.7.10.3 Gini Coefficient for centrality

The Gini-Coefficient indicator was used by Porta, Crucitti and Latora (2006a) to diagnose the distribution of centrality resources among street segments. Originally the measure was used in economic studies to determine the inequality of income distribution between citizens (Gini, 1921). The Gini-coefficient scale is close to 0 when all incomes are close to equal, and close to 1 when the distribution of resources is totally unequal; for example, if one category of employees receives the whole income at the expense of other categories. The measurement of the coefficient depends on the ratio between the two areas of the income distribution graph.

The graph is based on data related to the income of different categories of employees and shows the two statuses of resource distribution. The first is an ideal status, where the resources are equally distributed among participants, and the coefficient value is 0, (area A). The second represents the reality of distribution and is expressed by a curve called the Lorenz curve (area B). The coefficient value is computed by the ratio between area B and area A (Figure 4-3).

Equation 4-16: Gini coefficient (Gini, 1921)

Gini coefficient = A/(A+B)

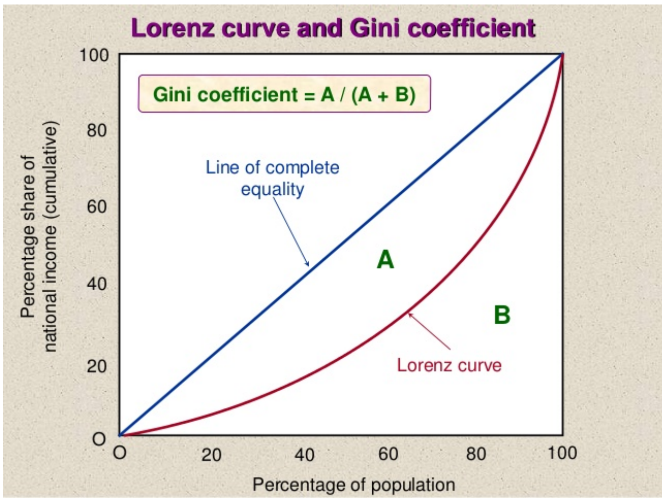

Figure 4-3: An illustration of the Gini coefficient based on (Gini, 1921)

This indicator is important because it explains whether the ingredients of a system contribute equally or differently to the whole system; in other words, how well the centrality resources were distributed. This coefficient is more useful than the mean of centrality because it explains the status-quo of distributing the centrality among several streets network items in one value (0-1). In comparison, the mean value explains the numerical centre of a group of centrality values and needs the standard deviation to explain how the items have differed from the mean. Thus, using the Gini coefficient in statistical analysis is sounder than the mean value. In this thesis, the Gini coefficient was computed for both the betweenness and straightness centralities, on one scale (400-metre radius).

4.7.11 The quality of edges

The studies of walking urban areas linked the quality of street edges with the number of walkers. Jacobs (in 1961) asserted the link between the quality of streets and street life. A street facilitates the interaction between people because it brings them together, even those who do not know each other. In a street, people do their favourite things: walking, watching, sitting, or choosing their favourite viewpoint. A good street has clearly designed edges, geometry and carefully delineated transparency (Jacobs, 2016). Hanson (2000) called the urban form morphology that considers physical characteristics related to edges the micromorphology of the urban form or the microscale of urban morphology. He highlighted the role of housing typology in generating urban form morphology and exemplified how Bloomsbury housing as an outward-facing typology contributed to the creation of street-oriented morphology. This morphology represents the interface for interaction with people and is directly perceived by the user of the space. He explained that space is a central issue in urban form studies and the edges of blocks directly shape that space; thus, the systematic measurement of street façades is important, like the morphology of plans, and this is called micromorphology (Hanson, 2000, 2001). Cullen (1971) discussed humanising the material dimension of the built-environment within townscapes. He criticised accelerated urban growth, which exceeded the normal level of human perception and called for an adoption and consideration of the human scale, physically and perceptually.

4.7.11.1 Frontage assessment

Studies concerned with physical activity and walkability asserted the role of street quality on the liveability of open space. Handy (2009) addressed five measures of a street environment related to street edges, which influence its walkability, and these include: imagine-ability, enclosure, human scale, transparency, and complexity. The block frontage is an important component of block structure, which impacts on human perception, traffic and pedestrian flow (Carmona, 2010; Montgomery, 1998; Moudon, 1997; Song & Knaap, 2004).

The method to assess the quality of street edges was adopted from Ramali et al., (2015), and depends on five factors to assess the quality of elevations. These factors are: the "number of visible units accessible from the street (S); visible diversity of function (F); openness to the public street (O); level of maintenance (M); and level of detail and quality of materials (D)" (Remali et al., 2015: p.108). The frontage quality index (SFOMD) method depends on a Likert scale of seven points, starting with (1), which is the lowest score of the assessment, and ending with (7), which the highest score of the assessment. The computing of the overall index was adopted from Gehl (1994, 2002) and Hershberger (1969), and combines the five indicators by totalling their raw scores. Thereby, the minimum score for the process is 5 points, which represents the poorest street quality, whereas, the highest score is 35 points which represents the best possible street quality (Remali et al., 2015).

4.7.12 Enclosure ratio

Studies in urban design developed different ideas about the relationship between human perception and street room. The enclosure notion defines the sense of place in connection with the relationship between street widths and adjacent building heights.

From an architectural point of view, Cullen (1961) illustrated that enclosure is an important tool that influences the human perception of a place or the “hereness”. Accordingly, the quality of enclosure is defined as a highly-required dimension of a streetscape, because the street-building proportions represent the “outdoor room” of walkers. For example, Ewing and Handy (2009) indicate that building height, and other vertical elements, are milestones to establishing well-defined outdoor spaces when they are proportionate with the width of the counter space, or street. Moreover, different proportions of street-building are considered ideal ratios; for example, Jacobs (1993) suggested a ratio of 1:2, building height street width respectively, as a minimum ratio.

4.8 Summary of the subjective and objective measurements

This chapter defined in detail the measurement protocol of this research. It is composed of two types, namely the subjective and objective methods of measurement. The subjective measurement manifests in the questionnaire instrument (NWOAQ), which involves four levels of measurement to gather information related to walking to occupational activities from residents of the selected neighbourhoods in Basra city. Moreover, the NWOAQ has been developed for this research, and applied to the three case studies in Chapter Five of this thesis. The objective measures are selected from previous studies concerned with walking in the built environment; these are based on the reported significance of their associations with walking. These measures will be applied to the three case studies in Chapter Six. Finally, in this chapter, the second part of the third objectivity of this research is achieved; in term of developing the required measurement instruments to infer the waking to occupational activities.

5 The Research Methodology

5.1 Introduction

Research methodology, or research design, concerns how to answer research questions. The structure, or framework, of a methodology enables a researcher to systematically answer their research questions; thus, the research design must adopt tactics and methods appropriate to the case of interest (Kroll & Neri, 2009). This study adopts mixed method research to address both its qualitative and quantitative requirements. Generally, this research depends on qualitative techniques to elaborate the quality of the selected case studies and develop the instrument of occupational activity and walking (partition B of the questionnaire) by the interview method, whilst the subjective measurement depends on a quantitative method that adopts a cross-section random sampling technique. In this respect, the instrument, called the Neighbourhood Walking and Occupational Activities Questionnaire (NWOAQ), is applied to the selected case studies. The questionnaire consists of five parts, which are: (A) personal information, (B) the instrument of occupational activity and walking, (C) the perceived environment, (D) the TPB (Theory of Planned Behaviour) constructs, and (E) a map of the case study including block labelling of the residents homes and the destinations, (Appendix 2). Finally, a descriptive analysis for the final sample is conducted, where the subjective variables of this research are defined, the required statistical analysis is addressed, and the reliability tests are conducted in this chapter.

5.2 Case study research

Yin (2003) explained that case study research is used in different disciplines as a powerful tool to explain complex, latent, socially-related phenomena. In effect, a case study facilitates the exploration and understanding of phenomena of everyday life, such as an, “individual life cycle, organizational and managerial processes, and neighbourhood change” (Yin, 2003:p.4). Also, he (2003:p.5) defines case study research as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident”. Moreover, Yin (2003) states that, in the hands of the researcher, a case study can be an exploratory, explanatory or descriptive tool. He (2003) further identifies four essential features of case study research, which are: (1) defining a real-life phenomenon which occurs in the context of a case study; (2) defining the boundaries of a case study; (3) defining whether the approach comprises single or multiple case studies; and (4) defining a methodology that covers research design, data collection, and data analysis methods.

Yin (2003) asserted that the context of the case study must be well-bounded or defined (Yin, 2003). To correspond with these criteria, in this research, walking to occupational activities will be inspected and the instrument will be designed in this regard. The samples will be taken from multiple case studies, which are three neighbourhoods of Basra city. In terms of the methodology, a mixed method is widely applied within case study research, especially within social studies. This is because social studies often require different types of qualitative and quantitative evidence related to the subject in question (Creswell, Plano Clark, Guttmann, & Hanson, 2003; Johnson & Onwuegbuzie, 2004; Lewis, 2015; Yin, 2011, 2017).

5.3 Mixed Method

A mixed research methodology results in a combination of qualitative and quantitative methods that accord with the study's requirements. According to Kroll & Neri (2009), the research purpose and questions are the important grounds to justify a mixed method design. Creswell (2013) attributed the selection of this method to limited resources, while Yin (2011, 2017) stated it was due to the different evidence requirements related to the phenomenon in question. Thus, for this study, the combination is designed to strengthen the methodology by securing an appropriate range and depth of the gathered information in response to the requirements of the research question. Moreover, Creswell, (2013) states that whatever is valid in qualitative and quantitative methods is also valid in a mixed method design, and research could benefit from both methods as it requires.

Although there are various mixed research methods, the three procedural steps are the same and include: data collection, data analysis, interpretation and validation. In addition, Creswell (2013) classified mixed method research into six typologies, which are: Convergent Parallel Mixed Methods Design; Explanatory Sequential Mixed Methods Design; Exploratory Sequential Mixed Methods Design; Embedded Mixed Methods Design; Transformative Mixed Methods, and Multiphase Mixed Methods. For this study, the Exploratory Sequential Mixed Methods Design has been selected. This is because the typology starts with a qualitative method to achieve certain tasks which are subsequently explained by the quantitative measurement. The ESMMD is compatible with the research procedure for this study, which starts with a qualitative discussion about the alteration of urban form of Basra city at the neighbourhood scale, also the interview, which is qualitative method, was considered in designing the questionnaire of this research (NWOAQ). Then, the study moves into a quantitative method by applying the NWOAQ questionnaire. The qualitative items of the questionnaire are either quantitatively measured by a Likert scale, like the perceived environment, or measured as a categorical variable then recorded as a numerical dummy variable, such as the work status of participants. Moreover, a quantitative method is important for testing and validating the ecological models of physical activity because these models depend on the statistical association between the outcome variables (dependent variables) and predictors (independent variables), as it was stated by Sallis et al. (2006, 2012). In this respect, the quantitative method in this research adopts the layout requirement criteria addressed by Creswell (2013). This aims to guarantee the reliability of the research and: (1) defines the measurement instruments; (2) selects whether sample is random or non-random; (3) defines the population and sample size; (4) determines the time of the survey; (5) checks "how do the variables cross-reference with [the] research question and items of survey"; and (6) discusses the statistical method of data analysis, and how the results will be interpreted (Creswell, 2013, p.180). These six criteria are considered in this research.

5.4 The methodology of applying the questionnaire

The quantitative method adopted by this research, by applying the questionnaire to the defined case studies, considered the six criteria in terms of the following (Creswell, 2013): (1) the objectivity of the questionnaire, which is defined in detail (section 4.4); (2) the random method that is adopted; (3) the sample size, which depends on the clustering sample size method, whilst the statistical validity of the sample depends on the Confidence Interval CI of accuracy test; (4) the time of the survey, which will be undertaken over two weeks in order to question the sample about one week of walking activity to occupational activities; (5) In term of "how do the variables cross-reference with research question", the integrative models were generated to response to the research questions of this study, in this chapter of the study (section 5.5.2); and (6) a discussion on the statistical method of data analysis (section 5.5). Moreover, the applied quantitative level of the methodology is precisely articulated below.

To apply the questionnaire (NWOAQ) to the three neighbourhoods, a random sampling method is adopted; this gives an equal opportunity for each resident to participate in the study (Thompson, 2012). In terms of the sample size, the main barrier facing the conduct of the questionnaire is the lack of resident census (the last census was conducted in Iraq in 1987). In this regard, although there is no general consensus about an appropriate sample size to population ratio, it must be considered for the purpose of sample size accuracy. There are several techniques to consider in random sampling, which includes: frame sampling, simple random sampling, systematic sampling, and cluster sampling. Cluster sampling depends on an extra factor to sample the targeted population, like a group of blocks rather than the sample itself. From this basis, the targeted population, who (in this case) have been spatially defined, will all have the same participation probability (based on Kish, 2004; Kish & Frankel, 1970; Kish & Frankel, 1974; Purcell & Kish, 1979). The targeted population in this research live in the defined (400x400-metres) and are thus defined by the clustered group of blocks.

The second barrier facing this research is the lack of mail service; therefore, it is not possible to mail the questionnaire to the residents. Instead, the researcher, with assistance of two members of staff in the Architecture Department of the University of Basra (who have Masters degrees in urban design and used to be students of the author of this study) personally delivered the 300 questionnaires within each neighbourhood, which included 900 in total for the three neighbourhoods. These were delivered to approximately 1350 housing units within the three case study neighbourhoods in the defined 400x400-meter areas. Moreover, this dissemination and collection occurred within the period (1^{st}-6^{th} October 2015). This number (900) represents approximately 64% of the total housing units. The rest of the housing units did not receive the questionnaires for several reasons, which included: nobody being in the house on these days, a refusal to participate, or unable to understand the purpose or the content of the questionnaire. The surveyors explained the content of the questionnaire to the people who initially agreed to participate and supplied them with a contact mobile phone number and explained the collection point. Over the subsequent two weeks, the surveyors answered phone calls and explained to participants any misunderstood elements of the questionnaire. The questions were mostly about using the map; for example, “where I can find the address of my house?”; “where can I find the address of my destination?”, and “can I fill out the questionnaire with another person in my family?”.

Previous literature concerning ecological models of physical activity, reported a range of accurately completed questionnaires, which totalled 20-30% of the total questionnaires issued (e.g. Duncan et al., 2005; Humpel, Owen & Leslie, 2002). On this basis, the expectation for this study was to gather 180 to 270 accurately completed questionnaires. One public shop in each neighbourhood was assigned as a point of collection for the completed questionnaires. As an incentive, a 10$ mobile phone voucher was awarded to any resident who submitted a completed questionnaire to the assigned local shop. The researcher personally afforded the money though the research sponsor (the Ministry of High Education and Scientific Research MoHESR) who promised to later repay the researcher. The participants were asked to keep the questionnaire for no more than two weeks and, during this period, they had the opportunity to call the surveyors during the day if they needed clarification. After one week and for a period of a week (13^{th}-20^{th} October 2015) the surveyors waited during the day (from 8:00am to 5:00pm) in the assigned local shops to gather the completed questionnaires.

Also, the surveyors collected the questionnaires directly from some participants, especially from acquaintances. Moreover, a permit to conduct the questionnaire was issued by the police in the case study districts. From Al-Saymmar neighbourhood 120 completed questionnaires were collected, either directly or from the assigned shop. Furthermore, 112 completed questionnaires were collected from Al-Mugawlen neighbourhood, and 93 questionnaire were collected from Al-Abassya neighbourhood. All the completed questionnaires were strictly ‘cleaned’ to determine valid participation. The cleaning check criterion determined whether the respondent correctly completed the questionnaire with the required information. Only 62 questionnaire formats were valid from Al-Saymmar neighbourhood, 58 were valid from Al-Mugawlen neighbourhood, and 55 were valid from Al-Abassya neighbourhood.

The disregard of many of the questionnaires was due to different reasons, which included: not fully completed, missing pages, completed by participants under the age of 18, and several selections for one question. Thus, the valid questionnaires totalled 53.8% of those returned, which represented 175 participants, and 22% of the sent questionnaires. Moreover, defining the sample size is considered important when running statistical analyses, like ANOVA and a Multi-Regression Analysis were considered in this research. In this respect, a sample size of 58 cases is the minimum sample size required to predict an outcome variable (Y), based on the five independent variables (Xi), towards a minimum (0.2) r-square or determination coefficient (Bujang & Adnan, 2016); In this regard, the valid questionnaire in this study meet this criterion except with Al-Abassya neighbourhood, which is sampled with an approximate number of participation to this criterion (55 valid participation). In the next step of the work procedure, the matrix of the SPSS analysis page assembles the participants (in rows) and all the variables of the study (in columns), and includes: independent (predictors), moderators, mediators, and walking outcome variables. From this basis, the participants' responses were uploaded into the appropriate variables. Moreover, each variable was represented by a unique code.

For more detail, the data set for the analysed questionnaires is provided in Appendix 4, and shown as CD in the SPSS format. Moreover, in 18th September 2015 the questionnaire was given ethical approved by the University of Strathclyde, (Appendix 1). A native Arabic translator translated the questionnaire into Arabic, and the final version was attached to a statement that explained the content of the questionnaire, the importance of taking part, and instructions on how to complete the instrument (Appendix 3).

5.4.1 Statistical descriptive analysis of the NWOAQ questionnaire:

The NWOAQ questionnaire, was divided into four partitions A to D, represents the subjective measurement level of this research, and employs a quantitative research method. Moreover, digital copies of the questionnaire (in English and Arabic) are attached to this thesis as Appendices 2, and 3, respectively. After the analysis of the questionnaire, the variables were considered in the context of the integrative models. Based on criteria from the research questions of this study, the socio-demographic items were considered moderators, (partition A), the walks to the seven occupational activity domains were the walking outcome variables (partition B), the perceived environment were the mediation variables (partition C), and the belief-based measures of walking were also mediation variables (partition D). Worth to mention that the determination variables are the objectively measure attributes of the physical environment, which are computed in chapter six of this thesis. Moreover, the variables are coded and entered into SPSS software and systematically defined in this software (Appendix 4, as CD in SPSS format).

5.4.1.1 Partition (A):

The total number of questions asking for personal information was 15; these were addressed to the participants, and represented the first partition (A) of the questionnaire. The first question was designed to determine individuals for legitimate participation; for example, whether the individual has a disability which impedes walking. Thus, after the first question only 14 socio-demographic questions were considered for further analysis.

The analysis of the questionnaire relied on the use of SPSS 23 software and explained the 14 personal trait dimensions that could influence participant walks to occupational activities. The analysis of the sampled population found that: four questionnaires were disregarded because the respondents had a disability that would impede their ability to walk (A1). Of the 175 of respondents, 38% (n=67) were female and 62% (n=108) were male (A2). The predominant age range of the respondents was the 35-44 category, which comprised 33.1% of the total valid sample. Moreover, the ratio gradually reduced above and below these ages. The younger age categories (25-34 and 18-24) comprised 22.3% and 14.3%, respectively; whilst the older age categories (45-54 and 55-65) comprised 20.6% and 9.7% respectively (A3).

The majority of the participants reported income levels amongst the lowest three categories (less than 400$, 400-600$, and 600-800$), which totalled 22.9%, 24.6%, and 21.1% respectively. Conversely, the highest three income categories showed far lower percentages; these were 800-100$, 1000$-1200$, and more than 1200$. These comprised 13.1%, 8.6%, and 9.6% respectively (A4). The employment status question showed that the Free Business category had the highest number of responses at 36.6%. Also, the Employed category showed a relatively high number at 30.3%, while the other three categories showed relatively low numbers; these were Unemployed, Housekeeper, and Students, and comprised 11.4%, 14.3%, and 7.4% respectively (A5). Meanwhile, the mean of number of total cars owned by the families of the respondents is 1.34 (SD=.7) with a minimum 0 and a maximum 3 cars (A11).

The marital status question saw three categories predominate; married with children and parents living with you; married with children; married with children, parents, and brothers; married with no children; these ratios were 26.6%, 24.3%, 24.7%, and 18.8% respectively. Single people who lived with their parents represented only 5.6%. Moreover, these proportions represented the status of the respondents of the sample (A6) Furthermore, the mean family size is 7.84 persons (SD=2.6), whilst the minimum number is 2 and the maximum number is 14 persons (A9). The mean number of under 18-yrs family members is 2.96 (SD=1) with minimum number of 0 and maximum number of 6 (A10).

In terms of regular physical exercise, 92% reported that “No” they did not practice any type of sport nor go to the gym regularly, while only 8% answered “Yes” (A7). The

BMI factor was computed according to the equation kg/m2 and based on the information collected from the respondents about their height and weight, The mean BMI score across the three neighbourhoods was 27 (SD=2.12) whilst the minimum was 22.6 and the maximum was 35.75 (A8). Moreover, the BMI was recorded as a variable in one of four categories that included: underweight (<18.5), healthy weight (18.5-24.99), above ideal weight (25-29.99), and obese (>30). These were coded in SPSS as 1, 2, 3, and 4 respectively. Of the 175 participants, 19.4% were considered within the healthy category, 74.3% were within the above ideal weight category, and 6.3% were within the obese category.

The mean living period in the three neighbourhoods was 18.8 years (SD=13.9) with a minimum 0.5 year and maximum 56 years (A12). In terms of the number of bedrooms, the majority of the respondents reported that they live in houses with four bedrooms (49.1%); far fewer respondents reported living in houses of three bedrooms (22.9%), and fewer respondents again stated that they lived in houses of two bedrooms (16%). Very few respondents confirmed they lived in two bedroom houses (6.3%), and finally, only 5.7% of respondents said they lived in houses with six bedrooms (A13). Meanwhile, the highest percentage ratio of house layout reported by respondents is the front yard house typology (50.3%); far fewer respondents inhabited a courtyard or no yard house typology, at 25.7% and 22.9% respectively. Furthermore, a minority of respondents reported inhabiting back yard only houses (1.1%) (A14). The final question examined house ownership; 76% of respondents owned their houses, while only 24% of respondents rented their houses (A15).

5.4.1.2 Partition (B):

This partition concerns walking to the seven occupational activity domains. The first question in this partition was formatted into a table listing seven activities, as responses to the question: “Where did you go from Sunday to Saturday?” From this, the seven activities were sorted as options under the question. Participants were asked to mark the activity, specify the address of the destination, and the minutes taken walking (10 to 30 minutes). The walking activity is a moderate daily activity, which jointly occurs with the occupational activities. In this respect, the respondents were given two choices, “Yes” and “No”, regarding whether they walked. A “yes” response requires the minutes spent walking, while a “No” means the participant did not walk.

Four variables are expected in relation to the walking outcomes, whilst information about the seven types of occupational activities is also expected. The four variables associated with walking include: the total walking distance per week (TotWkDis); the total number of walking journeys (TotWkFrq); the total walking minutes per week (TotWkMin); and the computed variables from the total walking minutes, which are ≥150 walking minutes per week (CatWlkMin), namely 30 minutes of walking for five typical days. This categorisation followed the recommendations of different international and national health bodies, including the UK's Department of Health. The postulated timescale of the study was a typical one-week of activity, which would mostly allow the opportunity to cover the seven domains. Moreover, because the instrument is context-specific, the definition of the context depends on the definition of "neighbourhood" within the literature. This was considered a 10-minute walking distance (400-metre Euclidian distance), but also included a buffer representing a 15-minute walk from the same centre that defines a 30-minute, two-way walk. These were illustrated in the map attached to the questionnaire, the map is based on the cadastral map which is developed in chapter two of this study.

Participants were asked to complete the questionnaire format (B-partition) on a daily basis, or recall their activities for one week. The activities needed to take place between 7:00am and 12:00 midnight. Each activity had to be explained by the address of the destination. For this purpose, a map was attached of the respondents' neighbourhoods to help them choose the block-based address of their house and the destination address. The map for the neighbourhood labelled the block of the participants' addresses for each residential area as (Bi) and the destinations within each case study as (Di).

Bi: the block number where participant lives.

Di: the destination number where the participant went to undertake their activity.

A cleaning process was applied to discriminate the valid instruments. The cleaning check criterion was whether the respondent correctly reported the required information regarding their walking activity in relation to each occupational domain. More specifically, this meant recording the destination address, minutes taken, and the Yes/No response in relation to walking. Any missed or miss-answered fields saw the questionnaire discounted. The criterion of a minimum four correct domains was applied in this research, meaning that if the respondent correctly reported four domains out of seven then their participation would be considered (after omitting the incomplete domains). After applying this criterion, only 175 participants were considered for analysis. The reported number of minutes was moved into the corresponding minutes variable. The number of walking journeys was combined from all the occupational domains and moved into the corresponding frequency variable. The addresses of the participants were documented with AutoCAD as an origin station, whilst the address of each destination for each occupational journey was documented in an Excel sheet that corresponded with the participant ID. The ID was a block-based origin address and neighbourhood code; for example, Ni-Bi, for neighbourhoods and blocks. For more detail, the data set for the analysed questionnaires is provided in Appendix 4, and shown as CD in the Excel format.

The information about the destination addresses was used to measure the total distance of the walking journeys using the road-graph plugin for QGIS software. This was based on the geo-referenced cadastral map, where the origins (block centroids) were defined as a layer, and the destinations were also defined as a layer (non-residential land use). From this basis, the walking distance variable (TotWkDis) was computed by aggregating the distances from all walking journeys for each participant. Information about the number of times the activity was undertaken helped to produce the frequency variable (TotWkFrq), whilst the number of minutes chosen by participants were aggregated in terms of each single occupational activity. From this, the totals were further aggregated to produce the total walking minutes per week (TotWkMin). For more detail, the data set for the analysed questionnaires is provided in Appendix 4, and shown as CD in the QGIS format.

Moreover, the Cronbach's Alpha test for reliability was conducted to produce the standardized values (z-score) of the three variables; this was important because the three measures represented three different parameters. Outcomes from this test indicated a good level of consistency (.87), whilst the category (.80-.80) alpha was good, based on Cronbach (1951). In terms of walking to the occupational activities within the three neighbourhoods of Basra city, the four outcome variables obtained were considered indicators of the walking lifestyle of the participant in terms of their occupational activity. This was potentially influenced by several neighbourhood environmental factors, which were also considered in this research.

5.4.1.3 Partition (C):

This partition of the NWOAQ is about the perceived environment qualities, which were adopted from the NEWS instrument (De Bourdeaudhuij, Sallis & Saelens, 2003; Saelens, Sallis, Black, & Chen, 2011). With respect to the neighbourhood environment qualities, only 13 questions were used for this study, based on their significance of associations with the physical activities, based on the reviewed models in chapter three of this thesis. The 13 questions represented 13 mediation variables, though they might be used as mediators, which were coded and applied to the three neighbourhoods. In other words, this type of variable mediates the direct effect of the built environment on respondents' walking outcomes.

The 13 items related to the perceived environment, and were measured by a seven point Likert scale, ranging from 1, when the respondents "disagreed", and 7 when the respondents completely "agreed". The results were entered into the SPSS sheet, and explained the 13 dimensions of the perceived environment that could influence the decision to walk to an occupational activity. Moreover, the first test of the perceived environment variables was determined by the Cronbach's alpha, to determine the internal consistency of the responses to the 13 questions. Across the three neighbourhoods, the outcome was (.76), the category (.70-.80) was acceptable based on Cronbach (1951).

5.4.1.4 Partition (D):

The beliefs-based measurement of walking behaviour is a type of measurement that is based on the constructs of the Theory of Planned Behaviour, and these constructs are the: behavioural attitude (BA), subjective norms (SN), perceived control belief (PCB) and intention. The measurement of the four constructs depends on two questions for each construct that address the instrumental belief measure and the affective evaluation measure. The instrumental belief measure determines the magnitude of the belief that the person holds towards a particular behaviour. Meanwhile, the affective evaluation measure functions as a moderator of the instrumental measure; thus, in this research, it was called a moderator. However, the intention is a direct one-instrument measurement that has no moderator.

In terms of walking behaviour, the behavioural beliefs assigned to measure the walking attitudes were related to health, safety, the beauty of the environment, having fresh air and time obligation; these were weighted by a moderator for each question. Thus, five instruments and five moderators were designed to measure the attitudinal beliefs of walking. The normative beliefs assigned to measure the subjective norm constructs are related to people, family, and doctor, and weighted by a moderator for each. Thus, three instruments and three moderators were designed to measure the subjective norms. The control beliefs assigned to measure the perceived control beliefs were related to the proximity of the destinations, ease of movement in the streets, diversity of destinations, the crowd of people in the streets, and intensity of houses. A moderator for each question weighted these beliefs. Thus, five instruments and five moderators were designed to measure the perceived control beliefs (PCB). Its moderator multiplied each instrument in order to produce the belief construct score that related to respondents' walking behaviours. However, the instrumental variable scores of the intentional construct were considered as final scores of the construct. Moreover, the instruments were measured with the Likert seven-point scale, while the moderator was measured with the Likert four-point scale. Therefore, the minimum construct score was 1x1=1, and the maximum score was 7x4=28. The raw score of the intention variable (IntWlk) was seven points and, for statistical purposes, it was transferred to become of 28 points. Following this transferral it was then possible to compare the score with the rest of constructs.

The resulting number of construct items totalled fourteen. Five items related to the attitude to walk and included: attitudinal health beliefs of walking (AtWkHlth); attitudinal environmental beliefs of walking (AtWkEnv); attitudinal time beliefs of walking (AtWkTim); attitudinal safety beliefs of walking (AtWkSaf); and attitudinal fresh air beliefs of walking (AtWkAir). Moreover, three items were related to the subjective norms of walking and included: people-subjective norms of walking (SNWkPep), family-subjective norms of walking (SNWkFam), and doctor advice-subjective norms of walking (SNWkDoc). Furthermore, five items were related to the perceived behavioural control of walking and included: the perceived walking control related to the proximity of destinations (PCWkProx); the perceived walking control related to the street design (PCWkEss); the perceived walking control related to the diversity of destinations (PCWkDiv); the perceived walking control related to the crowdedness of streets (PCWkCrw); the perceived walking control related to the density of houses (PCWkHoDn). Finally, one item related to the direct intention to walk (IntWlk). Moreover, these types of variables were considered the second type of mediation variable because they mediate the direct effect of the built environment on the behavioural outcomes in general and on walking more specifically. The resulting 14 variables are postulated mediation variables, based on the theoretical and empirical evidence. It was anticipated that these would influence the relationship between the objectively measured physical environment and the outcome variables. The elicited data were entered into the SPSS sheet for each participant, for more detail, the data set for the analysed questionnaires is provided in Appendix 4, and shown as CD in the SPSS format. The first test was the Cronbach's alpha that showed that the internal consistency of the 14-item responses across the three neighbourhoods; this calculated as .74, and the category .70-.80 alpha was therefore acceptable based on Cronbach (1951).

5.5 The statistical analysis

The statistical analysis of this research used the SPSS-23 software licenced by the University of Strathclyde. The gathered information was entered into the SPSS format as coded and defined variables (rows) and adjusted to the participants (column). The independent variables were adjusted to the appropriate participant according to their neighbourhood, while the individual responses were adjusted to the appropriate individuals, regardless of their neighbourhood. The datasets of the variables were defined by the appropriate units of measurement for the three types; nominal, ordinal, and scale for categorical variables, Likert, and continuous for continuous variables. For more detail, the data set for the analysed questionnaires is provided in Appendix 4, and shown as CD in the SPSS format.

5.5.1 Reliability tests

The reliability of the adopted subjective measures in this research firstly comes from the utilisation of the measure considered as reliable in previous studies; furthermore, according to the significance of their influences on the physical activity. The Cronbach's alpha test was conducted on the perceived environment variables, the constructs of the TPB variables, and the walking outcome variables and showed different alpha levels, which were .76, .74, and .87, respectively. Based on the Cronbach's (1951) alpha test[10].

5.5.2 Integrative models

For the purpose of answering the research question, integrative models are created for this study. They are designed models that compound several variables and depend

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[10] the level of internal consistency that makes a group of indicators reliable should not be less than .6; Moreover the test was conducted by the assistance of the SPSS in this research.

on the structural equation model to associate the variables. In this respect, the variables have different roles within the model. The predictor, or the independent variable (X), represents the main effect of the model on the outcome variable, which is the dependent variable (Y). The dependent variable is considered continuously under the influence of the external effects. The independent variables were categorised into predictors (determinants), moderators, and mediators, which have different loads on the outcome variable. Thus, three integrative models were adopted in this research to response the research questions. The first model depends on the determinant variable (walkability index) which has: a mediation set of variables including the perceived environment (elicited from partition C of the questionnaire); the beliefs-based measures of walking (elicited from partition D of the questionnaire), and the walking to the seven occupational activity domains as the walking outcome variables (elicited from partition B of the questionnaire) (Figure 5-1). The second model depends on the determinant variable (walkability index) and this has the: moderator set of the socio-demographic variables (elicited from partition A of the questionnaire) (Figure 5-2). These two types of integrative models have adopted two statistical formulas from Hayes (2013); namely, model (4) (compatible with Figure 5-1) and model (1) (compatible with Figure 5-2) for the mediation and moderation tests, respectively.

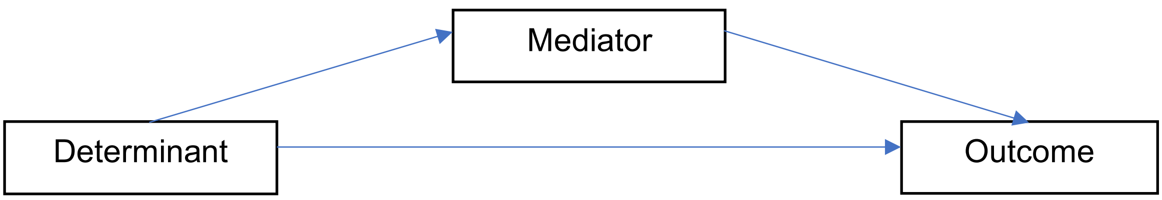


Figure 5-1: Mediation model-4 by Hayes (2012, and 2016)

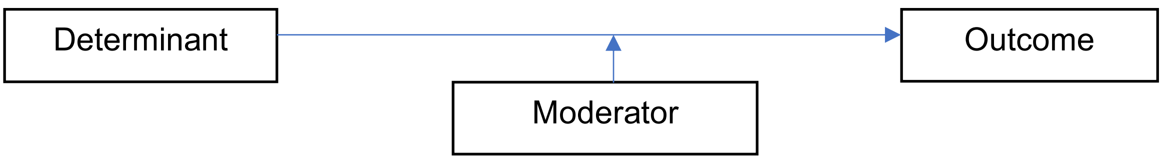


Figure 5-2: Moderation model-1 by Hayes (2012, and 2016)

The third type of integrative model depends on the logistic regression analysis to integrate all the independent variables, and includes determination, moderation, and mediation variables in a compound model to identify their direct effects on the ≥150 minutes per week walking outcome variable. Finally, the fourth type of integrative model depends on the multilevel hierarchical regression analysis to integrate all the independent variables. This includes the determination and mediation variables in a compound model to identify their direct effects on the walking outcome variable. A further explanation on the conduct of these models is provided in the next section, which explain the types of the statistical analyses of this study.

5.5.2.1 Levels of statistical analysis

The first level concerns the validity of the measured variable for the statistical tests; this relied on a normal distribution of the variable. A 'normal distribution' meant checking the normal distribution for all types of variables of the study, with the exception of the predictors (objectively measuring attributes of the physical environment). This is because the predictors are a level-based measurement; in other words, each predictor has a maximum three levels of measurement with respect to the three neighbourhoods. Meanwhile, the behavioural outcome variables, mediators, and personal information are individually based measures. Thus, normal distribution analyses were required to test their validity. In this regard the Shapiro & Wilk test (Shapiro & Wilk, 1965) of normal distribution is adopted. Also, the Skewness and Kurtosis test of normal distribution was conducted for the individually based measures. Thus, only the variables with an approximate normal distribution were moved to a higher level of analysis.

The second level of the statistical analysis was conducted to explore the effect size on walking outcomes. This was determined by certain factors, including neighbourhood typology, socio-demographics, perceived environment factors, and beliefs-based measures of walking. In this level, these were considered as sources of a direct effect on walking outcomes. Thus, different One-way-ANOVA tests were conducted on the walking-related outcome continuous variables. Also, the walking variable (≥150 walking minutes per week) was examined as a dependent variable with factors from the personal traits, perceived environment, and beliefs-based measures related to walking from the TPB. This aimed to determine the factors that had a significant association. For this purpose, the binary logistic regression analyses were run to calculate the odds ratio (OR); this was because the ≥150 walking variable is a categorical variable of two categories.

The third type of the statistical analysis was the Pearson Correlation test. This test was conducted between the outcome variables and the corresponding factors concerning personal information and mediation variables. This test was applied to explore the significance and the extent of the correlation between the independent variable and the walking outcome variables. The two informative outcomes from this test were: firstly, the value and direction of the correlation, which was -1 to 0 for a negative correlation, and 0 to 1 for a positive correlation, and secondly, the *p*-value that explained the significance of the correlation (<.05). From these outcomes, only the variables with a significant level of correlation qualified for the higher level of analysis.

The fourth type of statistical analysis was the mediation analysis. This test was conducted between the independent and dependent variables. In this respect, the predictors (X) and mediators (M) were considered independent variables, while the dependent variables were the behavioural outcomes (Y). The aim of this test was to determine which mediators had a significant indirect effect on the behavioural outcomes. Thus, the mediators with a significant effect were qualified for the prediction level of analysis.

The fifth type of statistical analysis was the moderation analysis. This test was conducted between independent and dependent variables. The dependent variable was the walkability index (X) plus the personal information, which was considered the moderation factors (Mo) and the dependent variables were the behavioural outcomes (Y). The moderation variables were used as indirect predictors after interaction with the independent variables; this produced the interaction factors (Int). Thus, the significant effect of the interaction variable indicates the moderation effect on the relationship between (X) and (Y). The aim of this test was to determine which socio-demographic factors have a significant indirect effect on walking behaviour.

The sixth type of statistical analysis was the prediction analysis, which aimed to determine which objectively measured environment had a correlated function as a determinant of walking behaviour. This type of analysis was based on the independent variables, including a predictor (X), and moderators (Mo) on one hand, and a walking outcome variable (Y), on the other hand. For such purposes, a hierarchal regression analysis was adopted because it could include the predictors in the process as different bundles or blocks according to the needs of the operation. The two types of independent variables (X, and Mo) were subsequently entered into the models to find the R^2 and R^2-change of the effect of the independent variables on the outcome variable. The outcomes of these tests are further described and analysed in Chapter Seven.

5.6 Chapter summary

Adopting a mixed method with multiple case study research helped to develop 45 variables that were based on the self-report method in the NWOAQ questionnaire (Table 5-1). Of these 45, 14 were moderation variables within partition (A); four were behavioural outcome variables related to walking (partition B); 13 were mediation variables related to the perceived environment (partition C), and 14 were mediation variables related to the beliefs-based measures of walking (partition D). These variables were systematically entered into SPSS, and based on individual participants (Appendix 4, CD, SPSS format). Also, in this chapter purposive integrative models were defined to answer the research questions. In this regard, the variables from partition A were considered for the next stage of analysis to satisfy the moderation roles of the effects on walking outcomes. Meanwhile, the variables from partitions C and D were considered for next stage of analysis to satisfy the mediation roles of effects on walking outcomes. Moreover, the variables from A, C, and D were used to test their direct effects on walking outcomes (from the partition B of the questionnaire). The next chapter includes the conducting of the statistical operations based on the integrative models (section 5.5.2) for the purpose of responding to the research questions. In other words, there is a certain combination of independent variables and a walking outcome variable in a model, which corresponding with a research question to find out the sources of influences on the walking outcome in question. Hence, this chapter achieved the fourth objectivity of this research; in term of methodology.

Table 5-1: 45 variables that were based on the self-report method in the NWOAQ

Mediators	Moderators	Outcome variables
1) Attitude to walk (5) 2) Subjective Norms SN belief to walk (3) 3) Perceived behavioural control PBC to walk (5) 4) Intention to walk (1) 5) Perceived environment factors (13)	1) Gender 2) Age 3) Exercise 4) Family type 5) Number of bedrooms 6) House type 7) Family member 8) Underage 9) Income 10) Cars number 11) Work status 12) BMI 13) House ownership 14) Period of living	1) Total walking distance per a week. 2) Total walking journeys per a week. 3) Total walking minutes per a week. 4) ≥150 walking minutes per week.
27 variables	14 variables	4 variables

6 Objective measurement of physical environment

6.1 Introduction

The objective measurement of the physical environment attributes, which were addressed in Chapter Four, to the case studies, which were defined and sampled in Chapter Two, are conducted and discussed in this chapter. These measures are concerned with measuring indicators related to urban planning and urban morphology, and streetscapes based on the cadastral maps of the three case studies. The independent variables related to the objective measures are also addressed, and based on the integrative models, which are defined in Chapter Five, the objective indicators represent the determinant indicators in the ecological processes of walking to occupational activities of this research.

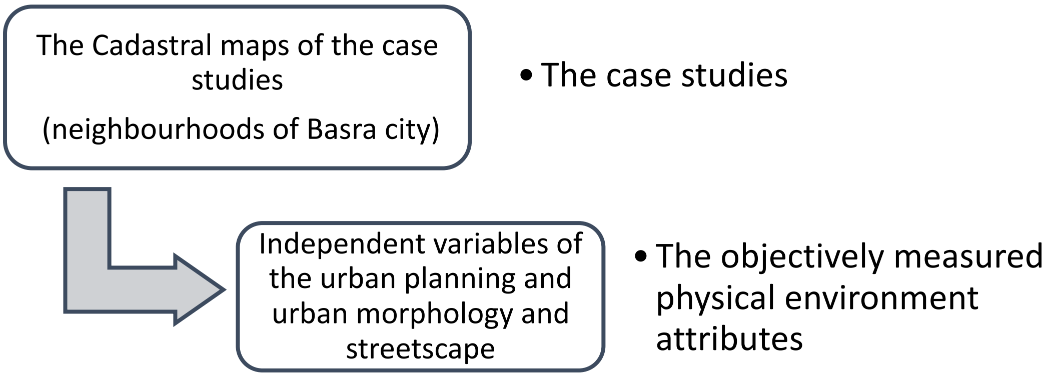


Figure 6-1: Illustration of the objectively measured physical environment attributes: (the author)

6.2 The objective measurement process of the physical environment attributes

Based on the cadastral maps of the three case studies, every physical environment attribute is objectively measured in this chapter. The raw information concerning the essential structure of the case studies is elicited from the cadastral map (Appendix 4, as CD in AutoCAD format), into an Excel sheet, (Appendix 4, as CD in Excel format), with the assistance of AutoCAD Map 3D and QGIS software. Then, every individual indicator is computed based on its defined equation. From this, the independent variables for the objective measure of the physical environment attributes are produced (Table, 6-2). Moreover, they were coded in the SPSS based on their initial letters (Table 6-1).

Table 6-1: The independent variables of objectively measured physical environment

Codes	Content	400x400 -meter	400-m Radius	600-m Radius	total
BlkDnSi	Block density (Built-up area)	x	-	-	1
HosDnSi	Houses density	x	-	-	1
LUDv1Si	Land use diversity of all commercial land uses.	-	x	x	2
LUDv2Si	Land use diversity of the commercial land use without parking, workshops, and wholesale .	-	x	x	2
LUDv3Si	Land use diversity of all the non-residential land uses.	-	x	x	2
NodDnSi	Nodes density per hectare	-	x	x	2
StDnSi	Streets length per hectare	-	x	x	2
LNRSi	Link-node ratio	-	x	x	2
ExtCnS1	External connectivity	-	x	-	1
BlkCoS1	Block compactness	x	-	-	1
PCAS2	Pedestrian catchment area	-	x	-	1
RetSi	Retail destinations (commercial)	-	-	x	1
PRDRSi	Pedestrian route directness ratio (PRDR)	-	-	x	1
ClsCofSi	Clustering coefficient	-	x	x	2
GCBSi	Gini coefficient of betweenness	-	x	-	1
GCSSi	Gini coefficient of straightness	-	x	-	1
SFOMDS2	Quality of edges	-	x	-	3
EnRBS2	Enclosure ratio based on betweenness	-	x	-	3
WkIndS2	Walkability index	-	x	-	1
Total number of independent variables of objective measurement					30

i : stands for the three scales

Table 6-2: The computed variables of objectively measured physical environment

Code		Al-Saymmar (N1)			Al-Mugawlen (N2)			Al-Abassya (N3)		
	Unite	S1*	S2*	S3*	S1	S2	S3	S1	S2	S3
BlkDSi	ratio	.78	.71	.67	.77	.65	.66	.71	.67	.58
HouDnS1	U/hctr	41.87	-	-	25	-	-	17.25	-	-
LUDv1Si	degree	-	.94	.94	-	.70	.75	-	.79	.73
LUDv2Si	degree	-	.98	.97	-	.67	.76	-	.68	.76
LUDv3Si	degree	-	.39	.45	-	.57	.63	-	.52	.63
NoDnSi	no./hctr	-	4.16	3.36	-	2.89	3.33	-	2.03	1.8
StDnSi	L./hctr	-	387	346	-	324	368	-	267	250
LNRSi	ratio	-	2.13	2.13	-	2.17	2.36	-	2.10	2.14
ExCnS1	no./L	1/57	-	-	1/80	-	-	1/100	-	-
BlkComS1	ratio	.43	-	-	.47	-	-	.40	-	-
PCAS2	%	-	61.67	-	-	73.18	-	-	70.4	-
CivBSi	no.	-	6	11	-	6	14	-	6	17
RetSi	no.	-	232	399	-	215	307	-	185	248
PRDRSi	ratio	-	.71	.75	-	.77	.79	-	.72	.76
ClsCofSi	ratio	-	.05	.04	-	.04	.03	-	.05	.04
BetwS2	degree	-	.012	-	-	.009	-	-	.015	-
GnCoBS2	degree	-	.66	-	-	.30	-	-	.69	-
StraiS2	degree	-	.71	-	-	.72	-	-	.78	-
GnCoSS2	degree	-	.08	-	-	.04	-	-	.03	-
SFOMDRS2	Likert	-	21	-	-	27	-	-	30	-
SFOMDGS2	Likert	-	20	-	-	23	-	-	27	-
SFOMDBS2	Likert	-	15	-	-	22	-	-	25	-
EnRRS2	ratio	-	2.9	-	-	2.7	-	-	2.7	-
EnRGS2	ratio	-	1	-	-	1.7	-	-	1.3	-
EnRBS2	ratio	-	1.1	-	-	1.7	-	-	.93	-
WkIndS2	Eq.									

S1: 400x400-meter square shape **S2: 400-meter radius** **S3: 600-meter radius**

Moreover, every measure was multiplied by the three defined scales of the case studies (for more details see section 2.3). For example, the density indicator has three variables for each case study; thus, it was measured three times to produce nine numerical values for three neighbourhoods. The three scales are S1 (400x400 meter), S2 (400-meter radius), and S3 (600-meter radius). Thus, the codes of the three density variables are DnS1, DnS2, and DnS3, respectively; this coding is continued for the rest of the independent variables (Table 6-1). Thirty independent variables were developed in this research, which resulted from the application of the objectively measured physical environment indicators to the case studies.

6.3 Block and housing units Density

To measure the block density based on the cadastral maps, the area of each block was computed by generating a shapefile layer with AutoCAD Map 3D software. The resulting data files were imported into QGIS software and then the required information related to the area of the blocks was computed. The area of the blocks were computed on the three scales (400x400-meters, 400-meters radius and 600-meters radius), and the density equation (Equation 4-2) was applied with the assistance of Excel software.

Although the block density indicator is computed on three scales, the housing unit density is computed on one scale. Thus, **four** independent variables were calculated for the densities, which are labelled as BDnSi $_{i=1,2,\text{ and }3}$, and HDnS1 (Table 6-1). Moreover, the block density is the only indicator that has been measured on the three scales. On the first scale (400x400-meters, or S1), the block density of the three case studies was slightly decreased from Al-Saymmar (.78) to Al-Mugawlen (.77), while it was significantly lower in Al-Abassya (.71). For the block density on the 400-meter radius scale, the highest density was found in Al-Saymmar (.71), while in Al-Mugawlen and Al-Abassya differed slightly from (.65) to (.67), respectively. Furthermore, the block density on the 600-meter radius scale was slightly degraded from Al-Saymmar (.78) to Al-Mugawlen (.77) to Al-Abassya (.72) (Table 6-2). The intensity of housing units (HDnS1) was measured only on scale (400x400-meter) (S1); however, a divergence was noted from Al-Saymmar (41.9) to Al-Mugawlen (25) to Al-Abassya (17.25), in light of the single-family housing per hectare (Table 6-2).

6.4 Mixed land use

The diversity of land use was computed by the entropy equation (Equation 4-3) and the variables used for that purpose were the different land uses measured by the area. The raw information about the land use categories are elicited and moved from the cadastral map (Appendix 4, as CD in AutoCAD format) into an Excel sheet, (Appendix 4, as CD in Excel format), with the assistance of AutoCAD Map 3D and QGIS software. From this, the equation was applied with the assistance of MATLAB software and the categories of land use, for instance, the retail shops and workshops, were entered as a variable of the equation (X1, X2, …. Xi) in the MATLAB format (Appendix 4, as CD in MATLAB format).

Additionally, because the land use categories are not unified across the three case studies, they could have different nature of influence on residents' lives. This research considers different combinations of land uses, or different type-based bundles. The first bundle involved all the commercial land uses, the second bundle involved the retail shops, which are the commercial land use without parking, workshops, and wholesale, and the third bundle included all the non-residential land uses, which are the commercial plus the civic buildings, such as mosques. Moreover, this indicator was applied to two of the scales; 400-meter radius, and 600-meter radius. Thus, **six** independent variables were calculated for the land use diversity, which were labelled as LUDiv1S2, LUDiv1S3, LUDiv2S2, LUDiv2S3, LUDiv3S2, and LUDiv3S3, (Table 6-1). In terms of the commercial land use variable (LUDiv1S2), on a 400-meter radius scale, the degree of diversity demonstrated a significant difference between the Al-Saymmar neighbourhood (.94) and the Al-Mugawlen and Al-Abassya neighbourhoods, (.7, and .79), respectively. Moreover, the same variables, on a 600-meter radius scale, had approximately a similar pattern of variance among the three case studies (.94, .75, and .73), respectively. In terms of the variable for commercial land use without parking, workshops and wholesale (LUDiv2S2), on a 400-meter radius scale the degree of diversity adequately differed between Al-Saymmar (.98) and the other two neighbourhoods, Al-Mugawlen and Al-Abassya, (.67, and .68), respectively. Moreover, the same variable, on a 600-meter radius scale, showed an approximately similar pattern of variance amongst the three case studies; Al-Saymmar brought about a .97 degree of variance, whereas, Al-Mugawlen and Al-Abassya each brought about .76 degree. In terms of the non-residential land use variable (LUDiv3S2), on scale 400-meter radius, the degree of diversity adequately differed between Al-Saymmar (.39) and the other two neighbourhoods (.56, and .52) for Al-Mugawlen and Al-Abassya, respectively. Moreover, the same variable, on a 600-meter radius scale, had approximately shown a similar pattern of variance amongst the three case studies: Al-Saymmar brought about (.45) degree of variance, whereas Al-Mugawlen and Al-Abassya each brought about (.63) degree (Table 6-2). Thus, the land use diversity of Al-Saymmar, as measured by the six variables (Table 6-2), is significantly different from the other two case studies, namely the Al-Mugawlen and Al-Abassya neighbourhoods.

6.5 Streets connectivity

In this research, the cadastral maps involved the streets' centrelines and the nodes layer. The raw information about the streets was elicited from the cadastral maps, whilst the street network layers were used to generate the shapefiles required to run QGIS analysis (Appendix 4, as CD in AutoCAD, and QGIS formats). The QGIS software was used to compute the number of segments, length of each segment, and number of nodes, and these were transferred to an Excel sheet (Appendix 4, as CD in Excel format). Moreover, the streets' segments are represented as polyline between two adjacent nodes, or from a node to a dead-end street. The nodes are either X-intersection or T-intersection types. This procedure is conducted twice, on a 400-meter radius scale and on scale 600-meter radius. In Chapter Four (the analytic framework), four indicators defined the connectivity, namely: node intensity, street intensity, link-node ratio, and external connectivity. Moreover, each indicator was applied to two scales, (400-meter and 600-meter); however, the external connectivity was only applied to the 400-meter radius scale because the 600-meter radius scale did not define neighbourhood boundaries, but instead the walking ranges. Thus, the total number of variables for this indicator is **seven** namely, NodDnSi $_{i=1,\,2}$, StDnSi, LNRSi, ExtConS1 (Table 6-1). Moreover, four equations were used to compute these indicators, and these were: equations 4-5, 4-7, 4-8, and 4-9.

The intensity of nodes (NodDnS2) on the 400-meter radius scale in the Al-Saymmar neighbourhood was (4.16), which is approximately double the number in for both Al-Mugawlen and Al-Abassya (2.89, and 2.03), respectively. Moreover, the node density (NodDnS3) on a 600-meter radius scale showed a decline in the node intensity per hectare, from Al-Saymmar (3.36) to Al-Mugawlen (2.33) to Al-Abassya (1.8), (Table 6-2).

The intensity of street lengths (StDnS2) on a 400-meter radius scale showed a significant reduction in total street lengths, from 387 meters/hectare for Al-Saymmar to 324 meters/hectare for Al-Mugawlen and 267 meters/hectare for Al-Abassya. However, the intensity of street lengths (StDnS3) on a 600-meter radius scale was the highest in Al-Mugawlen 368 at meters/hectare, whilst Al-Saymmar was slightly lower at 346 meters/hectare, and Al-Abassya illustrated the lowest street density in terms of length at 250 meters/hectare (Table 6-2). The link-node ratio (LNRS2) on a 400-meter radius scale, showed a slight decrease from (2.17 link/node) for Al-Mugawlen, to (2.13 link/node) for Al-Saymmar, and (2.1 link/node) for Al-Abassya neighbourhood. Moreover, in a different order, a similar ratio reduction was noted on a 600-meter radius scale through the three case studies, 2.36, 2.14, and 2.13 and their links per node of Al-Mugawlen, Al-Abassya, and Al-Saymmar, respectively, (Table 6-2). The external connectivity (ExtConS1) on a 400-meter radius scale demonstrated an adequate reduction in the number of entrances per mile length, whilst the Al-Saymmar neighbourhood showed the highest score with 28.1 entrance/mile, and the Al-Mugawlen neighbourhood showed a moderate score at 20 entrance/mile; meanwhile, the lowest score was in the Al-Abassya neighbourhood at 16 entrance/mile (Table 6-2).

6.5.1 Block compactness

Based on the cadastral maps, the sampled urban tissue of the 400x400-meter scale was used to compute the total area and the longest diameter of each sampled block. With the assistance of the AutoCAD software, the longest diameter of each block was used to draw a circle to accommodate the block. As a hypothetical reference, this circle represents the optimum compacted geometric form that gives the shortest elevation for a certain amount of area (Figure 6-2). The ratio of the real block area to the circle area (which have identical diameters) indicates how well the block structure benefited from the total available area. Moreover, this procedure was conducted with every block of each case study (Table 6-3) on the 400x400-meter scale. From this, the blocks' compactness scores were averaged to find an average value of block compactness for each case study. Thereby, **one** independent variable was computed according to the blocks' compactness indicator (BlkComS1) (Table 6-1). The average block compactness across the three neighbourhoods (BCS1) on the 400x400-meter scale was slightly different across the three case studies. In this regard, Al-Mugawlen illustrated the highest average ratio of compactness (.47); Al-Saymmar showed a moderate averaged ratio of compactness (.43), and Al-Abassya showed the lowest averaged ratio of compactness (.4) (Table 6-2).

(S1) 400X400-METER RADIUS

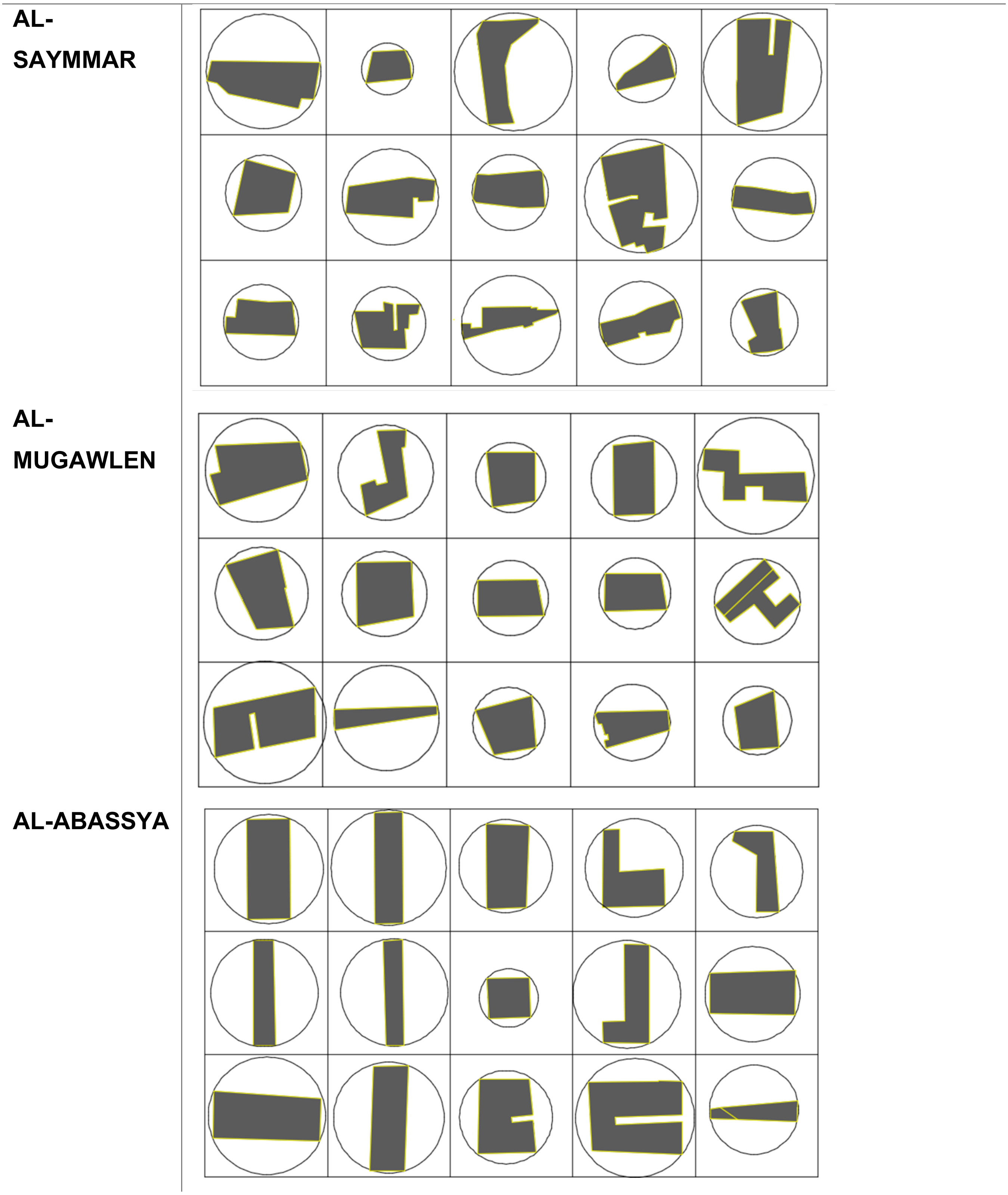


Figure 6-2: Block compactness analysis method illustration: (The author)

Table 6-3: Block compactness analysis of the three case studies

	Al-Saymmar			Al-Mugawlen			Al-Abassya		
	(S1) 400x400-meter								
Areas m²	Circle	Real	Ratio	Circle	Real	Ratio	Circle	Real	Ratio
Block 1	8950	3425	0.38	10671	5580	0.52	10887	5062	0.46
Block 2	1812	1044	0.58	8606	4290	0.50	3140	1958	0.62
Block 3	9434	2791	0.30	14971	6153	0.41	21460	5233	0.24
Block 4	3107	1160	0.37	9052	2864	0.32	21575	4581	0.21
Block 5	22344	9873	0.44	7270	4304	0.59	12127	3666	0.30
Block 6	3936	2237	0.57	11143	1964	0.18	25980	8300	0.32
Block 7	6264	2346	0.37	4878	3035	0.62	15670	6060	0.39
Block 8	3932	1983	0.50	5659	2933	0.52	8260	4284	0.52
Block 9	8715	4502	0.52	5217	3173	0.61	29900	8960	0.30
Block 10	4748	1493	0.31	7305	3802	0.52	7929	4566	0.58
Block 11	3840	1859	0.48	5126	2833	0.55	19965	7577	0.38
Block 12	3681	1781	0.48	5823	2481	0.43	7267	1550	0.21
Block 13	13634	2735	0.20	21190	5783	0.27	7972	4948	0.62
Block 14	4675	1656	0.35	7365	3100	0.42	21730	7891	0.36
Block 15	3056	1564	0.51	4738	2576	0.54	12602	5580	0.44
Sum.			6.38			7.00			5.97
Average			**0.43**			**0.47**			**0.40**

6.6 Pedestrian Catchment Area (PCA)

The cadastral maps were used to apply the PCA indicator. The centre of each case study is the centre of the 400-meter radius, as sampled in the cadastral maps. Every single block was considered a destination that needs to be accessed from the centre of the neighbourhood within 10 minutes of walk along the street network. The required information was elicited from the cadastral maps with the assistance of AutoCAD 3D map software. In this regard, the shapefile maps were generated to create the blocks, block centroids, and street networks on a 400-meter radius scale. From this, the three layers were added to the QGIS software. The QGIS Road-Graph tool was utilised to measure the shortest network distance between two spatial points, which are the centre of the case study and each individual block falls within the 400-meter radius, as illustrated in the figures 6-14, 6-15, and 6-16. After the adjustment of the human speed to 5 kilometers per hour, only the blocks within a 10-minute walk were considered in determining the total accessible area in each neighbourhood, (Browning, Baker, Herron, & Kram, 2006). Thus, the accessible blocks in ≤10 minutes were added up, and the resulting total accessible block area was represented as percentage area out of the total block area within a 400-meter radius. Thus, only **one** independent variable was noted in applying this indicator, PCAS2, (Table 6-1).

The PCA variable illustrates that, in the Al-Saymmar neighbourhood, out of 356,135 square meters of built-up area, there was 219,635 square meters of accessible area in 10-minutes of network walking within the 400-meter radius area; this is 61.67% of the total built-up area (Figure 6-3). In the Al-Mugawlen neighbourhood, out of 326,500 square meters of built-up area, there was 219,635 square meters of accessible area in 10-minutes of network walking within a 400-meter radius area; this is 73.18% of the total built-up area (Figure 6-4). In Al-Abassya neighbourhood, out of 333,600 square meters of built-up area, there was 2235,600 square meters of accessible area in a 10-minute network walk within the 400-meter radius area; this is 70.4% of the total built-up area (Figure 6-4), (Table 6-2).

Al-Saymmar

(S2) 400-meter radius

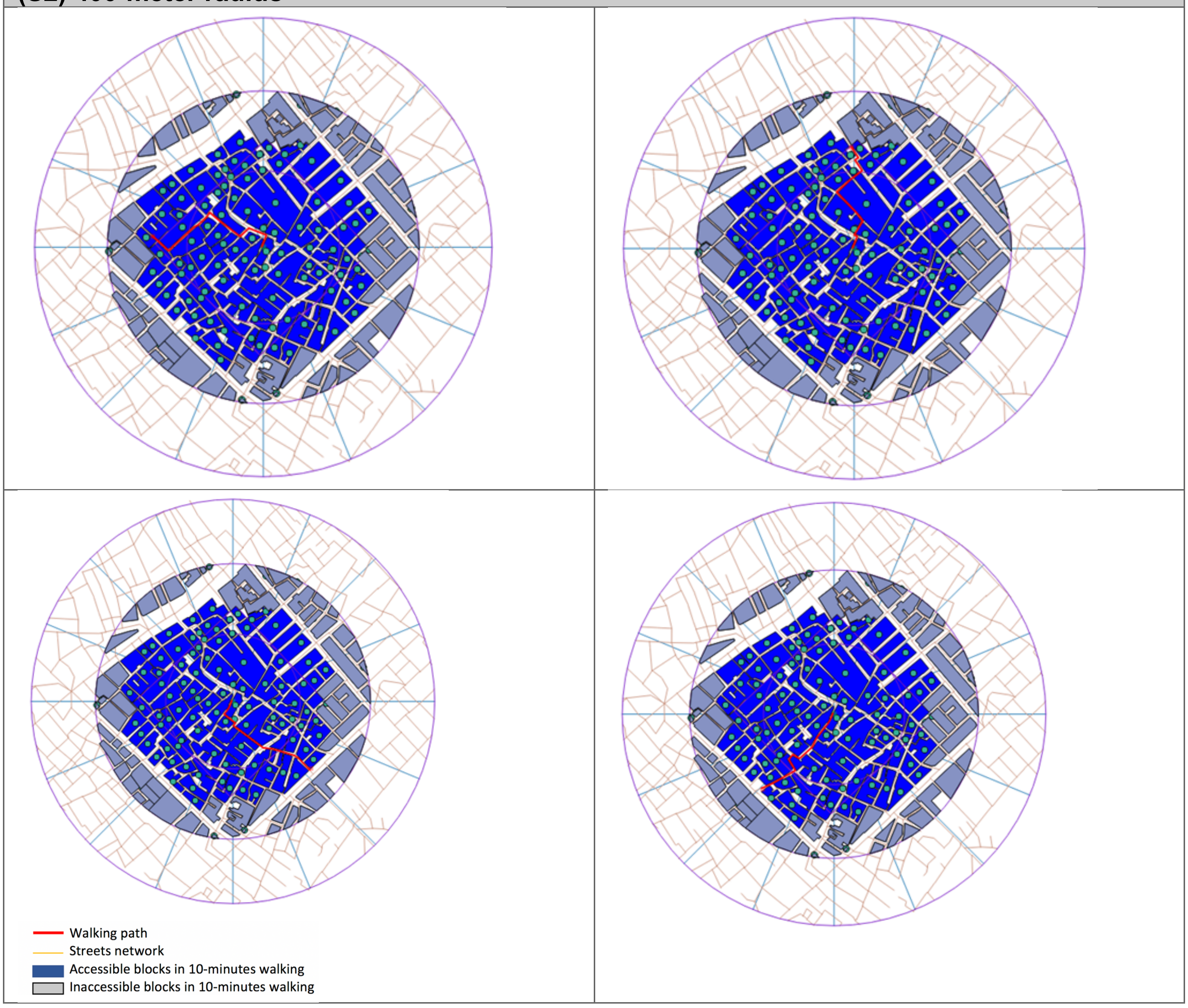


Figure 6-3: QGIS maps illustrate accessible blocks in 10 minute network distance Al-Saymmar neighbourhood: (The author)

Al-Mugawlen

(S2) 400-meter radius

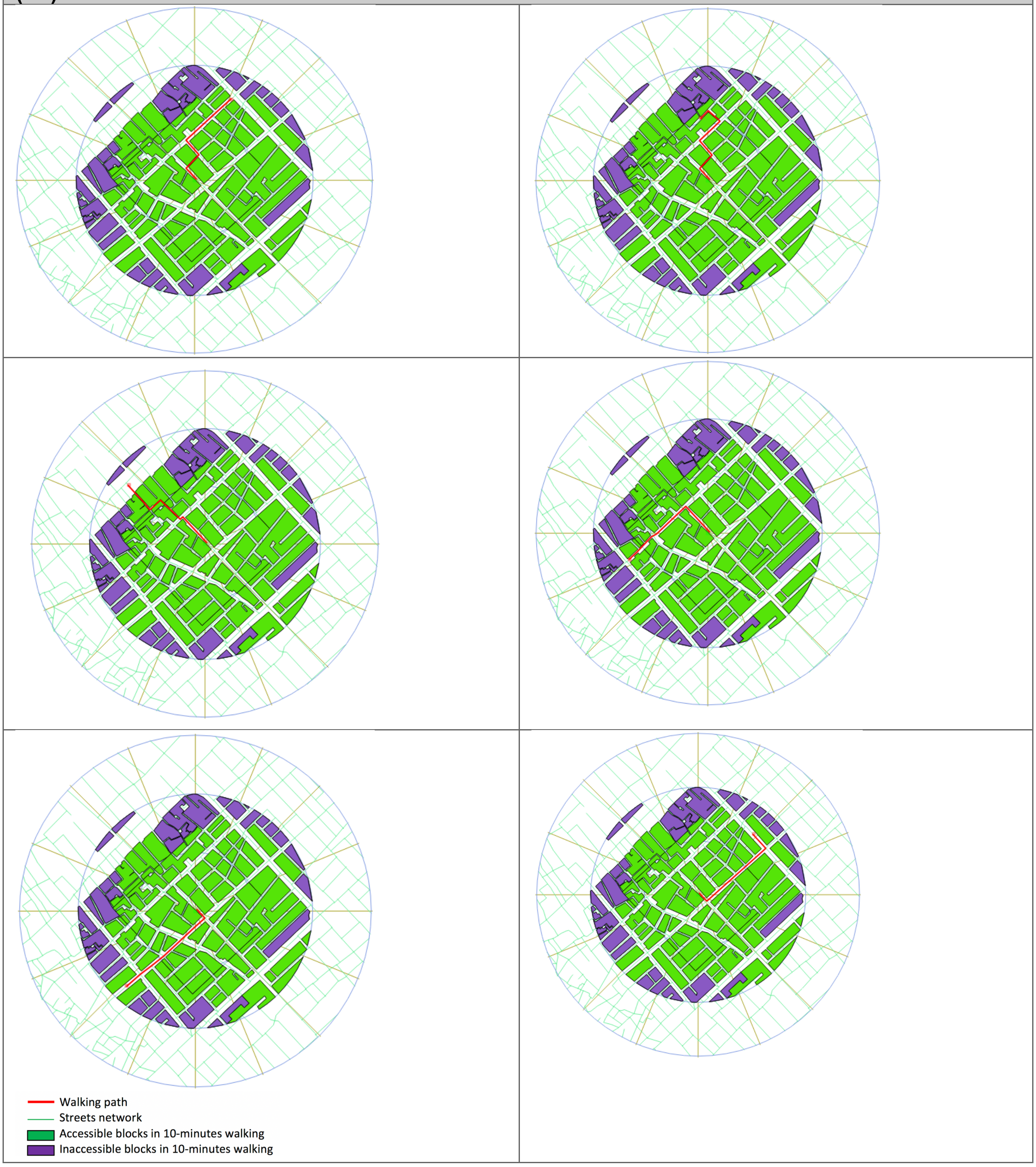


Figure 6-4: QGIS maps illustrate accessible blocks in 10 minute network distance Al-Mugawleen neighbourhood: (The author)

Al-Abassya

(S2) 400-meter radius

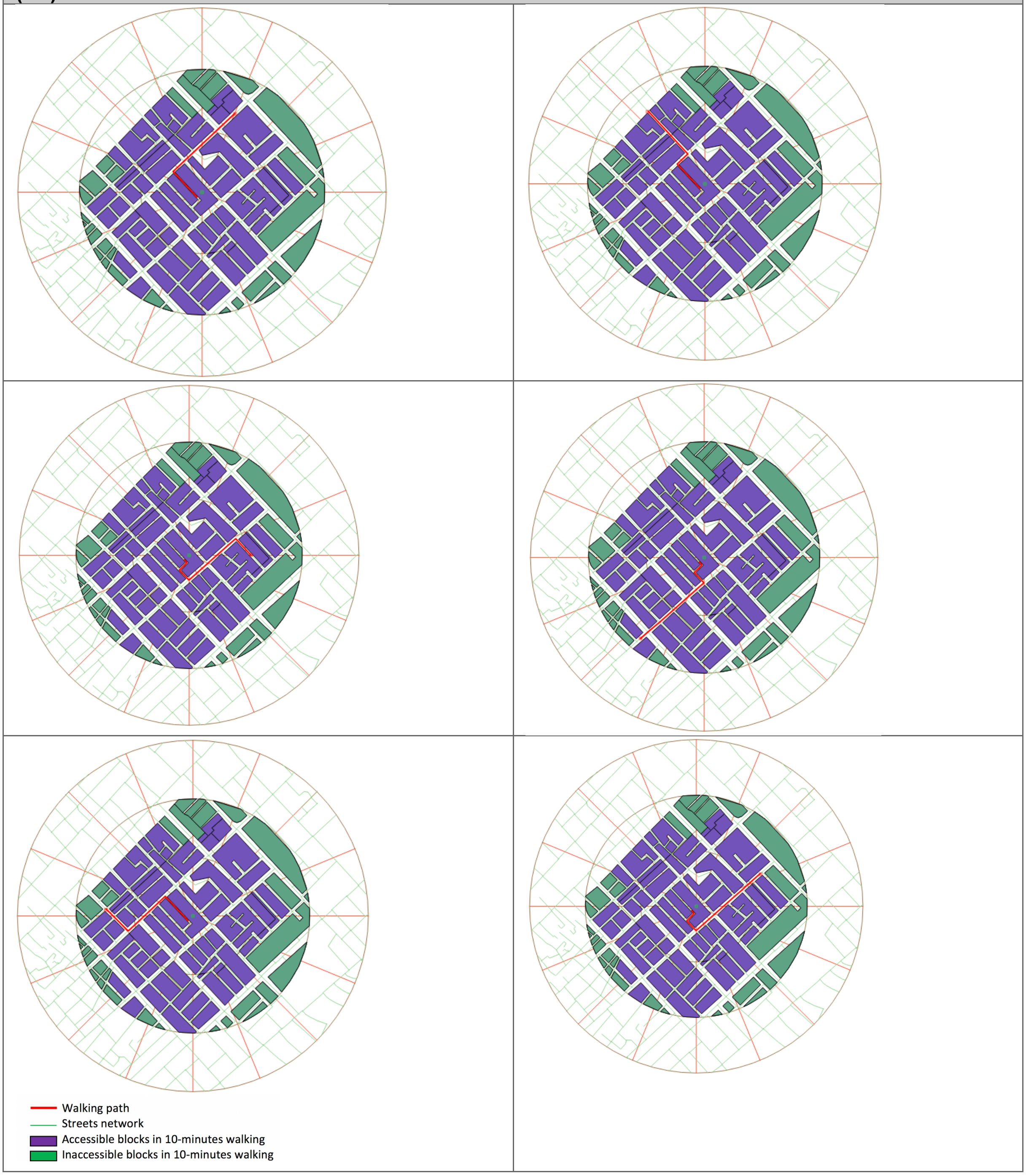


Figure 6-5: QGIS maps illustrate accessible blocks in 10 minute network distance Al-Abassya neighbourhood: (The author)

6.7 The number of destinations

Although the destinations were principally considered in terms of their mixed land use, the number of destinations is an influential factor because the increase in number of destinations means increasing the opportunities for services. The commercial destinations can be classed into one of seven types; namely, food shops, consumer goods, general services, wholesale, workshops, offices, and parking. The retail type, namely, food shops, consumer goods, and general services, generate two variables in this research (RetS2 and RetS3), (Table 6-1). The number of the retailers within the commercial destination variable (RetS2) on a 400-meter radius demonstrated that the Al-Saymmar neighbourhood has the highest amount of retail (232); in Al-Mugawlen, there was a modest amount of retailers (215), and in Al-Abassya there was the lowest amount of retailers (185). Moreover, the number of retailers on a 600-meter radius scale (RetS3), showed a similar hierarchy to the 400-meter radius scale, namely 399, 307, and 248 retailers for Al-Saymmar, Al-Mugawlen, and Al-Abassya, respectively (Table 6-2).

6.8 Pedestrian route directness ratio (PRDR)

The cadastral maps were used to apply the PRDR indicator. The centre of each case study is the centre of the 400-meter radius, as sampled in the cadastral maps. The retailers are those that inhabitants want to access from the centre of the neighbourhood in 10 minutes of walk along street networks. The required information was elicited from the cadastral maps with the assistance of the AutoCAD 3D map software. In this regard, the shapefile maps were generated to create the blocks, blocks centroids, and streets networks on the 400-meter radius and the 600-meter scale. From this, the three layers were added to the QGIS software. The QGIS Road-Graph tool was utilised to measure the shortest network distance between two spatial points, which are the centre of the case study and each individual retailer within the 400-meter radius and the 600-meter radius (Figures 6-7). Moreover, because the indicator concerns how well the street network is connected between the destinations and residents' houses, this research designed an approach to test the PRDR for 16 destinations within each case study on each scale. The approach divided the circles of the two scales into 16 sectors (Figures 6-7) then the intersection point of the radiuses with the circles (for the 400-meter and the 600-meter radiuses) are defined; from this, the nearest destination to those points are considered to compute the indicator (Table 6-4). Thus, **two** independent variables were addressed by the PRDR, which were labelled: PRDRS2, PRDRS3 (Table 6-1).

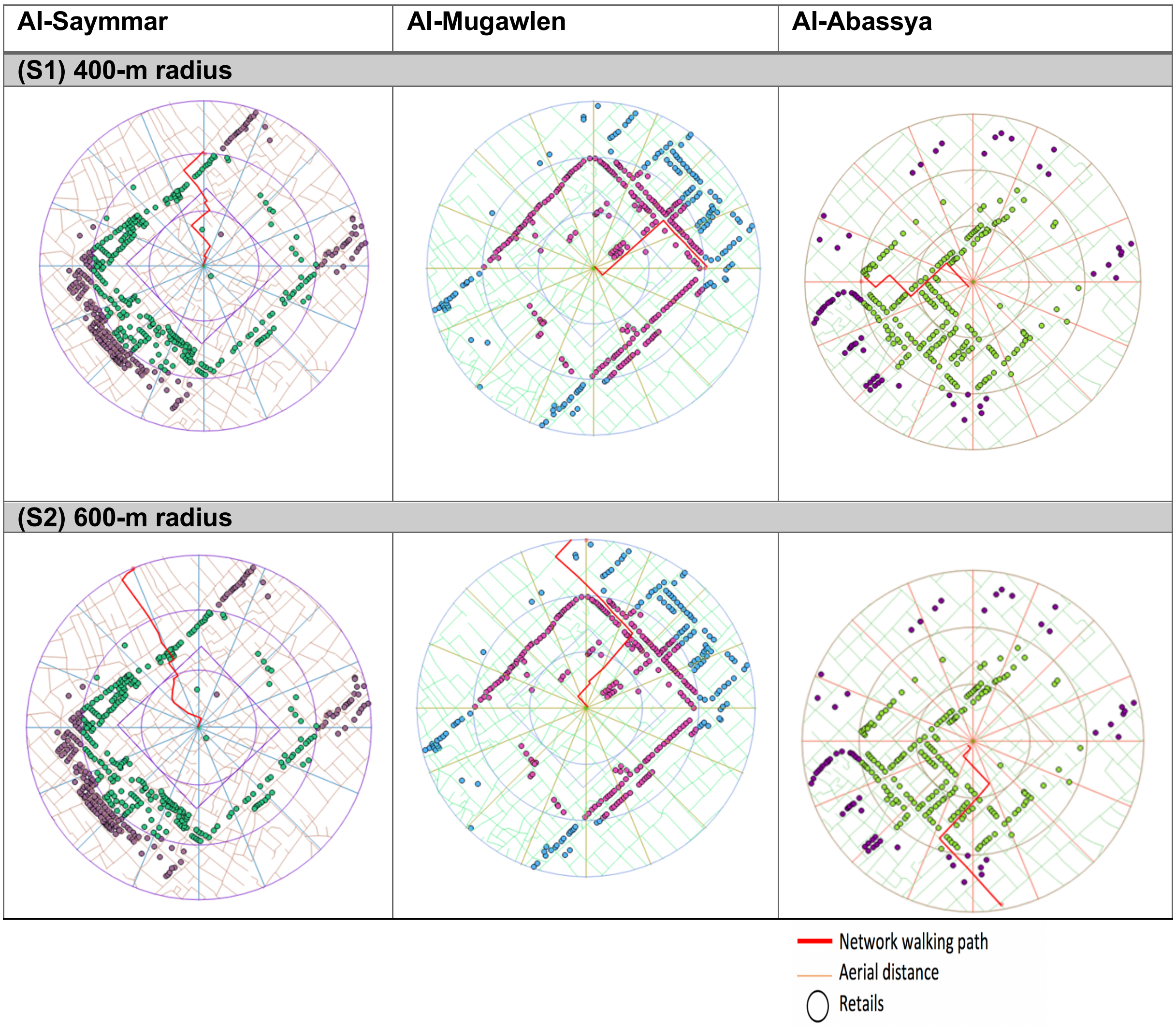


Figure 6-6: QGIS maps illustrate the PRDR of the three neighbourhood: (The author)

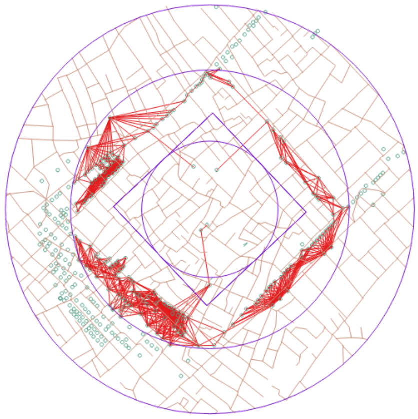
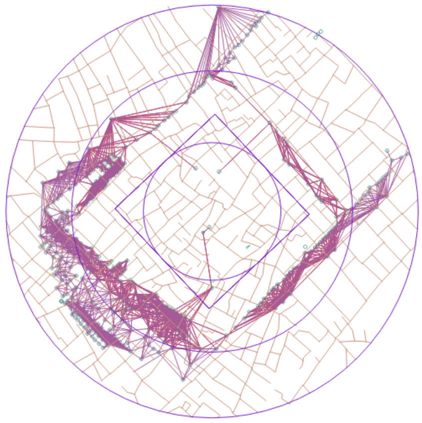
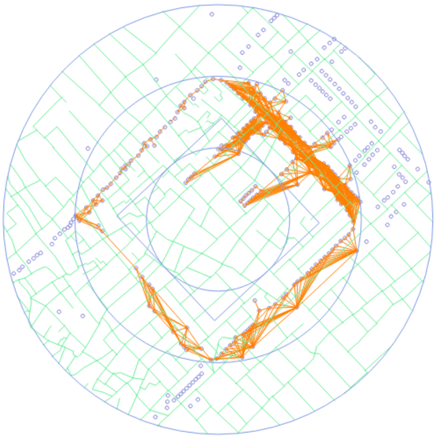
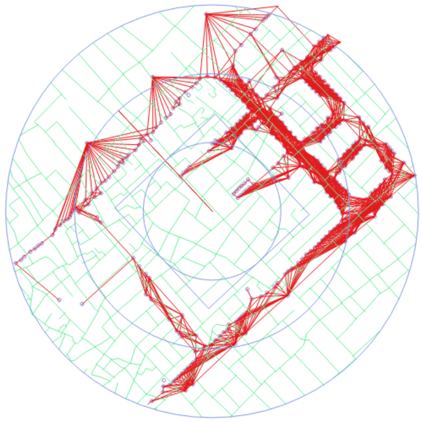
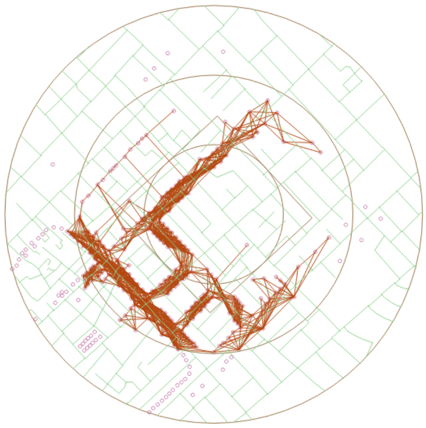
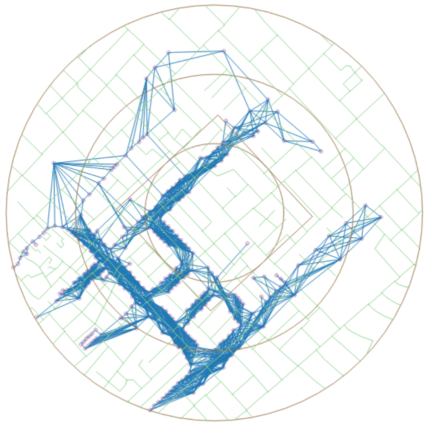
Then, the specified PRDR equation (equation 4-12) was utilised to compute the indicators, which must be ≤1. A value of 1 represents an optimum relationship that has identical aerial and real distances; whereas, the smaller ratio illustrates that the real route is longer than the aerial distance. In other words, the street network route distance between the two points relates the user's departure station to the location of a contextual destination; thus, the shorter distance indicates the more accessible destination. The PRDR for the 16 destinations of each case study were averaged to determine how well the destinations of each case study are served by the street network. The PRDRS2 on the 400-meter radius scale slightly differed among the three neighbourhoods, at .73, .77, and .72 for Al-Saymmar, Al-Mugawlen, and Al-Abassya neighbourhoods, respectively. Also, it illustrated similar differences for the 600-meter radius scale, at .76, .79, and .76 for Al-Saymmar, Al-Mugawlen, and Al-Abassya neighbourhoods, respectively (Table 6-2, and 6-4).

Table 6-4: PRDR of the three neighbourhoods

	Al-Saymmar			Al-Mugawlen			Al-Abassya		
	S1) 400-m radius								
	Euclidian Dist.	Real D.	Ratio	Euclidian D.	Real D	ratio	Euclidian D	Real	Ratio
sector 1	400	545.7	0.73	400	540	0.74	400	666	0.60
sector 2	400	470.23	0.85	400	524	0.76	400	560	0.71
sector 3	400	507	0.79	400	493	0.81	400	463.7	0.86
sector 4	400	611	0.65	400	546.2	0.73	400	508.4	0.79
sector 5	400	571.6	0.70	400	546.3	0.73	400	526	0.76
sector 6	400	553	0.72	400	535.4	0.75	400	517.1	0.77
sector 7	400	465.5	0.86	400	463	0.86	400	503.4	0.79
sector 8	400	630.7	0.63	400	560.7	0.71	400	515.6	0.78
sector 9	400	556	0.72	400	576.5	0.69	400	521.4	0.77
sector 10	400	557	0.72	400	526.3	0.76	400	496.4	0.81
sector 11	400	489.6	0.82	400	414.3	0.97	400	528.6	0.76
sector 12	400	531.6	0.75	400	522.2	0.77	400	602	0.66
sector 13	400	547.1	0.73	400	572.3	0.70	400	694.3	0.58
sector 14	400	612	0.65	400	522.3	0.77	400	633.5	0.63
sector 15	400	502	0.80	400	498	0.80	400	661.6	0.60
sector 16	400	661.5	0.60	400	507.4	0.79	400	577	0.69
sum		8811.53	11.7		8348	12.4		8975	11.6
AV of the Coefficient			0.73			0.77			0.72
	(S2) 600-m radius								
sector 1	600	812.3	0.74	600	834.7	0.72	600	861	0.70
sector 2	600	728.8	0.82	600	762	0.79	600	770	0.78
sector 3	600	724.7	0.83	600	692	0.87	600	723	0.83
sector 4	600	769	0.78	600	802	0.75	600	783	0.77
sector 5	600	872	0.69	600	863	0.70	600	785	0.76
sector 6	600	789	0.76	600	807.5	0.74	600	744	0.81
sector 7	600	675	0.89	600	711.2	0.84	600	654	0.92
sector 8	600	770	0.78	600	791	0.76	600	779	0.77
sector 9	600	882	0.68	600	817	0.73	600	825	0.73
sector 10	600	847.5	0.71	600	786	0.76	600	785	0.76
sector 11	600	823	0.73	600	607	0.99	600	770	0.78
sector 12	600	825	0.73	600	755.3	0.79	600	883	0.68
sector 13	600	785	0.76	600	833	0.72	600	954	0.63
sector 14	600	728	0.82	600	743	0.81	600	808.4	0.74
sector 15	600	802	0.75	600	721.2	0.83	600	853	0.70
sector 16	600	812.2	0.74	600	755	0.79	600	771	0.78
sum		12645.5	12.2		12281	12.6		12748.4	12.13
AV of the Coefficient			0.76			0.79			0.76

6.9 Clustering coefficient

The clustering coefficient indicator of the physical environment is about how well a group of destinations are spatially combined in bundles. It is measured by applying the equation of the clustering (equation 4-13), and the major two components to run the equation are the observed number of links among the destinations and the possible number of links. However, there was no a clear explanation about how to measure these two components in the reviewed literature; therefore, the criteria to measure these two components are designed by this research. In this regard, the first component of this equation is the observed links between destinations. It considered five minutes as the maximum walking distance between two destinations, which is a 200-meter length. Thus, each destination has a potential relationship with all other destination in the 200-meter radius. The reason for such an assumption is because, if the distance between every two destinations is not a complete journey for the walker but rather a sub-journey, then the minimum distances mean a better relationship. Based on this criterion, each destination was defined as a centre and a straight line was drawn to all other adjacent destinations in the 200-meter radius. The required information was elicited from the cadastral maps with the assistance of AutoCAD 3D map software; in this regard, the shapefile maps were generated to both the links and the destinations on the 400-meter radius and 600-meter radius scales. From this, the layers were added into QGIS software (Figure 6-7). The resulting total number of links was considered the observed links (Numerator). The second component is the possible number of links, even if they did not exist, between the destinations; for this purpose, the equation used was: the number of possible links = $(n^2-n)/2$ (denominator), from the original equation (4-13), where n is the total number of destinations. Thus, **two** independent variables resulted from this indicator, on the 400-meter radius and 600-meter radius scales. The two variables were labelled as ClsCofS2, ClsCofS3 (Table 6-1). Thereafter, on the 400-meter radius scale, the clustering coefficient variable,CICS2 , indicated that the Al-Saymmar and Al-Abassya neighbourhoods were identical, at .05 for each. Meanwhile, Al-Mugawlen was slightly different at .04. Moreover, on the 600-meter radius scale, the clustering coefficient variable CICS3, indicated that the Al-Saymmar and Al-Abassya neighbourhoods are identical at .04 for each. Finally, Al-Mugawlen was slightly different at .03 (Table 6-2).

	(S2) 400-meter radius	(S3) 600-meter radius
Al-Saymmar		
Al-Mgawlen		
Al-Abassya		

Hypothetical <200-meter like between two destinations

Figure 6-7: QGIS maps illustrate the clustering of destinations of the three neighbourhoods: (The author)

6.10 Centrality measures (Betweenness and straightness)

The cadastral maps were used to generate the centreline map for the required streets; this was achieved by using AutoCAD map 3D, which, as previously stated, must be in shapefile format (.shp). Each street segment is a polyline that connects between two intersections, with either an X-type or Y-type, or a dead end. Using the same criteria, this street network covers the sampled areas plus a buffer of 1-kilometer. The street network map is a crucial requirement when running the centrality analysis using the Multi Centrality Assessment (MCA) software tool. This was used to run the centrality analysis of the generated street networks for the three case studies. Using the software is a straightforward process, which does not need any further adjustment than those prepared in advance by the founder of the software.

The first step was to transfer the maps into the software by generating a network for each street network map. This was because the shapefile AutoCAD drawings were not yet classed as networks, and thus the specified spatial reference system of the maps in question required definition. Moreover, the maps on AutoCAD were geographically referenced with the coding for the World Geographic System 1984 (UTM84-38S). Thus, the imported maps are spatially defined. Three analyses were run: closeness, 'betweenness', and straightness. The closeness centrality did not demonstrate enough of a degree of differentiation among the segments with the neighbourhood scale. Therefore, this measure was not adopted by the research. However, applying the betweenness and straightness analyses visually differentiated the segment of the networks into several categories. The MCA provides the flexibility to define the number of categories. Although the standard street hierarchy of Basra city is based on five categories that include: arterial, collector, local, and cul-de-sac (Basra City Master Plan, 1985), in this research the output categories were determined in five categories as an appropriate range of street differentiations, which is convenient for the neighbourhood scale plus the bounded arterial streets. The visual hierarchy of streets in the maps support such a claim; the arterial streets represent the coarse scale; and these surround the case studies and permeate through the urban tissue. Meanwhile, the finest scale is represented by the cul-de-sacs, and, three intermediate categories fall between those two limits; namely, collector streets (the streets which collect the movement from the fine scale streets into the arterial streets); the local streets (permeable streets between two nodes with limited vehicle activity besides the pedestrians), and local avenues (permeable walking pathways).

Although three centrality measures variables are expected after accounting for the two scales, only two variables were embraced in this research because the closeness of the centrality indicator did not show significant differentiation between the segments of the streets networks. These two variables are related to the 'betweenness' and 'straightness' centrality measures. Moreover, because these two measures are a street segment level of measurement while this research is at a neighbourhood level of study, this study cannot use them directly. Therefore, the Gini coefficient was applied to the betweenness and straightness centrality measures to define what they mean for the neighbourhood scale and to serve the comparative purpose of different case studies. Thus, **two** independent variables have resulted from this indicator, one from each measure, namely: the Gini coefficient of betweenness (400-meter radius), and the Gini coefficient of straightness (400-meter radius) GinCoBS2, and GinCoSS2, respectively (Table 6-1). In this regard, Porta et al. (2008) used the Gini coefficient for inequality to measure the degree of resource distribution among the components of the street networks or segments.

6.10.1 Betweenness measure

Based on the output of running the centrality analyses by the MCA, the degree of betweenness of the street segments was sorted into five categories in each neighbourhood, where each category represents a certain interval of betweenness. The betweenness scores for the five categories of Al-Saymmar neighbourhood are blue (.000-.001), grey (.001-.003), green (.003-.008), orange (.008-.018), and red (.018-.104) (Figure 6-8). The betweenness scores for the five categories of Al-Mugawlen neighbourhood are blue (.000-.001), grey (.001-.003), green (.003-.008), orange (.008-.018), and red (.018-.117); the only difference in this neighbourhood is in the red category (Figure 6-9). The betweenness scores for the five categories of Al-Abassya neighbourhood are blue (.000-.001), grey (.001-.003), green (.003-.008), orange (.008-.021), and red (.021-.13). Only the orange and red categories slightly differ from the other two neighbourhoods (Figure 6-10).

A visual inspection of the three neighbourhoods and their betweenness analysis output maps suggest that the betweenness degree of the streets segments broadly aligns with the principle categorisations of the streets. The arterial street segments mostly were shaded in red, while the cul-de-sacs and local avenues were often shaded in blue. The majority of the collector streets segments are shaded in orange and red. However, limited segments of collector streets were shaded in grey and green, (Figures 6-8, 6-9, and 6-10). Moreover, local and avenue streets were confusing because they could be confined to limited categories appropriate to their hierarchical level. In this regard, a visual inspection indicates that these two categories of street were involved all the degrees of betweenness intervals; namely, red, orange, green, grey, and blue. Moreover, in some positions, they disturb the continuity of groups of commensurate collector/arterial street segments, which are red and orange, and then, suddenly, decreases into green, grey, and even blue levels of betweenness, whilst the adjacent local street segment increases to red or orange. This paradox between the postulated hierarchical design of streets and the betweenness levels of some streets segments suggest potential clues impede the conventional street networks; however, the issue is out of the scope of this research. The variable related to the betweenness degree is the Gini coefficient (GinCoBS2), on a 400-meter radius scale. Its highest score was for Al-Mugawlen neighbourhood (.3), which means that the best distribution of betweenness degrees is in this area. However, far more unequal degrees of betweenness were demonstrated with Al-Saymmar and Al-Abassya neighbourhoods (.66, and .69 respectively) (Table 6-2).

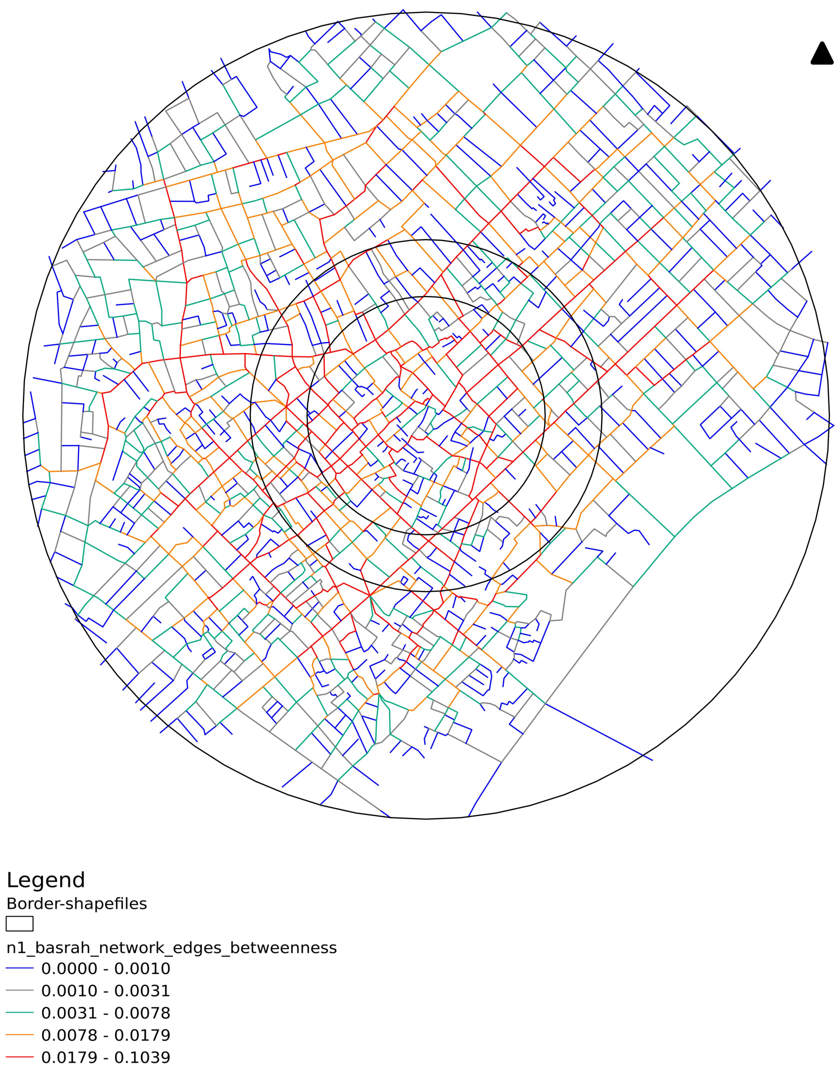


Figure 6-8: MCA illustration of the betweenness analysis of the streets network of Al-Saymmar: (the author)

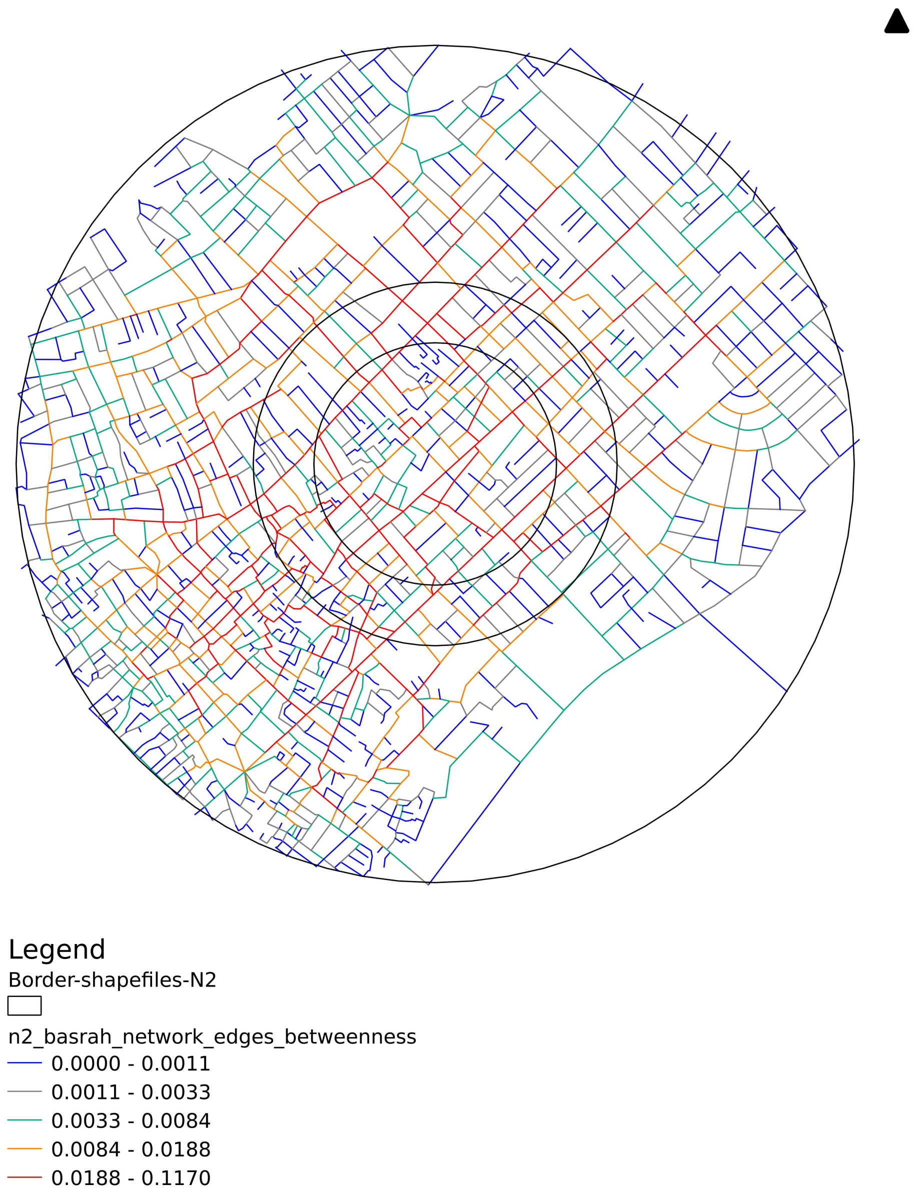


Figure 6-9: MCA illustration of the betweenness analysis of the streets network of Al-Mugawleen: (the author)

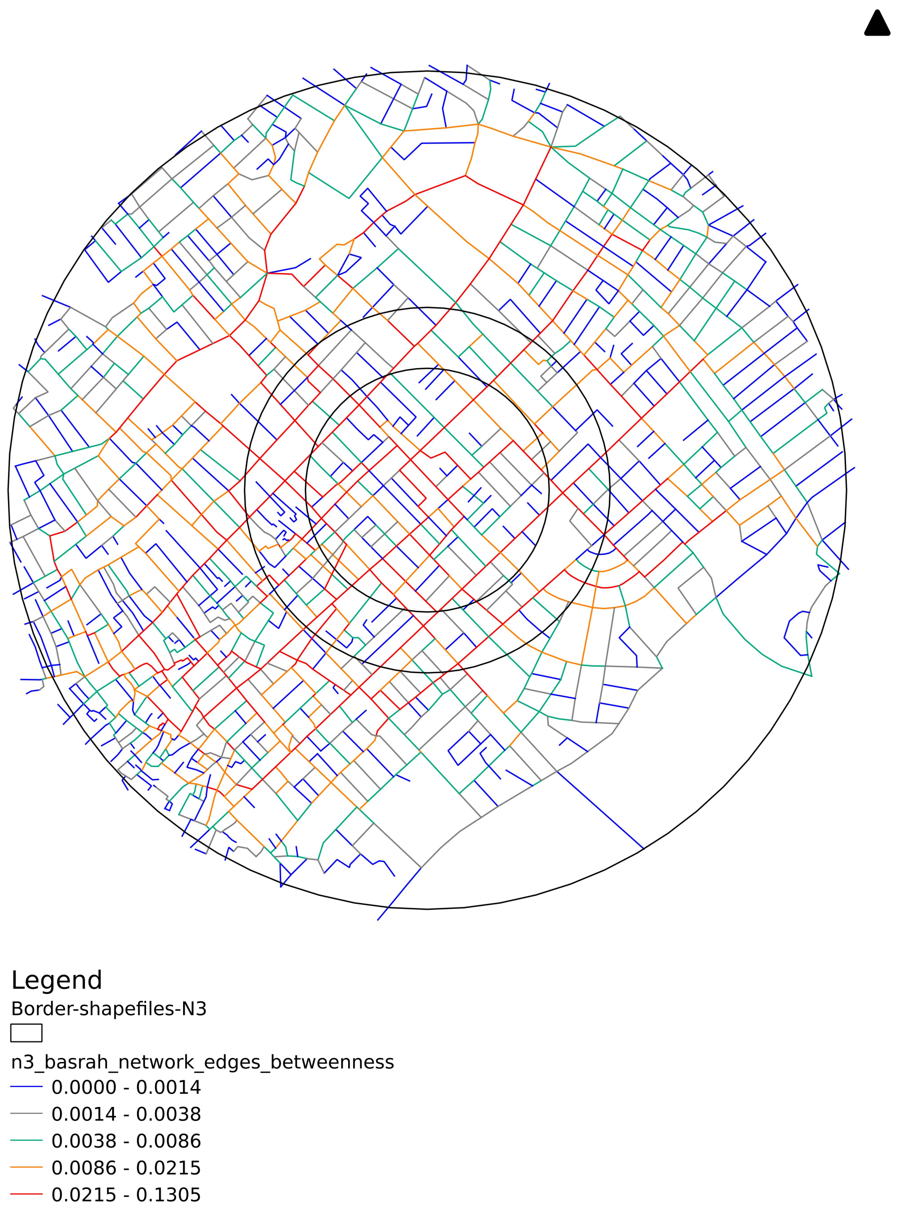


Figure 6-10: MCA illustration of the betweenness analysis of the streets network of Al-Abassya: (the author)

6.11 Straightness Analysis

Based on the output from the MCA centrality analyses, the degree of street segment straightness was sorted into five categories for each case study, and each category illustrates a certain interval of straightness. Moreover, the five categories across the case studies have approximately similar intervals regarding the degree of straightness; namely, blue (.59-.77), grey (.77-.78), green (.78-.79), orange (.79-.8), and red (.8-1). A visual inspection of the straightness analysis output maps suggests that the more straight and longitudinally-aligned street segments have the highest degree of straightness. In this respect, the arterial and collector streets have higher scores of straightness and straight-aligned street segments; thus, they were coloured with red and orange. In terms of the straightness degree with the Gini coefficient variable (GinCoSS2) on a 400-meter radius scale, its highest score was within Al-Saymmar neighbourhood (.08) (Figure 6-11). Its moderate score was within Al-Mugawlen neighbourhood (.04) (Figure 6-12); and its low score was within Al-Abassya neighbourhood's street network (.03) (Figure 6-13). The inequity of the straightness distribution is demonstrated in Al-Saymmar neighbourhood's self-organised street network typology; whereas, the Al-Mugawlen and Al-Abassya neighbourhoods showed a lower score of inequity. In other words, the straightness resources were equally distributed in the grid-like streets networks and far less equally distributed in self-organised street networks.

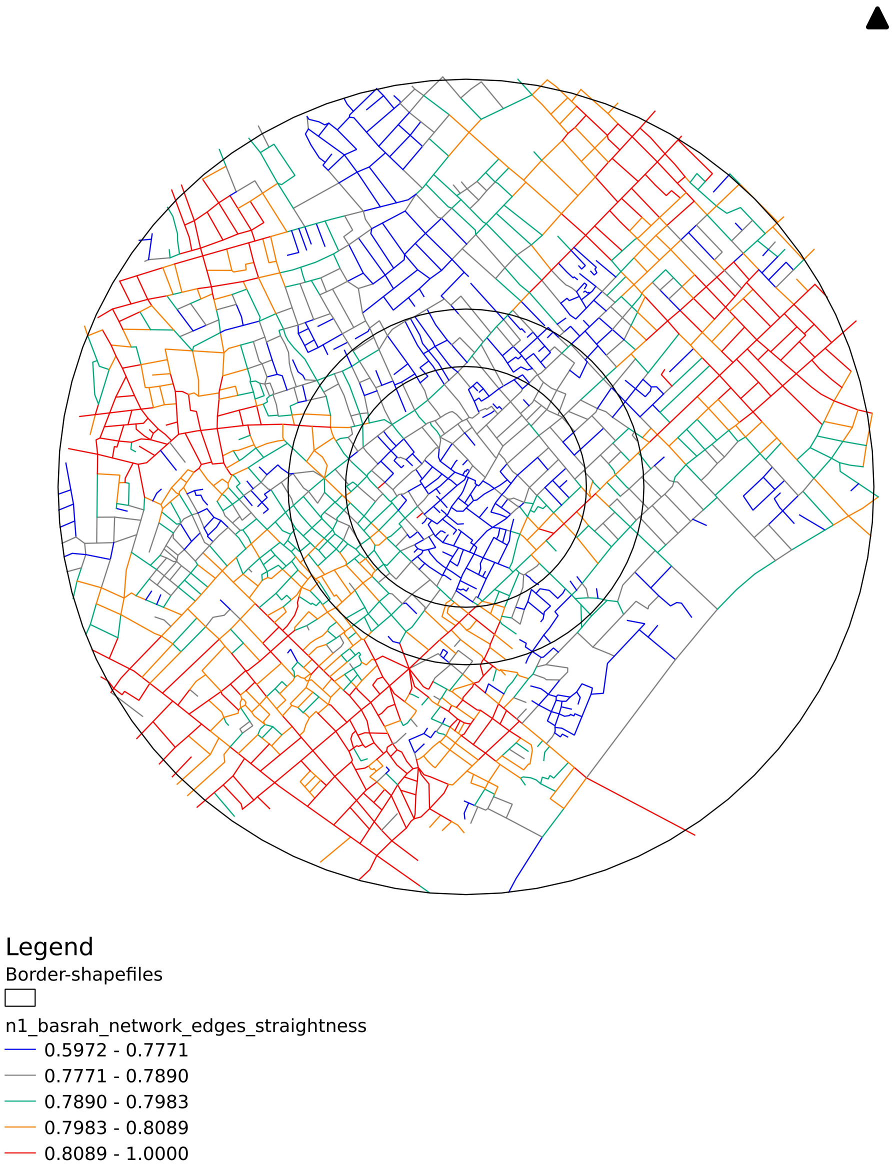


Figure 6-11: MCA illustration of the straightness analysis of the streets network of Al-Saymmar: (the author)

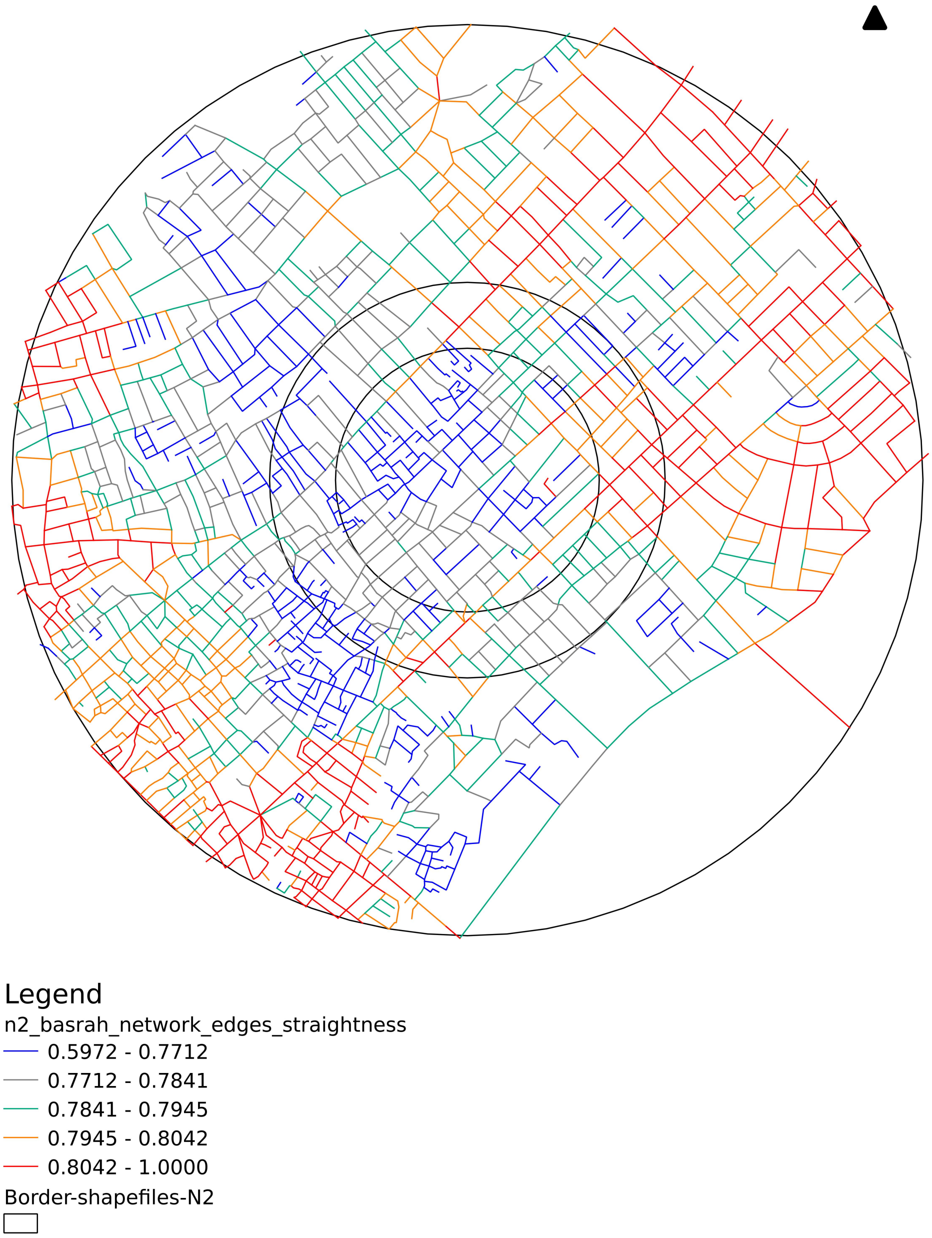


Figure 6-12: MCA illustration of the straightness analysis of the streets network of Al-Mugawleen: (the author)

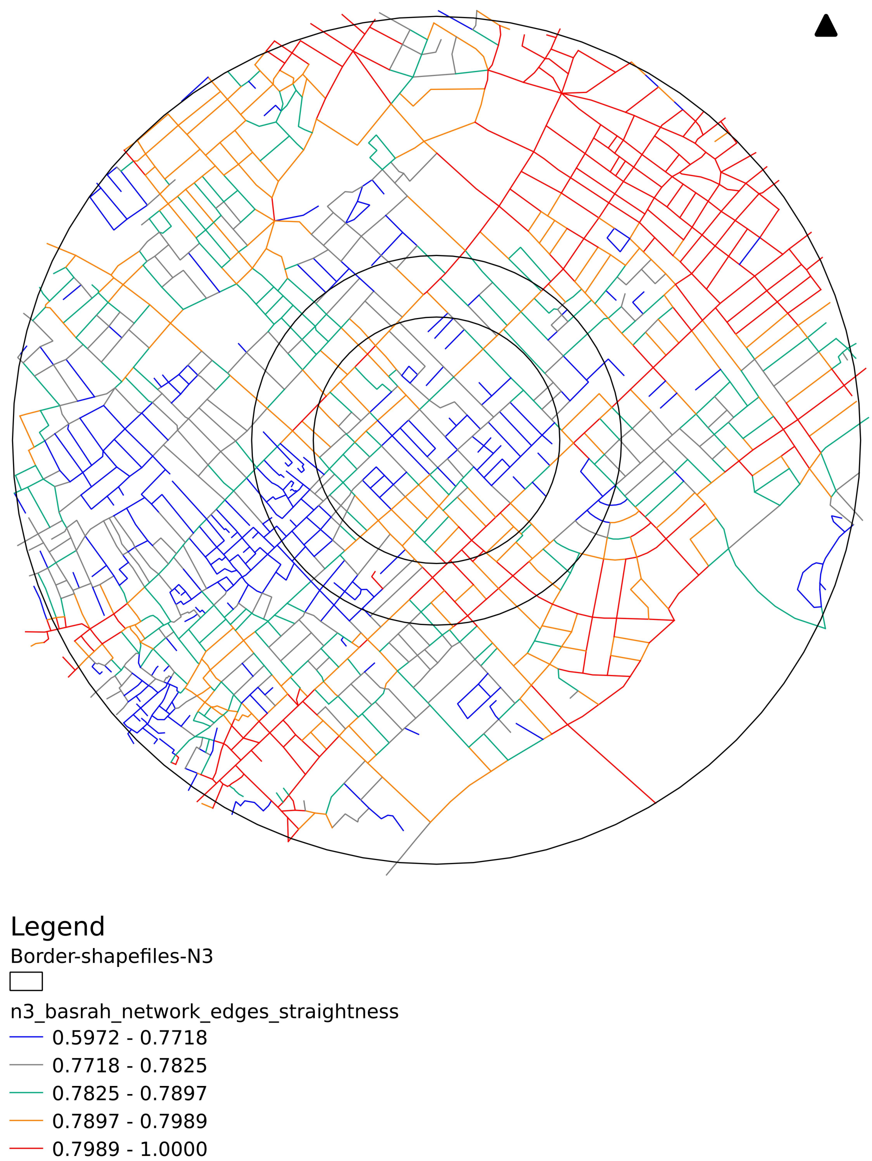


Figure 6-13: MCA illustration of the straightness analysis of the streets network of Al-Abassya: (the author)

6.12 Edges assessment

The method to assess the quality of street edges was adopted the frontage quality index (SFOMD) (Remali et al., 2015:p.108). It depends on a Likert scale of seven points, starting with (1), which is the lowest score of the assessment, and ending with (7), which is the highest score. The application of the method depends on observations and is conducted by a specialist team and criteria based sampling of the urban tissue. The computation of the overall index concerning the quality of the area was adopted from Gehl (1994, 2002) and Hershberger (1969), which combines the five indicators by totalling their raw scores. Therefore, the minimum score of the process is five points which represents the poorest quality streets, whereas, the highest score is 35 points, which represents the best possible quality. Thus, **one** independent variable was developed in terms of the edges assessment, namely: The Frontage quality index (SFOMDS2) on the 400-meter radius scale (Table 6-1).

The factor (S) defined a number of units as the number of the visibly important features in 100-meter length, such as entrances, or shops. However, the method was not clear enough about this point, because the number of important features is varied among the urban area elevations. Thus, this research developed criteria to apply this indicator, and a primary survey was conducted to estimate the maximum number of important features. The range of important features in a single residential block falls somewhere between (30 – 54) units. By dividing the average of this number, which is 42, by seven, which are the grades of the Likert scale, each point on the Likert is equivalent to six features in reality. Thus, the surveyors adopted a criterion of one Likert point for every six features. The (F) factor was defined as the diversity of functions in a 100-meter length. This research has classified the land use into seven kinds, including a house, shop, general service (like a mosque or doctor's practice), wholesale, workshop, office building, and parking. Subsequently, each single possible land use assigns one point on the Likert scale, out of seven. The (O) factor was defined as the percentage of openness of the 100-meters that is visible from the street. The features of the openness could be the windows, or window-shops. The percentage of openings of the 100-meter length could be 0-15%, 16-30%, 31-45%, 46-60%, 61-75%, 76-90%, or 91-100%; moreover, every single possible range of openness is assigned one point on the Likert scale, out of seven.

The (M) factor was defined as the maintenance status of the façades of the blocks, and the seven point Likert scale was used to assess the level of maintenance. In this research, the points define precise levels of maintenance; including: (1) very poor, (2) poor, (3) under maintenance, (4) medium, (5) good, (6) very good, (7) excellent. Factor (D) was defined as the quality and intensity of the architectural details and building materials, and the seven point Likert scale was used to assess the quality of the level of the detail. In this research, the points define precise factor levels; include, (1) very poor, (2) poor, (3) under construction, (4) medium, (5) good, (6) very good, (7) excellent.

Moreover, the principle of sampling the streets is an important issue to avoid bias and to validate the generalisation of the results. Therefore, this research adopts the method of Ramali et al. (2015); it depends on the selection of three streets segments based on two criteria, the hierarchal level of the street and the degree of betweenness centrality. From the hierarchical street levels, they define the main street, connector street, and cul-de-sac, which in this research, must have high, medium, and low degrees of betweenness centrality from each case study. Therefore, the sampling the arterial streets was conducted at the red level of betweenness; sampling the collector streets was conducted at the green level of betweenness, and sampling the local and cul-de-sac streets was conducted at the blue level of betweenness. Based on the betweenness analysis output maps, the frontages of the three streets from each neighbourhood were selected; one from the red level, one from the green level, one from the blue level of betweenness, (Figure 6-14, 6-15, and 6-16).

Since the researcher is a member of the Department of Architecture at Basra University, three architects, members of Basra City Architecture Department who have master degrees in urban design, volunteered to achieve the assessment of the facades and fulling the survey formats, which were designed for this task (Attachment 8). Moreover, they worked under the supervision of the researcher. This process of visual assessment took 10 days at six hours per day of work (from 1st -11th of October 2015). Moreover, the surveys that were conducted after the researcher had left Iraq were sent by email. The information was transferred into Excel-sheets for the purpose of analysis. The individual survey sheets were summarised (Table 6-5). Accordingly, three variables were developed from this analysis, which were: The Frontage quality index of the high betweenness street (SFMODS2R - from the red level), The Frontage quality index of the medium betweenness street (SFMODS2G - from the green level), and the Frontage quality index of the low betweenness street (SFMODS2B - from the blue level) (Table 6-1).

Table 6-5: SFOMD index, analysis of the edges

Factors	Al-Saymmar			Al-Mugawlen			Al-Abassya		
	SFMO DS2R	SFMO DS2G	SFMO DS2B	SFMO DS2R	SFMO DS2G	SFMO DS2B	SFMO DS2R	SFMO DS2G	SFMO DS2B
S	6	4	3	6	5	4	6	6	5
F	5	4	3	6	4	4	6	5	5
O	4	3	3	5	4	4	6	5	5
M	1	4	4	6	5	5	6	6	5
D	5	5	5	6	5	5	6	5	5
Total scores	21	20	15	27	23	22	30	27	25

The SFOMD index in Al-Saymmar neighbourhood demonstrated the lowest levels of frontage quality, at 21, 20, and 15 points for the variables SFOMDS2-Red, SFOMDS2-Green, SFOMDS2-Blue, respectively. The SFOMD index in Al-Mugawlen neighbourhood demonstrated moderate levels of frontage quality, at 27, 23, and 22 points for the variables SFOMDS2-Red, SFOMDS2-Green, SFOMDS2-Blue, respectively. Finally, the SFOMD index in Al-Abassya neighbourhood demonstrated the highest levels of frontage quality, at 30, 27, and 27 points for the variables SFOMDS2-Red, SFOMDS2-Gren, SFOMDS2-Blue, respectively, (Tables 6-2, and 6-5). Therefore, the SFOMD index showed a hierarchal increase in the levels of street frontages quality that paralleled the increase in betweenness degrees of the street segments in question. Also, in terms of each variable, the value of the SFOMD index increased in parallel with the increased grid structure amongst the street typologies. For example, the red level of the SFOMD index, brought about different scores across the three neighbourhoods, 21, 27, and 30, for Al-Saymmar, Al-Mugawlen, and Al-Abassya respectively (Table 6-4).

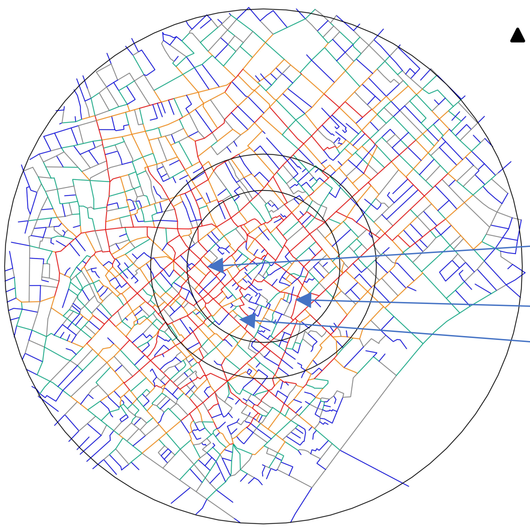
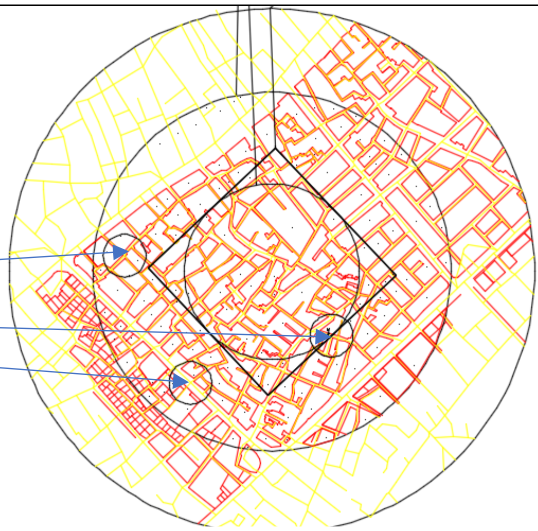
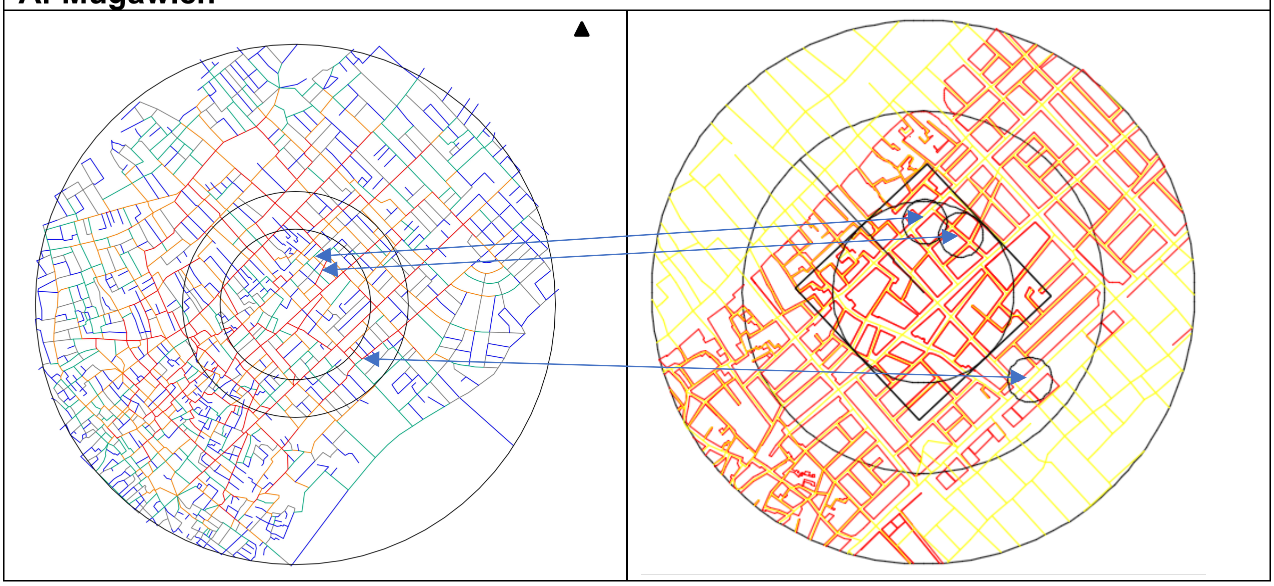
Al-Saymmar		
		
High betweenness street	**Medium betweenness street**	**Low betweenness street**
		

Figure 6-14: Al-Saymmar edges assessment

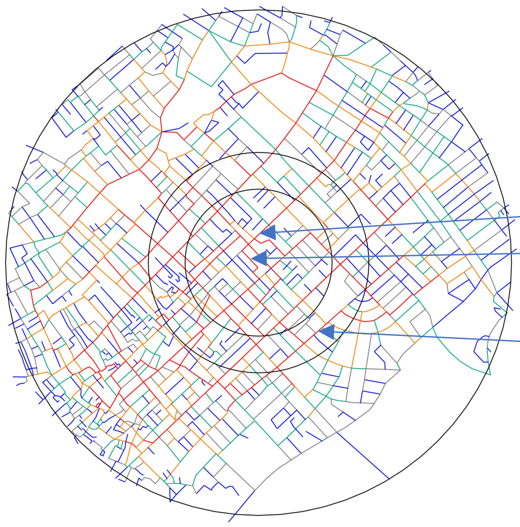
Al-Mugawlen

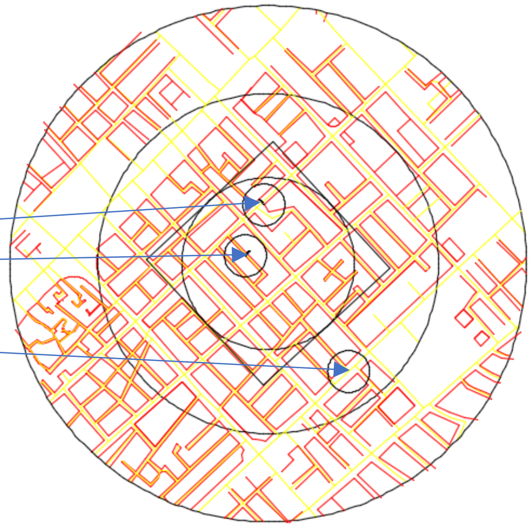


High betweenness street	Medium betweenness street	Low betweenness street
		
		
		
		
		

Figure 6-15: Al-Mugawlen edges assessment

Al-Abassya





High betweenness street	Medium betweenness street	Low betweenness street
		
		
		
		

Figure 6-16: Al-Abassya edges assessment.

6.13 Enclosure ratio

Based on the sampled streets in Figures 6-14, 6-15 and 6-16, the enclosure ratio was measured by MCA in terms of three streets segments (coded red, green, and blue) and the levels of betweenness, of each case study. Thus, three independent variables resulted from applying the enclosure indicator on the 400-meter radius scale; these were coded as EnRBRS2, EnRBGS2 and EnRBBS2 (Table 6-1). The variables required to apply the indicator are the width of the street and the heights of the adjacent buildings, which were measured directly in this study. Then, the function of the indicator (Equation 4-17) was applied to the sections of all the sampled streets segments, which are shown in Figures 6-17, 6-18 and 6-19.

In terms of the red level of betweenness (EnRBRS2) of the arterial streets, the three case studies have a broadly similar value of enclosure ratios, at 2.9, 2.7, and 2.7, for Al-Saymmar, Al-Mugawlen, and Al-Abassya, respectively. In terms of the collector streets with the green level of betweenness (EnRBGS2), the highest score was noted with the Al-Mugawlen neighbourhood (1.7); Al-Abassya showed a moderate enclosure ratio level (1.3), and the lowest level was noticed within Al-Saymmar (1). In terms of the local streets and the blue level of betweenness (EnRBBS2), the highest score was noted within the Al-Mugawlen neighbourhood (1.7); Al-Saymmar showed a moderate enclosure ratio level (1.1), and the lowest level was noticed with Al-Saymmar (.93) (Table 6-2).

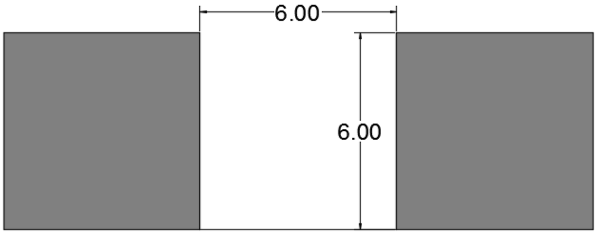
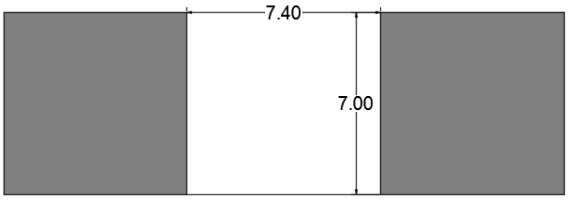
	Al-Saymmar
EnRBRS2, R: red	
EnRBGS2 G: green	
EnRBBS2, B: blue	

Figure 6-17: Enclosure ratio related sections of Al-Saymmar: (the author)

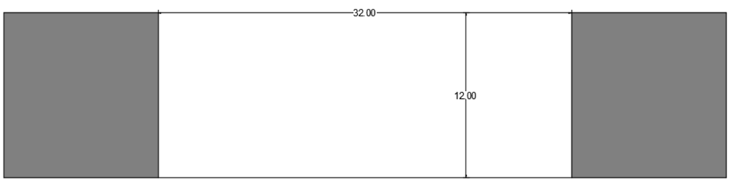
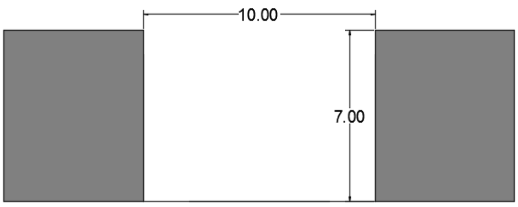
	Al-Mugawlen
EnRBRS2, R: red	
EnRBGS2 G: green	
EnRBBS2, B: blue	

Figure 6-18: Enclosure ratio related sections of Al-Mugawlen: (the author)

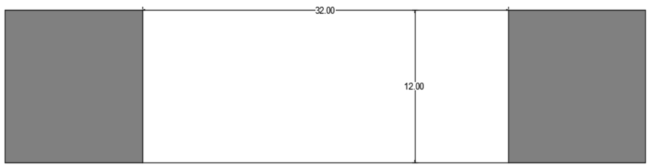
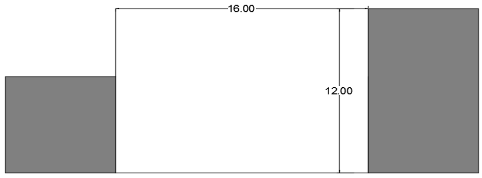
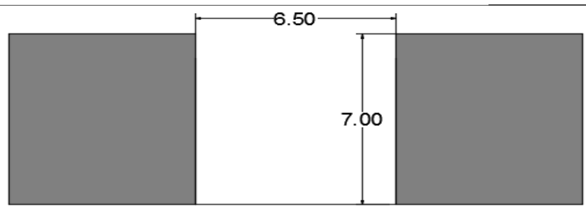
	Al-Abassya
EnRBRS2, R: red	
EnRBGS2 G: green	
EnRBBS2, B: blue	

Figure 6-19: Enclosure ratio related sections of Al-Abassya: (the author)

6.14 Walkability index

The walkability index was computed based on Equation 4-6 (Frank et al., 2005). Moreover, the raw scores of the three variables required to run the equation were standardised into z-scores before the summation. Thus, the walkability index is a compositional score, which was computed from three individual indicators, and coded as WalkIndx (Table 6-1). The walkability index of the three case studies was relatively different in that respect; Al-Saymmar neighbourhood showed a high level (z-score = 3.12), Al-Mugawlen neighbourhood showed a moderate level (z-score = .24), and Al-Abassya neighbourhood a low level (z-score = -3.77) (Table 6-2).

6.15 Summary of the chapter

In this chapter, the objectively measured physical environment attributes were systematically calculated on the elicited information from the cadastral maps, and the direct survey. In this regard, each indicator defined at least one variable after multiplying the scale factor and systematically measured by its defined equation to produce the final score/s of each individual variable. The scores of the variables were comparatively articulated cross the three case studies (neighbourhoods) to demonstrate the relevant differentiation of each indicator among the three case studies. These variables will be used in further multilevel statistical tests as determining factors based on the determination coefficient (R^2) of the walking behaviour outcomes.

7 The statistical analysis, findings and discussion

7.1 Introduction

This chapter outlines the variables that were developed from the objective and the subjective measures to answer the research questions; these variables were used simultaneously in purposive integrative models to answer the research questions. In this regard, the chapter reports on the conduct of five levels of statistical analysis, which included: (1) the validation of the research variables, (2) the effect size on walking outcomes, (3) the mediation, (4) the moderation, and (5) the determination. As a primary step for use in further tests, the first level is concerned with checking the validity of each type of data set for further statistical analysis. The second level tests the effect size of all the independent variables on the walking outcome variables, whilst the third level tests the ability of the perceived environment and the beliefs measures to mediate the effect of the physical environment (walkability index) on the walking outcomes. The fourth level is concerned with testing the ability of the socio-demographic factors and BMI to moderate the direct effect of the physical environment (walkability index) on the walking outcomes. Finally, the fifth level is concerned with testing the predictability of the walking outcomes through the application of objectively measured physical environment variables, shown in Table 6-2. This defines the potential of the built environment to influence walking behaviour.

The last four levels of the statistical analysis were applied to test the research hypothesis and subsequent responses to the research questions. From the knowledge gained, it is hoped that further understanding emerges from the multiple levels of association between the social and the physical environments and walking behaviour to occupational activities in three different neighbourhood typologies in Basra city. These links are defined in this research as the direct and indirect effects of the physical environment on walking behaviour. The indirect effect is concerned with the potential influences on walking behaviour outcomes: socio-demographic factors and BMI as moderators, and perceptual and belief factors as mediators. Meanwhile, the direct effect is implied in the relationship between the physical environment attributes and walking behaviour. Finally, the last part of this chapter discusses the research findings.

7.2 The variables of the research

Four types of research variable were developed by this research, namely, moderators, mediators, walking outcomes, and predictors, which are classified below, and altogether comprise 75 variables across the four types (Table 7-1). The responses to all variables were entered into SPSS (Appendix 4, SPSS-file format):

1- **Moderators**: the socio-demographic factors and BMI variables, namely the individual information of participants, obtained from partition A (14 variables) of the questionnaire.
2- **Mediation** variables from partitions C and D of the questionnaire, which include the belief-based measures of walking behaviour based on the TPB (14 variables) and the perceived environment items (13 variables).
3- The **walking outcome** variables from partition B of the questionnaire, which include the total walking distance per week, the total number of walking journeys, the total walking minutes per week, and the average walking minutes per day (4 variables).
4- **Predictors**: the objectively measured attributes of the physical environment, (30 variables). Moreover, in the literature of the ecological models of physical activity they are called the determination variables.

Table 7-1: The four types of research variables (total 75 variables)

Predictors	Mediators	Moderators	Outcome variables
• Block density (1) • Housing unites density (1) • Nodes intensity (2) • Link-node ratio (2) • Land-mix use (6) • Streets density (2) • External connectivity (1) • Pedestrian route directness ratio (1) • Clustering coefficient (2) • Betweenness (1) • Straightness (1) • Clustering coefficient (2) • Number of destinations (1) • Edges quality (3) • Enclosure (3) • Walkability index (1)	• Attitude to walk (5) • Subjective Norms SN belief to walk (3) • Perceived behavioural control PBC to walk (5) • Intention to walk (1) • Perceived environment factors (13).	• Gender • Age • Exercise • Family type • Number of bedrooms • House type • Family member • Underage • Income • Cars number • Work status • BMI • House ownership • Period of living	1) Total walking distance per a week. 2) Total walking journeys per a week. 3) Total walking minutes per a week. 4) ≥150 walking minutes per week.
30 variables	27 variables	14 variables	4 variables

7.3 Level 1 analyses: The validation of the research variables:

7.3.1 The validity of the study samples

The first level of the statistical analysis aimed to test the validity of the sample to avoid bias in terms of the categories. In this regard, the validation was obtained by conducting the One-way-ANOVA test to check the randomisation of the samples (Seltman, 2012). The null hypothesis of this test demonstrated that, broadly speaking, the categories are equal across the sample. In this regard, three variables are considered as baseline criteria, and these are age, gender, and employment status. Moreover, there were no significant differences in the mean scores among the categories of every variable, (*p*-value=.1, 1, and .16, respectively). Therefore, the null hypothesis is correct and the randomisation successful in producing broadly equivalent categories amongst the groups in terms of age, gender, and employment status.

7.3.2 The validity of the research variables

The subjectively measured research variables, namely the mediators, moderators, and walking outcomes (Table 7-1), were tested in terms of their normal distribution to check their validity. In this regard, the normality test been individually conducted to test the normal distribution of every variable. All the variables were not normally distributed data, according to the Shapiro-Wilk test (Shapiro & Wilk, 1965:p.593) was significant with all the tested variables (p<.001), which means rejecting the null-hypothesis H0, that the tested variable are not different from the normal distribution. Then, the this research considered the visual inspection of the data distribution based on. The research then considered the visual inspection of the data distribution based on the histogram, Normal Q_Q, and boxplot, which suggested that the data sets of the four outcome variables have relatively normal distributions (Seltman, 2012). Moreover, the extreme outlier cases (labelled with stars in the boxplot diagrams) were removed from the data-sets, while the outlier cases (that are labelled with circles) were kept because they were considered mild outliers (Appendix 5, Figures 10-1, 10-2 and 10-3). Also, the Skewness and Kurtosis test was conducted to confirm the visual inspection of the variables (Seltman, 2012).

The Skewness and Kurtosis test was conducted and showed that the skewness of the data sets varied at .456, .684, and .542, for the total walking distance per week (TotWkDis), total number of journeys (TotWkFrq), and total number of minutes walking per week (TotWkMin), respectively. This indicates that if the distribution of the data sets fall between -1 and +1, the distribution is approximately symmetric. Also, the Kurtosis test indicates that, if the distribution of the data sets for the same four outcome variables falls under +3, -.212, and 1.55, .236, for the total walking distance per week (TotWkDis), total number of journeys (TotWkFrq), and total number of minutes walking per week (TotWkMin), respectively, the distribution curves will flatten more than peak (Table 7-2).

Table 7-2: Skewness and Kurtosis test for the behavioural outcome variables

		Total Travel Distance by walking per a week Km/W	Total number of walking journeys	Total walking minutes per a week
N	Valid	175	175	175
	Missing	45	45	45
Std. Deviation		2.58964	2.70652	60.30935
Skewness		.456	.684	.542
Std. Error of Skewness		.184	.184	.184
Kurtosis		-.212	1.551	.236
Std. Error of Kurtosis		.365	.365	.365

The outcomes of the Skewness and Kurtosis test showed that (in order of Table 7-3) the skewness of data sets vary between .857, .551, .315, .775, .432, .865, .787, .625, .575, .792, .544, .514, .484, .593 and .27 for the beliefs-based measures of walking (Table 7-3). Thus, if the distribution of the data sets fall between -1 and +1, the distribution is approximately symmetric. Also, if the Kurtosis test for the same fourteen mediation variables indicate that (outcomes were as follows in order of Table 7-3) the distribution of the data sets falls under +3, as follow: .248, -.121, .23, -.394, 1.02, .46, -.02, -.1, .445, -.032, -.151, -.182, .232 and -.923), then the distribution curves will flatten rather than peak (Table 7-3).

The outcomes of the Skewness and Kurtosis test showed that (in order of Table 7-4) the skewness of the data sets vary between .325, .356, .406, -.25, -.119, .444, .068, .035, .003, .255, -.322, .056, and .086 for the perceived environment factors (Table 7-4). Therefore, if the distribution of the data sets fall between -1 and +1, then the distribution is approximately symmetric. Also, the Kurtosis test for the same fourteen mediation variables, (outcomes were as follows in order of Table 7-4), indicates that, if the distribution of the data sets fall under +3 values, as follow: -.257, -.570, -.511, -446., -.386, -.884, -.753, -.907, -.57, -.088, -.433, -.712 and -.714), then the distribution curves will flatten rather than peak (Table 7-4).

Based on the Skewness and Kurtosis tests, a visual assessment of the data distribution shapes for the subjectively measured variables are confirmed to fall within acceptable ranges. In terms of the skewness test, if the distribution of the data sets of all the variables falls between -.1 and +.1 the distribution is approximately symmetric (Tables 7-2, 7-3 and 7-4). In terms of the Kurtosis test, if the distribution of the data sets of all the variables falls under +3, the distribution curves will flatten rather than peak (Tables 7-2, 7-3 and 7-4).

Table 7-3: Skewness and Kurtosis test for the mediation variables

Mediators (M1 - M14)	N		Std. Deviation	Skew ness	Std. Error of Skewness	Kurtosis	Std. Er Kurtosis
	Valid	Missing					
Attitudinal beliefs of walking related to health benefits (M1)	175	45	4.58944	.857	.184	.284	.365
Attitudinal beliefs of walking related to environment pleasance (M2)	175	45	4.28391	.551	.184	-.121	.365
Attitudinal beliefs of walking related to time Saving (M3)	175	45	3.78896	.775	.184	.230	.365
Attitudinal beliefs of walking related to safety (M4)	175	45	4.28644	.432	.184	-.394	.365
Attitudinal beliefs of walking related to fresh air (M5)	175	45	4.14984	.865	.184	1.02	.365
Subjective norms of walking related to people (M6)	175	45	3.90749	.787	.184	.460	.365
Subjective norms of walking related to family (M7)	175	45	3.89939	.625	.184	-.018	.365
Subjective norms of walking related to doctor (M8)	175	45	3.71393	.575	.184	-.100	.365
Perceived walking control related to proximity of destinations (M9)	175	45	4.50781	.792	.184	.445	.365
Perceived walking control related to streets design (M10)	175	45	3.81891	.544	.184	-.032	.365
Perceived walking control related to diversity of destinations (M11)	175	45	4.65162	.514	.184	-.151	.365
Perceived walking control related to crowdedness of streets (M12)	175	45	3.51531	.484	.184	-.182	.365
Perceived walking control related to density of houses (M13)	175	45	3.56643	.593	.184	.232	.365
Intention to walk (M14)	175	45	3.89444	.270	.184	-.923	.365

Table 7-4: Skewness and Kurtosis tests for the perceived environment variables

Mediators (M1 - M13)	N		Std.	Ske wne ss	St. Er Skew ness	Kurt osis	St. Er. Kurtos is
	Valid	Missed					
"There are many attractive thinks to look at while walking in my neighbourhood" (M1)	175	45	.726	.325	.184	-.267	.365

"My neighbourhood is a safe enough so that I would let a 10-years-old boy walk around my block alone in the day time" (M2)	175	45	.866	.356	.184	-.570	.365
"I can most of my shopping at my neighbourhood" (M3)	175	45	.887	.406	.184	-.511	.365
"Local shops in my neighbourhood are within easy walking distance of my home" (M4)	175	45	.739	-.250	.184	-.446	.365
"The side-walks in my neighbourhood are well designed for walking" (M5)	175	45	.938	-.119	.184	-.389	.365
"The streets in my neighbourhood do not have many cul-de-sacs" (M6)	175	45	1.233	.444	.184	-.884	.365
"There are many alternative routes to move from place to another place in my neighbourhood" (M7)	175	45	1.155	.068	.184	-.753	.365
"The high traffic in my neighbourhood make it unsafe place to walk" (M8)	175	45	1.154	.035	.184	-.907	.365
"The low crime rates in my neighbourhood make it safe place to walk" (M9)	175	45	1.020	.003	.184	-.570	.365
"In my neighbourhood, there are many places within easy walking distance on my home", like parks, mosques, Gym halls, cafes, play grounds" (M10)	175	45	.936	.255	.184	-.088	.365
"I see and speak to other people when I am walking in my neighbourhood" (M11)	175	45	1.055	-.322	.184	-.433	.365
"Parking cars in the streets of my neighbourhood Impedes my walking" (M12)	175	45	1.104	.056	.184	-.712	.365
"Considering the overall condition of houses in my neighbourhood, I am satisfied of living in it" (M13)	175	45	1.136	.086	.184	-.714	.365

7.4 Level 2 analyses: The effect of the neighbourhood typology, personal traits, and individual traits on the walking outcomes

This level of statistical analysis is about the effect size of the spatial factor (neighbourhood typology) on the walking outcomes. For research question one, a One-Way-ANOVA test was utilised with all continuous variables except the categorical outcome variable, which was tested with the logistic regression test. The logistic regression depends on the odds ratio to predict the probability that ≥150 walking minutes per week is achieved, which is referenced as <150 minutes of walking per week, as predicted by the independent factor/s. Research question one was as follows:

1: Do neighbourhood typology, individual and personal traits have an effect on walking to occupational activities in the neighbourhoods of Basra city?

Moreover, the post hoc tests were applied to probe the significance of the variance in the mean scores of the walking outcome in question, between each pair of the three groups. Moreover, the null hypothesis of this test is the mean score, which is the same for all groups in terms of the walking outcome in question. Meanwhile, the significance of the test ($p<.05$) means that the groups have significantly differed in this respect. Moreover, the significance is attributed to the influence of the independent variable and the level of significance represents the extent to which the research hypothesis responds to the research question.

The One-Way-ANOVA analyses were run to test the influence of the neighbourhood typology on the walking outcomes (Table 7-5). It showed that the walking outcomes were significantly influenced by this spatial factor ($p<.001$). Table 7-5 illustrates that a change in the type of neighbourhood, or groups of participants, generated a significant difference in the mean score of the following:

- total walking distance per week (TotWkDis), $F(2, 174) = 46.733$, $p<.001$
- total walking journeys per week (TotWkFrq), $F(2, 174) = 43.311$, $p<.001$
- total walking minutes per week (TotWkMin), $F(2, 174) = 13.461$, $p<.001$.

Also, the Post hoc tests revealed statistical significance between each pair of neighbourhoods in terms of their walking outcomes (Table 7-6). All the outcome variables differed significantly ($p<.001$) between each pair of neighbourhoods, (Al-Saymmar-Al-Mugawlen, Al-Saymmar-Al-Abassya, and Al-Mugawlen-Al-Abassya),. However, the total walking distance (Km/W) per week did not significantly differ between the Al-Mugawlen and Al-Saymmar neighbourhoods ($p>.05$). Also, the total number of walking journeys did not significantly differ between the Al-Mugawlen and Al-Saymmar neighbourhoods ($p>.05$). Thus, this confirms the research hypothesis that the three walking outcomes were significantly associated with the neighbourhood typology factor.

Table 7-5: Influence of the spatial factor on the walking outcomes

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Total walking Distance Km/W by walking per a week	Between Groups	410.841	2	205.421	46.733	.000
	Within Groups	756.040	172	4.396		
	Total	1166.881	174			
Total number of walking journeys	Between Groups	426.910	2	213.455	43.311	.000
	Within Groups	847.684	172	4.928		
	Total	1274.594	174			
Total walking minutes per a week	Between Groups	85652.105	2	42826.053	13.461	.000
	Within Groups	547223.728	172	3181.533		
	Total	632875.834	174			

Table 7-6: Post Hoc LSD analysis of the influence of the spatial factor on walking outcomes

Multiple Comparisons							
Post Hoch (LSD)							
Dependent Variable	**The three groups**		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Total walking Distance	Al-Saymmar neighbourhood	Al-Mugawlen	3.09647*	.38299	.000	2.3405	3.8524
		Al-Abassya	3.30635*	.38835	.000	2.5398	4.0729
	Al-Mugawlen neighbourhood	Al-Saymmar	-3.09647*	.38299	.000	-3.8524	-2.3405
		Al-Abassya	.20988	.39460	.595	-.5690	.9888
	Al-Abassya neighbourhood	Al-Saymmar	-3.30635*	.38835	.000	-4.0729	-2.5398
		Al-Mugawlen	-.20988	.39460	.595	-.9888	.5690
Total number of walking journeys	Al-Saymmar neighbourhood	Al-Mugawlen	3.20745*	.40554	.000	2.4070	4.0079
		Al-Abassya	3.32375*	.41121	.000	2.5121	4.1354
	Al-Mugawlen neighbourhood	Al-Saymmar	-3.20745*	.40554	.000	-4.0079	-2.4070
		Al-Abassya	.11630	.41783	.781	-.7084	.9410
	Al-Abassya neighbourhood	Al-Saymmar	-3.32375*	.41121	.000	-4.1354	-2.5121
		Al-Mugawlen	-.11630	.41783	.781	-.9410	.7084
Total walking minutes	Al-Saymmar neighbourhood	Al-Mugawlen	29.06932*	10.3038	.005	8.7311	49.4076
		Al-Abassya	54.04575*	10.4480	.000	33.4229	74.6686
	Al-Mugawlen neighbourhood	Al-Saymmar	-29.0693*	10.3038	.005	-49.407	-8.7311
		Al-Abassya	24.97643*	10.6160	.020	4.0220	45.9309
	Al-Abassya neighbourhood	Al-Saymmar	-54.0457*	10.4480	.000	-74.668	-33.422
		Al-Mugawlen	-24.9764*	10.6160	.020	-45.930	-4.0220
*** The mean difference is significant at the 0.05 level.**							

7.4.1 ≥ 150 minutes walking per week

Also, in term of research question one, the tests below examine the direct effects of the neighbourhood typology (objective measure), and the subjective measures, the perceived environment, and the beliefs-based walking measures of the TPB, on walking for ≥150 minutes per week. This was based on a logistic regression analysis because the walking outcome is a categorical variable. This analysis was conducted to calculate the extent to which walking for ≥150 minutes per week is responsive to the environmental factors. Worth to mention, the socio-demographic and BMI factors are not tested with this walking variable because they have no significant association with the total number of walking minutes.

7.4.1.1 Walking for ≥150 minutes per a week and neighbourhood typology

The logistic regression analyses were run to test whether the neighbourhood typology factors and personal traits are associated with walking for ≥150 minutes per week. The neighbourhood typology factor was significantly associated with walking for ≥150 minutes per week (b=1.774, p<001), as people from Al-Saymmar were approximately six times more likely to achieve the recommended level of walking than those from Al-Abassya (OR: 5.895, 95% CI: 2.122-16.379, *p*<.001). Thus, the neighbourhood typology factor was significantly associated with the walking for ≥150 minutes per week (*b*=.914, *p*<001). Moreover, people from Al-Mugawlen were approximately 2.5 times more likely to achieve the recommended level of walking compared to those from Al-Abassya (OR: 2.495, CI: 1.094-5.692, *p*<.05). However, the personal traits have no significant association with the ≥150 minutes per week (Table 7-7). Thus, the findings of this test positively confirm the research hypothesis that the 'number of cars' factor has a significant association with the ≥150 minutes of walking per week. However, in terms of the socio-demographic and BMI factors, the associations respond to the null hypothesis of non-association.

Table 7-7: Odds ratio test of ≥150 m/w walking predicted by the spatial factor and personal traits

		B	Sig.	Exp. (B)	95% C.I. for EXP. (B)	
					Lower	Upper
≥150 m/w	Neighbourhood (Al-Abassya – reference)		.003			
	Neighbourhood Al-Saymmar	1.774	.001	5.895	2.122	16.379
	Neighbourhood Al-Mugawlen	.914	.030	2.495	1.094	5.692
	Age	-.093	.632	.911	.622	1.335
	Income	-.020	.898	.980	.722	1.330
	Work Status (Unemployed - reference)		.444			
	Work Status (Employed)	-1.559	.186	.210	.021	2.121
	Work Status (Student)	-.976	.437	.377	.032	4.420
	Work Status (Free business)	-1.917	.111	.147	.014	1.552
	Work Status (House keeper)	-1.617	.178	.198	.019	2.088
	Practising Sport (No) referenced by (Yes)	-.208	.769	.812	.202	3.262
	BMI	-.039	.728	.961	.770	1.200
	Number of Cars	-.033	.897	.967	.587	1.595
	Constant	2.998	.294	20.054		

7.4.1.2 Walking for ≥150 minutes per week and the perceived environment

The logistic regression analyses were run to test whether the perceived environment factors are associated with walking for ≥150 minutes per week. The 'Local shops in my neighbourhood are within easy walking distance of my home' factor was significantly associated with walking for ≥150 minutes per week (OR: 3.532, CI: 1.707-7.306, *p*<.001). This means that, if people perceive local shops as accessible, they are likely to walk more than the recommended amount per week (*b*=1.262). Moreover, 'The dead-end streets in my neighbourhood impact my walking' factor was significantly associated with walking for ≥150 minutes per week (OR: 1.766, CI: 1.056-2.955, *p*<.05); thus, the more that individuals perceive cul-de-sacs, the more likely they are to walk more than recommended amount per week. Furthermore, the ‘Parking cars in the streets of my neighbourhood impacts my walking’ factor was significantly associated with walking for ≥150 minutes per week (OR: .595, CI: .368-.963, *p*<.05). Therefore, the more people perceive parked cars on streets of their neighbourhood, the less likely they are to walk more than recommended amount per week (b=-.519) (Table 7-8).

Thus, the findings of this test positively confirm the research hypothesis with the following factors: perceived proximity of retail, perceived cul-de-sacs, and perceived parking of cars. These all have a significant association with the ≥150 minutes walking per week. However, in terms of the rest of the perceived environmental factors, the associations respond to the null hypothesis of non-association.

Table 7-8: Odds ratio test of ≥150 m/w walking predicted by the perceived environment factors

		B	Sig.	Exp. (B)	95% C.I. - EXP. (B)	
					Lower	Upper
≥150 m/w	“There are many attractive thinks to look at while walking in my neighbourhood”	.072	.814	1.075	.587	1.968
	“My neighbourhood is a safe enough so that I would let a 10-years-old boy walk around my block alone in the day time”	-.224	.506	.799	.413	1.546
	“I can most of my shopping at my neighbourhood”	.613	.068	1.846	.956	3.565
	“Local shops in my neighbourhood are within easy walking distance of my home”	1.262	.001	3.532	1.707	7.306
	“The side-walks in my neighbourhood are well designed for walking”	.042	.870	1.043	.634	1.714
	“The streets in my neighbourhood do not have many cul-de-sacs”	.569	.030	1.766	1.056	2.955
	“There are many alternative routes to move from place to another place in my neighbourhood”	.499	.065	1.648	.969	2.801
	“The high traffic in my neighbourhood make it unsafe place to walk”	-.207	.437	.813	.482	1.371
	“The low crime rates in my neighbourhood make it safe place to walk”	.230	.274	1.259	.833	1.902
	“In my neighbourhood, there are many places within easy walking distance on my home”, like parks, mosques, Gym halls, cafes, play grounds	.159	.514	1.172	.727	1.890
	“I see and speak to other people when I am walking in my neighbourhood”	-.059	.784	.942	.617	1.440
	“Parking cars in the streets of my neighbourhood impede my walking”	-.519	.035	.595	.368	.963
	“Considering the overall condition of houses in my neighbourhood, I am satisfied of living in it”	.327	.153	1.387	.886	2.170
	Constant	-8.31	.000	.000		

7.4.1.3 Walking for ≥150 minutes per week and the beliefs-based measures of walking

The logistic regression analyses were run to test whether the factors related to the beliefs-based walking measures of the TPB are associated with walking for ≥150 minutes per week. The attitudinal beliefs of walking related to the health benefits factor was significantly associated with walking for ≥150 minutes per week (OR: 1.205, 95% CI: 1.070-1.357, p<.01). Thus, the more beliefs an individual has about the health benefits of walking, the more likely they are to walk more than recommended amount (b=.187). Furthermore, the perceived walking control related to the proximity of destinations factor was significantly associated with walking for ≥150 minutes per week (OR: 1.182, 95% CI: 1.019-1.370, p<.05). Therefore, the more control an individual perceives they have over a destination's proximity, the more likely they are to walk more than recommended amount per week (b=.167) (Table 7-9).

Table 7-9: Odds ratio test of ≥150 m/w walking predicted by belief-based measures for the TPB

		B	Sig.	Exp. (B)	95% C.I. - EXP. (B)	
					Lower	Upper
≥150 m/w	Attitudinal beliefs of walking related to health benefits	.187	.002	1.205	1.070	1.357
	Attitudinal beliefs of walking related to environment pleasance	.003	.950	1.003	.919	1.095
	Attitudinal beliefs of walking related to time saving	.013	.828	1.013	.899	1.143
	Attitudinal beliefs of walking related to safety	.005	.927	1.005	.902	1.120
	Attitudinal beliefs of walking related to fresh air	-.094	.052	.910	.831	.996
	Subjective norms of walking related to people	-.027	.799	.974	.793	1.196
	Subjective norms of walking related to family	-.036	.691	.965	.807	1.153
	Subjective norms of walking related to doctor	-.016	.823	.984	.857	1.131
	Perceived walking control related to proximity of destinations	.167	.027	1.182	1.019	1.370
	Perceived walking control related to streets design	.029	.683	1.030	.895	1.185
	Perceived walking control related to diversity of destinations	-.021	.684	.979	.882	1.086
	Perceived walking control related to crowdedness of streets	-.055	.330	.946	.846	1.058
	Perceived walking control related to density of houses	.055	.382	1.056	.934	1.194
	Intention to walk	-.023	.637	.977	.887	1.076
	Constant	-1.35	.318	.259		

However, the rest of the beliefs-based measures of the TPB factors have no significant association with this outcome. Moreover, the rest of the perceived environment factors have no significant association with this outcome (Table 7-9).

Thus, the findings for the belief-based measures of walking factors with the ≥150 minutes of walking per week only positively confirm the research hypothesis for the following factors of the belief-based measures of walking: health benefits of walking, proximity of retail, cul-de-sacs, and the parking of cars. These three factors have a significant association with the recommended ≥150 minutes of walking per week. However, in terms of the rest of the factors for the belief-based measures of walking, the associations record a null hypothesis of non-association.

7.5 Level 3 analyses: The mediation roles of the beliefs measures and the perceived environmental factors:

The belief-based measures of walking behaviour and the perceived environment factors were tested in terms of their ability to mediate the effect of the physical environment (walkability index) on the walking outcomes. The model of analysis comprises three components: a predictor (walkability index: X), a group of mediators (Mi), and an outcome variable (walking behaviour outcome: Y). Moreover, statistic model-4, which was designed by Hayes (2016), is adopted for this purpose. The walkability index was used as a predictor (X) with all mediators used as control variables, and the walking outcomes (Y) were used as dependent variables.

7.5.1 The analysis method

To test the mediation role of the factors for research questions two and three, the mediation model (Figures 3-1) addressed by Bauman, Sallis, Dzewaltowski and Owen (2002) is considered. It illustrates the direct and indirect effect paths of predictor (X) on outcome (Y). Moreover, the indirect effect is calculated through the mediator/s (Mi). In this regard, the regression analysis was conducted to determine the effect size of the predictor and mediator variables on the walking outcome variables, and the extent to which the mediation role was significant. To conduct the statistical analysis, Hayes (2012) developed models that represent several relationship compositions between the predictors (X), mediators (M), and dependent outcomes (Y). His work was developed as a plugin, called *PROCESS macros*, that is compatible with SPSS software. The most compatible model was selected for this study, which was mediation model-4.

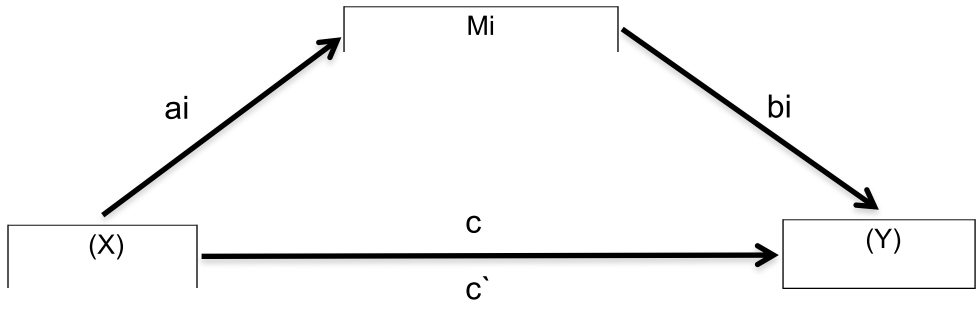


Figure 7-1: Mediation Model-4, according to Hayes (2012, and 2016).

Hayes' (2012) model-4 split the effect of X on Y into the direct effect (c`) and indirect effect (a & b) paths. The total effect is the result of adding the direct effect to the indirect effect (c = c`+ ab), where ai is the effect of X on M and b is the effect of M on Y. From this, the paths of effect, based on the SEM, were computed as follows:

Equation 7-1: Path (ai) the effect of the predictor of the moderator (Hayes, 2012)

$Mi = \beta_0 + \beta_i X$

Equation 7-2: Path (bi) the effect of the mediator on the outcome variable (Hayes, 2012)

$Y = \beta 0 + \beta i\ Mi$

Equation 7-3: Path (c`) the direct effect of the predictor on the outcome variable (Hayes, 2012)

$Y = \beta i\ X$

Equation 7-4: The total effect on the outcome variable (Hayes, 2012)

$Y = \beta_0 + aibi + c`$

X: The walkability index (Table 6-2) as a predictor

Y: A walking outcome variable

Mi: Mediators (either the belief-based measures or the perceived environment factors)

ai, bi, c, c`: Paths of effect as shown in Figure (7-1).
[11]

In this research, the model is applied three times with each walking outcome variable, and the output models of the analysis are utilised to respond to the research questions.

[11] The equations 7-1, 7-2, 7-3 and 7-4 are elicited by this research from the *PROCESS* macros software-tool by Hayes (2012)

For example, based on Hayes' instrument (2016), if the three mediators (M1, M2, and M3) and (X) in this study are applied to Equation 7-1 to compute ai, then:

- Path a1: M1=β0+β1X
- Path a2: M2=β0+β1X
- Path a3: M3=β0+β1X

  (β_0: from the regression of X on M)

Also, the three mediators (M1, M2, and M3) and Y will be applied to Equation 7-2 to compute bi, as follows:

- Path b1: Y=β0+β1M1
- Path b2: Y=β0+β1M2
- Path b3: Y=β0+β1M3

  (β_0: from the regression of Mi on Y)

Based on model-4, it can be seen that the indirect effect of X through M1 on Y is the product of β_1 from path a1 times β_1 from b1 (Equations 7-1 and 7-2). Also, in the same manner, the effects of M2 and M3 are computed. The direct effect of X on Y is c\` (Equation 7-3). The total effect of X on Y, including both the indirect and direct effects, is equal to the sum of the direct effect, the direct effect of X on Y (c\`) and indirect effects, the sum of ai times by bi (Equation 7-4).

Moreover, because this stage of analysis tests the 'mediate-ability' of the mediation variables, only the walkability index was used as a control factor for the purpose of modelling and comparison. After applying the Pearson correlation tests between the mediators and outcome variables (using SPSS), only the significantly correlated variables were considered to run the statistical analyses (Table 7-16, and 7-17). In other words, only the mediators (Mi), that show a significant correlation with the outcome variables (Yi) were used in the regression analyses. Moreover, no covariate factors were considered at this stage of the analysis because this would instead be about mediation.

7.5.2 The mediation tests of the belief-based measures of walking behaviour

Research question two: Do the belief-based measures of walking mediate the direct effect of the physical environment on the walking outcomes?

In this test, the belief-based measures of walking behaviour are the mediation variables. The first step is to test the correlation between the mediators and the walking outcome variables to check their validity for further regression analyses. From this, only eight mediation variables had significant correlations with the outcome variables, whereas six variables showed non-significant correlations (Table 7-10). Thus, the eight variables were considered for further analyses, which due to the multiple walking outcomes involve three mediation tests.

Table 7-10: Pearson Correlation test for the belief-based measures and walking outcomes

			Total walking minutes per a week	Total travel distance	Total walking journeys
M1	Attitude to walk related to health benefits	Pearson Correlation	.451**	.551**	.443**
		Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M2	Attitude to walk related to environment pleasantness	Pearson Correlation	.143	.036	.120
		Sig. (2-tailed)	.058	.632	.112
		N	175	175	175
M3	Attitude to walk related to time saving	Pearson Correlation	.177*	.369**	.379**
		Sig. (2-tailed)	.019	.000	.000
		N	175	175	175
M4	Attitude to walk related to safety	Pearson Correlation	.247**	.315**	.324**
		Sig. (2-tailed)	.001	.000	.000
M5	Attitude to walk related to fresh air	Pearson Correlation	-0.146	-0.153	-.147
		Sig. (2-tailed)	.051	.057	.052
M6	Subjective norms of walking related to people	Pearson Correlation	.300**	.430**	.378**
		Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M7	Subjective norms of walking related to family	Pearson Correlation	.118**	.142**	.118**
		Sig. (2-tailed)	.090	.051	.067
		N	175	175	175
M8	Subjective norms of walking related to doctor	Pearson Correlation	.082	.019	-.068
		Sig. (2-tailed)	.281	.799	.374
		N	175	175	175
M9	Perceived walking control related to proximity of destinations	Pearson Correlation	.441**	.519**	.457**
		Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M10	Perceived walking control related to streets design	Pearson Correlation	.352**	.369**	.375**
		Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M11	Perceived walking control related to diversity of destinations	Pearson Correlation	.300**	.459**	.486**
		Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M12	Perceived walking control related to crowdedness of streets	Pearson Correlation	.112	.174*	.190*
		Sig. (2-tailed)	.138	.200	.210
		N	175	175	175
M13	Perceived walking control related to density of houses	Pearson Correlation	.202**	.231**	.229**
		Sig. (2-tailed)	.070	.053	.061
		N	175	175	175
M14	Intention to walk	Pearson Correlation	.198**	.177*	.175
		Sig. (2-tailed)	.009	.019	.018
		N	175	175	175

7.5.2.1 Mediation modelling with the total walking distance

Model One tests whether the eight factors related to belief-based measures of walking (Table 7-10) mediate the direct effect of the walkability index (X) on the total walking distance (TotWkDis or Y) per week.

7.5.2.1.1 The indirect effect of X on Y through Mi

To conduct this model, the path analyses were run on the SPSS-PROCESS-*macros*, using Hayes's instrument (2016). The paths ai and bi (Figure 7-1) are computed based on Equations 7-1 and 7-2, respectively. Table 7-11 summarises the output of the path analyses. The path of direct effect c\` is computed using Equation 7-3, (Appendix 6, Model 1). Although the direct effect of the walkability index (X) on the total walking distance (c\`) was mediated by the tested mediators, it is still significant, b=.2809, t (165) = 4.5425, p<.001. Accordingly, from a1b1, a2b2, a3b3, a4b4, a5b5, a6b6, a7b7, a8b8 and c\`, the total effect on Y is computed using Equation 7-4:

The total effect (0.4633) = indirect effect (Table 7-11) 0.1824 + direct effect (c\`) 0.2809

Table 7-11: The total indirect effect of the belief-based measures on total walking distance

Path	β_1 from a $_i$	β_1 from b $_i$	Indirect effect (B)	
a1b1	0.5226	0.1842	0.0963	
a2b2	0.5425	0.0562	0.0305	
a3b3	0.8108	-0.0812	-0.0659	
a4b4	0.2530	0.0927	0.0235	
a5b5	0.4847	0.1073	0.0520	
a6b6	0.3333	0.0434	0.0145	
a7b7	0.6776	0.0575	0.0389	
a8b8	0.3553	-0.0207	-0.0073	
Total indirect effect			0.1824	

Although the mediators contributed differently to the total indirect effect, not all of them showed a significant effect. The significance of the mediation role could be identified by the interval between the lower (BootLLCI) and the upper (BootULCI) values of the bootstrap analysis (Efron and Tibshirani, 1993), which is included in Model-4 (Hayes, 2016). Therefore, the interval should not contains zero, otherwise the mediation role would be considered non-significant;

- M1, b= .0963, BootLLCI= .0418, BootULCI= .1708;
- M2, b= .0305, BootLLCI= -.0175, BootULCI= .0838;

- M3, b= -.0659, BootLLCI= -.1391, BootULCI= -.0001;
- M4, b= .0235, BootLLCI= .0037, BootULCI= .0645;
- M5, b= .0520, BootLLCI= .0099, BootULCI= .1094;
- M6, b= .0145, BootLLCI= -.0155, BootULCI= .0568;
- M7, b= .0389, BootLLCI= -.0084, BootULCI= .0960; and
- M8, b= -.0073, BootLLCI= -.0367, BootULCI= .0176.

Thus, it is demonstrated that, with four variables, the interval between the lower and the upper bootstrap values do not go via zero (contain zero value); as such, only four mediators have a mediation role, which absorbs the effect from the independent variable and creates an indirect effect on the dependent variable (the walking outcome).

As the calculations (M1-M8 from Table 7-10) indicate, the belief-based measures of walking factors with the total walking distance positively confirm the research hypothesis for the following: (M1) the attitudinal beliefs of walking related to health benefits (AtWkHt), (M4) the subjective norms of walking related to people (SNWkPep), and (M7) the perceived walking control related to land use diversity (PCWkDiv). However, in terms of the rest of the belief-based measures of walking factors, the associations respond to the null hypothesis of non-association. Moreover, the walkability index was associated with the following: approximately 0.1 kilometers greater walking distance, as mediated by M1, which was the attitudinal beliefs of walking related to health benefits (AtWkHt); approximately .07 kilometers less walking distance, as mediated by M3, which was the attitudinal beliefs of walking related to safety (AtWkSaf); approximately .024 kilometers greater walking distance as mediated by M4, which was the subjective norms of walking related to people (SNWkPep); and approximately .05 kilometers greater walking distance, as mediated by M5, which was the perceived walking control related to the proximity of destinations (PCWkProx).

7.5.2.2 Mediation modelling and the total number of walking journeys

Model 2 tests whether the eight factors of belief-based measures of walking (Table 7-10) mediate the direct effect of the walkability index (X) on the total number of walking journeys (TotWkFrq or Y) per week. The path analyses were run using the SPSS-PROCESS-*macros*, and Hayes's (2012) instrument was adopted to conduct this model. The paths ai and bi (Figure 7-1) are computed from Equations 7-1 and 7-2 respectively, and Table 7-12 summarises the output of the path analyses. The path of direct effect c` was computed from Equation 7-3 (Appendix 6, Model 2). Although the direct effect of walkability index X on the total walking number of journeys (c`) was mediated by the tested mediators, it is still significant, (b=.2521, t (165) = 3.5787, p<.001). Accordingly, from a1b1, a2b2, a3b3, a4b4, a5b5, a6b6, a7b7, a8b8 (Table 7-12) and c` ($b$=.2521), the total effect on Y is computed from Equation 7-4: The total effect (0.4648) = indirect effect (0.2127) + direct effect c` (0.2521)

Table 7-12: Total indirect effect of the belief-based measures on total walking journeys

Path	β_1 from a_1	β_1 from b_1	Indirect effect (B)	
a1b1	0.5226	0.1202	0.0628	
a2b2	0.5425	0.844	0.0458	
a3b3	0.8108	-0.0425	-0.0345	
a4b4	0.2530	0.0849	0.0215	
a5b5	0.4847	0.0454	0.0220	
a6b6	0.3333	0.093	0.0310	
a7b7	0.6776	0.1152	0.0781	
a8b8	0.3553	-0.0395	-0.0140	
Total indirect effect			0.2127	

Although the mediators contributed differently to the indirect effect, not all showed a significant effect. The significance of the mediation role was determined by the bootstrap analysis, and the interval between the lower (BootLLCI) and upper (BootULCI) values showed that the following have a significant mediation role: (M1) attitudinal beliefs of walking related to health benefits (AtWkHt), (M4) subjective norms of walking related to people (SNWkPep), and (M7) perceived walking control related to diversity of destinations (PCWkDiv). Therefore, the interval should not contains zero value, otherwise the mediation role will be considered non-significant, as shown:

- M1, b= .0628, BootLLCI= .0146, BootULCI= .1342;
- M2, b= .0458, BootLLCI= -.0068, BootULCI= .1084;
- M3, b= -.0345, BootLLCI= -.1064, BootULCI= .0398;
- M4, b= .0215, BootLLCI= .0018, BootULCI= .0613;
- M5, b= .0220, BootLLCI= -.0213, BootULCI= .0743;
- M6, b= .0310, BootLLCI= -.0034, BootULCI= .0828;
- M7, b= .0781, BootLLCI= .0167, BootULCI= .1571;
- M8, b= -.0140, BootLLCI= -.0531, BootULCI= .0138.

Thus, it is demonstrated that, for only for three variables, the intervals between the lower and the upper values of the bootstrap analysis do not go via zero (contain zero value); these are therefore considered to have a mediation role, which absorbs the effect from the independent variable and creates an indirect effect on the dependent variable (which in this case is the walking outcome variable).

The findings from calculating the belief-based measures of walking factors with the total walking number of journeys positively confirm the research hypothesis with: (M1) attitudinal beliefs of walking related to health benefits (AtWkHt), (M4) the subjective norms of walking related to people (SNWkPep), and (M7) the perceived walking control related to land use diversity (PCWkDiv). However, in terms of the remaining factors for belief-based measures of walking, the associations respond to the null hypothesis of non-association. Moreover, the walkability index was associated with: approximately .1 point greater score in each single walking journey, as mediated by attitudinal beliefs of walking related to health benefits (AtWkHt); approximately .022 points, as mediated by the subjective norms of walking related to people (SNWkPep), and approximately .1 point as mediated by the perceived walking control related to the diversity of land use (PCWkDiv).

7.5.2.3 Mediation modelling with the total number of walking minutes

Model 3 tests whether the eight factors for the belief-based measures of walking (Table 7-10) mediate the direct effect of the walkability index (X) on the total number of walking minutes (TotWkMin or Y) per week. The path analyses were run on the SPSS-PROCESS-*macros*, using Hayes's (2012) instrument to conduct the model. The paths ai and bi (Figure 7-1) are computed based from Equations 7-1 and 7-2, respectively. Table 7-13 summarises the output of the path analyses. The path of the direct effect (c`) is computed from Equation 7-3, (Appendix 6, Model 3). Although the direct effect of the walkability index X on the total walking minutes (c`) was mediated, it is still significant (b= 4.8581, t (165) = 3.5787, p<.001). Accordingly, from a1b1, a2b2, a3b3, a4b4, a5b5, a6b6, a7b7, a8b8 (Table 7-19) and c` (b= 4.8581), the total effect on Y is computed from Equation 7-4:

The total effect (7.7862)= indirect effect 2.9281+direct effect (c`) 4.8581

Table 7-13: The total indirect effect of the belief-based measures on total walking minutes

Path	β_1 from a_1	β_1 from b_1	Indirect effect (B)	
a1b1	0.5226	3.9530	2.066	
a2b2	0.5425	-0.8650	-0.4692	
a3b3	0.8108	-1.3421	-1.0882	
a4b4	0.2530	0.9309	0.2355	
a5b5	0.4847	2.5908	1.2557	
a6b6	0.3333	1.9568	0.6522	
a7b7	0.6776	0.0015	0.001	
a8b8	0.3553	0.7739	0.2750	
Total indirect effect			2.9281	

Although, the mediators contributed differently to the indirect effect, not all showed a significant effect. The significance of the mediation role was determined by the bootstrap analysis, and the interval between the lower (BootLLCI) and upper (BootULCI) values showed that the following have significant a mediation role, where the interval should not contain zero value, otherwise the mediation role is considered non-significant: (M1) attitudinal beliefs of walking related to health benefits (AtWkHt) and (M5) perceived walking control related to proximity of destinations (PCWkProx). Thus:

- M1, b= 2.0660, BootLLCI= .8942, BootULCI= 3.8081;
- M2, b=-.4692, BootLLCI= -1.8238, BootULCI= .7312;
- M3, b= -1.0882, BootLLCI= -2.8492, BootULCI= .4201;
- M4, b= .2355, BootLLCI= -.1608, BootULCI= 1.0978;
- M5, b= 1.2557, BootLLCI= .2198, BootULCI= 2.7456;
- M6, b= .6522, BootLLCI= -.1047, BootULCI= 1.7941;
- M7, b= .0010, BootLLCI= -1.3099, BootULCI= 1.2602;
- M8, b=.2750, BootLLCI= -.4344, BootULCI= 1.1536.

Thus, the interval between the lower and upper bootstrap analysis values do not go via zero (contain zero value) for only two variables; these were considered to have a mediation role, which absorbs the effect from the independent variable and creates an indirect effect on the dependent variable (which in this case is the walking outcome variable).

Thus, from examining the factors for the belief-based measures of walking with the total number of walking minutes, the research hypothesis is positively confirmed by: the (M1) attitudinal beliefs of walking related to health benefits (AtWkHt), and (M5) the perceived walking control related to the proximity of destinations (PCWkProx). However, in terms of the rest of the factors for the belief-based measures of walking, the associations respond to the null hypothesis of non-association. Moreover, the walkability index was associated with approximately 2.1 more minutes of walking per week as mediated by (M1) the attitudinal beliefs of walking, which is related to health benefits (AtWkHt), and approximately 1.3 more minutes of walking per week, as mediated by the perceived walking control, which is related to the proximity of destinations (PCWkProx).

7.5.3 Perceived environment factors

Research question three: Do the factors of the perceived environment mediate the direct effect of the physical environment on the walking outcomes?

To test the ability of the perceived environment measures to mediate the effect of the physical environment (walkability index X) on the walking behaviour outcomes, the correlation between the mediators and the walking outcome variables first needed testing. This aimed to check its validity for the regression analysis as correspondent predictors for the dependent variable. From this test, ten variables showed a significant correlation with the outcome variables, and six variables showed a non-significant correlation. Thus, the ten mediators that showed a significant correlation with the outcome variables were employed in this model, namely: M1, M2, M3, M4, M5, M6, M7, M8, M9, and M11 (Table 7-14). Moreover, the ten variables were considered for further analyses, using three mediation tests due to the multiple walking outcomes.

Table 7-14: Correlation between the perceived environment factors and outcome variables

Mi			Total walking minutes per a week	Total Travel distance per a week	Total number of journeys
M1	"I think that my neighbourhood is a pleasant place to walk"	Pearson Correlation	.355**	.332**	.283**
		Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M2	"I think that my neighbourhood is a safe place to walk"	Pearson Correlation	.406**	.618**	.578**
		Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M3	"I think that the local shops in your neighbourhood satisfy my daily needs"	Pearson Correlation	.460**	.581**	.551**
		Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M4	"Local shops in my neighbourhood are within easy walking distance of my home"	Pearson Correlation	.529**	.584**	.508**
		Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M5		Pearson Correlation	.325**	.386**	.333**

	"Streets in my neighbourhood are well designed for walking"	Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M6	"The dead-end streets in my neighbourhood embed my walking"	Pearson Correlation	.360**	.537**	.511**
		Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M7	"There are many alternative routes to move from place to another place in my neighbour-hood"	Pearson Correlation	.382**	.533**	.487**
		Sig. (2-tailed)	.000	.000	.000
		N	175	175	175
M8	"I feel safe of traffic when I walk in or near my neighbourhood"	Pearson Correlation	.258**	.434**	.409**
		Sig. (2-tailed)	.001	.000	.000
		N	175	175	175
M9	"The crimes in my neighbourhood are low then I feel safe to walk"	Pearson Correlation	.094	.044	.052
		Sig. (2-tailed)	.214	.564	.492
		N	175	175	175
M10	"My neighbourhood has several facilities, like schools, mosques, Gym halls, cafes, play grounds	Pearson Correlation	.009	-.060	-.083
		Sig. (2-tailed)	.905	.433	.273
		N	175	175	175
M11	"I see and speak to other people when I am walking in my neighbourhood"	Pearson Correlation	.250**	.326**	.300**
		Sig. (2-tailed)	.001	.000	.000
		N	175	175	175
M12	"Parking cars in the streets of my neighbourhood embed my walking"	Pearson Correlation	.144	.053	.051
		Sig. (2-tailed)	.057	.570	.56
		N	175	175	175
M13	"Considering the overall condition of my neighbourhood, I am satisfied of living in it"	Pearson Correlation	-.188*	-.332**	-.342**
		Sig. (2-tailed)	.013	.000	.000
		N	175	175	175

Note: The models of the mediation effects are multiplied due to the multiple walking outcomes.

7.5.3.1 Mediation modelling with the total walking distance

Model one tests whether the ten perceived environment factors (Table 7-14), mediate the direct effect of the walkability index (X) on the total walking distance (TotWkDis or Y) per week. The path analyses were run on the SPSS-PROCESS-*macros*, using Hayes's (2016) instrument to conduct the model. The paths, ai and bi, (Figure 7-1) are computed from Equations 7-1 and 7-2, respectively, and Table 7-15 summarises the output of the path analyses. The path of direct effect c` is computed from Equation 7-3 (Appendix 6, Model 4). However, the direct effect of the walkability index (X) on the total walking minutes (c`) was non-significant (*b*=-.0028, *t*(163) = -.0245, *p*>.05). Accordingly, from a1b1 to a10b10 (Table 7-15) and c` (*b*=-.0028), the total effect on Y is computed from Equation 7-4:

The total effect (0.4633) = indirect effect (Table 7-15) 0.4661+direct effect (c`) -0.0028

Table 7-15: Total indirect effect of the perceived environment on total walking distance

Path	β_1 from a_1	β_1 from b_1	Indirect effect (B)	
a1b1	0.0333	0.3595	0.0120	
a2b2	0.1281	0.7333	0.0939	
a3b3	0.1727	0.4037	0.0697	
a4b4	0.1224	0.7442	0.0911	
a5b5	0.1795	0.0107	0.0019	
a6b6	0.3385	0.4161	0.1408	
a7b7	0.3088	0.2081	0.0643	
a8b8	0.3173	-0.0661	-0.0210	
a9b9	0.1982	0.1159	0.0230	
a10b10	-0.2258	0.0427	-0.0096	
Total indirect effect			0.4661	

Although the mediators contributed differently to the indirect effect, not all showed a significant effect. The significance of the mediation role was determined by the bootstrap analysis, and the interval between the lower (BootLLCI) and upper (BootULCI) values showed that the following have a significant mediation role, where the interval should not contain zero value, otherwise the mediation role would be considered non-significant: (M2) ‘My neighbourhood is a safe enough so that I would let a 10-years-old boy walk around my block alone in the day time’ (SafePls), (M3) ‘I can do most of my shopping at my neighbourhood’ (ShopSat), (M4) ‘Local shops in my neighbourhood are within easy walking distance of my home’ (ProxDist), (M6) ‘The streets in my neighbourhood do not have many cul-de-sacs’ (CulDeSec) Therefore, the following were calculated:

- M2, b=.0939, BootLLCI= .0326, BootULCI=.1832;
- M3, b=.0697, BootLLCI= .0027, BootULCI= .1454;
- M4, b=.0911, BootLLCI= .0285, BootULCI= .1695;
- M6, b= .1408, BootLLCI=.0169, BootULCI=.2595.

Thus, the interval between the lower and the upper bootstrap analysis values do not go via zero (contain zero value) for only four variables for the perceived environment. These were considered with regard to their mediation role, namely to absorb the effect from the independent variable and create an indirect effect on the dependent variable (the walking outcome variable).

As such, from examining the factors of the perceived environment with the total walking distance, the research hypothesis is positively confirmed with M2, M3, M4, and M6. However, in terms of the rest of the factors of the perceived environment, the associations respond to the null hypothesis of non-association. Moreover, the walkability index was associated with approximately: 0.1-kilometer greater walking distance per week, as mediated by M2, which is ‘My neighbourhood is a safe enough so that I would let a 10-years-old boy walk around my block alone in the day time’ (SafePls); 0.1-kilometer greater walking distance per week, as mediated by M3, which is ‘I can do most of my shopping at my neighbourhood’ (ShopSat); 0.1-kilometer greater walking distance per week, as mediated by M4, which is ‘Local shops in my neighbourhood are within easy walking distance of my home’ (ProxDist); and 0.14-kilometer greater walking distance per week, as mediated by M6, which is ‘The streets in my neighbourhood do not have many cul-de-sacs’ (CulDeSac).

7.5.3.2 Mediation modelling with the total number of walking journeys

Model two tests whether the ten perceived environment factors (Table 7-10) mediate the direct effect of the walkability index (X) on the total number of walking journeys (TotWkFrq or Y) per week. The path analyses were run on the SPSS-PROCESS-*macros*, using Hayes’s (2016) instrument to conduct the model. The paths, ai and bi, (Figure 7-1) are computed from Equations 7-1 and 7-2, respectively. Table 7-16 summarises the output of the path analyses, and the path of direct effect c` is computed from Equation 7-3 (Appendix 6, Figure Model 5). However, the direct effect of the walkability index (X) on the total walking journeys (c`) was non-significant (*b*=0.0699, *t*(163) = .0445, *p*>.05). Accordingly, from a1b1 to a10b10 (Table 7-16) and c` (*b*=0.0699), the total effect on Y is computed from Equation 7-4:

The total effect (0.4648) =indirect effect (Table 7-16) 0.3949 + direct effect (c`) 0.0699

Table 7-16: The total indirect effect of the perceived environment on total walking journeys

Path	β_1 from a_1	β_1 from b_1	Indirect effect (B)	
a1b1	0.0333	0.2789	0.0093	
a2b2	0.1281	0.8285	0.1061	
a3b3	0.1727	0.4569	0.0789	
a4b4	0.1224	0.5171	0.0633	
a5b5	0.1795	-0.0906	-0.0163	
a6b6	0.3385	0.3813	0.1291	
a7b7	0.3088	0.0882	0.0227	
a8b8	0.3173	-0.0932	-0.0292	
a9b9	0.1982	0.0810	0.0161	
a10b10	-0.2258	-0.0478	0.0108	
Total indirect effect			0.3949	

Although the mediators contributed differently to the indirect effect, not all showed a significant effect. The significance of the mediation role was inspected by the bootstrap analysis, and the interval between the lower and upper bootstrap, (b=.1061, BootLLCI= .0433, BootULCI=.1980), was only significant with M2, which is: 'My neighbourhood is a safe enough so that I would let a 10-year-old boy walk around my block alone in the daytime' (SafePls). Thus, it is demonstrated that the interval between the lower and upper bootstrap analysis values do not contain zero for only one variable, which is considered to have a mediation role. In other words, it absorbs the effect from the independent variable and creates an indirect effect on the dependent variable (namely, the walking outcome). Thus, from examining the perceived environment factors with the total walking number of journeys, the research hypothesis is positively confirmed with M2. However, in terms of the remaining perceived environment factors, the associations respond to the null hypothesis of non-association. Moreover, the walkability index was associated with approximately 0.1 greater number of walking journeys per week, as mediated by M2.

7.5.3.3 Mediation modelling with the total walking minutes

Model three tests whether the ten perceived environment factors (Table 7-14) mediate the direct effect of the walkability index (X) on the total walking minutes (TotWkMin or Y) per week. Path analyses were run on the SPSS-PROCESS-*macros*, using Hayes's (2016) instrument to conduct the model. The paths, ai and bi, (Figure 7-1) are computed from Equations 7-1 and 7-2, respectively, and Table 7-17 summarises the output of the path analyses. The path of direct effect c\` is computed from Equation 7-3 (Appendix 6, Model 6). However, the direct effect of the walkability index (X) on the total walking minutes (c\`) was non-significant (b=1.3547, t (163) =.4381, p>.05). Accordingly, from a1b1 to a10b10 (Table 7-23) and c\` (b=1.3547), the total effect on Y is computed from Equation 7-4:

The total effect (7.7862) = indirect effect (Table 7-17) 6.4316+direct effect (c\`) 1.3547

Table 7-17: The total indirect effect of the perceived environment on the total walking minutes

Path	β_1 from a_1	β_1 from b_1	Indirect effect (B)	
a1b1	0.0333	14.7084	0.4894	
a2b2	0.1281	-0.7967	-0.1021	
a3b3	0.1727	13.0937	2.2615	
a4b4	0.1224	25.4799	3.1179	
a5b5	0.1795	1.5268	0.2741	
a6b6	0.3385	6.7096	2.2713	
a7b7	0.3088	4.0427	1.2485	
a8b8	0.3173	-6.4816	-2.0565	
a9b9	0.1982	1.4082	0.2791	
a10b10	-0.2258	-5.9870	1.3516	
Total indirect effect			6.4316	

Although the mediators contributed differently to the indirect effect, not all showed a significant effect. The significance of the mediation role was calculated by the bootstrap analysis, and the interval between the lower (BootLLCI) and upper (BootULCI) values showed that the following have a significant mediation role (where the interval should contains zero value, otherwise the mediation role will be considered non-significant: (M1) 'There are many attractive thinks to look at while walking in my neighbourhood' (PlsntPls); (M3) 'I can do most of my shopping at my neighbourhood' (ShopSat); (M4) 'Local shops in my neighbourhood are within easy walking distance of my home' (ProxDist). Thus, the following are calculated:

- M1, b=.4894, BootLLCI= .0164, BootULCI=1.4099;
- M3, b=2.2614, BootLLCI= .3402, BootULCI= 4.6476;
- M4, b=3.1179, BootLLCI= 1.4968, BootULCI= 5.0119.

It is demonstrated that the interval between the lower and upper bootstrap analysis values do not go via zero (contain zero value) for four variables, which are considered the mediators of the mediation roles. In other words, they absorb the effect from the independent variable and create an indirect effect on the dependent variable (the walking outcome variable). Thus, from examining the perceived environment factors with the total walking minutes, the research hypothesis is positively confirmed with M1, M3, M4, and M6. However, in terms of the remaining perceived environment factors, the associations respond to the null hypothesis of non-association. Moreover, the walkability index was associated with: approximately 0.5 more walking minutes per week, as mediated by M1, which is 'There are many attractive thinks to look at while walking in my neighbourhood' (PlsntPls); approximately 2.3 more walking minutes per week, as mediated by M3, which is 'I can do most of my shopping at my neighbourhood' (ShopSat); and approximately 3.1 more walking minutes per week, as mediated by M4, which is 'Local shops in my neighbourhood are within easy walking distance of my home' (ProxDist).

7.6 Level 4 analyses: The moderation roles of the socio-demographic factors:

The fourth statistical analysis level comprises the moderation tests. The personal traits were considered postulated moderators that might influence the direct effect of the physical environment on the walking outcome. The physical environment factor was considered the independent factor (X) that influenced the walking outcomes as a dependent variable (Y) and the personal traits were considered moderation factors which interacted with X to generate a third factor of influence (Int) on Y.

Research question four: Do the personal trait factors moderate the direct effect of the physical environment on the walking outcomes?

Table 7-18: The correlation between personal information and outcome variables

		Total Travel Distance Km/W	Total number of walking	Total walking m/w
(A2) Gender of respondent	Pearson Correlation	.117	.281**	-.087
	Sig. (2-tailed)	.124	.055	.252
	N	175	175	175
(A8) Body Mass Index	Pearson Correlation	-.328**	-.330**	-.170*
	Sig. (2-tailed)	.000	.000	.024
	N	175	175	175
(A3) Age categories of respondents	Pearson Correlation	-.239**	-.240**	-.174*
	Sig. (2-tailed)	.001	.001	.022
	N	175	175	175
(A4) How much is your approximate monthly income?	Pearson Correlation	-.104	.197**	-.141
	Sig. (2-tailed)	.171	.009	.05
	N	175	175	175
(A5) Work Status DM1	Pearson Correlation	-.038	-.079	-.001
	Sig. (2-tailed)	.614	.301	.991
	N	175	175	175
Work Status DM2	Pearson Correlation	-.213**	-.236**	.005
	Sig. (2-tailed)	.005	.002	.949
	N	175	175	175
Work Status DM3	Pearson Correlation	-.074	.273**	-.120
	Sig. (2-tailed)	.333	.000	.114
	N	175	175	175
(A6) Marital_status_DM1	Pearson Correlation	-.057	-.024	-.020
	Sig. (2-tailed)	.457	.748	.794
	N	175	175	175
Marital_status_DM2	Pearson Correlation	.014	-.106	-.033
	Sig. (2-tailed)	.856	.161	.666
	N	175	175	175
Marital_status_DM3	Pearson Correlation	-.159*	-.073	-.141
	Sig. (2-tailed)	.055	.337	.063
(A7) Do you practice any type of sport or regular exercise?	Pearson Correlation	.198**	.102	.183*
	Sig. (2-tailed)	.008	.180	.015
	N	175	175	175
(A9) How many Person of your family?	Pearson Correlation	.184*	.105	.136
	Sig. (2-tailed)	.055	.168	.072
	N	175	175	175
(A10) How many under 18 years old members of your family?	Pearson Correlation	-.017	-.123	-.073
	Sig. (2-tailed)	.827	.104	.337
	N	175	175	175
(A11) How many total cars that your family has?	Pearson Correlation	-.172*	-.088	-.122
	Sig. (2-tailed)	.023	.045	.05
	N	175	175	175
(A12) How long you been living in this house?	Pearson Correlation	.053	.013	.030
	Sig. (2-tailed)	.490	.867	.699
	N	174	174	174
(A13) How many of bedrooms your house is consisting?	Pearson Correlation	-.154*	-.180*	-.083
	Sig. (2-tailed)	.052	.057	.276
	N	175	175	175

(A14) HousTyp_DM1	Pearson Correlation	-.125	-.121	-.029
	Sig. (2-tailed)	.100	.111	.704
	N	175	175	175
HousTyp_DM2	Pearson Correlation	-.125	-.121	-.029
	Sig. (2-tailed)	.100	.111	.704
	N	175	175	175
(A15) Does your household owned or rented?	Pearson Correlation	-.059	-.043	-.011
	Sig. (2-tailed)	.435	.574	.887
	N	175	175	175

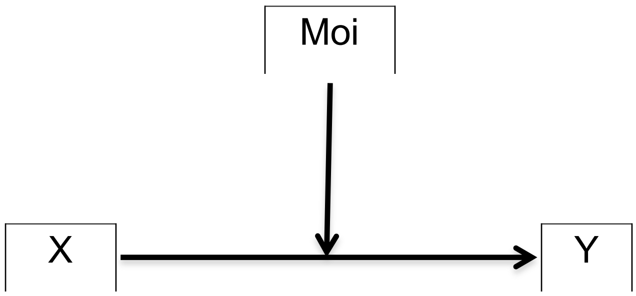
As a preliminarily step, the Pearson correlation test was conducted and only the variables with a significant correlation with the outcome variables were considered in the subsequent statistical analyses. In this respect, only age (A2), approximate monthly income (A4), work status (A5), practicing any type of sport or regular exercise (A7), body mass index (BMI) (A8), and number of cars (A11) showed significant correlations (Table 7-18).

7.6.1 Explaining the method

To test the moderation role of the socio-demographic and BMI factors on the research questions, the moderation model (Figure 3-1) outlined by Bauman, Sallis, Dzewaltowski, & Owen (2002) is considered in this research. It illustrates the paths of the direct effect (by the determining factor X) and indirect effects (by a moderator Mo) on the outcome (Y). Also, the third variable of effect is generated from the interaction between X and Mo, which is Int_1. In this regard, the regression analysis was conducted to calculate the effect size of the predictor and moderation variables on the walking outcome variables. The significance of the moderation is considered in relation to the effect of the interaction variable (Int_1). To operate the statistical analysis, Hayes (2016) developed models to represent several combinations or relationships between a predictor (X), moderators (M), and a dependent outcome (Y). His work was developed as a plugin, called *PROCESS macros*, that is compatible with SPSS software. A compatible model with the moderation model of this research was selected (model-1) (Figure 7-2), which depends on SEM (Equation 7-6) Hayes (2012).

Equation 7-5: The moderation effect on the relationship between the predictor and the outcome variable (Hayes, 2012)

$$Y=\beta_0+\beta_1 Mo1+\beta_2 X+\beta_3 Int\_1$$



X: Predictor variable

Moi: Moderator variable

Y: Total walking distance per a week

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Figure 7-2: Moderation effect model-1 by Hayes (2012, and 2016)

7.6.2 Moderation test: socio-demographic factors with the walking behaviour outcomes

This model tests whether the personal trait variables (Moi) moderate the direct effect of the walkability index (X) on walking behaviour outcomes, and include: age (Mo1), approximate monthly income (Mo2), work status (Mo3), practicing sport or regular exercise (Mo4), body mass index (BMI) (Mo5), and number of cars (Mo6).

1. **Age:**

The age (Mo1) and walkability index (X) predictors were simultaneously entered into the regression device for every walking outcome. The model's summary indicated that the predictors significantly explain the variance of the total walking distance (F(3, 171) = 25.2256, p<.001, R^2 = .3068). Thus, the higher the value of X, (b=.4572, t(171) = 7.8235, p<.001) and the younger the age (Mo1) (b= -.4929, t(171) = -3.5160, p<.001), the greater the walking distance achieved per week (negatively correlated). However, the interaction factor (int_1) between the walkability index and age has a non-significant effect on the total walking distance (b=.0301, t(171)=.5499, p>.05, R^2 change=.0149) suggesting that the effect of the walkability index (X) does not depend on age (Table 7-19). Similarly, in term of interaction factor (Int_1), when the age factor was tested with the other two walking outcomes, the results produced a non-significant

[12] The equation 7-5 is elicited by this research from the *PROCESS* macros software-tool by Hayes (2012)

moderation (Table 7-19). Thus, this test confirms the null hypothesis of the non-association of all walking behaviour outcomes with the age factor as a moderator.

Table 7-19: Testing the direct and moderation effect of the age factor on walking outcomes

Walking outcome	Model	Coeff.	s.e.	t	p.value
Total walking distance	constant	8.1063	.1663	48.7465	.0000
	Age	-.4929	.1401	-3.5182	.0006
	WalkIndx	.4572	.0609	7.5014	.0000
	int_1	.0301	.0521	.5773	.5645
Total walking journeys	constant	12.6338	.1750	72.1958	.0000
	Age	-.5190	.1550	-3.3493	.0010
	WalkIndx	.4583	.0586	7.8168	.0000
	int_1	-.0046	.0467	-.0989	.9213
Total walking minutes	constant	182.6289	4.2797	42.6729	.0000
	Age	-8.3837	4.0825	-2.0536	.0415
	WalkIndx	7.6786	1.6118	4.7639	.0000
	int_1	-1.0685	1.4362	-.7439	.4579

2. **Income**:

The income (Mo2) and walkability index (X) predictors were simultaneously entered into the regression device for every walking outcome. The model's summary indicated that the predictors significantly explained the variance of the total walking distance (*F(3, 171)=23.9116, p<.001,* R^2*=.295*). Thus, the higher the value of X (*b*=.4526, *t*(171)=7.3793, *p*<.001), and the lower the income (Mo2) (*b*=-.0821, *t*(171)=-.7499, *p*>.05), the greater the walking distance per week (negatively correlated). Moreover, the interaction factor between the walkability index and the income showed a significant effect on the total walking distance (Y, *b*=.1052, *t*(173)=2.7703, *p*<.01, R^2 change=.0351). This suggests that the effect of the walkability index (X) significantly depends on the income factor. Based on *PROCESS macros*, Simple slopes test for the association between the walkability index and total walking distance were tested for low (-1 SD below the mean), moderate (mean), and high (+1 SD above the mean) participant incomes. Each category showed a significant effect on the association between the walkability index value and the total walking distance; however, the walkability index score was a little closer related to the total walking distance for higher incomes (*b*=.6193, *t*(173)=7.5667, *p*<.001), than the moderate level income (*b*=.4526, *t*(173)=7.3793, *p*<.001), and lower category income (*b*=.2860, *t*(173)=3.1849, *p*<.01). In other words, the higher the income, the lower the walking distance (Table 7-20). This test positively confirms the research hypothesis that the total walking distance is significantly associated with the income factor as a moderator. However, in term of interaction factor (Int_1), when the income factor was tested with the other two walking outcomes, the results produced non-significant moderation effects (Table 7-20).

Table 7-20: Testing the direct and moderation effect of the income factor on walking outcomes

Walking outcome	Model	Coeff.	s.e.	t	p.value
Total walking distance	constant	8.1347	48.0039	48.0039	.0000
	Income	-.0821	.1095	-.7499	.4543
	WalkIndx	.4526	.0613	7.3793	.0000
	int_1	.1052	.0380	2.7703	.0062
Total walking journeys	constant	12.6357	.1781	70.9356	.0000
	Income	.3953	.1130	3.4984	.0006
	WalkIndx	.4793	.0606	7.9147	.0000
	int_1	.0047	.0349	.1339	.8937
Total walking minutes	constant	183.2647	4.3083	42.5376	.0000
	Income	-3.9153	2.8152	-1.3908	.1661
	WalkIndx	7.5112	1.6213	4.6328	.0000
	int_1	1.7766	.9631	1.8447	.0668

3. **Practising a sport or regular exercise**:

The ‘practicing sport or regular exercise’ (Mo3) and walkability index (X) predictors were simultaneously entered into the regression device for every walking outcome. The model’s summary illustrated that the predictors significantly explained the total walking distance variance (F(3, 171)=22.0631, p<.001, R^2=.3045). Thus, the higher values of X (b=.4711, t(171)=7.5697, p<.001), and ‘practicing sport or regular exercise’ (Mo4) (b=0046, t(171)=2.7531, p<.01) are associated with greater walking distances per week (positively correlated).

Table 7-21: Testing the direct and moderation effect of the ‘practicing a type of sport’ factor on the walking outcomes

Walking outcome	Model	Coeff.	s.e.	t	p.value
Total walking distance	constant	8.1072	.1676	48.3866	.0000
	PrcSport	2.0046	.7281	2.7531	.0065
	WalkIndx	.4711	.0622	7.5697	.0000
	int_1	.1167	.2784	.4193	.6755
Total walking journeys	constant	12.6349	.1810	69.8063	.0000
	PrcSport	1.1464	.6867	1.6694	.0969
	WalkIndx	.4695	.0617	7.6141	.0000
	int_1	.0177	.2130	.0832	.9338
Total walking minutes	constant	182.9463	4.2637	42.9078	.0000
	PrcSport	43.5206	19.2454	2.2613	.0250
	WalkIndx	7.9355	1.6212	4.8947	.0000
	int_1	6.3709	7.3653	.8650	.3883

However, the interaction factor (int_1) between the walkability index and the 'practising sport or regular exercise' factor has a non-significant effect on the total walking distance (*b*=.1167, $t(171)=.4193$, $p>.05$, R^2 *change* =.0014). This suggests that the walkability index (X) effect does not depend on practising sport or regular exercise to influence the walking outcomes (Table 7-21). Similarly, in term of interaction factor (Int_1), when the 'practising sport or regular exercise' factor was tested with the other two walking outcomes, the results produced non-significant moderation effects (Table 7-21). Thus, this tests the null hypothesis that all walking outcomes have a non-significant association with the income factor as a moderator.

4. **BMI**:

The BMI (Mo4) and walkability index (X) predictors were simultaneously entered into the regression device for every walking outcome. The model's summary presented predictors that significantly explained the variance amongst the total walking distances ($F(3, 171)=23.4853$, $p<.001$, $R^2=.2925$). The effect of each predictor was significant, and the higher the value of the walkability index (X), (*b=.4101*, $t(171)=5.8446$, $p<.001$), and the lower the BMI (Mo3), (*b*=-.2413, $t(171)=-2.1335$, $p<.01$), the greater the walking distance per week (negatively correlated). However, the interaction factor (int_1) between the walkability index and the BMI factor showed a non-significant effect (*b*=.0166, $t(171)=.4154$, $p>.05$, and R^2 change =.0015) (Table 7-22).

Table 7-22: Testing the direct and moderation effect of the BMI factor on walking outcomes

Walking outcome	Model	Coeff.	s.e.	t	p.value
Total walking distance	constant	183.4270	4.9812	36.8240	.0000
	BMI	-1.9942	3.2078	-.6217	.5350
	WalkIndx	7.3368	1.8858	3.8905	.0001
	int_1	.4009	1.1376	.3524	.7250
Total walking journeys	constant	12.6768	.1971	.1971	.0000
	BMI	-.2627	.0217	-2.3174	.0217
	WalkIndx	.4066	.0669	6.0757	.0000
	int_1	.0246	.0381	.6450	.5198
Total walking minutes	constant	.1917	42.4189	42.4189	.0000
	BMI	-.2413	.1131	-2.1335	.0343
	WalkIndx	.4101	.0702	5.8446	.0000
	int_1	.0166	.0399	.4154	.6783

Similarly, in term of interaction factor (Int_1), when the BMI factor was tested with the other two walking outcomes, the results produced non-significant moderation effects (Table 7-22). Thus, this test confirms the null hypothesis that all walking outcomes have non-significant associations with the BMI factor as a moderator.

5. **The number of cars**:

The number of cars (Mo5) and walkability index (X) predictors were simultaneously entered into the regression device. The model's summary illustrated that the predictors significantly explained the variance of the total walking distance, (F(3, 171)=18.1351, p<.001, R^2=.2557). The effect of the walkability index (X) was significant (b=.4617, t (171)=6.9410, p<.001), but the effect of the number of cars that participants owned was not significant (Mo6) (b=-.0573, t(171)=-.2303, p>.05). Also, the interaction factor between the walkability index and the number of cars has no significant effect on the total walking distance (b= -.0330, t (171) = -.4027, p>.05, R^2 change = .0006). This suggests that the effect of the walkability index (X) does not depend on the number of cars, or, in other words, the number of cars does not moderate the effect of predictor X on outcome variable Y. Moreover, based on *PROCESS macros*, the simple slopes test for the association between the walkability index and total walking distance were not conducted because the effect of the interaction factor was non-significant (Table 7-23). Similarly, in term of interaction factor (Int_1), when the number of cars factor was tested with the other two walking outcomes, the results produced non-significant moderation effects (Table 7-23). Thus, this test confirms the null hypothesis that all walking outcomes have non-significant associations with the number of cars factor as a moderator.

Table 7-23: Testing the direct and moderation effects of the number of cars factor on walking outcomes

Walking outcome	Model	Coeff.	s.e.	t	p.value
Total walking distance	constant	8.0832	.1797	44.9804	.0000
	NuCars	-.0573	.2488	-.2303	.8181
	WalkIndx	.4617	.0665	6.9410	.0000
	int_1	-.0330	.0818	-.4027	.6877
Total walking journeys	constant	12.5612	.1845	68.0941	.0000
	NumCar	.2512	.2902	.8655	.3880
	WalkIndx	.4947	.0642	7.7018	.0000
	int_1	-.1195	.0884	-1.3527	.1779
Total walking minutes	constant	181.5395	4.1869	43.3589	.0000
	NuCars	-1.2141	6.0170	-.2018	.8403
	WalkIndx	7.8641	1.6395	4.7965	.0000
	int_1	-1.9535	2.2975	-.8503	.3964

6. **Work status**:

The work status (Mo6) factor is a categorical variable of five levels. The categories were recorded into four dummy variables with the unemployed status left as a control, or no effect, variable. From this, the interaction variables were produced to determine the interaction between the walkability index variable (X) and the four dummy variables. A hierarchical regression analysis was conducted to test the moderation effect of work status on every walking outcome (Y). Before applying the regression analysis, the Pearson correlation test was conducted to assure the entry condition of the variables. It showed that the following variables were significantly correlated with outcome Y: employed-walkability-index interaction, and free-business-walkability-index interaction. In contrast, the house-keeper-walkability-index interaction variable and the student-walkability-index variable have no significant correlation with Y. Thus, the second two interaction variables were excluded from the later regression tests.

Table 7-24: Testing the moderation effect of the work status factor on walking outcomes

Walking outcomes		Unstandardized Coefficients		t	p.value
		B	Std. Error		
Total walking distance	(Constant)	7.978	.162	49.227	.000
	Walkability index	.116	.097	1.194	.234
	IntWS1	.339	.139	2.430	.016
	IntWS3	.666	.135	4.920	.000
Total walking journeys	(Constant)	12.563	.181	69.546	.000
	Walkability index	.385	.108	3.550	.000
	IntWS1	-.063	.155	-.407	.685
	IntWS3	.272	.151	1.801	.073
Total walking minutes	(Constant)	180.743	4.214	42.889	.000
	Walkability index	1.174	2.530	.464	.643
	IntWS1	7.782	3.626	2.146	.033
	IntWS3	11.570	3.520	3.287	.001

The model summary (Table 7-24) illustrated that the walkability index (X) showed a non-significant effect (b=.116, $t(171)$=1.194, p>.05). The employed-walkability-index interaction variable (IntWS1) showed a significant effect on the total walking distance (Y b=.339, $t(171)$=2.43, p<.05), a non-significant effect on the total number of walking journeys (Y b=-.063, $t(171)$=-.407, p>.05), and a significant effect on the outcome variable (Y b=7.782, $t(171)$=2.146, p<.05). Also, the effect of the free-business-walkability-index interaction factor (IntWS3) was significant on the total walking distance (b=.666, $t(171)$=4.920, p<.001). However, it was non-significant on the total number of walking journeys (b=.272, $t(171)$=1.801, p>.05), and significant for the total walking minutes (b=11.570, $t(171)$=3.287, p<.001). The analysis explains that the effect of the walkability index (X) on the total walking distance considerably depended on the work status for employed and free business types of jobs (Table 7-24). Thus, this test confirms the research hypothesis that the walking behaviour outcomes are significantly associated with the employed and free business types of jobs (from the work status factors) as moderators.

7.7 Level 5 analyses: The determination roles of the objectively measured physical environment factors

This level of statistical analysis examines the extent to which the objective measures of the physical environment are able to explain the variance amongst the walking outcomes. The objectively measured attributes of the physical environment were tested in terms of their predictability for the walking outcomes. Thus, their variables are considered predictors (X), which need to be tested in terms of their predictability for walking outcomes (Y). For such a purpose, the hierarchal regression analysis was chosen because of its flexibility to enter predictors in a split block with extra predictors. In this respect, the personal information that have a significant correlation with the outcomes were entered as a second regression block and this included: age, income, work status, practising sport or regular exercise, BMI, and the number of cars. Moreover, the p-value (<.05) indicates the significance of the models, while the R^2 and R^2-change explain the potential of the predictors to explain the variance of the outcomes.

Research question five: Do the objective measures of the physical environment predict the walking outcomes?

This analysis tests whether the walking outcome variables can be individually predicted by the objectively measured attributes of the physical environment, and moderated by the personal traits, and thus produce significant correlations. The hierarchical regression analyses were run to test the predictability of the objective measures, which were individually tested with the three outcome variables in three models (Models 1, 2, and 3) for each indicator. Moreover, the moderation variables (the socio-demographic factors and BMI) were added into the second block of each model, while the first block of every model included only the predictor in question (an objectively measured physical environment attribute (X) to determine the effect significance of the predictor on the outcome variables (p-value), the determination coefficient (R^2), and the R^2-change after adding the moderators.

7.7.1 Block density:

The block density was measured on a 400-meter radius scale (Table 6-2). It represents predictor (X) that needs to be tested in terms of its effect and predictability on each of the three walking outcome variables. Thus, three models are analysed after resembling the independent variable (X) into the outcome variables (Y). Moreover, the moderation variables were added into the models to test the predictability of the predictors (X), as moderated by the personal traits (otherwise known as the moderators (Mo)).

(a) **The block density (BlkDnS2) on a 400-meter radius scale**

The predictability of the first block amongst the three models was significant with all of the outcome variables, including the total walking distance (F (173, 1) = 88.064, p<.001, R^2=.337), the total walking journeys (F (173, 1) = 82.947, p<.001, R^2=.324), and total walking minutes (F (173, 1) =16.989, p<.001, R^2=.089). Thus, the singular models were able to explain, 33.7%, 32.4%, and 8.9% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Also, the predictability significantly increased after adding the moderators into the models with the total walking distance and the total walking journeys; however, it marginally increased with the total walking minutes (R^2 change= .127, .179, and .075 respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on all three outcome variables of the three models. Furthermore, the higher walking behaviour outcome scores were associated with higher block densities (BlkDnS2) at a 400-meter square radius scale (X), in terms of the total walking distance (b=21.343, p<.001), the total walking journeys (b=19.594, p<.001), and the total walking minutes (b=11.817, p<.001) (Appendix 7, Table 10-1).

7.7.2 Housing density:

The housing unit density was measured on one scale, namely the 400x400-meter square (Table 6-2). This indicator represents a predictor (X) that needs to be tested in terms of its effect and predictability for each of the three walking outcome variables. Thus, this analyses three models after resembling the independent variable (X) into the outcome variables (Y). Moreover, the moderation variables were added to the models to test the predictability of the predictors (X), as moderated by the personal traits, or moderators (Mo).

(a) **The housing units density: 400x400-meter square**

The predictability of the first block of the three models was significant with all of the outcome variables, which included: the total walking distance (F (173, 1) = 85.418, p<.001, R^2=.331), the total walking journeys (F (173, 1) =77.807, p<.001, R^2=.310), and the total walking minutes (F (173, 1) =26.231, p<.001, R^2=.132). Thus, the singular models were able to explain, 33.1%, 31%, and 13.2% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Also, after adding the moderators into the models the predictability significantly increased with the total walking distance and the total walking journeys but only marginally increased with the total walking minutes (R^2 change= .123, .174, and .080, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on all of the three outcome variables in the three models. Thus, the higher scores for walking behaviour outcomes were associated with higher housing units densities on the 400x400-meter square scale (X), impacting the total walking distance (b=.056, p<.001); the total walking journeys (b=.051, p<.001), and the total walking minutes (b=.040, p<.001) (Appendix 7, Table 10-2).

7.7.3 Land use diversity:

The land use diversity variables include all commercial land use (LUDiv1S2) within a 400-meter radius scale, which involves; commercial land use without parking, wholesale, and workshops (LUDiv2S2) within a 400-meter radius scale, and all non-residential land use (LUDiv3S2) within a 400-meter radius scale (Table 6-2). Each variable represents a predictor (X) that needs to be tested in terms of its effect and predictability on each of the three walking outcome variables. Thus, this analysis is conducted with nine models after resembling the independent variable (X) into the outcome variables (Y). Moreover, after accounting for the moderators, the moderation variables were added into the second block of each model to test the predictability of the predictors, as moderated by the personal traits (or moderators (Mo). Meanwhile, the first block of each model only includes the predictor in question (X).

(a) Diversity of all commercial land use (LUDiv1S2) on a 400-meter radius scale

The predictability of the first block of three models was significant with all of the outcome variables, including the total walking distance (F(173, 1)=71.636, p<.001, R^2=.293), the total walking journeys (F(173, 1)=68.864, p<.001, R^2=.285), and the total walking minutes (F(173, 1)=11.145, p<.001, R^2=.061). Also, the singular models were able to explain, 29.3%, 28.5%, and 6.1% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Moreover, after adding the moderators into the models, the predictability significantly increased with the total walking distance and total walking journeys, but only marginally increased with the total walking minutes (R^2 change= .136, .192, and .075, respectively). After accounting for the moderators, the effect of this predictor on the three outcome variables was significant with all the models. Furthermore, the higher walking behaviour outcome scores were associated with a higher diversity of all commercial land uses (LUDiv1S2) on a 400-meter radius scale (X), in terms of the total walking distance (b=5.146, p<.001); the total walking journeys (b= 4.772, p<.001); and the total walking minutes (b=2.478, p<.001) (Appendix 7, Table 10-3).

(b) Commercial land use without parking, wholesale, and workshops variable (LUDiv2S2) on a 400-meter radius scale

The predictability of the first block of the three models was significant with all of the outcome variables, including the total walking distance (F(173, 1)=93.027, p<.001, R^2=.350), the total walking journeys (F(173, 1)=86.695, p<.001, R^2=.334), and the total walking minutes (F(173, 1)=20.176, p<.001, R^2=.104). Thus, the singular models were able to explain, 35%, 33.4%, and 10.4% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Also, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys; however, it only marginally increased for the total walking minutes (R^2-change= .125, .175, and .076 respectively). Moreover, after accounting for the moderators, the effect of this predictor on the three outcome variables was still significant with all models, and the higher scores of walking behaviour outcomes were associated with the higher diversity of commercial land use without parking, wholesale, and workshops (LUDiv2S2) on a 400-meter radius scale (X). Thus, this is significant in terms of the total walking distance (b=4.029, p<.001), total walking journeys (b= 3.678, p<.001), and total walking minutes (b=2.390, p<.001) (Appendix 7, Table 10-4).

(c) Diversity of the non-residential land use (LUDiv3S2) on a 400-meter radius scale

The predictability of the first block of the three models was significant with all of the walking outcome variables, including the total walking distance (F(173, 1)=80.502, p<.001, R^2=.318), the total number of walking journeys (F 173, 1)=76.614, p<.001, R^2=.307), and the total walking minutes (F(173, 1)=13.947, p<.001, R^2=.075). Thus, the singular models were able to explain, 31.8%, 30.7%, and 7.5% of the variances of the total walking distance, the total walking journeys, and the total walking minutes, respectively. Also, after adding the moderators into the models the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .131, .185, and .075, respectively). Moreover, after accounting for the moderators, the effect of this predictor on the three outcome variables is still significant for all the models, and the higher of walking behaviour outcomes scores were associated with a lower diversity of non-residential land use (LUDiv3S2) on a 400-meter radius scale (X) in terms of the total walking distance (b=-7.066, p<.001); the total walking journeys (b=-6.521, p<.001); and the total walking minutes (b=-3.390, p<.001) (Appendix 7, Table 10-5).

7.7.4 Number of destinations:

The number of retail shops (RetShSi) was measured on two scales, a 400-meter radius and a 600-meter radius (Table 6-2). Each of the resulting four variables represent a predictor (X) that needs to be tested in terms of its effect and predictability on each of the three walking outcome variables. Thus, six models are analysed after resembling the independent variable (X) into three outcome variables (Y). Moreover, the moderation variables were added into the models to test the predictability of the predictors (X), as moderated by the personal traits or moderators (Mo).

(a) **The number of retail shops (RetShS2) on a 400-meter radius scale**

The predictability of the first block of the three models was significant for all of the outcome variables, including the total walking distance (F(173, 1)=52.818, p<.001,

R^2=.234), the total walking journeys (F(173, 1)=47.239, p<.001, R^2=.214), and the total walking minutes (F(173, 1)=25.821, p<.001, R^2=.130). Also, the singular models were able to explain, 23.4%, 21.4%, and 13% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Also, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .123, .185, and .078 respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on all three outcome variables in the three models. Thus, the higher walking behaviour outcome scores were associated with a higher number of retail shops (RetShS2) on a 400-meter radius scale (X), in terms of the total walking distance (b=.024, p<.001), and the total walking journeys (b=.021, p<.001); however, it was non-significant with the total walking minutes (b=.021, p<.001) (Appendix 7, Table 10-6).

(b) **The number of the retail shops (RetShS3) on a 600-meter radius scale**

The predictability of the first block of the three models was significant with all of the outcome variables, including the total walking distance (F(173, 1)=79.244, p<.001, R^2=.314), the total walking journeys (F(173, 1)=71.860, p<.001, R^2=.293), and the total walking minutes (F(173, 1)=26.873, p<.001, R^2=.134). Thus, the singular models were able to explain, 31.4%, 29.3%, and 13.4% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Also, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys; however, it only marginally increased for the total walking minutes (R^2 change= .123, .175, and .080, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on all three outcome variables in the three models. Thus, the higher walking behaviour outcome scores were associated with the higher number of the retail shops (RetShS3) on a 600-meter radius scale (X), in terms of total walking distance (b=.009, p<.001) and total walking journeys (b=.008, p<.001); however, it was non-significant with the total walking minutes (b=.007, p<.001), (Appendix 7, Table 10-7).

7.7.5 Connectivity of the street network

The connectivity of street network indicators include, node intensity (NodDnSi), street intensity (StDnSi), and the link-node ratio (LNRSi); these were measured on two scales, namely the 400-meter radius, and the 600-meter radius. Meanwhile, the external connectivity (ExtConS2) was measured on one scale, and this was the 400-meter radius (Table 6-2). Each of the seven variables represent a predictor (X) that needs to be tested in terms of its effect and predictability on each of the three walking outcome variables. Thus, after resembling the independent variable (X) into the outcome variables (Y), this analysis involved twenty-one models. Moreover, the moderation variables were added into the models to test the predictability of the predictors (X), as moderated by the personal traits, or moderators (Mo).

(a) **The node intensity (NodDnS2) on a 400-meter radius scale**

The predictability of the first block of three models was significant with all of the outcome variables, including the total walking distance (F (173, 1) = 78.050, p<.001, R^2=.311), total walking journeys (F (173, 1) = 70.724, p<.001, R^2=.290), and total walking minutes (F (173, 1) =26.940, p<.001, R^2=.135). Thus, the singular models were able to explain, 31.1%, 29.0%, and 13.5% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Also, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .122, .175, and .080, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on all three outcome variables in the three models. Therefore, the higher walking behaviour outcome scores were associated with the higher node intensities (NodDnS2) on the 400-meter radius (X) scale in terms of the total walking distance (b=.642, p<.001), and the total walking journeys (b=.573, p<.001) (Appendix 7, Table 10-8).

(b) **The nodes intensity (NodDnS3) on a 600-meter radius scale**

The predictability of the first block of the three models was significant with all of the outcome variables, including the total walking distance (F (173, 1) = 21.706, p<.001, R^2=.111), total walking journeys (F (173, 1) = 18.860, p<.001, R^2=.098), and total walking minutes (F (173, 1) =18.678, p<.001, R^2=.097). Also, the singular models were able to explain, 11.1%, 9.8%, and 9.7% of the variances of the total walking distance, total walking journeys, and total walking minutes respectively, (Appendix 7, Table 10-9).

(c) **The street intensity (StDnS2) on a 400-meter radius scale**:

The predictability of the first block of the three models was significant for all of the outcome variables, including the total walking distance (F(173, 1)=70.940, p<.001, R^2=.291), total walking journeys (F(173, 1)=64.028, p<.001, R^2=.270), and total walking minutes (F(173, 1)=27.071, p<.001, R^2=.135). Also, the singular models were able to explain, 29.1%, 27%, and 13.5% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Moreover, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .122, .177, and .08, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on all three outcome variables in the three models. Thus, the higher walking behaviour outcome scores were associated with a higher street intensity (StDnS2) on a 400-meter radius (X) scale in terms of the total walking distance (b=.011, p<.001), the total walking journeys (b=.010, p<.001), and the total walking minutes (b=.009, p<.001) (Appendix 7, Table 10-10).

(d) **The street intensity (StDnS3) on a 600-meter radius scale**:

The predictability of the first block of the three models was significant for all of the outcome variables, including the total walking distance (F(173, 1)=9.683, p<.01, R^2=.053), total walking journeys (F(173, 1)=8.067, p<.01, R^2=.045), and total walking minutes (F(173, 1)=13.331, p<.001, R^2=.072). Also, the singular models were able to explain 5.3%, 4.5%, and 7.2% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Moreover, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys; however it only marginally increased for the total walking minutes (R^2 change= .157, .238, and .069, respectively). In addition, after accounting for the moderators, the effect of this predictor was significant with two of the three outcome variables of the three models. Therefore, a higher walking behaviour outcome score was associated with a higher street intensity (StDnS3) on a 600-meter radius (X) scale in terms of the total walking journeys (b=.003, p<.05) and the total walking minutes (b=.005, p=.001); however, it was non-significant in terms of the total walking distance (b=.002, p>.05) (Appendix 7, Table 10-11).

(e) **Link-node ratio (LNRS2) on a 400-meter radius scale**:

The predictability of the first block of the three models was non-significant for all of the outcome variables, including the total walking distance (F (173, 1) =.126, p>.05, R^2=.001), total walking journeys (F (173, 1) =.289, p>.05, R^2=.002), and total walking minutes (F (173, 1) =3.118, p>.05, R^2=.018). Also, the singular models were able to explain .1%, .2%, and 1.8% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Additionally, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .195, .278, and .08, respectively). Moreover, after accounting for the moderators, the effect of the link-node ratio (LNRS2) on a 400-meter radius (X) scale was non-significant on all of the three outcome variables in the three models, in terms of the total walking distance (b=-3.008, p>.05); total walking journeys (b=-3.503, p>.05); and total walking minutes (b=3.991, p>.05) (Appendix 7, Table 10-12).

(f) **Link-node ratio (LNRS3) on a 600-meter radius scale**:

The predictability of the first block of the three models was significant for two of the outcome variables, including the total walking distance (F (173, 1) =17.238, p<.001, R^2=.091), and the total walking journeys (F (173, 1) =17.878, p<.001, R^2=.094). However, the total walking minutes showed non-significance (F (173, 1) =.317, p>.05, R^2=.002). Also, the singular models were able to explain, 9.1%, 9.4%, and .2% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Furthermore, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes, (R^2 change= .187, .260, and .08, respectively). In addition, after accounting for the moderators, the effect of this predictor was significant on two of the outcome variables in the three models, and the higher walking behaviour outcome scores were associated with the lower link-node ratio (LNRS3) on a 600-meter radius scale (X) in terms of the total walking distance (b=-2.838, p<.001), and total walking journeys (b=-2.751, p<.001). However, it was non-significant in terms of the total walking minutes (b=-.464, p>.05) (Appendix 7, Table 7-13).

(g) **External connectivity (ExtConS2) on a 400-meter radius scale**:

The predictability of the first block of the three models was significant with all the outcome variables, namely the total walking distance (F (173, 1) =80.636, p<.001, R^2=.318), the total walking journeys (F (173, 1) =73.188, p<.001, R^2=.297), and the total walking minutes (F (173, 1) =26.774, p<.001, R^2=.134). Also, the singular models were able to explain, 31.8%, 29.7%, and 13.4% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Moreover, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .122, .175, and .080, respectively). Furthermore, after accounting for the moderators, the effect of this predictor was significant on all the outcome variables in the three models, and the higher walking behaviour outcome scores were associated with a higher external connectivity (ExtConS2) on a 400-meter radius scale (X), in terms of the total walking distance (b=172.221, p<.001), the total walking journeys (b=154.119, p<.001), and the total walking minutes (b=125.756, p<.001) (Appendix 7, Table 10-14).

7.7.6 Block compactness:

The block compactness (BlkComS1) was measured on one scale, namely 400x400-meter square (Table 6-2). This variable represents a predictor (X) that needs to be tested in terms of its effect and predictability on each of the three walking outcome variables. Thus, this analysis involves three models after resembling the independent variable (X) into the outcome variables (Y). Moreover, the moderation variables were added into the models to test the predictability of the predictor (X), as moderated by the personal trait or the moderators (Mo).

(a) Block compactness (BlkComS1) on a 400x400-meter scale:

The predictability of the first block of the three models was non-significant for all the outcome variables, including the total walking distance (F (173, 1) = 78.050, p>.05, R^2=.311), total walking journeys (F (173, 1) = 70.724, p>.05, R^2=.290), and total walking minutes (F (173, 1) =26.940, p>.05, R^2=.135). Thus, there was no need to discuss the total models since the predictors showed non-significant predictabilities (Appendix 7, Table 10-15).

7.7.7 Pedestrian Catchment Area (PCA):

The Pedestrian Catchment Area (PCAS2) was measured on one scale, namely the 400-meter radius (Table 6-2). The variable of this indicator represents a predictor (X) that needs to be tested in terms of its effect and predictability for each of the three walking outcome variables. Thus, after resembling the independent variable (X) into the outcome variables (Y), this analysis involves three models. Moreover, the moderation variables were added into the models to test the predictability of the predictors (X), as moderated by the personal traits, or moderators (Mo).

(a) **The Pedestrian Catchment Area (PCAS2) on a 400-meter radius scale**:

The predictability of the first block of the three models was significant with all of the outcome variables, including the total walking distance (F (173, 1) = 83.160, p<.001, R^2=.325), total walking journeys (F (173, 1) = 78.879, p<.001, R^2=.313), and total walking minutes (F (173, 1) =14.914, p<.001, R^2=.079). Also, the singular models were able to explain, 32.5%, 31.3%, and 7.9% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Furthermore, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys; however, it only marginally increased for the total walking minutes (R^2 change= .129, .183, and .075, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on all three outcome variables in the three models. Thus, the higher walking behaviour outcome scores were associated with the lower value of the Pedestrian Catchment Area (PCAS2) on the 400-meter radius scale (X) in terms of the total walking distance (b=-.111, p<.001), and total walking journeys (b=-.102, p<.001); however, it was non-significant for the total walking minutes (b=-.059, p<.001) (Appendix 7, Table 10-16).

7.7.8 Pedestrian Route Directness Ratio (PRDR):

The Pedestrian Route Directness Ratio was measured on two scales; the 400-meter radius, and the 600-meter radius. This included two variables: the Pedestrian Route Directness Ratio (PRDRS2) on a 400-meter radius, and the Pedestrian Route Directness Ratio (PRDRS3) on a 600-meter radius (Table 6-2). Each variable represents a predictor (X) that needs to be tested in terms of its effect and predictability on each of the three walking outcome variables. Thus, this analysis involves six models after resembling the independent variable (X) into the outcome variables (Y). Moreover, the moderation variables were added into the second block of each model to test the predictability of the predictors, as moderated by the personal traits, or moderators (Mo); meanwhile the first block of each model only includes the predictor in question (X).

(a) **Pedestrian Route Directness Ratio (PRDRS2) on a 400-meter radius scale**: The predictability of the first block of the three models was significant for two of the outcome variables namely: the total walking distance (F (173, 1) = 5.563, p<.05, R^2=.031), and the total walking journeys (F (173, 1) = 6.198, p<.001, R^2=.035). However, the total walking minutes were non-significant (F (173, 1) =.301, p>.05, R^2=.002). Similarly, the singular models were able to explain the variances of the total walking distance, total walking journeys, and total walking minutes, at 3.1%, 3.5%, and .2%, respectively. Also, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .198, .277, and .079, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on two of the outcome variables of the three models. Thus, the higher walking behaviour outcome scores were associated with the lower Pedestrian Route Directness Ratio (PRDRS2) on a 400-meter radius (X), in terms of the total walking distance (b=-9.543, p<.01) and the total walking journeys (b=-9.614, p<.01). However, it was non-significant with the total walking minutes (b=1.231, p>.05) (Appendix 7, Table 10-17).

(b) **Pedestrian Route Directness Ratio (PRDRS3) on a 600-meter radius scale**: The predictability of the first block of the three models was significant for two of the outcome variables, including the total walking distance (F (173, 1) = 6.028, p<.001, R^2=.079) and the total walking journeys (F (173, 1) = 15.520, p<.001, R^2=.082). However, the total walking minutes were non-significant (F (173, 1) =.142, p>.05, R^2=.001). Also, the singular models were able to explain, 7.9%, 8.2%, and .1% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Furthermore, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .190, .264, and .080, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on two of the outcome variables of the three models. Moreover, the higher walking behaviour outcome scores were associated with the lower Pedestrian Route Directness Ratio (PRDRS3) on a 600-meter radius (X) in terms of the total walking distance (b=-20.228, p<.001) and total walking journeys (b=-19.697, p<.001). However, it was non-significant with the total walking minutes (b=-2.596, p>.05) (Appendix 7, Table 10-18).

7.7.9 Clustering coefficient of destinations:

The clustering coefficient of destinations was measured on two scales, the 400-meter radius (ClsCofS2), and the 600-meter radius (ClsCofS3), thus, two variables were included (Table 6-2). Each variable represents a predictor (X) that needs to be tested in terms of its effect and predictability on each of the three walking outcome variables. Thus, six models were analysed after resembling the independent variable (X) into the outcome variables (Y). Moreover, the moderation variables were added into the second block of each model to test the predictability of the predictors, as moderated by the personal trait or the moderators (Mo). Meanwhile, the first block of each model only includes the predictor in question (X).

(a) **Clustering coefficient of destinations (ClsCofS2) on a 400-meter radius scale**: The predictability of the first block of the three models was significant for two of the outcome variables, including the total walking distance (F (173, 1) = 14.847, p<.001, R^2=.079), and total walking journeys, (F (173, 1) = 15.520, p<.001, R^2=.082). However, the total walking minutes were non-significant (F (173, 1) =.142, p>.05, R^2=.001). Also, the singular models were able to explain, 7.9%, 8.2%, and .1% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Furthermore, after adding the moderators into the models the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased with the total walking minutes (R^2 change= .3, .264, and .079, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on two of the outcome variables of the three models. The higher walking behaviour outcome scores were associated with the higher clustering coefficient of destinations (ClsCofS2) on the 400-meter radius scale (X) in terms of the total walking distance (b=60.683, p<.001) and total walking journeys (*b*=59.091, $p<.001$). However, it was non-significant with the total walking minutes (*b*=7.788, $p>.05$) (Appendix 7, Table 10-19).

(b) **Clustering coefficient of destinations (ClsCofS3) on a 600-meter radius scale**: The predictability of the first block of the three models was significant for two of the outcome variables, including the total walking distance (F (173, 1) = 37.909, $p<.001$, R^2=.180), and total walking journeys, (F (173, 1) = 37.820, $p<.001$, R^2=.179). However, the total walking minutes were non-significant (F (173, 1) =2.288, $p>.05$, R^2=.019). Also, the singular models were able to explain, 18%, 17.9%, and 1.9% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Also, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .164, .230, and .079, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on two of the outcome variables of the three models. Thus, the higher walking behaviour outcome scores were associated with the higher clustering coefficient of destinations (ClsCofS3) on a 600-meter radius scale (X) in terms of the total walking distance (*b*=73.346, $p<.001$) and total walking journeys (*b*=69.423, $p<.001$). However, it was non-significant with the total walking minutes (*b*=24.662, $p>.05$) (Appendix 7, Table 10-20).

7.7.10 Centrality measures:

In terms of centrality, the Gini coefficient of both betweenness and straightness were measured on one scale, namely the 400-meter radius; thus, two variables were included, namely the Gini Coefficient of the betweenness degree (GinCoBS2) for the 400-meter radius, and the Gini Coefficient of the straightness degree (GinCoSS2) for the 400-meter radius (Table 6-2). Each variable represents a predictor (X) that needs to be tested in terms of its effect and predictability on each of the three walking outcome variables. Thus, six models are analysed after resembling the independent variable (X) into the outcome variables (Y). Moreover, the moderation variables were added into the second block of each model to test the predictability of the predictors, as moderated by the personal traits, or moderators (Mo). Meanwhile, the first block of each model only includes the predictor in question (X).

7.7.10.1 The ‘betweenness’ degree:

(a) **Gini Coefficient of the ‘betweenness’ degree (GinCoBS2) on a 400-meter radius scale**

The predictability of the first block of the three models was significant for two of the outcome variables, including the total walking distance (F (173, 1) = 10.973, p<.001, R^2=.06) and total walking journeys (F (173, 1) = 11.669, p<.001, R^2=.063). However, it was non-significant for the total walking minutes (F (173, 1) =24.623, p>.05, R^2=.125). Also, the singular models were able to explain, 6%, 6.3%, and 12.5% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. In addition, after adding the moderators into the models, the predictability significantly increased for the total walking distance, and total walking journeys (R^2 change= .333, and .216, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on these two outcome variables, and the higher walking behaviour outcome scores were associated with the higher Gini Coefficient of the betweenness degrees (GinCoBS2) for the 400-meter radius scale (X) in terms of the total walking distance (b=1.380, p=.001) and the total walking journeys (b=1.420, p<.001) (Appendix 7, Table 10-21).

(b) **Gini Coefficient of the ‘straightness’ degree (GinCoSS2) for the 400-meter radius scale**

The predictability of the first block of the three models was significant for all outcome variables, including the total walking distance (F (173, 1) = 91.595, p<.001, R^2=.346), total walking journeys (F (173, 1) = 84.037, p<.001, R^2=.327), and total walking minutes (F (173, 1) =24.623, p<.001, R^2=.125). Also, the singular models were able to explain, 34.6%, 32.7%, and 12.5% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Furthermore, after adding the moderators into the models, the predictability significantly increased for the total walking distance, total walking journeys, and total walking minutes (R^2 change= .123, .173 and .079, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on all three outcome variables in the three models. Thus, the higher walking behaviour outcome scores were associated with the higher Gini Coefficient straightness degree (GinCoSS2) for the 400-meter radius (X) in terms of the total walking distance (b=27.298, p<.001), the total walking journeys (b=24.670, p<.001), and the total walking minutes (b=18.090, p<.001) (Appendix 7, Table 10-22).

7.7.11 Frontage quality index:

The frontage quality indexes of the high betweenness street (SFMODRBS2), the medium betweenness street (SFMODGBS2) (from the green level), and the low betweenness street (SFMODBBS2) (from the blue level) were measured on a 400-meter radius scale (Table 6-2). Each of the three indexes represent a predictor (X) that needs to be tested in terms of its effect and predictability on each of the three walking outcome variables. Thus, nine models are analysed after resembling the independent variable (X) into the outcome variables (Y). Moreover, the moderation variables were added into the models to test the predictability of the predictors (X), as moderated by the personal traits, or moderators (Mo).

(a) **Frontage quality index of the high betweenness street (SFMODRBS2) on the 400-meter radius scale**

The predictability of the first block of the three models was significant for all outcome variables, including the total walking distance (F (173, 1) = 84.029, p<.001, R^2=.327), total walking journeys (F (173, 1) = 76.454, p<.001, R^2=.302), and total walking minutes (F (173, 1) =26.427, p<.001, R^2=.133). Also, the singular models were able to explain, 32.7%, 30.2%, and 13.3% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. In addition, after adding the moderators into the models, the predictability significantly increased for the total walking distance and total walking journeys; however, it only marginally increased for the total walking minutes (R^2 change= .123, .174, and .080, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on all three outcome variables in the three models. Therefore, the higher walking behaviour outcome scores were associated with the lower frontage quality index of the high betweenness street (SFMODRBS2) for the 400-meter radius scale (X) in terms of the total walking distance (b=-.154, p<.001) and total walking journeys (b=-.138, p<.001); however, it was non-significant for the total walking minutes, (b=-.110, p<.001) (Appendix 7, Table 10-23).

(b) **Frontage quality index of the medium betweenness street (SFMODGBS2) on the 400-meter radius scale**

The predictability of the first block of the three models was significant for all of the outcome variables, including the total walking distance (F (173, 1) = 60.332, p<.001, R^2=.259), total walking journeys (F (173, 1) = 54.166, p<.001, R^2=.238), and total walking minutes (F (173, 1) =26.586, p<.001, R^2=.133). Also, the singular models were able to explain, 25.9%, 23.8%, and 13.3% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Furthermore, after adding the moderators, the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .122, .181, and .079, respectively) (Table 7-66). After accounting for the moderators, the effect of this predictor was significant on all three outcome variables in the three models. Thus, the higher walking behaviour outcome scores were associated with the lower Frontage quality index of the medium betweenness street (SFMODGBS2) on a 400-meter radius scale (X) in terms of the total walking distance (b=-.175, p<.001), and total walking journeys (b=-.154, p<.001); however, it was non-significant for the total walking minutes (b=-.145, p<.001) (Appendix 7, Table 10-24).

(c) **Frontage quality index of the low betweenness street (SFMODBBS2) on the 400-meter radius scale**

The predictability of the total models significantly increased after adding the moderation variables (Mo) with the two outcome variables, namely the total walking distance (F (164, 9) = 13.739, p<.001, R^2=.456) and total walking journeys (F (164, 9) = 15.536, p<.001, R^2=.486). However, it did not significantly increase for the total walking minutes (F (164, 9) =4.374, p>.05, R^2=.211). In other words, the total models were able to explain, 45.6%, 48.6%, and 21.1% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Also, after adding the moderators the predictability significantly increased for the total walking distance and total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .123, .174, and .080, respectively) (Appendix 10.5, Table 7-66). Moreover, after accounting for the moderators, the effect of this predictor was significant on all of the three outcome variables in the three models. Therefore, the higher walking behaviour outcome scores were associated with the lower frontage quality index of the low betweenness street (SFMODBBS2) scale on a 400-meter radius (X) in terms of the total walking distance (*b*=-.139, $p<.001$), and total walking journeys (*b*=-.125, $p<.001$); however, it was non-significant for the total walking minutes (*b*=-.097, $p<.001$) (Appendix 7, Table 10-25).

7.7.12 Enclosure ratio:

The enclosure ratios of the high betweenness street (EnRBRS2), the medium betweenness street (EnRBGS2) (from the green level), and the low betweenness street (EnRBBS2) (from the blue level) were measured on a 400-meter radius scale (Table 6-2). Each of the three indexes represent a predictor (X) that needs to be tested in terms of its effect and predictability on each of the three walking outcome variables. Thus, nine models were analysed after resembling the independent variable (X) into the outcome variables (Y). Moreover, the moderation variables were added to the models to test the predictability of the predictors (X), as moderated by the personal traits, or the moderators (Mo).

(a) **Enclosure ratio of the high betweenness street (EnRBRS2) on the 400-meter radius scale**

The predictability of the first block of the three models was significant with all of the outcome variables, including the total walking distance (F (173, 1) = 93.572, $p<.001$, R^2=.351), total walking journeys (F (173, 1) = 87.009, $p<.001$, R^2=.335), and total walking minutes (F (173, 1) =20.840, $p<.001$, R^2=.108). Also, the singular models were able to explain, 35.1%, 33.5%, and 10.8% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. In addition, after adding the moderators into the models, the predictability significantly increased for the total walking distance and the total walking journeys, but only marginally increased with the total walking minutes (R^2 change= .124, .174, and .076, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on all of the three outcome variables in the three models. The higher walking behaviour outcome score was associated with the higher Enclosure ratio of the high betweenness street (EnRBRS2) scale on a 400-meter radius (X) in terms of the total walking distance (*b*=6.180, $p<.001$), and the total walking journeys (*b*=5.635, $p<.001$); however, it was non-significant with the total walking minutes (*b*=3.720, $p<.001$) (Appendix 7, Table 10-26).

(b) **Enclosure ratio of the medium betweenness street (EnRBGS2) on the 400-meter radius scale**

The predictability of the first block of the three models was significant with all of the outcome variables, including the total walking distance (F (173, 1) = 50.498, p<.001, R^2=.226), total walking journeys (F (173, 1) = 49.636, p<.001, R^2=.223), and total walking minutes (F (173, 1) =5.841, p<.001, R^2=.110). Also, the singular models were able to explain, 22.6%, 22.3%, and 11% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Additionally, after adding the moderators into the models, the predictability significantly increased for the total walking distance and the total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .152, .214, and .077, respectively). Moreover, after accounting for the moderators, the effect of this predictor was significant on all three outcome variables in the three models, and the higher walking behaviour outcome score was associated with the lower Enclosure ratio (X), in terms of the total walking distance (b=-1.547, p<.001), and total walking journeys (b=-1.452, p<.001); however, it was non-significant for the total walking minutes (b=-.615, p<.05) (Appendix 7, Table 10-27).

(c) **Enclosure ratio of the low betweenness street (EnRBBS2) for the 400-meter radius scale**

The predictability of the first block of the three models was significant with two of the outcome variables, including the total walking distance (F (173, 1) = 4.785, p<.05, R^2=.027), and the total walking journeys (F (173, 1) = 5.397, p<.05, R^2=.030). However, it was non-significant with the total walking minutes (F (173, 1) =.428, p>.05, R^2=.002). Also, the singular models were able to explain, 2.7%, 3%, and .2% of the variances of the total walking distance, total walking journeys, and total walking minutes, respectively. Also, after adding the moderators into the models, the predictability significantly increased for the total walking distance and the total walking journeys, but only marginally increased for the total walking minutes (R^2 change= .199, .278, and .079, respectively). Moreover, after accounting for the moderators, the effect of this predictor (X) was significant on two of the three outcome variables of the three models, and the higher walking behaviour outcome score was associated with the lower Enclosure ratio of the low betweenness street in terms of the total walking distance (b=-.595, p<.01), and total walking journeys (b=-.603, p<.01); however, it was non-significant with the total walking minutes (b=.103, p>.05) (Appendix 7, Table 10-28).

7.8 The findings and discussion in response to the research questions

The main objectivities of this section are: 1) to calculate and discuss the findings of the statistical analysis and analyse the responses to the research questions and their consistency with the research hypotheses; 2) to validate the results by comparing findings with those of parallel studies. Moreover, to facilitate the discussion, this research suggests criteria to categorise the strength of the predictors based on their level of association with the walking outcomes. These criteria are drawn from recommendations by Lee & Moudon (2006b), that $R^2 \geq 20\%$ is a high ratio for the explained variance of walking, and the level of significance is based on the p-value. Thus, three levels of association are considered in this research, including: (1) weak predictability (p<.05, R^2<20%), (2) moderate predictability (p<.01-.001, R^2<20%), and (3) strong predictability (p<.05, R^2≥20%).

7.8.1 The impact of neighbourhood typology and individual traits on walking outcomes

In this section, the results specifically discuss information pertinent to research question one, which is: do neighbourhood typology and individual traits effect walking to occupational activities in the neighbourhoods of Basra city? The analyses related to this question test whether neighbourhood typology and individual traits are related to walking outcomes. Based on the reviewed literature, the hypothesis, considers the association of the social and physical environment factors with the walking outcomes.

In relation to the influential factors in the analyses models (level-2), the responsiveness of walking outcomes were differed. Generally speaking, the total walking distance and the total number of walking journeys were considerably more responsive to the prediction test than the total walking minutes. Also, they showed similar patterns of responsiveness with mediation and moderation factors. In other words, when the total walking distance was significantly explained by an independent factor, there was a high probability that the same factor could explain the total number of walking journeys. However, the probability of the same independent factor to explain the total walking minutes is far lower. The ANOVA analysis sufficiently tested the effect size of the spatial factor on the walking outcomes. Also, the ≥150 minutes of walking per week as a categorical variable provided an informative outcome because it explained the level of correspondence of the participants with the recommended level of walking. However, it was far less responsive to the prediction tests than the other three continuous walking outcomes.

The results from testing the neighbourhood typology as a spatial factor were found to significantly differ amongst participants from the three walking outcome groups. Moreover, the testing of the spatial factor with the paired neighbourhoods (Al-Saymmar vs. Al-Mugawlen, Al-Saymmar vs. Al-Abassya, Al-Mugawlen vs. Al-Abassya) showed specific patterns of influence on the walking outcomes. In terms of the total walking distance, with all but the Mugawlen-Abassya pairing, the participants significantly differed amongst the various groups of walking outcomes. For example, the conventional neighbourhoods demonstrated a less significant influence on the walking distance compared with the traditional neighbourhood. In terms of the total number of walking journeys, the spatial factor had exactly the same effect on the total walking distance. However, with the total walking minutes in all paired neighbourhoods, the participants significantly differed, as predicted by the spatial factor. This means that the difference between the neighbourhoods in terms of the total walking minutes was more influenced by the spatial factor than the other two walking outcomes, (Table 7-5 and 7-6).

In terms of walking for ≥150 walking minutes per week, according to the effect of the spatial factor participants significantly differed within the up-to/under recommended walking minutes per week. However, no factor amongst the personal traits showed a significant effect in that respect, (Table 7-7). Furthermore, the factors of the perceived environment showed a limited significant effect in terms of walking for ≥150 walking minutes per week. Only the perceived proximity of retail, and the perceived dead-end streets have a significant positive effect on achieving the recommended weekly minutes walking; meanwhile, the perceived cars parking in the street has a significant negative effect on reaching the recommended weekly walk minutes (Table 7-8).

Examining the effect of belief-based measures of walking on the ≥150 walking minutes per week showed that only the ‘attitudinal beliefs of walking related to health benefits’ and the ‘perceived walking control related to the proximity of retail’ have significant positive effects on meeting the recommended weekly minutes walking (Table 7-9).

Research question one was developed for inferring evidence about the association (direct effect) between the physical environment (neighbourhood typology), individual and personal traits and walking outcomes, which may help to enhance walking in future developments. In this regard, the association between walking behaviour to occupational activities and the neighbourhood typology significantly confirm the research hypothesis. Thus, adults who live in traditional neighbourhoods are likely to walk more than those living in conventional neighbourhoods, and this could be attributed to the significant differentiation between the physical environments. However, in term of the personal traits the evidence confirm the null hypothesis, (Table 7-7). Also, in term of the individual traits, a limited number of perceived factors were able to predict ≥150 walking minutes per week (Table 7-8), and a limited number of the belief-measures of walking were able to predict ≥150 walking minutes per week (Table 7-9). These findings suggest the importance of traditional neighbourhood characteristics for improving walking outcomes in Basra city. Thus, the best urban planning and urban design practice should take into consideration the attributes of the physical environment of the traditional neighbourhoods of Basra city.

7.8.2 The mediation factors and walking outcomes (mediation analyses)

In this section, the results specifically discuss information on research questions two and three; namely, do the belief-based measures of walking mediate the direct effect of the physical environment on the walking outcomes and, do the factors of the perceived environment mediate the direct effect of the physical environment on the walking outcomes? The analyses test whether the mediation factors are related to the walking outcomes.

New Urbanism adopted the notion that the built environment influences the psychosocial lives of residents, which in turn impacts their physical activity (Davies, 2015). The principles of this neo-traditional movement have been applied to new and existing developments across the world, especially in the U.S. (e.g. Friedman, Gordon and Peers, 1994; Handy, 1993, 1996, 2006; Hess, Moudon, Snyder, & Stanilov, 1999; Kitamura, Mokhtarian, and Laidet, 1997; Lee & Moudon, 2006a, 2006b). It has demonstrated that a better understanding of the built environment positively influences residents' satisfaction of the living environment and their sense of community, which could improve physical activity. In physical activity studies, the perceived environment has been widely examined in terms of predicting physical activity, and the factors in this area were mostly examined from urban planning related measures (Duncan et al., 2005; Humpel, Owen & Leslie, 2002). In a similar respect, social cognition factors were tested, including the belief-based measures of walking from the Theory of Planned Behaviour. Thus, this research seeks further evidence about the mediating roles of belief-based measures of walking and the perceived environment, concerning the physical environment (walkability index) and walking outcomes (Y). Thus, the hypothesis considers the association of the mediation factors with the walking outcomes.

7.8.2.1 The belief-based measures of walking

The research evidence concerning the mediation effect of the belief-based measures of walking behaviour on walking to occupational activities are:

1) In terms of the total walking distance, the following factors have shown the significant mediation effect of the walkability index of the physical environment on this walking outcome: ‘attitudinal beliefs of walking related to health benefits’; the ‘attitudinal beliefs of walking related to safety’; ‘subjective norms of walking related to people’; the ‘perceived walking control related to proximity of destinations’, and the ‘perceived walking control related to land use diversity’ (section 7.5.2.1).
2) In terms of the total number of walking journeys, the factors that have shown the significant mediation effect of the physical environment on this walking outcome are: ‘attitudinal beliefs of walking related to health benefits’, the ‘subjective norms of walking related to people’, and the ‘perceived walking control related to land use diversity’ (section 7.5.2.2).
3) In terms of the total walking minutes, the following factors have shown a significant mediation effect of the physical environment on this walking outcome: ‘attitudinal beliefs of walking related to health benefits’, and the ‘perceived walking control related to the proximity of destinations’ (section 7.5.2.3).

Thus, five factors have shown significant mediation effects between the walkability index of the physical environment and the walking outcomes. Also, the walking outcomes were differently influenced by the belief-based measures of walking, as explained above. These research outcomes partially agree with the theoretical posits of the original theory of Ajzen (1990); namely, that the belief-based predictors of behaviour could function as proximates of behavioural intention, which in turn function as proximates of real behavioural outcomes. Also, the results considerably agree with physical activity and TPB-related studies, which demonstrate that the constructs of the TPB can explain the satisfactory ratio of variance of physical activity that includes walking (Chatzisarantis, Hagger, Biddle, & Karageorghis, 2002; Chatzisarantis, Hagger, & Smith, 2007; Chatzisarantis, Hagger, Smith, & Phoenix, 2004; Eves, Hoppéa, & McLaren, 2003; Maddison et al., 2009; Rhodes, Brown, & McIntyre, 2006). Also, these results agree with other studies in terms of the significant influence of perceived control on walking outcomes (Giles-Corti & Donovan, 2002; Lee & Shepley, 2012). However, the findings of this study also suggest that the intention to walk factor has no significant association with the walking outcomes. Thus, this research mostly agrees with the results from previous studies in terms of the importance of proximity and diversity of amenities on the perceived control of walking by residents. Also, to a lesser degree, the study finds that the walking attitude construct of the TPB relates to health benefits, and the walking subjective norms construct of the TPB relates to people's influence over their walking behaviours. However, this research also finds that the intention to walk construct of the TPB did not mediate the effect of the physical environment on the walking outcomes.

The findings for research question two developed from evidence on the mediation role of respondents' individual traits (beliefs concerning the TPB about walking) on the relationship between the physical environment (walkability index) and walking outcomes. These could be considered to enhance walking. In this regard, the association between individual beliefs about walking behaviour and walking to occupational activities partially confirms the research hypothesis. Hence, in response to research question two, the findings indicate that the higher scores for the following are significantly associated with higher scores of walking: the awareness of health benefits of walking, social norms, perceived control of proximity, and diversity of land use.

7.8.2.2 The perceived environment

The findings concerning the mediation effect of the factors for the perceived environment on walking to occupational activities are described within this section.

1) In terms of the total walking distance, the sense of neighbourhood safety, the diversity of local shops, the proximity of the local shops, and the perceived dead-end streets showed significant mediation effects on the walking outcome. This suggests that people who have a higher sense of safety within the neighbourhood are more likely to walk longer distances if they perceive the following: a greater diversity of local shops, closer local shops, and that dead-end streets within their neighbourhood do not impede their walkability, (section 7.5.3.1).
2) In terms of the total number of walking journeys, only the sense of safety of the neighbourhood showed a significant mediation effect on the walking outcome. This suggests that people who have a higher sense of safety in the neighbourhood are more likely to undertake a greater number of walking journeys (section 7.5.3.2).
3) In terms of total walking minutes, the aesthetics of the neighbourhood, the diversity of local shops, and the proximity of the local shops had a significant mediation effect on the walking outcome. This suggests that people who scored highly on the perceived aesthetics of the neighbourhood, the diversity of local shops, and the closeness of the local shops, are more likely to walk more minutes, (section 7.5.3.3).

Five factors have shown a significant mediation effect between the physical environment (walkability index) and walking outcomes. Also, the walking outcomes were indirectly influenced by these factors in different ways. These results confirm the findings of some studies, but differ from others. The findings elsewhere demonstrated a positive association with walking, include the 'sense of safety of the neighbourhood' (McCormack et al., 2004), the 'diversity of local shops' (McCormack et al., 2004), the 'proximity of the local shops' (Humpel et al., 2004; McGinn, Evenson, Herring, Huston, & Rodriguez, 2007; McCormack, Cerin, Leslie, Du Toit, & Owen, 2008), the 'perceived dead-end streets' or lower street connectivity (Tappe, Glanz, Sallis, Zhou, & Saelens, 2013), and the 'aesthetic of the neighbourhood' (Ball, Bauman, Leslie, & Owen, 2001; Humpel et al., 2004; McCormack et al., 2004). Therefore, safety, diversity of land use, cul-de-sacs, and neighbourhood aesthetics are important factors that enhance walking in the built environment.

The findings for research question three developed from evidence concerning the mediation role of respondents' individual traits (perceived environment factors) on the relationship between the physical environment (walkability index) and the walking outcomes, and whether these might enhance walking. In this regard, the findings indicate that the association between the individual perception of the neighbourhood environment and walking to occupational activities partially confirms the research hypothesis. Hence, in response to the third research question, the findings indicate that the higher scores for the following are significantly associated with higher scores of walking: the individual perception of the neighbourhood environment related to a 'sense of safety of the neighbourhood', the diversity of local shops, the proximity of the local shops, the perception of dead-end streets (or lower street connectivity), and the aesthetics of the neighbourhood.

7.9 The socio-demographics, BMI and walking outcomes (moderation analyses)

In this section, the findings in response to research question four are discussed, namely, do the personal trait factors moderate the direct effect of the physical environment on walking outcomes?

1) In terms of the total walking distance, the income, and 'employed' and 'free business' types of work status significantly moderate the effect of the physical environment on walking outcomes (Tables 7-20 and 7-24).
2) In terms of the total number of walking journeys, none of the personal trait factors significantly moderate the effect of the physical environment on this walking outcome.
3) In term of the total walking minutes, the 'employed' and 'free business' types of work status significantly moderate the effect of the physical environment on this walking outcome, (Table 7-24).

None of the previous studies from the reviewed literature tested the moderation effect of personal traits between the walkability index of the physical environment and the walking outcomes. Therefore, the findings for this area have been newly developed by this research. Moreover, only a limited number of previous studies recommended investigating the moderation effect of demographic factors on physical activity (McCormack et al., 2008), whilst Ferreira et al. (2007) suggested that obesity moderates physical activity, which differs from the finding for this study.

The findings for research question four developed form evidence connected with the moderation role of respondents' personal traits (socio-demographic and BMI factors) on the relationship between the physical environment (walkability index) and walking outcomes, to determine whether they might be considered to impact on walking. In other words, this concerned the indirect effect of personal traits on walking outcomes. In this regard, the association between the residents' personal traits and walking to occupational activities partially confirms the research hypothesis. Hence, in response to the fourth research question concerning the indirect effects (moderation role) of the personal traits on the walking outcomes to occupational activities on the neighbourhood scale of Basra city, the income category, and employed and free business types of work status are significantly associated with higher walking scores.

7.10 The physical environment and walking outcome findings

In this section, the results specifically discuss research question five, namely, do the objective measures of the physical environment predict the walking outcomes? The analyses test whether the objectively measured physical environment attributes and the same attributes and personal traits are related to the walking outcomes. Therefore, the hypothesis, which was based on the reviewed literature, considered the association of the objectively measured physical environment factors with the walking outcomes.

7.10.1 Urban planning measures

The findings below outline the predictability of the urban planning measures '3Ds' in relation to walking to occupational activities. Furthermore, all street design measures are discussed alongside the urban planning measures:

- All the urban planning measures are high predictors of the total walking distances in the singular models, (p<.05, R^2≥20%). For the 600-meter radius scale (p<.001, R^2=35.1%), the greatest predictors for the total walking distance to occupational activities were the diversity of retail, or commercial land use without parking, wholesale, and workshops. Moreover, the block density on the 400x400-meter scale, the node density on the 400-meter radius scale, and the street intensity on 400-meter radius scale, moderately predicted the total walking distance (p<.001, R^2=16%, p<.001, R^2=11.1%, and p<.01, R^2=31.3%, respectively). However, this walking outcome was non-significantly predicted by the link-node ratio (400-meter radius) (p>.05, R^2=.1%) (Table 7-25).

- All the urban planning measures are high predictors of the total number of walking journeys in the singular models, (p<.05, R^2≥20%). The greatest predictor of the total walking distance to occupational activities was the diversity of the retail or the commercial land use without parking, wholesale, and workshops on the 600-meter radius indicator, (p<.001, R^2=33.4%). However, the exceptions to this were the block density on the 400x400-meter scale, the node density on the 400-meter radius scale, and the street intensity on 400-meter radius scale, which moderately predicted the total walking journeys, (p<.001, R^2=14.4%, p<.001, R^2=9.8%, and p<.01, R^2=29.2%, respectively). However, the link-node ratio on the 400-meter radius scale showed a non-significant predictability for this outcome (p>.05, R^2=.2%) (Table 7-25).
- All the urban planning measures moderately predicted the total walking minutes, where the greatest predictors were the node density on the 400-meter radius (p<.01, R^2<20%), and the street intensity on the 400-meter radius and the 600-meter radius scales (p<.001, R^2=13.5% for each). However, the link-node ratio on the 400-meter radius scale, showed a non-significant predictability for this outcome (p>.05) (Table 7-25).

Generally speaking, in considering the objective measures of urban planning, the total walking minutes variable was a far less effective predictor than the total walking distance and total walking minutes. Moreover, the land use diversity indicator was a greater predictor of the walking outcome than either the density indicator or street connectivity. Moreover, adding the personal traits factors (age, income, work status, practising a type of sport, BMI, and number of cars) into the regression model significantly increased the predictability of the models (by 12%-20%). However, in some tests, the addition of the personal traits meant the total models became non-significant.

In terms of the density, these findings are consistent with those of other pedestrian-related studies (e.g. Cervero & Kockelman, 1997; Frank & Engelke, 2001; Frank et al., 2002; Frank et al., 2005; Handy, 1992; Lee & Moudon, 2006; Moudon et al., 2007). Also, in terms of the land use diversity and street connectivity, these findings are consistent with those from other community design related studies (e.g. Joseph &

Zimring, 2007; Saelens et al., 2003; Schumacher, 1986; Siksna, 1997; Southworth & Ben- Joseph, 1995; Southworth & Ben-Joseph, 1997; Southworth & Owens, 1993).

The clear discrimination of urban planning measures between traditional and modern neighbourhoods is arguably responsible for the increase in automobile activity amongst modern developments, and this has developed at the expense of pedestrian activity. Also, on the 600-meter radius scale, the overall pattern of information concerning the outcome variables of the urban planning measures was reduced in comparison with the information on the 400-meter radius scale Table (7-25). This could be attributed to the reduction in the level of heterogeneity between the selected urban tissues, which was caused by the inclusion of common qualities of the three neighbourhoods as the scale increased. Moreover, the findings suggest that the land use diversity indicators are better predictors of walking outcomes than the density and street design aspects. Also, in terms of land use diversity, the retail shops were slightly better predictors than other indicators.

The overall patterns of prediction for all urban planning measures and every walking outcome suggested a considerable level of consistency on the 400-meter radius scale. For example, the first column of Table 7-25 (the total walking distance), the prediction levels of all indicators on the 400-meter radius scale ranges between p<.001-.01, R^2=23.4%-35%, while on the 600-meter radius scale it ranges between p<.001-.01, R^2=9.1%-35.1%. The consistency of the 400-meter radius scale is supported by the predictability of the compositional and walkability indexes, which demonstrated higher levels of prediction for this walking outcome (p<.001, R^2=50.5%). In the same respect, the total walking journeys range between p<.001-.01, R^2=21.4%-33.4%, while the compositional walkability index explained p<.001, R^2=48.5%, on the 400-meter radius scale. Also, the variance in the total walking minutes on the 400-meter radius scale was explained as p<.001-.01, R^2=6.1%-13.5%, while the compositional walkability index was explained as p<.001, R^2=36.4%. This means that the compositional index increases the inter-consistency of the physical environment (urban planning) indicator and thus the predictability of the different urban planning measures. This finding echoes the suggestions of similar studies, which state that the 3Ds concurrently and synergistically influence the everyday life of users of the built environment (Cervero and Kockelman, 1997; Frank et al. 2005a, 2005b, 2006, 2007a, 2007b, 2009, 2012, 2013).

The findings for research question five developed from evidence connected with the determining role of the objectively measured physical environment (urban planning measures) and walking outcomes, which might be considered to enhance walking. In this regard, the association between the objectively measured physical environment (urban planning measures) and walking to occupational activities highly confirms the research hypothesis. Hence, in response to the fifth research question concerning the predictability (determining role) of the objectively measured physical environment (urban planning measures) on walking outcomes to occupational activities on the neighbourhood scale of Basra city, the following are significantly associated with higher scores of walking: the higher density, higher degree of land use diversity, higher street density, and higher density of active streets intersections.

Table 7-25: Summary results for testing the predictability of the urban planning measures on the walking outcomes

	Total walking distance		**Total walking journeys**		**Total walking minutes**	
	***p*-value**	**R^2**	***p*-value**	**R^2**	***p*-value**	**R^2**
Block density (400-meter radius)	.001	33.7%	.001	32.4%	.001	8.9%
Housing density (400x400-meter)	.001	33.1%	.001	31%	.001	13.2%
All commercial land uses diversity (400-meter radius)	.001	29.3%	.001	28.5%	.001	6.1%
All commercial land uses diversity (600-meter radius)	.001	35%	.001	33.4%	.001	11.6%
Retail land uses diversity (400-meter radius)	.001	35%	.001	33.4%	.001	10.4%
Retail land uses diversity (600-meter radius)	.001	35.1%	.001	33.5%	.001	10.8%
Diversity of the non-residential land use (400-meter radius)	.001	31.8%	.001	30.7%	.001	7.5%
Diversity of the non-residential land use (400-meter radius)	.001	35%	.001	33.4%	.001	10.8%
Number of retail shops (400-meter radius)	.001	23.4%	.001	21.4%	.001	13%
Number of retail shops (600-meter radius)	.001	31.4%	.001	29.3%	.001	13.4%
Nodes density (400-meter radius)	.001	31.1%	.001	29%	.001	13.5%
Nodes density (600-meter radius)	.001	11.1%	.001	9.8%	.001	9.7%
Streets intensity (400-meter radius)	.001	29.1%	.001	29%	.001	13.5%
Streets intensity (600-meter radius)	.01	31.3%	.01	29.2%	.001	13.5%
Link-node ratio (400-meter radius)	>.05	.1%	>.05	.2%	>.05	2%
Link-node ratio (600-meter radius)	.001	9.1%	.001	9.4%	>.05	.2%
External connectivity (400x400-meter)	.001	31.8%	.001	29.7%	.001	13.4%

Walkability index (400-meter radius)	<.001	50.5%	.001	48.5%	.001	36.4%

7.10.2 Urban form morphology and streetscape indicators

The findings below present the predictability (determining role) of the urban morphology and streetscape indicators on walking to occupational activities. In terms of the total walking distance, the urban morphology and streetscape measures are split into three outcomes, as follows:

1. Strongly predicted walking outcomes: this includes the following at a 400-meter radius scale: the Pedestrian Catchment Area (PCA) on scale 400-meter radius, (p<.001, R^2=32.5%), the Gini Coefficient of straightness on scale 400-meter radius, (p<.001, R^2=34.6%); the frontage quality index on a high, medium and low degree of 'betweenness' (p<.001, R^2=32.7%, R^2=25.9%, R^2=33.3%, respectively); and the enclosure ratio of the high, and medium betweenness streets (p<.001, R^2=35.1%, R^2=22.6%, respectively);
2. Moderately predicted total walking distances: this includes the following: the pedestrian route directness ratio on (600-meter radius) (p<.001, R^2=7.9%); Clustering coefficient of destinations (400-meter radius), (p<.001, R^2=7.9%); Clustering coefficient of destinations scale 600-m radius (p<.001, R^2=18%); and Gini Coefficient of betweenness (400-meter radius) (p<.001, R^2=6%);
3. Weakly predicted total walking distances, which include the pedestrian route directness ratio (400-meter radius), (p<.05, R^2=3.1%). However, the block compactness (400x400-meter) showed a non-significant predictability for this walking outcome, (p>.05, R^2=.1%), (Table 7-26).

In terms of the total walking journeys, the urban morphology and streetscape measures are split into the following:

1. Strongly predicted walking outcomes, which includes: the Pedestrian Catchment Area (PCA) on a 400-meter radius (p<.001, R^2=31.3%); the Gini Coefficient of straightness on a 400-meter radius (p<.001, R^2=32.7%); the frontage quality index on a high (p<.001, R^2=30.2%), medium (p<.001, R^2=23.8%) and low (p<.001, R^2=31.3%) street 'betweenness' (all 400-meter radius); the enclosure ratio on a high (p<.001, R^2=33.5%), medium (p<.001, R^2=22.3%) and low (p<.05, R^2=31.3%) street 'betweenness' (all 400-meter radius);

2. Moderately predicted total walking journeys, which includes: the pedestrian route directness ratio (400-meter and 600-meter radius) (p<.001, R^2=3.5% and p<.001, R^2=8.2%); the Clustering coefficient of destinations (400-meter and 600-meter radius) (p<.001, R^2=8.2% and p<.001, R^2=17.9%), the Gini Coefficient of 'betweenness' (400-meter radius) (p<.001, R^2=6.3%). However, the block compactness (400x400-meter) showed a non-significant predictability on the total walking journeys, (p>.05, R^2=.1%) (Table 7-26).

In terms of the total walking minutes, the urban form morphology and streetscape measures moderately predicted the walking outcomes

1. This included: the Pedestrian Catchment Area (PCA) (400-meter radius) (p<.001, R^2=7.9%), Gini Coefficient of straightness (400-m radius) (p<.001, R^2=12.1%), frontage quality index of the high, medium and low 'betweenness' street (all 400-meter radius), (p<.001, R^2=13.3%), (p<.001, R^2=13.3%) and (p<.001, R^2=13.1%) respectively;
2. However, the block compactness (400x400-meter); pedestrian route directness ratio (400-meter and 600-meter radius); Clustering coefficient of destinations (400-meter and 600-meter radius); and Gini Coefficient of 'betweenness' (400-meter radius) showed a non-significant predictability for this walking outcome, (p>.05), (Table 7-26).

In addition, adding the personal traits (six factors) into the models increased the predictability by approximately 15% to 20% for all walking outcomes. However, in some tests, the addition of the personal traits meant the total models became non-significant.

Furthermore, two contradicted directions of association between the predictors and walking outcomes were noticed, namely positive and negative associations. These are indicated with (-) in Table 7-26. The positive association means that the predictors and the outcome change follow the same direction (either increasing or decreasing); meanwhile, the negative association means that the predictor and the outcome change follow two different directions. These correlations seem paradoxical; for example, the frontage quality indexes, which showed a negative association with the walking outcomes, literally mean that the increase in walking depends on the deterioration of the edge frontages. However, when considered more rationally it actually means that the walking outcomes are not confined to this predictor, and this situation is similar for other cases. In this regard, the deterioration of the quality of frontages within the traditional neighbourhood did not impede the high walking scores to occupational activities. This significantly contradicts findings from other relevant studies (e.g. Carmona, 2010; Cullen, 1971; Gehl, 1994, 2002; Hershberger, 1969; Montgomery, 1998; Moudon, 1997; Song and Knaap, 2004).

In terms of the findings with positive associations, these are consistent with other pedestrian and urban design related studies, which generally find urban design important for walking (e.g. Ewing & Cervero, 2001; Ewing, Handy, Brownson, Clemente, & Winston, 2006; Lee & Moudon, 2006a, 2006b; Mehaffy, Porta, Rofe, & Salingaros, 2010; Moudon et al., 2007). Also, these findings are consistent with those from other studies that examine the relationship between community design and physical activity, which targeted a specific category of residents and examined design aspects including connectivity, accessibility, and proximity. The consistency between this and other studies confirms that urban planning indicators have more effect on physical activity than urban design indicators (Norman et al., 2006; Saelens, Sallis, & Frank, 2003; Witten et al., 2012). Also, the findings demonstrated consistency with other studies that emphasise the importance of a streetscape for physical activity in ecological models (Giles-Corti & Donovan, 2002).

The findings for research question five developed from evidence connected with the determining role of the objectively measured physical environment (urban planning measures) and walking outcomes, which might be considered to enhance walking. In this regard, the association between the objectively measured physical environment (urban morphology and streetscape indicators) and walking to occupational activities partially confirms the research hypothesis. Hence, in response to the fifth research question about the predictability (determining role) of the objectively measured physical environment (urban morphology and streetscape indicators) on walking outcomes to occupational activities on the neighbourhood scale of Basra city, the following are significantly associated with the higher walking distance scores and number of journeys: the higher Clustering coefficient of destinations on 400-meter and 600-meter radius scales; the higher Gini Coefficient of 'betweenness' on a 400-meter radius scale; and the higher Enclosure ratio of high 'betweenness' (collector) street scale on a 400-meter radius scale.

Table 7-26: Summary of testing the predictability of the urban morphology and streetscape indicators to the walking outcomes

	Total walking distance		Total walking journeys		Total walking minutes	
	p-value	R^2	*p*-value	R^2	*p*-value	R^2
Block compactness (BlkComS1), 400x400-meter	>.05	00	>.05	00	>.05	00
Pedestrian Catchment Area (PCA) scale 400-meter radius	.001 (-)	32.5%	.001 (-)	31.3%	.001 (-)	7.9%
Pedestrian route directness ratio on scale 400-meter radius	<.05 (-)	3.1%	.001 (-)	3.5%	>.05 (-)	.2%
Pedestrian route directness ratio on scale 600-meter radius	.001 (-)	7.9%	.001 (-)	8.2%	>.05	.1%
Clustering coefficient of destinations scale 400-meter radius	.001	7.9%	.001	8.2%	>.05	.1%
Clustering coefficient of destinations scale 600-meter radius	.001	18%	.001	17.9%	>.05	1.9%
Gini Coefficient of betweenness scale 400-meter radius	.001	6%	.001	6.3%	>.05	00
Gini Coefficient of straightness scale 600-meter radius	.001 (-)	34.6%	.001 (-)	32.7%	.001 (-)	12.5%
Frontage quality index of the high betweenness 400-meter radius	.001 (-)	32.7%	.001 (-)	30.2%	.001 (-)	13.3%
Frontage quality index of the medium betweenness 400-meter radius	.001 (-)	25.9%	.001 (-)	23.8%	.001 (-)	13.3%
Frontage quality index of the low betweenness 400-meter radius	.001 (-)	33.3%	.001	31.3%	.001	13.1%
Enclosure ratio of the high betweenness street EnRBRS2 scale 400-meter radius	.001	35.1%	.001	33.5%	.001	10.8%
Enclosure ratio of the medium betweenness street EnRBGS2 scale 400-meter radius	.001 (-)	22.6%	.001 (-)	22.3%	.001 (-)	11%
Enclosure ratio of the low betweenness street EnRBBS2 scale 400-meter radius	<.05 (-)	33.3%	<.05 (-)	31.3%	>.05	.2%

7.11 Summary of the statistical analysis

In this chapter, the findings from several statistical tests were illustrated and discussed, in relation to the research questions. The findings confirm that walking to occupational activities in the neighbourhoods of Basra city are more connected to the built environment, or more precisely to the objectively measured urban planning measures, than other mediation, moderation, or urban design factors. In this regard, the urban density, diversity, and street designs play a determining role on walking to occupational activities. Also, the proximity of destinations, diversity of land use, and street designs are affective factors on walking to occupational activities, as subjectively measured by the perceived environment measures and the constructs of the TPB. The next chapter will address the conclusions of this research. Finally, this chapter contribute to this thesis in term of achieving the fifth, sixth and seventh objectivities; In term of the effects of the socio-demographic and BMI, the individual traits, and the physical environment on walking to occupational activities in Basra city neighbourhoods.

8 Conclusions, Limitations and Recommendations

8.1 Introduction

Based on the overall aim of the study, this thesis helps to explain the multiple levels of social and physical environmental influence on walking behaviour to occupational activities in three different neighbourhood typologies in Basra city. The purpose was to provide evidence-based feedback to inform neighbourhood master planning changes and thus encourage an increase in walking amongst inhabitants. In achieving the aim, this research applied an ecological model of walking to occupational activities. The model aimed to support urban planning and design practices, especially in Basra city, and produce feedback for the current Master Plan of Basra city. This chapter outlines the conclusions as guided by the last four objectives of this research, include (5,6,7) which are related to the three types of influences by the social and physical environmental indicators on enhancing walking activity. Meanwhile, the objective (8) is related to maintaining feedback to the current master plan of Basra city. However, the objectives (1,2,3, and 4) are related to the induction level of this research (qualitative level). The final section of this chapter discusses the implications for further research.

8.2 Feedback for the new Master Plan of Basra city

The quantitative data analysis concerning walking behaviour provides empirical evidence based on individual realities. However, Hiller (1996) argues that architects predominantly rely on normative criteria for design and future developments. Nevertheless, master planning represents a strategic framework that comprises several aspects of a particular location, including its physical, social and economic contexts (C.A.B.E., 2009); thus, it is a reality-pertaining activity as much as normative activity. Evidence-based practice (EBP) within planning has recently emerged as a method to link planning practice to research in order to inform decision makers and professionals within urban planning (Krizek, Forysth, & Slotterback, 2009). Thus, this research also offers evidence as a source of feedback for the future master planning of neighbourhoods in Basra city. Moreover, the notion of the feedback relationship is considered in the inter-level relationships of social-ecology models (Grimm, Grove, Pickett & Redman, 2008). In this regard, the Master Plan of Basra city is considered the fourth level of the conceptual framework for this research, where it considers the type of feedback relationship in conjunction with the other three levels in the study. Thus, this research evidence is utilised to provide feedback to decision-makers about future developments concerning the current master planning of neighbourhoods in Basra city (2010-2035).

The statement and criteria for the current Master Plan of Basra city (2010-2035) recognised a joint problem, which was the significant shortage of both residential units and land for new development (Basra, 2015). Thus, in accordance with these two shortages and the status quo, urban intensification presents a potentially effective solution. The vacant lands available for future development are limited and thus insufficient for the required number of residential units. The required residential units range from 61,000 to 93,000 between 2015 and 2020, and from 93,000 to 180,000 between 2020 and 2035. In total, between 11,000 and 37,000 residential units are planned for 2020; however, by 2020 it is anticipated that the total required units will have increased 56,000, and by 2035 this are likely to have increased to 143,000. Alongside the need for additional new residences, approximately 19,500 residential units also need to be renewed (Basra, 2015). Moreover, the proposed new developments suggest several land-uses, including residential, mixed-use, open space, and services.

Existing residential land-use organisations will apply the residential quarter unit for future developments; this is equal to four neighbourhoods. Three housing typologies were proposed for each quarter, namely, high, medium, and low density housing units, whilst the Master Plan explained the requirements of each residential quarter. The estimated residents in each quarter total 15,000, whilst the total residential units number 2,140. The units are classified into three types where each type has a different percentage of the total quantity. Of the total area specified for each residential portion, high-density units will comprise 100-unit/hectare (10%), medium density will total 45-unit/hectare (25%), and low-density will amount to 35-unit/hectare (65%). Furthermore, the structure of the residential quarter includes two commercial centres (1 hectare), retail space (1 hectare), two religious centres (1 hectare), health and social centres (1 hectare), seven nurseries (2.5 hectares), four primary schools (2.2 hectares), four middle schools (3.8 hectares), four secondary schools (4.4 hectares), playgrounds (2 hectares), local parks (3.5 hectares), roads and open spaces (25.2 hectares). Thus, the total area of a quarter is 100.8 hectares (25.2 hectares for every neighbourhood), whilst the overall housing density is 22 units/hectare, and the residential density is 153 hectares.

In terms of neighbourhood sizes, the feedback from this thesis contradicts the 25.02 hectares suggested by the current Master Plan. Instead, it proposes 50.24 hectares, which denotes a 400-meter radius, or 10-minutes walking; this is based on evidence from this research and other relevant urban planning literature. The walking outcomes and accessible amenities within a 10-minute walk were highly associated and found to enhance pedestrian activity. In terms of the percentage ratio of retail space, the findings from this study disagree with the suggested proportion of approximately 1%. Instead, they suggest that mixed types of commercial and retail activity should occupy 10% of the total land use. The findings suggest that the ratio should be separated into: food shops (approximately 5%); consumer goods shops, selling items such as appliances or clothes (approximately 2.5%); and general services, such as barbers, coffee shops, or maintenance workshops (approximately 2.5%). In terms of health and religious centres, this research agrees the Master Plan’s proposed approximate proportion of less than 1% for each. Meanwhile, open space was specified into playgrounds, local parks, roads and open spaces, and this research agrees with the approximate amount of 30% suggested by the Master Plan. However, more walking was observed in the traditional neighbourhood, which accommodates more and smaller open spaces. In terms of housing, the evidence from this study suggests 50% for the single-family housing residential typology; thus, this research significantly contradicts the suggested high ratio of low-density housing within the Master Plan. Finally, no feedback was offered in terms of educational land use, which could depend on relevant standardisations.

For other planning and design criteria, the indicators applied by this research suggest that the planning of new neighbourhoods should not only be confined to defining the densities and types of land use. Instead, they should also consider the morphologic organisation, topologic relationships, and streetscapes design, as these are important influences on physical activity, namely walking in this research. In this respect, further suggestions, in the form of both qualitative and quantitative recommendations, were made by this study. Based on evidence, the recommendations mostly focused on the organisation of traditional neighbourhoods (Al-Saymmar), which are considered more pedestrian-friendly environments than the more modern developments (Al-Mugawleen and Al-Abassya). However, modern neighbourhoods were found to be better in other respects than traditional neighbourhoods; for example, commercial growth within the centre of modern neighbourhoods was far greater than in traditional neighbourhoods, as was the permeability, and straightness of edges. Moreover, all urban design, morphologic, and streetscape measures are recommended to be included in the planning and design of future urban developments in Basra city.

Table 8-1: Evidence-based feedback for the neighbourhood master planning of Basra city

	Urban form measures	**Suggested by the Master Plan**				**Recommended based on evidence by this research**			
		Unit	**No.**	**Area**	**%**	**Unit.**	**No.**	**Area**	**%**
1	Neighbourhood	hctr.	4	100.8	100	hctr.	1	50.24	100
2	Commercial Centres	hctr.	2	1	.99	-	-	-	-
3	Retail shops	hctr.	N/A	1	.99	hctr.	-	5.02	10
4	Religious Centres	hctr.	2	1	.99	hctr.	-	1.26	.25
5	Health and social centres	hctr.	2	1	.99	hctr.	-	3.77	.75
6	Nursery	hctr.	8	2.5	2.48	-	-	-	-
7	Primary schools	hctr.	4	2.2	2.18	-	-	-	-
8	Middle schools	hctr.	4	3.8	3.77	-	-	-	-
9	Secondary schools	hctr.	4	4.4	4.36	-	-	-	-
10	Playgrounds	hctr.	N/A	2	2	-	-	-	-
11	Local parks	hctr.	N/A	3.5	3.5	-	-	-	-
12	Roads and open spaces	hctr.	N/A	25.2	25	-	-	-	-
13	High-density housing	hctr.	N/A	2	2	-	-	-	-
14	Medium density housing	hctr.	N/A	12	12	-	-	-	-
15	Low-density housing	hctr.	N/A	39.5	39	-	-	-	-
16	Total single-family housing	-	-	-	-	U/hctr.	-	25.12	50
17	Total open spaces	-	-	-	-	U/hctr.	-	15.06	30

8.3 Limitations of the ecological model

The following section outlines a number of limitations encountered by this study.

- This research is cross-sectional, which is generally less reliable than longitudinal studies that cover the same variables over a longer time span.

Moreover, the three neighbourhoods, which represent different spatial factors, provided the minimum acceptable threshold on which to run the regression analysis. Thus, more case studies would arguably help to provide a more reliable variance in terms of the independent factors.

- Furthermore, the self-reported physical activity data was considered less reliable than the objectively measured data. However, this research mostly depended on self-reported information about walking to occupational activities. Moreover, using an accelerometer to measure physical activity was excluded for financial reasons; this was because the study was self-funded by the researcher and no financial support was available.
- In addition, this research aggregated the information about walking to seven domains of occupational activity. However, no specified variables about an individual variable of the seven domains of occupational activity was generated because this research solely focussed on walking activity. Moreover, no observational variables of walking were tested to support the self-reported information; this was because of the security situation in Iraqi cities, which prohibited the consideration of this method.
- Although the BMI was considered an outcome variable amongst other reviewed studies, it was considered a moderator variable in this study. This is because the study had a cross-sectional and one-week timeframe, which is too short to observe any changes in participants' weights.
- During the prediction tests, the models were based on one variable of the objectively measured physical environment. This was to avoid statistical collinearity as each objective measure of the physical environment represents three in value (i.e. the three neighbourhoods). Thus, the statistical difference within each variable is approximate to the difference within the other variables. Also, the moderation tests included one moderator within each test; this was because the adopted software was only able to analyse one predictor per test. However, the mediation tests used several mediators per test; this is because the variables were based on the individual level and no statistical collinearity was anticipated. Also, the software was able to analyse several predictors within each test.
- The reliability of the walking outcome variables was calculated from the z-scores of the variables instead of from the raw scores. This was because the variables were measured in different units, namely kilometers, minutes, number of journeys.
- In term of generalisations, to give more validity to the evidence of this study, more research is required and more modern neighbourhoods need to be comparatively tested against traditional neighbourhoods in terms of their walkability and walking ecology.

8.4 Conclusions

This research contributes to knowledge by revealing the multiple levels of influence from the neighbourhood environment on walking to occupational activities. Moreover, it also generates evidence-based feedback for current and future neighbourhood developments within Basra city with the aim of improving walking and reducing sedentary lifestyles amongst inhabitants in the neighbourhoods. In this regard, the findings demonstrated that the traditional neighbourhood typology (Al-Saymmar neighbourhood), which was founded during the Ottoman colony of Iraq and before World War I, is more conducive to walking behaviour than modern developments. In contrast, modern developments within Basra city, which have emerged since 1956, have been far less conducive to walking, and this has much to do with their physical environment attributes that include grid-like streets and blocks, low land-coverage and homogenised land use. This finding supports the theoretical posits of New Urbanism and the neo-traditional trends of urban development in the U.S.A that demonstrate that the traditional organisation of neighbourhoods is more pedestrian friendly (e.g. Handy, 1993, 1996, 2006; Hess, Moudon, Snyder & Stanilov, 1999; Kitamura, Mokhtarian & Laidet, 1997; Lee & Moudon, 2006a, 2006b).

Further key conclusions are provided as follows;

- Based on the conceptual model of walking to occupational activities, the analytical framework facilitated the causal association between walking behaviour and the multiple levels of the social and physical environment. In this regard, of the 41 subjective measures, and as tested with the cross-sectional random sample in one typical week, a limited number demonstrated a positive significant association with the higher scores of walking and the recommended level of walking. However, the objective measures of the physical environment showed a far greater association with higher scores of walking and with the recommended level of walking over one week. Generally speaking, the objectively measured physical environment demonstrates strong to moderate associations with the walking outcomes, while the subjective measures showed weaker associations with the walking outcomes. Therefore, this research agrees with the findings from the reviewed ecological models of physical activity, which demonstrated that the perceived factors within the environment are less predictive than the objectively measured attributes of the physical environment. However, the diversity of land use and proximity of retail shops demonstrated a significant influence on walking activity, either way. Thus, future developments can rely on the satisfaction of users with their neighbourhoods to develop intervention plans that aim to improve the walkability of the neighbourhood.

8.4.1 Conclusion and recommendations based on the subjective measurement (NWOAQ):

The ecological model of walking to occupational activities was a useful tool to determine the influence of the neighbourhood environment on walking for occupational activities. In this respect, the Neighbourhood Walking and Occupational Activities Questionnaire (NWOAQ) was an effective instrument for the individual level of measurement. This was due to the generation of appropriate qualities and quantities of dependent and independent variables. Moreover, based on Cronbach's alpha, the questionnaire showed good levels of internal consistency for the perceived environment factors (.76), the beliefs-based measurement of walking (.74), and the walking outcomes to occupational activities (.87).

- The comparative cross-sectional methods with a random sample proved efficient for use with a case study method; this was because the independent variables produced were as varied as the case studies. In addition, more case studies enabled the production of more variance amongst the independent variables, which helped to explain more of the dependent variables in question.
- The socio-demographic factors, income, and 'employed with free business types' of work status considerably (but indirectly) influenced walking to occupational activities in the neighbourhoods of Basra city. Thus, one future development could consider increasing the number of job opportunities and improving the income of residents on the scale of the neighbourhood by adopting appropriate policies to achieve this aim. This could stimulate walking and help to improve public health.
- The belief-based measures of walking demonstrated a considerable effect on the walking outcomes. Thus, the attitudinal beliefs of walking and their connection with health benefits, the sense of safety, and subjective norms of walking, significantly but indirectly influenced walking to occupational activities on the neighbourhood scale. Thus, intervention plans and initiatives to motivate people to walk must consider these three factors. Also, the perceived walking control related to the proximity of destinations and land use diversity demonstrated the significant mediation effect of the physical environment on walks to occupational activities on the neighbourhood

scale. Thus, future neighbourhood master planning for Basra city should consider these two factors.

- The perceived environmental factors of Basra city's neighbourhoods presented considerable factors of effect on walking outcomes. Thus, the sense of neighbourhood safety, the diversity of local shops, the proximity of the local shops, the aesthetics of the neighbourhood, and the perception of dead-end streets were significant indirect influences (mediation effects) concerning the physical environment on the total walking distance. This suggests that people are more likely to walk more if they have a higher sense of safety within their neighbourhood, perceive closer and higher diversity amongst their local shops, and perceive that dead-end streets within their neighbourhood do not impede its walkability. Thus, the future master planning and urban design of the neighbourhoods of Basra city should consider these four factors.

8.4.2 Conclusions related to the objectively measured urban planning attributes

The objectively measured urban planning attributes of Basra city's neighbourhoods demonstrated the considerable direct effects on walking to occupational activities. This included the density, diversity and street design, which highly and moderately explained the variance in walking outcomes. In this regard, the positive association between the tested attributes of the physical environment and the walking outcomes indicate that more walking occurs amongst neighbourhoods with higher densities, higher diversities, and greater street connectivity. These three are at their greatest in number in the traditional neighbourhood. Thus, this research recommends the consideration of planning attributes from the traditional neighbourhoods of Basra city in future development, and to amend residential areas in the current Master Plan to also reflect these attributes where possible. In this regard, the evidence from this research contributes to decision-making activities related to the planning of neighbourhoods in Basra city, in the following areas:

8.4.2.1 Block density

The increase of walking behaviour is associated with the increase in block density (on a 400-meter radius). Therefore, the land cover ratio of 66% and 68% is the best record amongst the traditional and modern neighbourhood typologies of Basra city, respectively.

8.4.2.2 Housing density

An increase in walking behaviour is associated with the increase in housing unit densities per hectare (on a 400x400-meter scale). Thus, a housing density of 41.9 units per hectare is the highest record amongst the traditional neighbourhood typology of Basra city. Smaller housing units adjusted to the boundaries of the plots could create a higher population density and decrease land consumption. This finding encourages the adoption of densification policies and thus encourages landlords to densify and retrofit existing developments. However, later developments have far lower housing unit densities, at 25 and 17.25 units per hectare, for Al-Mugawleen and Al-Abassya respectively. Thus, the denser urban developments, either through block or housing density, are predictive indicators of walking behaviour.

Moreover, denser physical environments have smaller open spaces in comparison with those areas with less density. Therefore, this finding suggests that the open spaces of denser urban areas are more likely to have active pedestrians, as residents are more likely to walk to occupational activities. Furthermore, routine visits to the Al-Saymmar neighbourhood during the study supports this conclusion, where it was seen that people sit on the street edges, and in the shadows of houses talking and watching children play in the corridors. Also, the denser areas of pedestrian movement could stimulate commercial growth, especially on the periphery of the traditional neighbourhood where there tends to be more space for both movement and development.

8.4.2.3 The diversity of all the commercial land use

An increase in walking behaviour is associated with an increase in the degree of land use diversity amongst all commercial land use (on the 400-meter and 600-meter radius scales). In this respect, the degree of land use diversity is at its highest record amongst the traditional neighbourhood typology (at .94 degree of 1).

8.4.2.4 The diversity of retail shops

The increase in walking behaviour is associated with an increase in the degree of land use diversity amongst retail shops (on the 400-meter and 600-meter radius scales). Moreover, the degree of land use diversity is at its highest within the traditional neighbourhood typology (at .98 degree of 1, and .97 degree of 1 for the two scales, respectively). In terms of the number of retailers, an increase in walking is associated with an increase in the number of retail shops. In this regard, the highest number of retail shops was noted in the traditional neighbourhood typology on both the 400-meter radius and 600-meter radius scales (at 232 and 399 stores, respectively). Thus, more destinations are important because they increase the incentives and opportunities for walking.

8.4.2.5 The land use diversity of non-residential land-use

An increase in walking behaviour is associated with a decrease in the degree of diversity for non-residential land use (on the 400-meter and 600-meter radius scales). Moreover, the degree of land use diversity is at its lowest within the traditional neighbourhood typology (at .39 degree of 1, and .45 degree of 1 for the two scales, respectively). The reason for the low degree of land use diversity within the traditional neighbourhood is potentially because some of the land uses occupy a large ratio of the commercial area (e.g. workshops, parking, and wholesale) at expense of other smaller commercial area uses, for example local shops.

The diversification of non-residential land use is an important aspect for pedestrian-oriented developments, which has already resulted in a reduction in the dependence on automobiles. Retail space, especially food shops, represent magnets to pedestrians. From the reported walking outcomes for this research (gathered through the NWOAQ), the researcher noted that a high ratio of participants who live in modern developments reported one-way walking journeys to food shops within the traditional neighbourhood where the return journey after shopping was conducted via modes of automobile transit. After telephone calls with nine participants who participated in the questionnaire (three from each neighbourhood) it was found that food is cheaper in the traditional area because the rents are lower than those within the modern developments. This phenomenon has resulted from the best use of land resources, alongside lower wages, which are associated with the greater population density and mix of social classes in the traditional neighbourhood.

8.4.2.6 Nodes intensity

An increase in walking behaviour is associated with an increase in node density (on the 400-meter and 600-meter radius scales). In this respect, the highest node density was observed in the traditional neighbourhood typology (at 4.16 nodes per hectare and 3.36 nodes per hectare for each scale, respectively).

8.4.2.7 Street intensity

An increase in walking behaviour is associated with an increase in street intensity (on the 400-meter radius scale). The highest street intensity was noted in the traditional neighbourhood typology, at 387-meter lengths per hectare. Similarly, on the 600-meter radius scale, the highest street intensity was noted within the Al-Mugawlen neighbourhood (at 368-meter lengths per hectare), which represents the early stage of modern development. Thus, a finer or smaller street scale is important because it provides more opportunities for walking, which permeate through more of the urban tissue.

8.4.2.8 External connectivity

The increase in walking scores to occupational activities is associated with the increase in external connectivity (on the 400x400-meter scale). In this respect, the highest external connectivity (at 1 entrance for each 57-meter length) was noted in the traditional neighbourhood typology; meanwhile, the lowest ratio was noted in the modern neighbourhood of Al-Abassya (at 1 entrance for each 100-meter length). Nevertheless, although the modern developments have fewer entrances, these are connected with permeable routes and function as entrances and exits. In contrast although the traditional neighbourhood has a greater number of entrances, they are connected to less more permeable routes. Thus, an increase in the number of permeable routes is recommended as these simultaneously serve as entrances and exits for the neighbourhoods.

Thus, the connectivity of streets is the principle attribute to enhance pedestrian activity, aside from complementary designs and furnishings for walking purposes, such as sidewalk design. The intensity of streets (Length/Area) is the principle attribute to increase the walking rates of residents; thus, the traditional neighbourhood has considerably greater total street length than conventional neighbourhoods, and therefore a significantly higher rate of walking behaviour. The higher node densities (for both the T-intersection and X-intersection), which are observed in the traditional neighbourhood, are a crucial quality for pedestrian-oriented development. Moreover, a control over the ratio of T-intersections to X-intersections is important, as more X-intersections mean greater connectivity, whilst more T-intersections mean greater safety. Thus, this research recommends a balance between T and X intersections because movement decreases with the former and increases with later.

Also, an increase in the number of X-intersections can contribute to an increase in the number of street segments. In this regard, the traditional neighbourhood demonstrated the highest number of street segments at 466. Moreover, although cul-de-sacs inhibit the accessibility of the traditional neighbourhood for 10-minute walks and increase the length and time of the walking journey, its denser streets and nodes still mean it has the highest rates of walking behaviour outcomes.

8.4.3 Conclusions related to the objectively measured morphology and streetscape attributes

Some of the objectively measured urban form morphologies and streetscapes of demonstrated considerable positive direct effects on walks to occupational activities within Basra city's neighbourhoods. In this regard, the following highly to moderately explained the variance in walking outcomes: the Clustering coefficient of destinations on the 400-meter radius and 600-meter radius scales; the Gini Coefficient of 'betweenness' scales on the 400-meter radius and 600-meter radius scales; and the Enclosure ratio of the high 'betweenness' street scale on the 400-meter radius. However, some of the attributes that demonstrated negative associations with walking outcomes require careful consideration in terms of their usefulness. For example, although the deterioration of the frontage quality of streets was associated with walking, it is not realistic to consider it responsible for an increase in walking. As such, this research recommends the consideration of the morphologic and streetscape attributes of traditional neighbourhoods of Basra city in future development and to provide this feedback the current Master Plan of residential areas. Based on this evidence, the research can contribute to decision-making by offering the following evidence related to the design of neighbourhoods in Basra city:

8.4.3.1 The clustering coefficient of destinations

An increase in walking behaviour is associated with an increase in the Clustering coefficient of destinations (on the 400-meter radius scale). The highest Clustering coefficient of destinations was noticed in the Al-Saymmar and Al-Abassya neighbourhood typologies (at .05 of 1). Also, on the 600-meter radius scale, the highest Clustering coefficient of destinations was noted in the Al-Saymmar and Al-Abassya neighbourhood typologies (at .04 0f 1). However, the Clustering coefficient of destinations presents a paradoxical issue when the designing land use because higher clustering means the satisfaction of more tasks with fewer inter-destination journeys.

Nevertheless, it also means an increase in the concentration of destinations in certain zones, which can mean separation from the residential zones. Meanwhile, a lower clustering indicates a better distribution of non-residential resources and more heterogeneous land use patterns, which hypothetically have a positive impact on ecological processes, or human-environment interactions (Alberti, 2005; Pickett et al., 2001; Pickett et al., 2008).

Thus, in order to access both benefits, this research suggest increasing the clustering into bundles of mixed destinations and distributing these clusters across the neighbourhood to avoid separate zoning, whilst maintaining well connected corridors of movement between such clusters. In this regard, the Al-Abassya neighbourhood (modern development) demonstrated a 0.05 (400-meter scale) and 0.04 (600-meter scale) Clustering coefficient, which are exactly same as the Al-Saymmar neighbourhood. However, the distribution of the clusters permeates into the centre of the neighbourhood instead of just collecting on the edges of the neighbourhood, as with the traditional neighbourhood.

8.4.3.2 Centrality measure conclusions:

8.4.3.2.1 The ‘betweenness’ degree

The increase of walking behaviour is associated with an increase in the Gini Coefficient of the ‘betweenness’ degree (on the 400-meter radius scale), and the inequality of distribution of ‘betweenness’ resources. Therefore, the highest Gini Coefficient of ‘betweenness’ (at .69 0f 1) was noted in the Al-Abassya neighbourhood typology, which is a modern development with a grid-like street network. This rate was slightly higher than the traditional neighbourhood score (at .66 of 1). This means that the street segments of the planned neighbourhood are slightly more homogeneous (closer to 1 in the Gini coefficient of ‘betweenness’) than the traditional neighbourhood (more heterogeneous, closer to 0 in the Gini coefficient of ‘betweenness’). Thus, based on the degree of ‘betweenness’, the less heterogeneous street patterns have a positive association with walking behaviour. This is contradicted with the premises of the ecologic perspective, which state that the heterogeneity of an ecosystem stimulates the interaction fluxes among its subsystems (Pickett et al., 2001; Pickett et al., 2008). Moreover, the centrality measures have never been used as design instruments, although they were used as inspecting tools for existing streets networks (see Porta, Crucitti & Latora, 2006, 2008). Therefore, this research suggests the use of the ‘betweenness’ centrality measure to inspect the match between the real importance of an individual street segment (the ‘betweenness’ degree) and its importance within a specific street network hierarchy. Thus, the collector streets need more attention because, in certain positions or junctions, the less important local streets and cul-de-sacs significantly disrupt the flow and impact on collector streets. This was identified by the MCA software, and particularly noted within the traditional neighbourhood. In other words, in several of the betweenness tests, the street segments at lower levels (such as local streets) showed higher betweenness degrees than the segments at higher levels (like collector streets).

8.4.3.2.2 The ‘straightness’ degree

The increase in walking behaviour is associated with a decrease in the ‘straightness’ degree (on a 400-meter radius scale), and the mean of the ‘straightness’ degree. Therefore, the highest ‘straightness’ degree was noted within the modern neighbourhood typology (at .78 of 1), and the lowest straightness degree was noted within the traditional neighbourhood typology (at .71 of 1). This contradicted the results of previous studies, which recommended linearity, and straight edges and paths as more active places (Brantingham & Brantingham, 1993; Hillier, Penn, Hanson, Grajewski & Xu, 1993; Porta et al., 2008; Zacharias, 2001). However, the increase of walking behaviour is associated with an increase in the Gini Coefficient ‘straightness’ (on the 400-meter radius scale), and the inequality of ‘straightness’ resource distribution. Therefore, the highest Gini Coefficient ‘straightness’ degree (at .08 of 1) was noted within the traditional neighbourhood typology. In other words, the less similar ‘straightness’ among the street segments is more promotive of walking behaviour. To further explain, when the edges or streets segments of a particular if the edges or streets segments have contradicting shapes (such as a combination of both straight lines and curve-like shapes), they tend to encourage walking. Meanwhile, urban tissue have similarly straight shapes or have similar curve-like shapes, they will tend to reduce walking rates. This acords with the premises of the ecologic perspective, which state that the heterogeneity of an ecosystem stimulates the interaction fluxes among its subsystems (Pickett et al., 2001; Pickett et al., 2008).

8.4.3.3 The Frontage quality index

This indicator demonstrated negative strong associations with all walking outcomes. Although the quality of frontages within the traditional neighbourhood have deteriorated more, the walking rates were high in comparison with neighbourhoods with better condition frontages. However, this does not mean that the deteriorated façades are more conducive of walking, but rather that there are other factors of influence responsible for walking behaviour. None of the frontage quality index evidence can, therefore, be considered. Moreover, from past studies that studied transportation generally and walking specifically, the frontage quality was the less commonly investigated aspect of the physical environment and this was due to data limitations (Handy, 1996; Southworth, 2005).

8.4.3.4 The Enclosure ratio:

8.4.3.4.1 The Enclosure ratio of the high betweenness street

An increase in walking behaviour is associated with an increase in the enclosure ratio of the high 'betweenness' streets (on a 400-meter radius) for the sampled collector streets. In this respect, the highest enclosure ratio of the high 'betweenness' street was noted in traditional neighbourhood typology (at 2.9 for the street width to building height ratio). Conversely, an increase in walking behaviour is associated with a decrease in the enclosure ratio for the medium and low 'betweenness' street (on a 400-meter radius). Thus, the lowest enclosure ratio of the medium 'betweenness' street was noted in the traditional neighbourhood typology (at 1) for the street width/building height ratio). Moreover, the enclosure ratio of the collector streets (high 'betweenness') is the only indicator that showed a significant effect on the walking outcomes. This potentially explains why people are more likely to walk in this stratum of the street network. The potential value of this finding lies in the concentration of pedestrians in collector streets and the follow-up commercial growth that may need more attention in future, either through policy planning or design. This could increase the area for pedestrians at the expense of automobile lanes.

8.4.4 Considering the neighbourhood as an ecosystem

The ecology of the city paradigm considers the built environment as an ecosystem. In this regard, three main qualities of the urban ecosystem are considered in this research, which includes: the urban pattern of human activity (Alberti, et al. 2003, and Alberti, 2005); the scale-dependence of the ecosystem (Cantrell & Holzman, 2015; Gibson et al., 2000; Pickett, Cadenasso, Grove, Groffman, et al., 2008), and the heterogeneity of the urban system (Pickett et al., 2016).

8.4.4.1 Urban patterns and human activity

Alberti (2005) demonstrated that the urban ecosystem is concerned with the interactions between humans, the man-made environment, and natural landscape. Human activity is clearly a driving force, which either directly or indirectly impacts the wellbeing of both humans and the entire ecosystem. Also, Alberti recognised that design practice is a human activity that impacts the ecosystem through altering the urban pattern, and that this impact arises through the distribution of resources. Moreover, he considered it a basis for human interest at the expense of the natural ecosystem and its characteristics, thus undermining the human-environment interaction by imposing human-focussed designs (Alberti, 2005).

Alberti, et al. (2003) and Alberti (2005) identified three dimensions of the urban space that classified it as an ecosystem, namely: structural ingredients that include humans and the environment; processes of interaction; and the boundaries of the ecosystem (Alberti et al., 2008). These three dimensions are useful tools to define the spatial pattern of an urban area as an ecosystem. The first dimension considers the urban pattern as an ecosystem that has structural aspects which contribute to the interaction processes of the human-environment; these interaction processes represent the second dimension. In this regard, human activities are emerging systems, like economic activity or physical activity, but not ingredients of the ecosystem. The last dimension is the boundaries, which define the ecosystem and are considered crucial to the interaction processes of the human-environment. For example, the type of walls impacts the visual and thermal relationship between the interior and the exterior of the space. Thus, the neighbourhood is considered an ecosystem of three dimensions, namely structural, processes of interaction, and boundaries.

Meanwhile, walking activity is an emerging system from human-environment interactions, and is non-detachable from its context. In this regard, the associations between the social and physical environments and walking to occupational activities strengthen the theoretical posits that the neighbourhood as an urban pattern could be considered an ecosystem (Grimm, Grove, Pickett & Redman, 2000). Moreover, the interaction processes among its structural ingredients are responsible for the variance within the walking outcomes identified by this research. With regard to the interaction processes, the determining role of the physical environment of the neighbourhoods in question demonstrated strong to moderate effects on the walking outcomes.

Meanwhile, the mediation and moderation processes showed far less influence on walking to occupational activities.

8.4.4.2 Scale-dependent ecosystems

Urban ecology is a systems-based approach to the city, which focuses on the "structural details and richness of processes that take place within the boundaries of the system" (Cantrell & Holzman, 2015, p.254). In literally defining the spatial boundaries of a certain urban pattern the scale of the urban tissue is also defined, which might be a block or neighbourhood (Clifton et al., 2008). The ecological processes of an ecosystem occur on different spatial scales or organisational levels (Grimm, Grove, Pickett & Redman, 2000), which represent different observational lenses (Pickett et al., 2013). Hence, the study of urban tissue as an ecosystem must carefully delineate the scale because it defines the operations of interaction within the chosen structure.

In this regard, the scales used by this research, namely the 400-meter radius, and 600-meter radius, efficiently contributed to the development of both independent and dependent variables. This facilitated the inference of the ecological process, which included determination, moderation, and mediation processes between the social and physical environments and walking to occupational activities. Also, using multiple scales in this research helped to identify different associations for a single indicator. For example, the Gini Coefficient indicator of 'betweenness' has a significant association with walking on a 600-meter radius scale, while it has non-significant associations on a 600-meter radius scale. This confirms the claim by Cash et al. (2006) that the human-environment dynamic should be considered within multiple rather than singular levels and scales. Therefore, this research concludes that multiple scales are prerequisites to run ecological models of physical activity.

8.4.4.3 The heterogeneity of the urban system

Pickett et al. (2016) considered heterogeneity as an apparent quality of the urban system (Jacobs, 1961; Lynch, 1960; Shane, 2005, as cited by Pickett et al., 2016). Based on the ecology of the city, they perceive the urban system as a complex entity of heterogeneous elements that are, in one way or another, linked to social-ecology relationships. Moreover, it drives and activates the system through its content and boundaries and the interactions between its contents (Pickett et al., 2016). Thus, the emergence of new systems within an urban ecosystem are a consequence of its consideration as a heterogeneous spatial system. The findings of this study embrace this notion, because the traditional neighbourhood, which is a more heterogeneous environment than the modern neighbourhood, is more encouraging of walking activity to occupational activities.

8.5 Future studies

The previous sections of this chapter focused on the implications and contribution of this research to future developments in Basra city in terms of the master planning of neighbourhoods to enhance walking activity. This section discusses further insights for the academic community regarding future areas of research.

1) The application of ecological models of physical activity to determine the walkability of neighbourhoods in Basra city pushes the boundaries of walking-related studies from simple correlations to causality associations. Thus, it allows the researcher to consider the case study as a system of several levels, which is a type of three-dimensional illustration of human environment interactions. This enables the research to deal with the loose ends of walking outcomes based on fixed baselines, which are the measurable factors of the social and physical environment.
2) The determination, mediation and moderation factors were utilised to test the basic associations between the levels of the conceptual framework for this research. However, further tests would be applicable, based on these same factors. For example, the socio-demographic and BMI factors could be tested as moderators between the mediation variables and the walking outcomes in order to determine to what extent these factors moderate the influence of the beliefs that people hold about walking on real walking outcomes. Alternatively, future studies could test the extent to which the socio-demographic and BMI factors are able to moderate the influence of the physical environment on beliefs about walking.
3) Previous studies highlighted the problem of indicator collinearity within the physical environment (Moudon, 2006). In this regard, the combination of several indicators into indexes of the physical environment requires the inclusion of a larger number of case study neighbourhoods. This is because the utilisation of more case studies would avoid research collinearity. Thus, for future studies, this research recommends using a bigger sample of, for example, 20 case

studies to produce reliable indexes from the individual indicators of the objectively measured physical environment.

4) The objectively measured physical environment attributes substantially contributed to the statistical tests related to walking outcomes. This means that developing more indexes from basic urban planning and urban design indicators requires more research. In this regard, future studies may utilise GIS software to develop more indexes, as this software is more practical than direct measurement. For example, this could include walkability indexes that are based on several combinations of urban planning indicators and accessibility indexes and founded on user activity and distances between destinations and user departure stations.

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10 Appendices

10.1 Appendix (1): The ethical approval

Department of Architecture

UNDERGRADUATE & POSTGRADUATE DISSERTATION PROJECT ETHICS APPLICATION FORM – RESEARCH ON HUMAN PARTICIPANTS

- Does your research involve people?
- Will you be sending out questionnaires?
- Will you interview people on the telephone or face-to-face?
- Does your research involve observing people at work?

If you answered **YES** to any of these questions then this form must be fully completed and approved by the Department of Architecture Research Ethics Committee **before** fieldwork can commence.

Before completing the form begin by considering the following issues:

- ✓ Have you read and incorporated into your research proposal the principles set out in the University's Research Code of Conduct?
- ✓ Have you considered how ethical concerns may impact upon your research process, its findings and future dissemination?
- ✓ Do you feel prepared for possible ethical/political dilemmas that may face you as a practitioner-researcher?

If you answered **YES** to these points, please complete the necessary ethical approval form (and associated appendices), and submit it with your project proposal for assessment and approval.

Please complete all sections. Tick each box as it applies. Where requested add extra information. **Each section must be fully completed**. For additional guidance refer to the University's 'Code of Practice on Investigations on Human Beings',– available on University intranet.

Name: Qaaid Zgher AL-Saraify

Registration:

Programme: PHD Architecture

Project Title: Towards Ecological URban Design Development Behavioural-spatial-Ecology model BSE-M Predictive Instrument for Neighbourhood livability

What data collection methods do you plan to use?

YES	NO	
✓		Questionnaires
	X	Structured Interviews (face-to-face/telephone)
	X	

YES	NO	
✓		Participant Observations
		Other – please define: Movie will be recorded

*Please note: approval will **NOT** be given for any covert observation or data collection that involves deception in any way.*

Participants

How many participants will be involved in your project? 150-200

Who are they?

YES	NO	
	✓	Employees
	✓	Managers (line and middle)
	✓	Managers (senior)
	✓	Owner-Managers
	✓	Sub-contractors and their employees
	✓	Customers
	✓	Clients
✓		Other – please define: Residents of Neighbourhood

How will you recruit the participants?

The recruitment of volunteers should, wherever possible, be via a letter, or, if orally, through a group approach rather than to individuals. If advertising for volunteers, then you need to state where you plan to place such advertisements and will need to attach a copy to the complete ethics approval form. There should be neither financial inducement nor any other coercion, actual or implied, that might persuade people to take part in any investigation.

YES	NO	
	✓	They are people you know (i.e. friends and/or family)
	✓	They are existing or previous work colleagues
	✓	You approach the company and they offer you a list of participants

☑ ☐ Random Street Survey

☐ ☑ You advertise in a newspaper/newsletter

☐ ☑ Is the proposed advertisement attached?

☐ ☐ Other – please define

Are any of the participants 'vulnerable people'?
Recruitment from certain groups raises particular ethical, and in some cases, special legal issues which require particular consideration. These groups include children, the elderly (over 65 years of age), those with a cognitive disability or learning difficulty, or those who live in or are connected to an institutional environment.

YES	NO	
☐	☑	Are they under 18, over 65
☐	☑	Suffer/suffered from mental or physical disabilities
☐	☑	Other – please define

If vulnerable groups are to be involved in your research then please explain their circumstances and why you need to seek their participation in your research.

Personal data which could be used to identify a participant should be anonymised and securely stored. Ethical guidelines recommend that it not be stored electronically.

YES	NO	
☐	☑	Have you devised a system so that you can anonymise data and protect participants' identity?
☑	☐	Have you a secure place to store data?
☑	☐	Are you able to reassure participants with confidence that their identity will not be revealed and data will remain confidential?

3

submit this form for approval. You MUST devise systems to protect the confidentiality of participants before submitting this form.

Protection of Participants:
Your research should not expose participants to harm in any way.

YES	NO	
☐	☑	Will your interview/questionnaires involve requests for very personal information?
☐	☑	Do you believe participants may experience any physical or emotional discomfort as a result of taking part in your project – i.e. due to overlong interviews or exposure of sensitive issues?
☐	☑	Do you believe your research exposes participants to any greater risks than those encountered in day-to-day life?

Risk to University
If you answer YES to any of the above concerning Protection of Participants and Protection of University Reputation you need to reconsider your approach to research as it potentially incurs 'risk' for the university and their insurers. Do <u>NOT</u> submit this form until you can state with confidence that your research design will NOT cause discomfort or risk for participants or supervisor and University.

YES	NO	
☐	☑	Might your research in some way breach basic codes of conduct of academic research as outlined in the University Guide to Research Ethics?

Informed Consent
Participants must give their informed consent to take part in any research. You should give each participant an information sheet which provides full relevant details of the nature, object and duration of the proposed investigation in a form that is readily understood. Once participants have read the <u>Participant Information</u> Sheet they should then read and complete and <u>Informed Consent Form.</u>

Have you attached your 'participant information sheet' and 'informed consent form' to this application?

YES	NO	
☑	☐	Participant information sheet
☑	☐	Informed consent form

i.e. if telephone interviews are to take place then informed consent may be gained verbally and recorded

Does your 'participation information sheet' explain in clear terms

YES	NO	
✓		What the research is about?
✓		The purposes of the research?
✓		Who is sponsoring it?
✓		The nature of their involvement in the research?
✓		How long their participation is going to take?
✓		That their participation is voluntary?
✓		That every care is taken to maintain confidentiality?

Participants should be aware that they can withdraw from the research at any time – without giving an explanation

YES	NO	
✓		Does your 'participation information sheet' and 'informed consent form' clearly inform participants of their 'right to withdraw'?

Thank you for completing this form and taking the time to reflect on your ethical approach to research. Please now attach this form together with the participation information sheet and informed consent form to your project proposal and submit for assessment.

STUDENT SIGNATURE [signature]

DATE 10/09/2015

Ethical Approval ...

Dr Andrew Agapiou

Chair of Departmental Ethics Committee

Date: 18/9/15

If a Departmental Ethics Committee has any doubts about any particular research project it is asked to consider, or if it cannot reach agreement, then this will be referred to the University Ethics Committee for consideration. You will be informed of such an outcome.

Note:
This form has been adapted from the original first developed by the Department of Management Strathclyde Business School and we are grateful for permission to re-produce it for our purpose.

Participant Information Sheet for (Ecologic Urban Design)

Name of department: Architecture
Title of the study: Towards Ecological Urban Design Development, Behavioural Spatial Ecology Model (BSE – M), Predictive Instrument for Neighbourhood Livability.

Introduction
My Name is Qaaid Al-Saraify; I am a Ph. D. student in University of Strathclyde, and an employee in Basra University.

Note: contact details entailed to this format.

What is the purpose of this investigation?
This investigation aims to understand the livability of your neighbourhood. Understanding the physical, social, and psychological environment is essential for the future developments. The broad aim of this study is to link Ecology to Urban design. Ecologic Urban Design is a promising research area it aims to produce an urban design process, which could accommodate human needs and physical environments compatibly.

Do you have to take part?
You participation in this research is voluntary. Your participation will help the researcher to reveal the unique qualities of residents and built environment which will help to inform planners, urban designers, decision makers and stack holders about the future insight for your neighbourhood. The type of information that you will feed the research with includes information about your beliefs in term of daily activities and quality of place.

What will you do in the project?
Your acceptance is the first step of your participation. The second step is to full the questionnaire format by selecting the right option or number which matches your status after careful reading of the adjacent statements. The neighbourhoods that are included in this investigation are (AlSaymar, AlMuqaolien, AlAbassyia); If you live in them you will be able to take part in this study. To answer the questionnaire you will need (10 to 15 minutes). This study takes place in September and October 2015

Why have you been invited to take part?
This study targets adults between (18-65 years old). This investigation aims to involve (60 to100) of residents of each neighbourhood. Such type and amount of participants will match the scope of our study. Gleaned information will be computed by different software like SPSS, and Excel. If the format is not completely filled it will be excluded of this study.

What are the potential risks to you in taking part?
There is no potential risk on you in case of taking part in this study.

What happens to the information in the project?
This study takes in consideration the confidentiality and anonymity of the participants, either personally or legally. University of Strathclyde will supervise the data storage and analysis, to insure the safety of the data.

Note: That The University of Strathclyde is registered with the Information Commissioner's Office who implements the Data Protection Act 1998. All personal data on participants will be processed in accordance with the provisions of the Data Protection Act 1998.

Thank you for reading this information – please ask any questions if you are unsure about what is written here.

If you are happy to be involved in the project, please sign consent form to confirm this.

If you do not want to be involved in the project, then I would like to thank you for your attention.

If the results of this study will be published you can visit Basra university web site then research news department will write the last news of staff researches. http://www.uobasrah.edu.iq/

Researcher contact details:
This should include the name of the Researcher and University of Strathclyde contact details (address, phone number and email address – do not include personal contact details).

Investigator details:
Qaaid Al-Saraify
PhD Student
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Email: nkb13112@strath.ac.uk

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This investigation was granted ethical approval by the University of Strathclyde Ethics Committee.

If you have any questions/concerns, during or after the investigation, or wish to contact an independent person to whom any questions may be directed or further information may be sought from, please contact:

Secretary to the University Ethics Committee
Research & Knowledge Exchange Services
University of Strathclyde
Graham Hills Building
50 George Street
Glasgow
G1 1QE

Telephone: 0141 548 3707
Email: ethics@strath.ac.uk

University of Strathclyde Glasgow

Consent Form for Ecologic Urban Design. *CI should alter this form to fit with the requirements of each individual study*

Name of department: Architecture

Title of the study: Towards Ecological Urban Design Development, Behavioural Spatial Ecology Model (BSE – M), Predictive Instrument for Neighbourhood Livability.

- I confirm that I have read and understood the information sheet for the above project and the researcher has answered any queries to my satisfaction.
- I understand that my participation is voluntary and that I am free to withdraw from the project at any time, up to the point of completion, without having to give a reason and without any consequences. If I exercise my right to withdraw and I don't want my data to be used, any data which have been collected from me will be destroyed.
- I understand that I can withdraw from the study any personal data (i.e. data which identify me personally) at any time.
- I understand that anonymised data (i.e. .data which do not identify me personally) cannot be withdrawn once they have been included in the study.
- I understand that any information recorded in the investigation will remain confidential and no information that identifies me will be made publicly available.
- I consent to being a participant in the project
- I consent to being audio and/or video recorded as part of the project

Where human biological samples are taken e.g. blood samples or biopsy samples then the following wording should be included: I consent to the taking of biological samples from me, and understand that they will be the property of the University of Strathclyde.

Where it is proposed to carry out DNA analysis of material in any samples then the following statement should be included in the consent form: I consent to DNA in the samples being analysed.

For investigations where it has been decided that "no fault compensation" cover will be provided the following wording needs to be included: In agreeing to participate in this investigation I am aware that I may be entitled to compensation for accidental bodily injury, including death or disease, arising out of the investigation without the need to prove fault. However, such compensation is subject to acceptance of the Conditions of Compensation, a copy of which is available on request.

(PRINT NAME)

Signature of Participant: Date:

10.2 Appendix (2): The questionnaire in English

Dear Sir/Madam,

I am a PhD student at the University of Strathclyde in Scotland. I was nominated by Basra University to conduct research into the development of Basra's residential neighbourhoods, and your neighbourhood is one of the carefully selected three neighbourhoods for this research. We will be grateful if you choose to answer the attached (A, B, C, and D) formats, as this will be really helpful for our study. After completing it, our representative will collect the questionnaire one week after you received the form. Alternatively, you can drop it into the appointed local shop.

1. Format **A** includes personal and family information.
2. Format **B** requires you to write down your everyday activities (7:00 am – 12:00 pm) for a whole week, to choose the activity and the minutes it takes you, if you walked or not, and (using the attached map) to help choose the address of your home block and destinations. Moreover, it does not make a difference which day of the week you start.
   Everyday activities mean what you do every day and whether you walked or not. This includes going: shopping for consumer goods, shopping for food, to work/study, to meet with friends in a public place, like the mosque, to the Gym or playing sport, or to see a doctor.
3. Format **C** includes your satisfaction with the quality of your neighbourhood.
4. Format **D** is about your walking behaviour. You must choose a number on a scale of seven grades or one of four phrases. Your choice represents your degree of satisfaction with the statement above each scale.
5. Format **E** is the map of your neighbourhood, where you can indicate the addresses for your house and your destinations

Notes:

1. This questionnaire is designed for adults (aged 18-65), and for those who do not have a disability that impedes their ability to walk.
2. This questionnaire does not need to mention the name of the participant.
3. You are voluntarily taking apart in this study and can withdraw at any time.
4. Your privacy is assured by the researcher and university, and is considered under a high level of confidentiality.
5. As soon as you submit this questionnaire you cannot withdraw it because it will become part of the study.
6. If you leave parts or questions blank, this will weaken the opportunity to consider the whole questionnaire.
7. The main aim of this questionnaire is to study the different physical activities of respondents, like walking.
8. If you complete the questionnaire and return it to the appointed local shop, you will receive a 10$ mobile phone voucher as a gesture of thanks.
9. If there is any thing you do not understand please call .... between 8am to 8pm from date to date.

Signature: ....

Date: / / 2015

A: Demographic information:

A1. Do you have any kind of disability or longstanding illness that impedes your walking ability? ☐ No ☐ Yes **If yes, then you do not need to complete the questionnaire**	A8. How much is your: Height: ☐ metres? Weight: ☐ rams?
A2. Are you: ☐ Female ☐ Male	A9. How many people are in your family? ☐
A3. Please tick your age category: ☐ 18 – 24 ☐ 25 – 34 ☐ 35 – 44 ☐ 45 – 54 ☐ 55 – 65	A10. How many individuals under 16 years of age are members of your family? ☐
A4. How much is your approximate monthly income? Tick the right category: ☐ 200 - 400 $ ☐ 400 - 600 $ ☐ 600 - 800 $ ☐ 800 - 1000 $ ☐ 1000 - 1200 $ ☐ More than 1200 $	A11. How many cars do your family own in total? ☐ A12. How long have you been living in your current house? ☐
A5. What is your employment status? ☐ Employed ☐ Unemployed ☐ Self-employed ☐ Housekeeper ☐ Student	A13. How many bedrooms does your house have? ☐
A6. What is the best description of your marital status? ☐ Single and living with parents ☐ Married with no children ☐ Married with children ☐ Married and living with children and parents ☐ Married and living with children, parents, and brothers ☐ Other	A14: What type is your house? ☐ Courtyard house ☐ Frontyard house ☐ Backyard house ☐ No yard house
A7. Do you practice any type of sport or regular exercise? This includes going to the gym. ☐ No ☐ Yes	A15. Is your house is owned or rented? ☐ Owned by one of the family ☐ Rented

B: Your address: Block……… / Choose your home address from the attached map:

Where did you go? Sunday - Saturday	Address Dest.	Minutes you walked						Walk	
		10	15	20	25	30	>30	Yes	No
To work/study		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
To do personal business		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
For shopping goods		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
For shopping food		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
To meet people in public places		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
To go to the gym or play a type of sport		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
To see the doctor		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○
◯		○	○	○	○	○	○	○	○

Choose your destinations' addresses from the attached map. If you do the same thing different times mention it all, by marking X in the circle and complete the details.

C: About your neighbourhood:

Q1: There are many attractive things to look at while walking in my neighbourhood: Disagree __1__: __2__: __3__: __4__: __5__Agree
Q2: My neighbourhood is safe enough that I would let a 10-year-old boy walk around my block alone in the daytime: Disagree__1__: __2__: __3__: __4__: __5__Agree
Q3: I can do most of my shopping within my neighbourhood Disagree__1__: __2__: __3__: __4__: __5__Agree
Q4: Local shops in my neighbourhood are within an easy walking distance of my home: Disagree__1__: __2__: __3__: __4__: __5__Agree
Q5: The sidewalks in my neighbourhood are well designed for walking Disagree__1__: __2__: __3__: __4__: __5__Agree
Q6: The streets in my neighbourhood do not have many cul-de-sacs: Disagree__1__: __2__: __3__: __4__: __5__Agree
Q7: There are many alternative routes that enable me to move from place to place in my neighbourhood: Disagree__1__: __2__: __3__: __4__: __5__Agree
Q8: The traffic in my neighbourhood makes it an unsafe place to walk: Disagree__1__: __2__: __3__: __4__: __5__Agree
Q9: The low crime rates in my neighbourhood makes it a safe place to walk: Disagree__1__: __2__: __3__: __4__: __5__Agree
Q10: In my neighbourhood, there are many places within easy walking distances from my home, like parks, mosques, gyms, cafes, playgrounds: Disagree __1__: __2__: __3__: __4__: __5__Agree
Q11: I see and speak to other people when I am walking in my neighbourhood: Disagree__1__: __2__: __3__: __4__: __5__Agree
Q12: Parked cars in the streets of my neighbourhood impede my walking: Disagree__1__: __2__: __3__: __4__: __5__Agree
Q13: Considering the overall housing conditions in my neighbourhood, I am satisfied with living in the area. Disagree__1__: __2__: __3__: __4__: __5__Agree

➢ Mark the number or square that represents your choice.

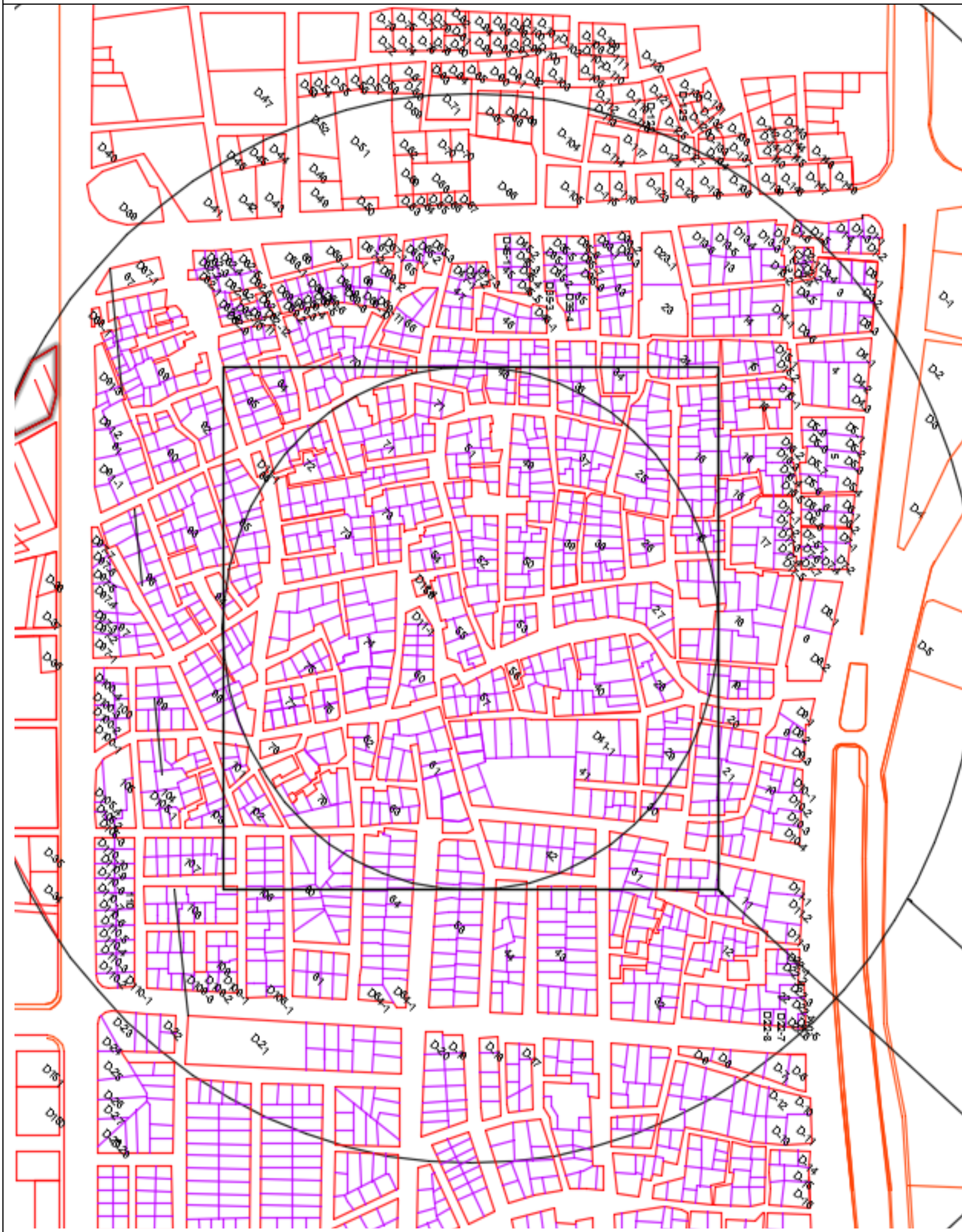
D: your beliefs about walking in your neighbourhood:

Attitude to questions:
29. I aim to walk for 30 minutes each day within my neighbourhood because it is healthy. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__ Agree
30. I think walking is healthy. ◯ **to some extent,** ◯ **to a large extent,** ◯ **to a very large extent,** ◯ **to an extremely extent**
31. I aim to walk for 30 minutes each day within my neighbourhood because the environment is pleasant. Disagree: __1_: __2__: __3__: __4__: __5__: _6__: __7__ Agree
32.I think walking is entertaining. ◯ **to some extent,** ◯ **to a large extent,** ◯ **to a very large extent,** ◯ **to an extremely extent**
33. I aim to walk for 30 minutes each day within my neighbourhood because it is safe. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__ Agree
34. I think walking is harmful. ◯ to some extent, ◯ to a large extent, ◯ a very large extent, ◯ an extremely large extent
35. I aim to walk for 30 minutes each day within my neighbourhood because of the fresh air. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__ Agree
36. I think walking is an opportunity to breathe fresh air. ◯ **to some extent,** ◯ **to a large extent,** ◯ **to a very large extent,** ◯ **to an extremely extent**
37. I do not want to walk for 30 minutes each day within my neighbourhood because it waste my time. **Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__ agree**
38. I think that walking wastes time. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
Subjective norms questions:
39. People encourage me to walk daily within my neighbourhood. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
40. I do consider the opinion of others. ◯ **to some extent,** ◯ **to a large extent,** ◯ **to a very large extent,** ◯ **to an extremely extent**
41. Family members encourage me to walk daily within my neighbourhood. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
42. I do consider my family's opinion. ◯ **to some extent,** ◯ **to a large extent,** ◯ **to a very large extent,** ◯ **to an extremely extent**
43. My doctor encourages me to walk for at least 30 minutes daily within my neighbourhood. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
44. I do consider my doctor's opinion. ◯ **to some extent,** ◯ **to a large extent,** ◯ **to a very large extent,** ◯ **to an extremely extent**

Perceived behaviour control:
45. I find the proximate destinations in my neighbourhood are walkable in 15 minutes. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
46. I think that proximate destinations facilitate walking. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
47. I find that it is easy to walk in the streets of my neighbourhood for 30 minutes daily. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
48. I think the design of the streets in my neighbourhood facilitate walking. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
49. I am capable of walking to different destinations in my neighbourhood. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
50. I think the diversity of destinations facilitates walking ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
51. I find crowds in the streets of my neighbourhood do not impede my walking for 30 minutes daily. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
52. I think that crowds in the streets of my neighbourhood impede walking. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
53. I find the density of buildings in my neighbourhood does not impede my walking for 30 minutes daily. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7___: agree
54. I think the density of buildings impedes my walking. ◯ to some extent, ◯ to a large extent, ◯ to a very large extent, ◯ to an extremely extent
Intention:
55. I intend to walk for 30-minutes daily in my neighbourhood. Disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__: agree

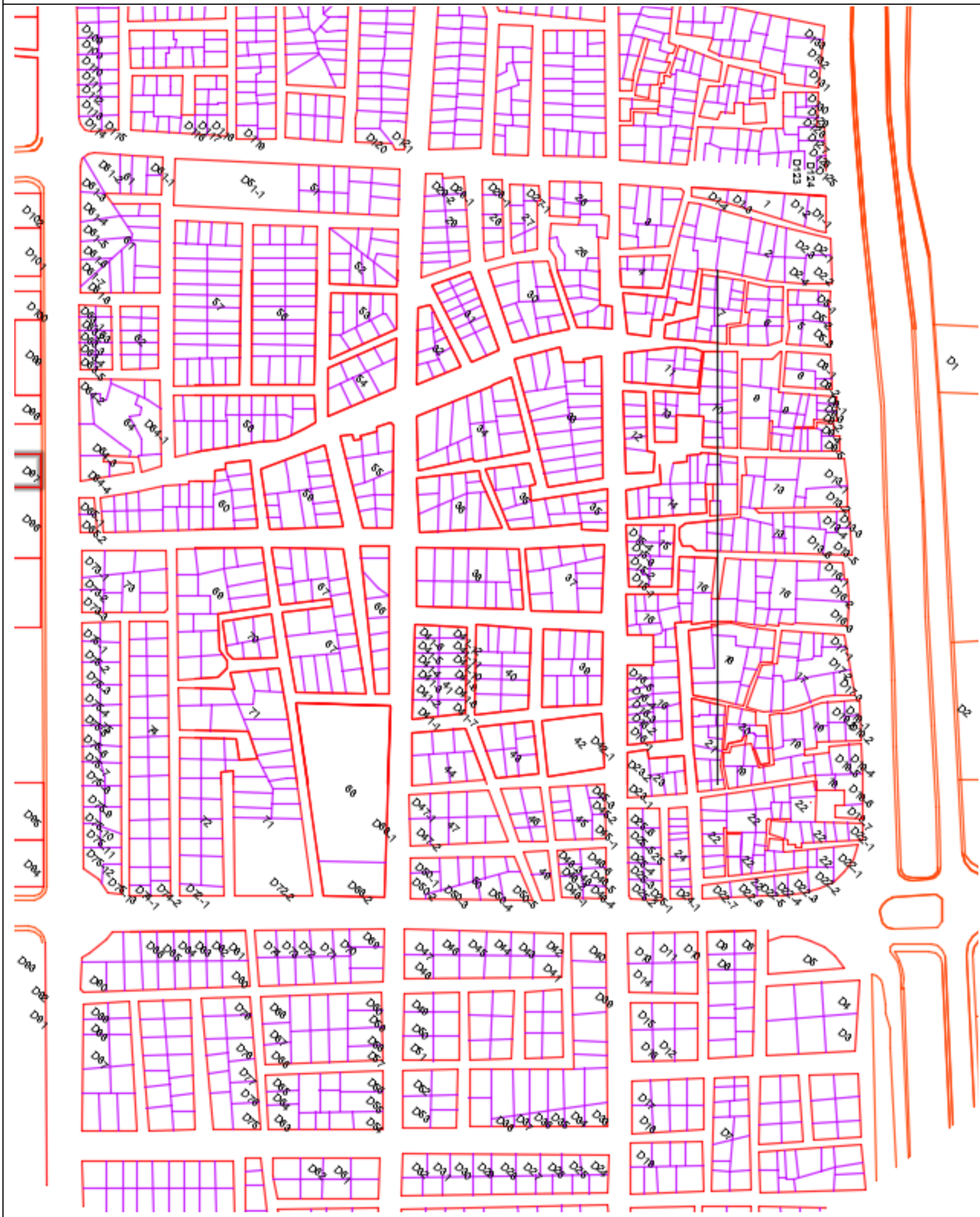
➢ Mark a number out of 7, or put X in the right circle to indicate your choice.

E: the map of Al-Saymmar neighbourhood



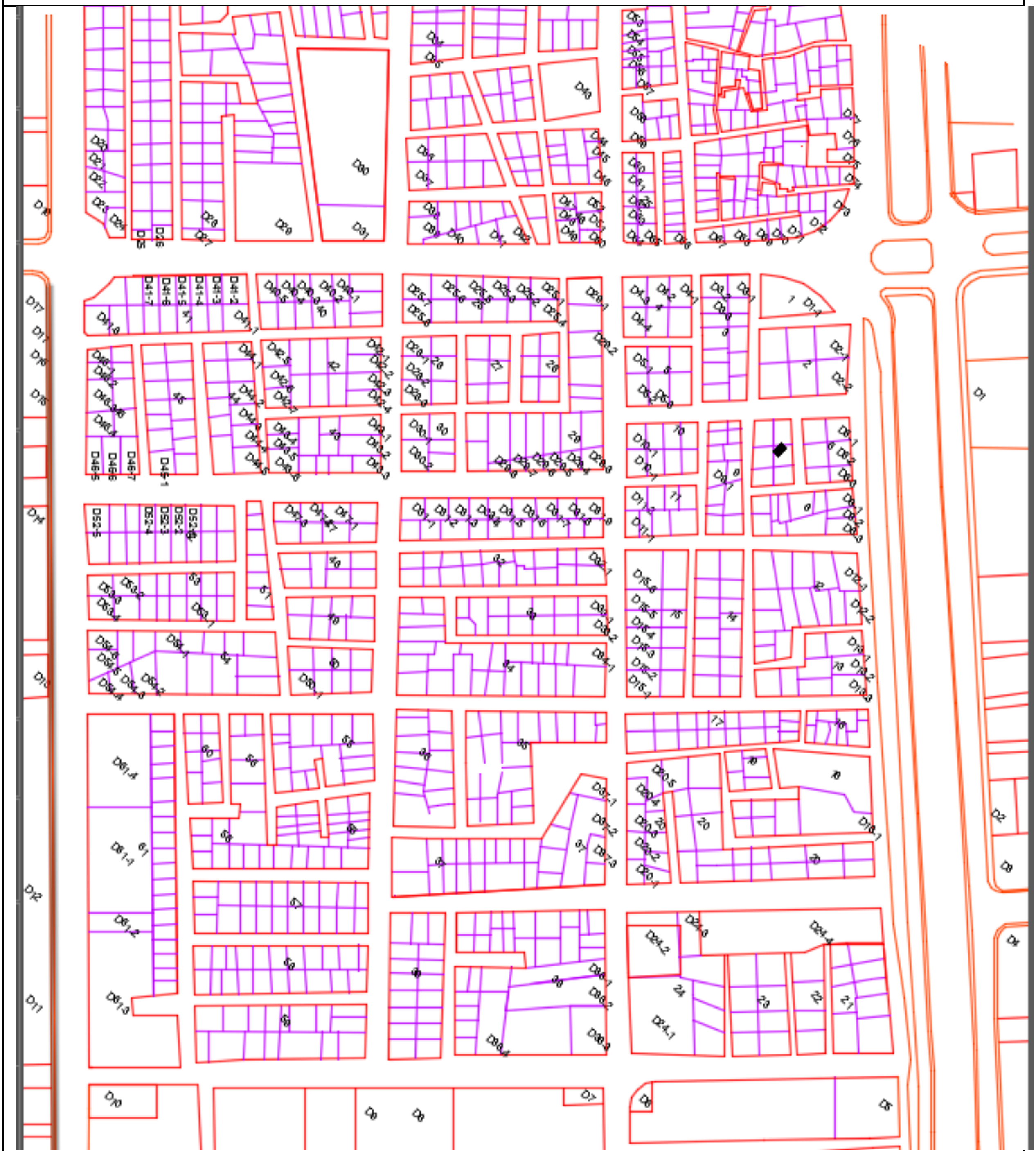
Choose the number of the block for your home address, and the number of the block for your destination (D1, D2, D3 …. etc.)

E: the map of Al-Mugawleen neighbourhood



Choose the number of the block for your home address, and the number of the block for your destination (D1, D2, D3 …. etc.)

E: the map of Al-Abassya neighbourhood



Choose the number of the block for your home address, and the number of the block for your destination (D1, D2, D3 …. etc.)

Thank-you for your participation

10.3 Appendix (3): The questionnaire in Arabic

تحيه طيبه:

أنا طالب دكتوره في الهندسة المعمارية في جامعة ستراثكلايد، وهذا الاستبيان هو جزء من مشروع بحثي الذي يعنى بتطوير تصميم وتخطيط المحلات السكنية في مدينة البصرة، ومحلتك هي احدى هذه المحلات. آذا قررت المشاركة أجب (ا – ب – ت – ج) المرفقة أدناه؛ بملء الاستمارات المرفقة حسب تعليمات تكون قدمت لي خدمة كبيرة. احد اعضاء فريق العمل سيقوم بجمع الاستمارات. أو بإمكانك تسليمها للمحل المعين.

١ - أستماره A تتطلب معلومات عامة وفردية عن الساكن

٢ - استمارة B تتطلب من المشترك تدوين فعالياته لمدة أسبوع **كامل منذ الساعة السابعة صباحاً حتى الثانية عشر ليلاً**. المطلوب من المشترك ملئ الاستمارة بالاستعانة بالمخطط المرفق. أختار الفعالية، الدقائق، والمشي من عدمه. كذلك يجب تحديد عنوان سكنك و عنوان المكان الذي قصدته من المخطط المرفق.

٣- استمارة C تتطلب اختيار درجة في مسطرة من سبع درجات تعبر عن مدى قناعتك بالعبارة فوق كل مسطرة، عن منطقة سكنك أو محلتك السكنية.

٤- استمارة D تتطلب اختيار درجة في مسطرة من سبع درجات تعبر عن مدى قناعتك بالعبارة فوق كل مسطرة، عن اعتقادك بالمشي في منطقة سكنك أو محلتك السكنية.

٥- استمارة E تتضمن مخطط لمحلتك السكنية مع العناوين المطلوبة.

معلومات هامه :

١ – يمكنك المشاركة أذا كنت بعمر (١٦-٦٥) ، ولا تعاني من عوق يسبب عدم المشي.

٢- هذا الاستبيان لا يحتاج لذكر أسم المشترك

٣ - اشتراكك اختياري تطوعي وبإمكانك الانسحاب في أي وقت.

٤ - المعلومات العامة التي ستذكرها بهذا الاستبيان والتي لا تحوي هويتك الشخصية لا يمكن سحبها من الدراسة.

٥ - الباحث جهة موثوقة تحترم خصوصية معلوماتك.

٦ - مشاركتك تنبع من حرصك وثقتك بدورك كمشترك بمشروع تطوير السكن في البصرة.

٧ – يمكنك المشاركة فقط أذا كنت مقتنع بالمشاركة بهذا المشروع الاكاديمي اللاربحي.

٨- يجب ملأ كل المعلومات المطلوبة والا سوف تهمل المشاركة.

٩- يمكنك الحصول على هدية ١٠$ عند تسليم الاستبيان الكامل.

١٠- أذا كان لديك أي استفسار أو سؤال يمكنك الاتصال بالرقم .... من ٨ صباحاً الى ٨ مساءا.

١١- أذا قرأت هذه المعلومات وفهمتها يمكنك التوقيع في أدناه.

توقيعك: ....

التاريخ: ....

معــــلومات شخــــصية وعـامــة:A

A1. يمكنك المشاركة أذا كنت لا تعاني من عوق يسبب عدم المشي. ☐ لا ☐ نعم أذا (لا) لا داعي لأكمال الاستبيان	A8: كم يبلغ طولك سم وزنك كغ ؟
A2. هل أنت : ☐ أمرأه ☐ رجل	A9. كم عدد أفراد عائلتك:
A3. أي الفئات العمرية آنت: ☐ ١٦ – ٢٤ ☐ ٢٥ – ٣٤ ☐ ٣٥ – ٤٤ ☐ ٤٥ – ٥٤ ☐ ٥٥ – ٦٥	A10. كم عدد أفراد العائلة تحت سن ١٨سنه؟
A4. أختر أحدى الفئات التي تقارب دخلك الشهري: ☐ ٢٠٠ - ٤٠٠ $ ☐ ٤٠٠ - ٦٠٠ $ ☐ ٦٠٠ - ٨٠٠ $ ☐ ٨٠٠ - ١٠٠٠ $ ☐ ١٠٠٠ - ١٢٠٠ $ ☐ أكثر من ١٢٠٠ $	A11. كم عدد السيارات في بيتك A12. ما هي المدة التي قضيتها في هذا المنزل؟
A5. ما هو عملك؟ ☐ موظف ☐ غير موظف ☐ كاسب ☐ ربة بيت ☐ طالب	A13. كم عدد غرف النوم في هذا المنزل؟
A6. ما هو أقرب وصف لنوع عائلتك؟ ☐ شخص واحد ☐ زوجان بدون أطفال ☐ زوجان مع أطفال ☐ زوجان وأطفال و أجداد ☐ زوجان وأطفال وأجداد ☐ زوجان وأطفال وأشقاء وأجداد	A14: ما نوع بيتك؟ ☐ بيت فناء وسطي "كورت" ☐ بيت مع حديقة أمامية ☐ بيت بحديقة خلفية ☐ بيت بدون فناء مفتوح نهائياً
A7. هل تمارس اي نوع من انواع الرياضة أو التمارين الرياضية بشكل منتظم ☐ لا ☐ نعم	A15. هل منزلك ملك أم مستأجر ☐ **ملك** ☐ مستأجر

عنـوانك: رقم البـلوك ..../ أختر من المخطط المرفق :B

أين ذهبت؟ من السبت الى الأحد	عدد دقائق المشي						العنوان المقصود	المشي	
	١٠	١٥	٢٠	٢٥	٣٠	أكثرمن٣٠		نعم	لا
الى العمل أو الدراسة	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
الى عمل شخصي	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
لشراء الطعام	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
لشراء سلع غير الطعام	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
الى لقاء الأصدقاء أو الصلاة بالجامع	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
الى لعب الرياضة أو الجم	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
لمراجعة الطبيب	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			
◯	○	○	○	○	○	○			

أختـــــــر العنــوان المقصــود مـن المخـــــطط المـرفـق

أسئـــــلة عن محـــــلتك السكنيـــــــــة:C

س١/ هنالك العديد من الاشياء التي تجذب النظر أثناء السير في محلتي السكنية لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س٢/ محلتي السكنية آمنة لذلك سأسمح لطفل بعمر ١٠ سنوات بالتجوال أثناء النهار لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س٣/ أستطيع القيام بالتسوق في محلتي السكنية لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س٤/ تقع المحلات التجارية على بعد مناسب للمشي في محلتي السكنية لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س٥/ مماشي السابلة مصممة بشكل جيد في محلتي السكنية لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س٦/ الشوارع في محلتي السكنية لا تحوي على نهايات ميته لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س٧/ توجد مسارات حركة بديلة للانتقال من مكان الى مكان آخر في محلتي السكنية لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س٨/ ازدحام السيارات في محلتي السكنية يجعل منها غير آمنه للمشي لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س٩/ انخفاض مستوى الجرائم في محلتي السكنية يجعل منها آمنه للمشي لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س١٠/ في محلتي السكنية توجد مرافق متنوعه تقع بمسافة مناسبة للمشي، مثل المدارس والمقاهي والمطاعم: لا تتفق: __1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س١١/ بإمكاني المشاهدة والتحدث الى الناس عندما أمشي في محلتي السكنية لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س١٢/ السيارات المتوقفة في الشارع في محلتي السكنية تُعيق مرور السابلة لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق
س١٣/ أذا أخذت بنظر الاعتبار الوضع العام للمساكن فأنا مقتنع بالسكن في محلتي السكنية لا تتفق:__1__:__2__:__3__:__4__:__5__:__6__:__7___: تتفق

أشر على الرقم الذي يمثل درجة قناعتك بالسؤال

اعتقادك حول فعالية المشـــي في محلتك السكنية :D

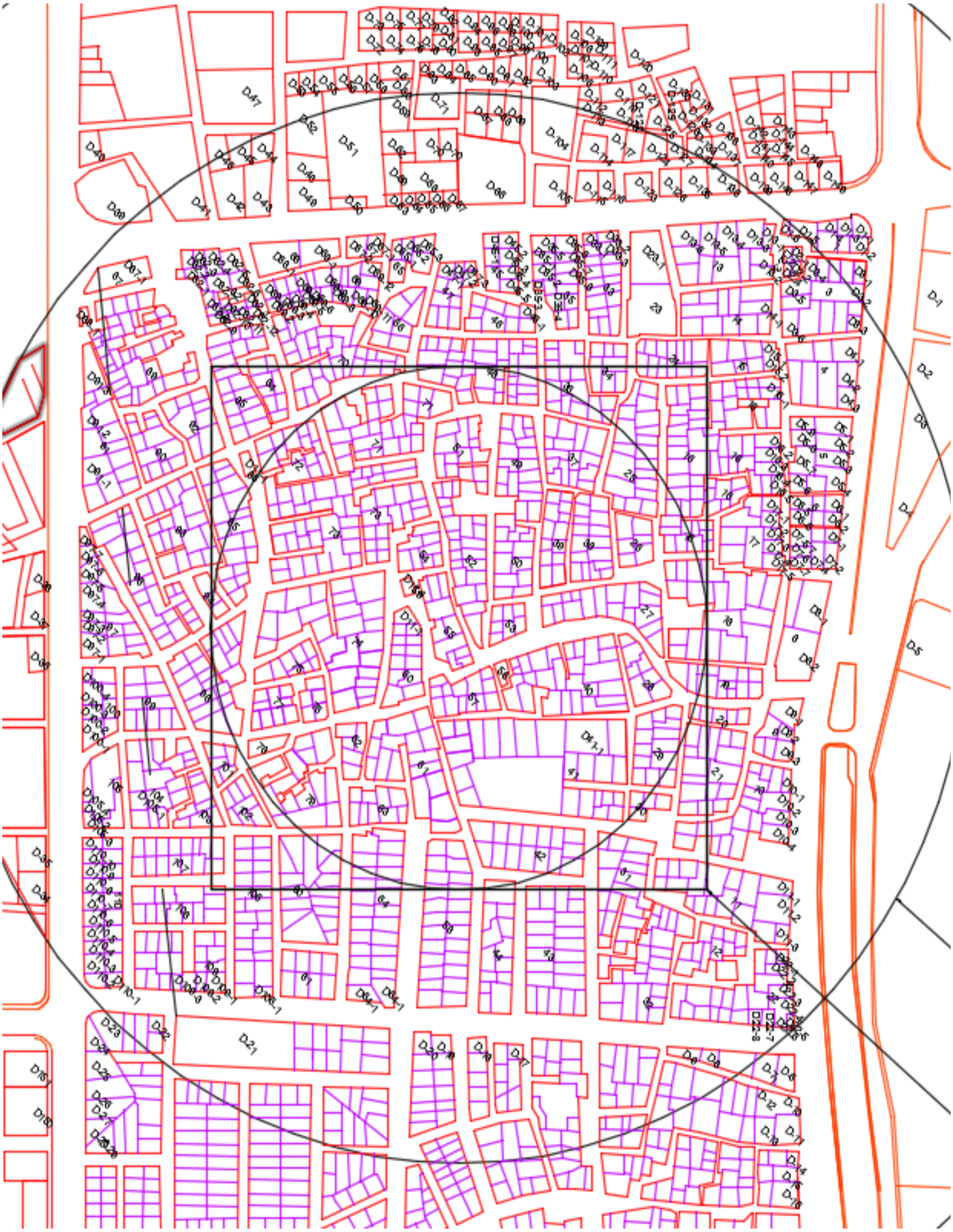
الجانب الشخصي
س١/ أنا أرغب بالمشي في محلتي السكنية لـ ٣٠ دقيقة لأنها مفيدة للصحة. لا تتفق: __1__:__2__:__3__:__4__:__5__:__6__:__7___ : تتفق
س٢/ أعتقد أن المشي يومياً صحي. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
س٣/ أنا أرغب بالمشي في محلتي السكنية لـ ٣٠ دقيقة لأن بيئتها جميلة. لا تتفق: __1__:__2__:__3__:__4__:__5__:__6__:__7___ : تتفق
س٤/ أعتقد أن المشي اليومي ممتع. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
س٥/ أنا أرغب بالمشي في محلتي السكنية لـ ٣٠ دقيقة لأنها آمنة. لا تتفق: __1__:__2__:__3__:__4__:__5__:__6__:__7___ : تتفق
س٦/ أعتقد أن المشي اليومي قد يسبب أذى. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
س٧/ أنا أرغب بالمشي في محلتي السكنية لـ ٣٠ دقيقة بسبب الهواء النقي. لا تتفق: __1__:__2__:__3__:__4__:__5__:__6__:__7___ : تتفق
س٨/ أعتقد أن المشي فرصة جيدة لتنفس الهواء النقي. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
.س٩/ أنا لا أرغب بالمشي في محلتي السكنية لـ ٣٠ دقيقة لأنه يضيع الوقت لا تتفق: __1__:__2__:__3__:__4__:__5__:__6__:__7___ : تتفق
س١٠/ أعتقد أن المشي يؤثر على الالتزام بالمواعيد. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
الجانب الاجتماعي
س١١/ الناس يشجعونني على المشي اليومي في محلتي السكنية لا تتفق: __1__:__2__:__3__:__4__:__5__:__6__:__7___ : تتفق
س١٢/ أنا آخذ رأيهم على محمل الجد. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
س١٣/ عائلتي يشجعونني على المشي اليومي في محلتي السكنية لا تتفق: __1__:__2__:__3__:__4__:__5__:__6__:__7___ : تتفق
س١٤/ أنا آخذ رأيهم على محمل الجد. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
س١٥/ الطبيب يشجعني على المشي اليومي في محلتي السكنية لا تتفق: __1__:__2__:__3__:__4__:__5__:__6__:__7___ : تتفق
س١٦/ أنا آخذ رأيه على محمل الجد. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً

أشر على الرقم الذي يمثل درجة قناعتك بالسؤال

جانب المقدرة
س١٧/ أستطيع الوصول الى الأماكن التي أقصدها عن طريق المشي في محلتي السكنية بـ ١٥ دقيقة. **لا تتفق: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : تتفق**
س١٨/ أعتقد أن الأماكن (كالمحال التجارية) القريبة تسهل المشي ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
س١٩/ أنا أستطيع المشي بسهولة في شوارع محلتي السكنية لـ ٣٠ دقيقة. **لا تتفق: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : تتفق**
س٢٠/ أعتقد أن تصميم الشوارع يسهل المشي. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
س٢١/ أعتقد أن تنوع الأماكن التي أقصدها في محلتي السكنية يساعدني على المشي لـ ٣٠ دقيقة. **لا تتفق: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : تتفق**
س٢٢/ تنوع الأماكن (كالمحال التجارية) يسهل المشي. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
س٢٣/ أعتقد أن زحام المشاة في محلتي السكنية يعيق قدرتي على المشي لـ ٣٠ دقيقة. **لا تتفق: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : تتفق**
س٢٤/ زحام المشاة يعيق المشي. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
س٢٥/ أعتقد أن كثافة البيوت في محلتي السكنية تعيق قدرتي على المشي لـ ٣٠ دقيقة. **لا تتفق: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : تتفق**
س٢٦/ كثافة البيوت تعيق المشي.. ◯لحد قليل ◯لحد معقول ◯ لحد كبير ◯ لحد كبير جداً
النية للمشي
س٢٧أنا أنوي المشي اليومي لمدة ٣٠ دقيقة في محلتي السكنية **لا تتفق: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : تتفق**

أشر على الرقم الذي يمثل درجة قناعتك بالسؤال

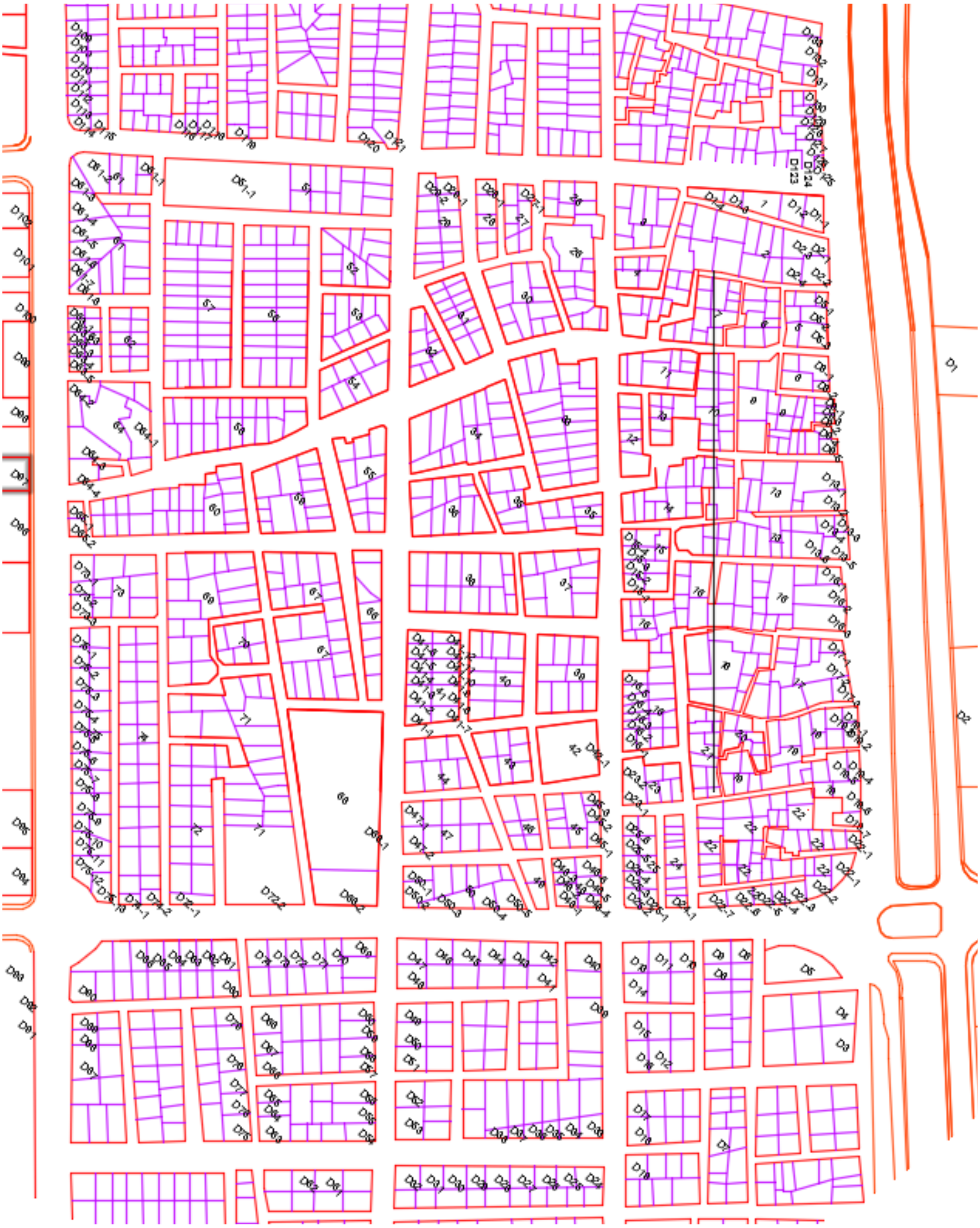
منطقة السيمر :E



آختر الرقم البلوك الذي يقع فيه بيتك، أما العنوان الذي تقصده فعليك اختيار حرف:

D (D1, D2, D3 …. etc.)

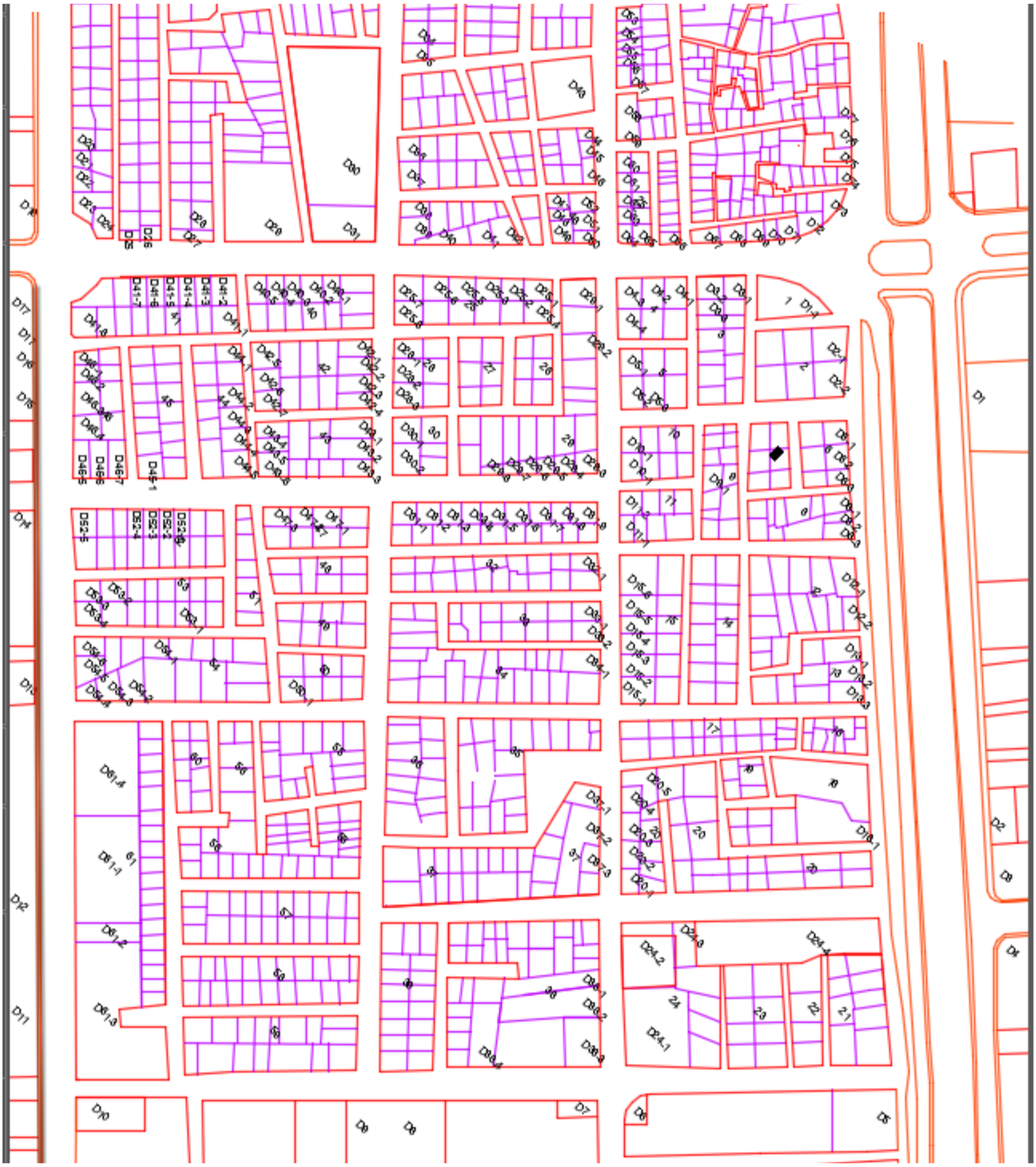
منطقة المقاولين :E



اختر رقم البلوك الذي يقع فيه بيتك، أما العنوان الذي تقصده فعليك اختيار حرف:

D (D1, D2, D3 …. etc.)

منطقة العباسية: E



اختر رقم البلوك الذي يقع فيه بيتك، أما العنوان الذي تقصده فعليك اختيار حرف:

D (D1, D2, D3 …. etc.)

شكراً جزيلاً

10.4 Appendix (4): Data sets of subjective and objective measures (CD):

The data sets include several files which are combatable with several types of the software include Excel, AutoCAD, QGIS, MATLAB, and SPSS.

CD

10.5 Appendix (5): Normality tests of the research variables

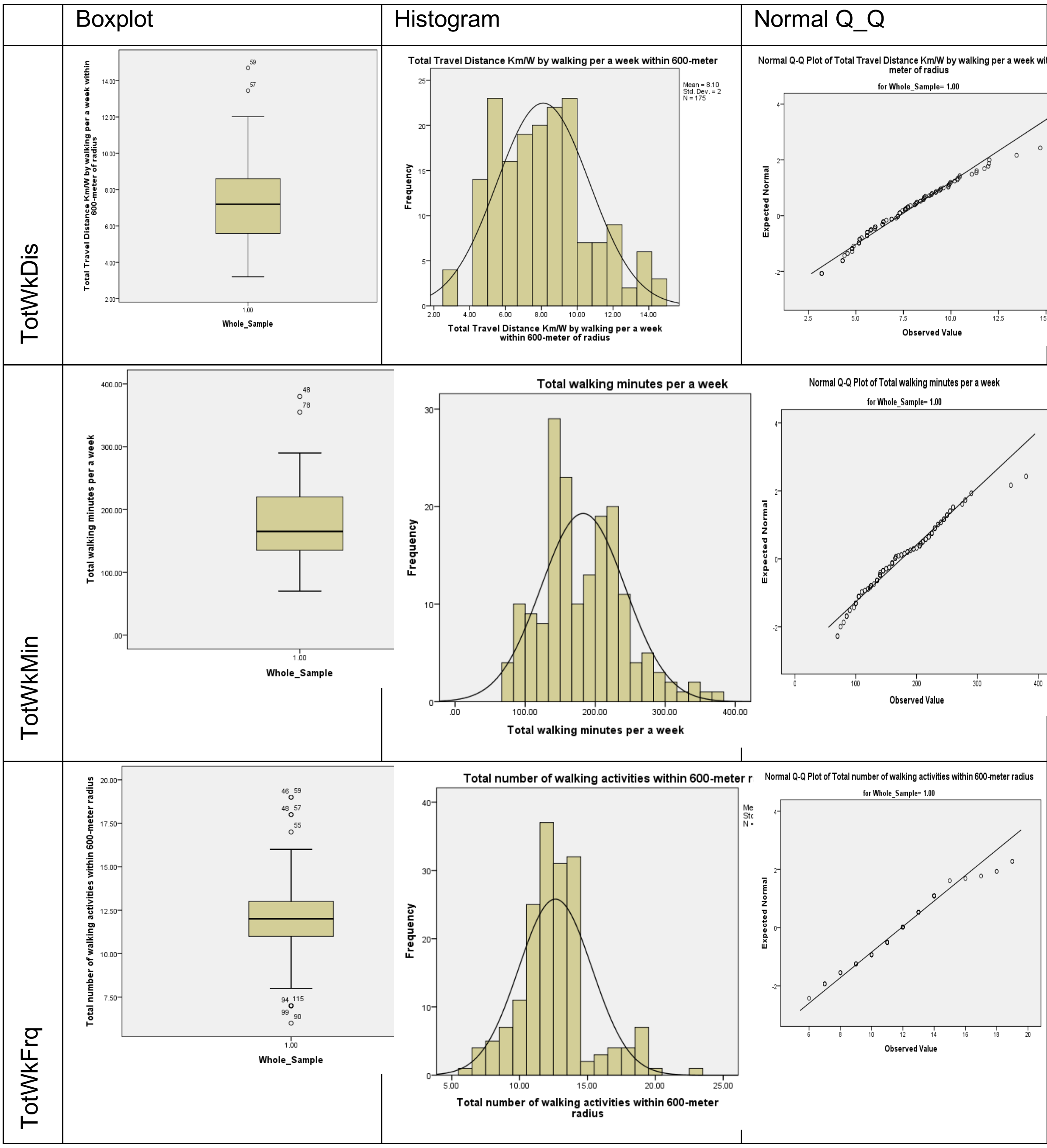
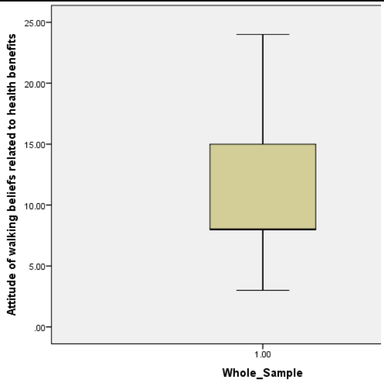
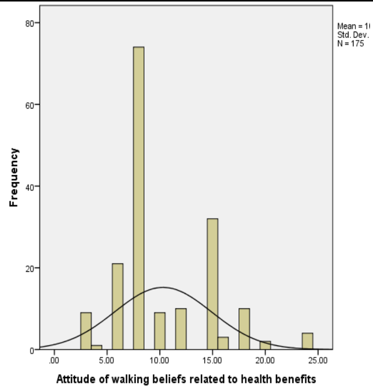
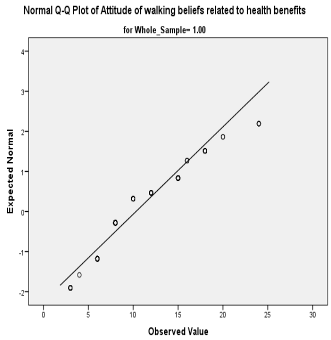


Figure 10-1: Test of normal distribution of the walking outcome variables

<table>
<tr><th></th><th>Boxplot</th><th>Histogram</th><th>Normal Q-Q Plot</th></tr>
<tr><td>AtWkHt</td><td>
</td><td>
</td><td>
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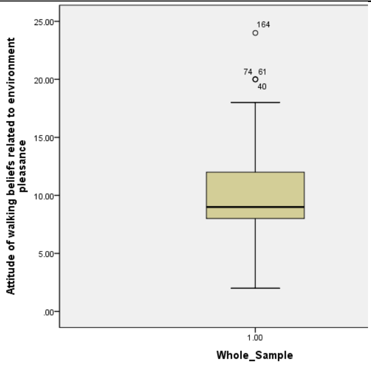
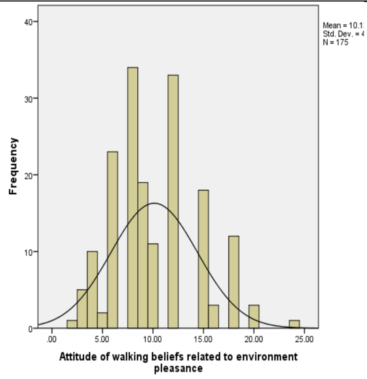
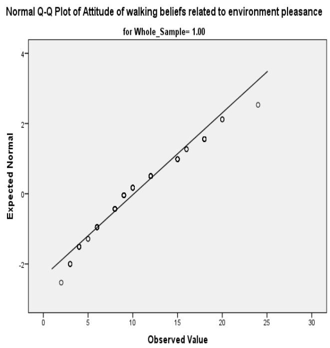
<tr><td>AtWkEnv</td><td>
</td><td>
</td><td>
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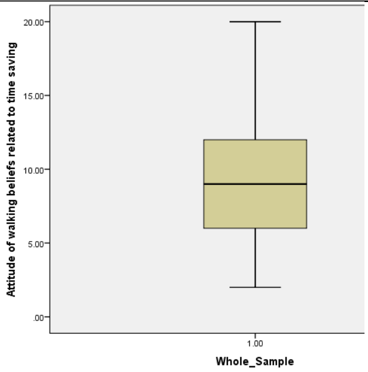
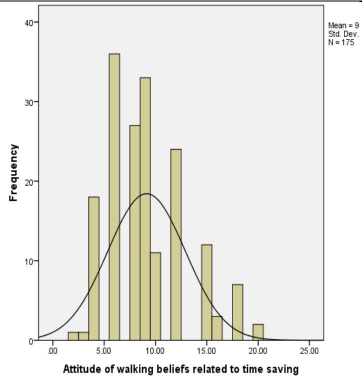
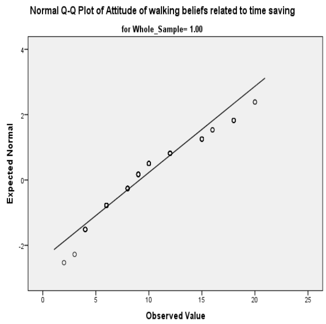
<tr><td>AtWkTim</td><td>
</td><td>
</td><td>
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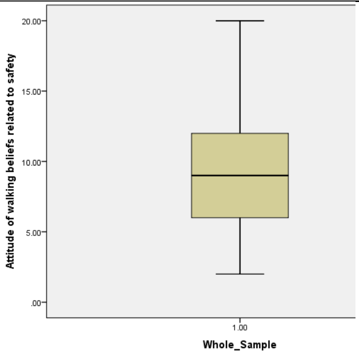
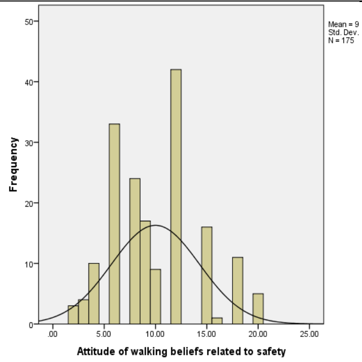
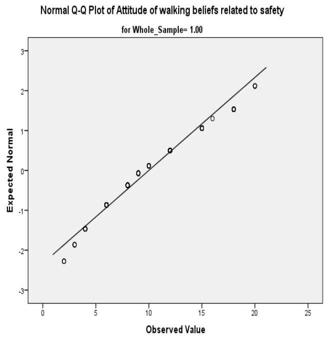
<tr><td>AtWkSaf</td><td>
</td><td>
</td><td>
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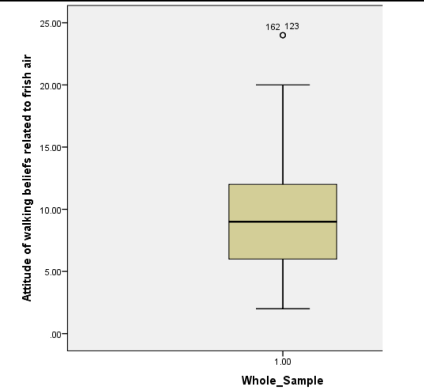
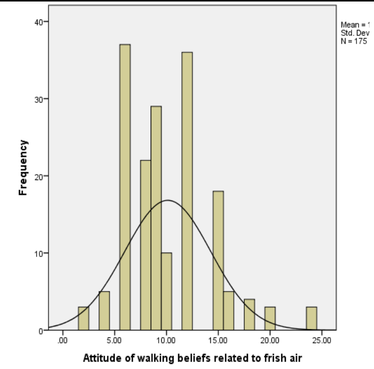
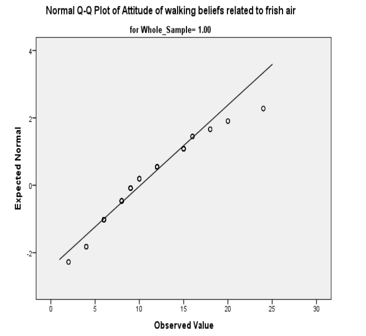
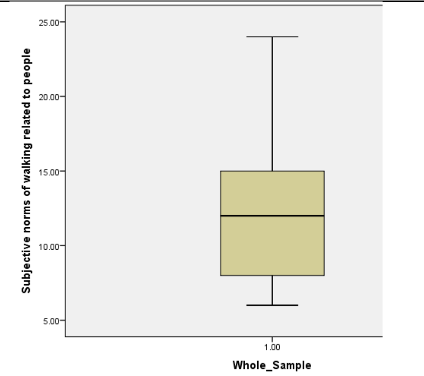
AtWkAir

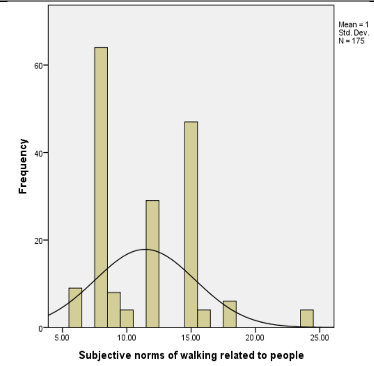


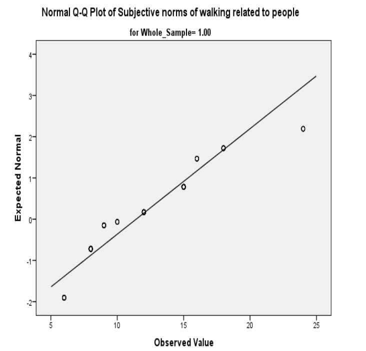




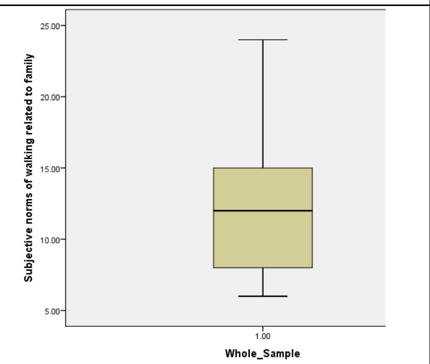
SNWkPep

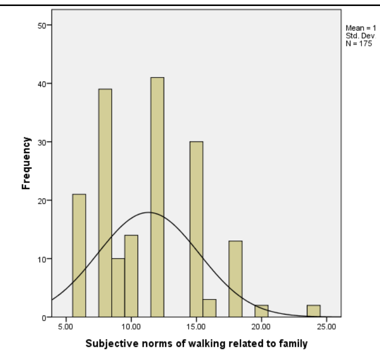


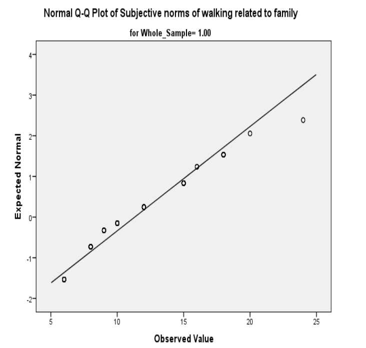




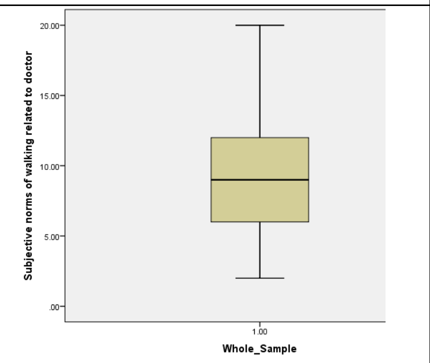
SNWkFam

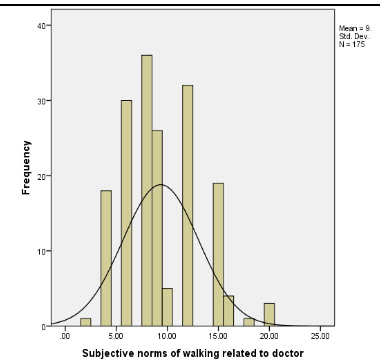


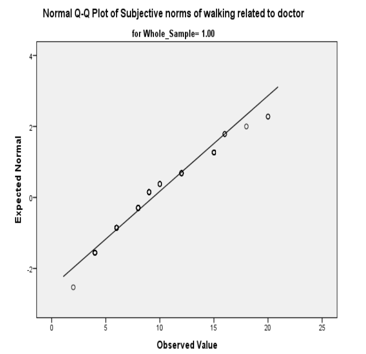




SNWkDoc







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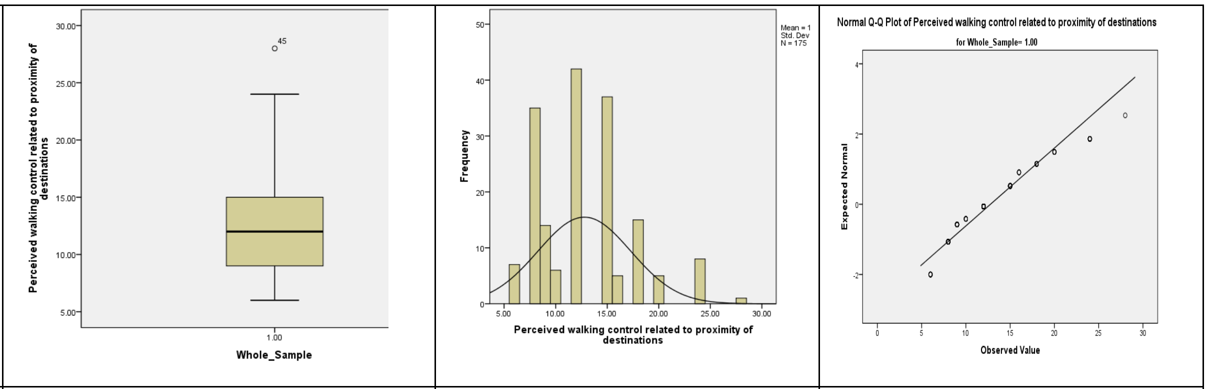

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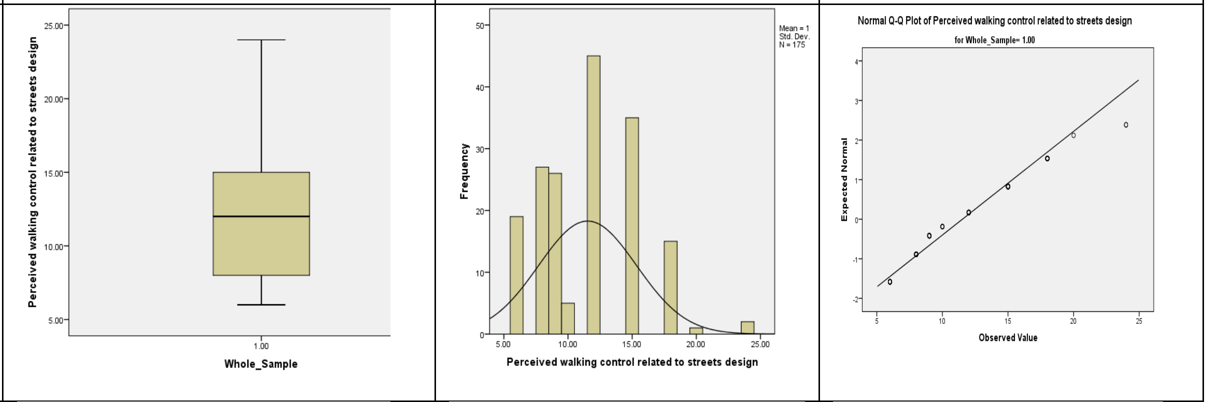
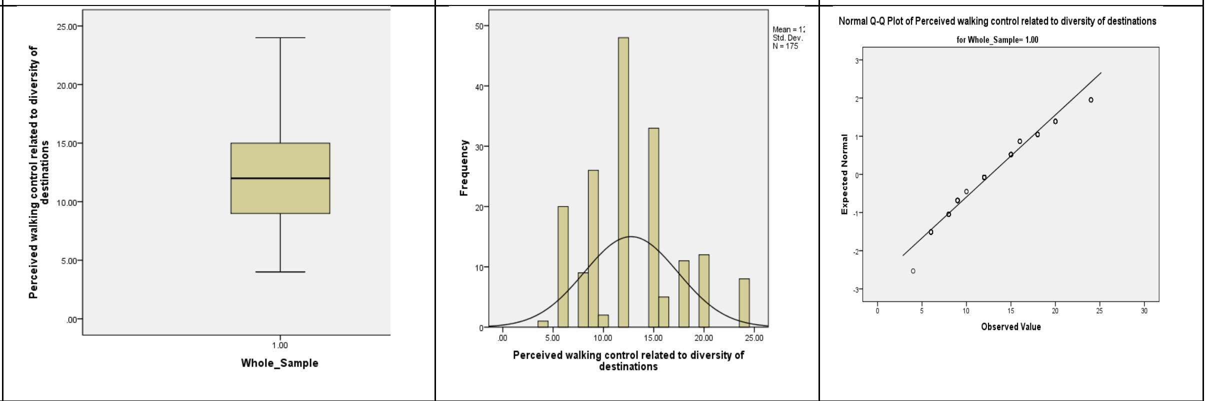


PCWkDiv



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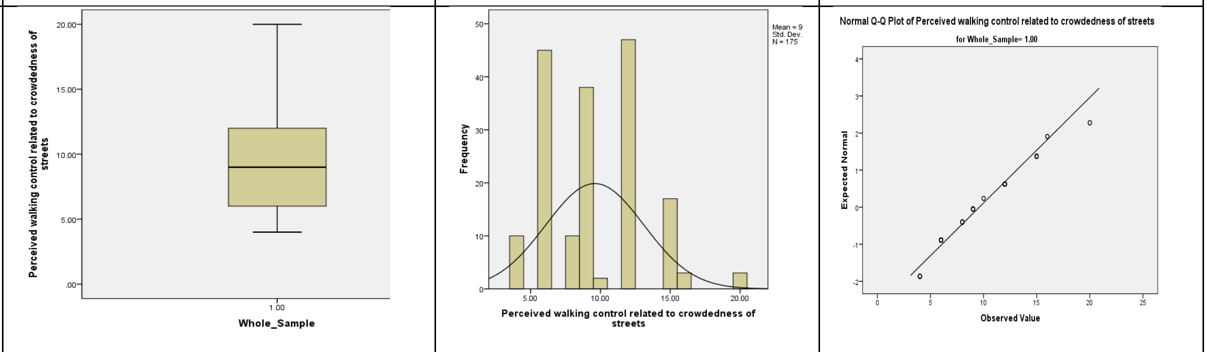
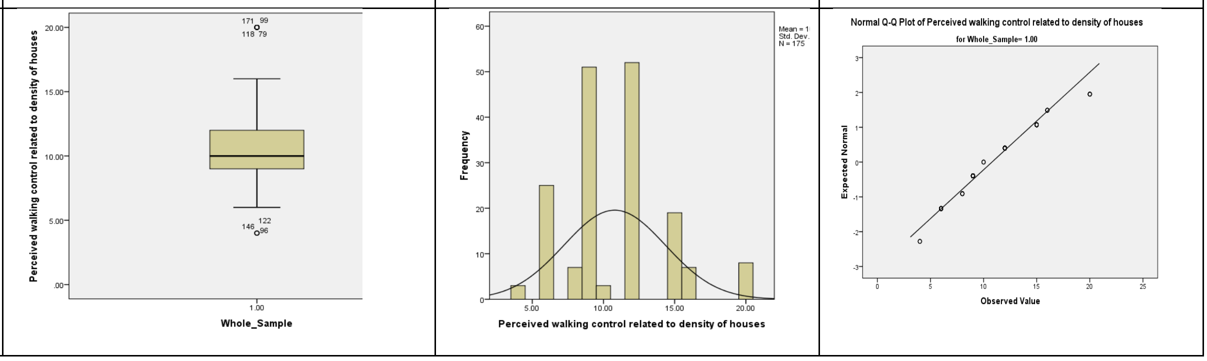
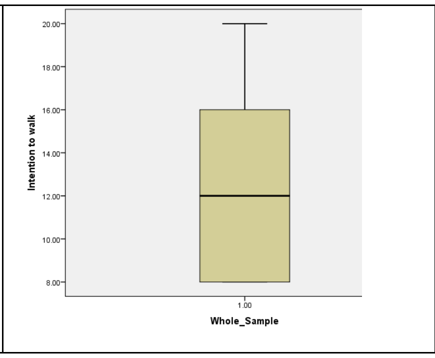
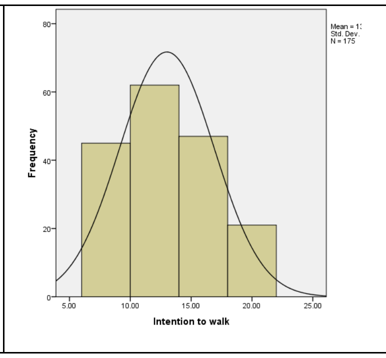


PCWkHoDn



IntWalk





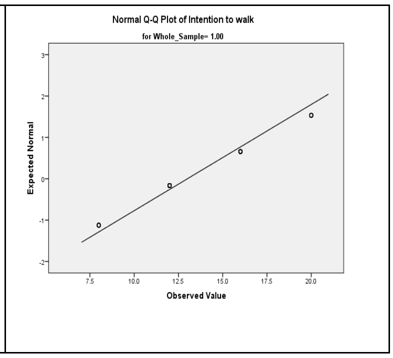
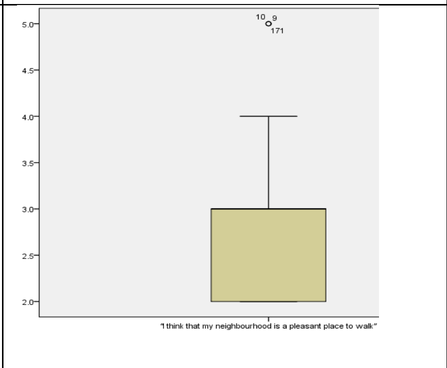
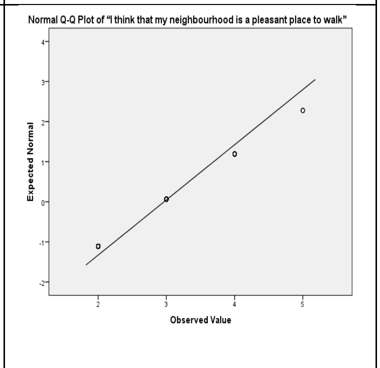
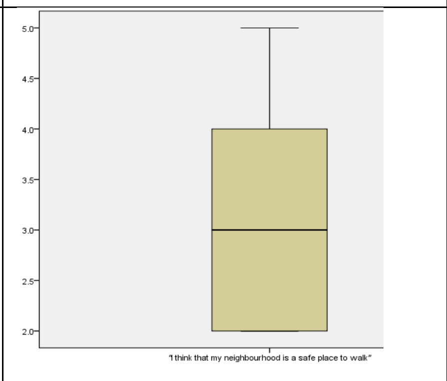
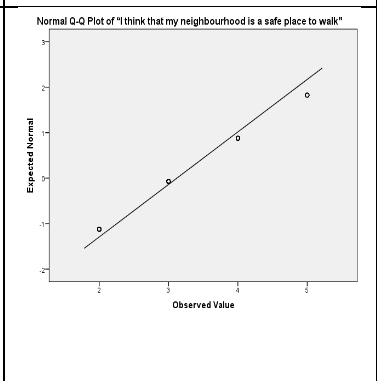
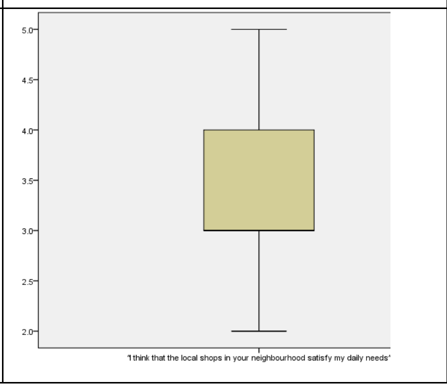
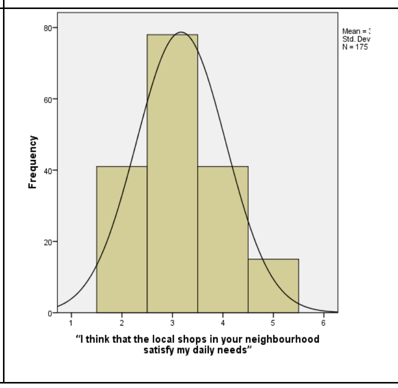
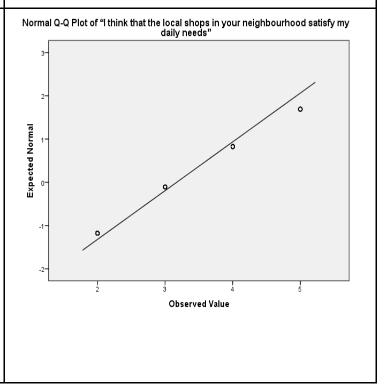
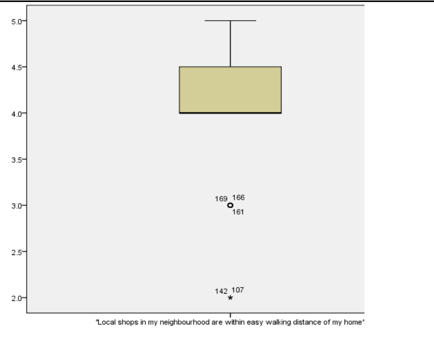
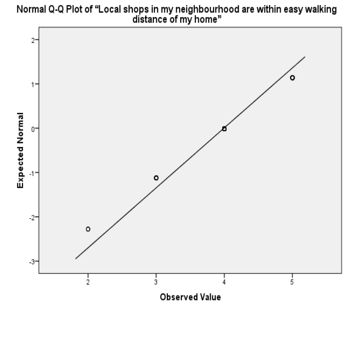


Figure 10-2: Test of normal distribution of the mediation variables of the TPB constructs

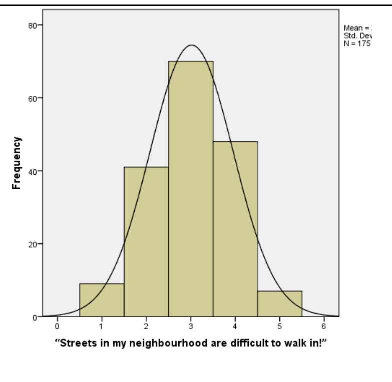
	Boxplot	Histogram	Normal Q-Q Plot
PlsntPls			
SafePls			
ShopSat			

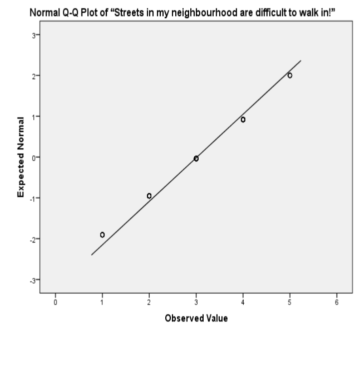
ProxDist



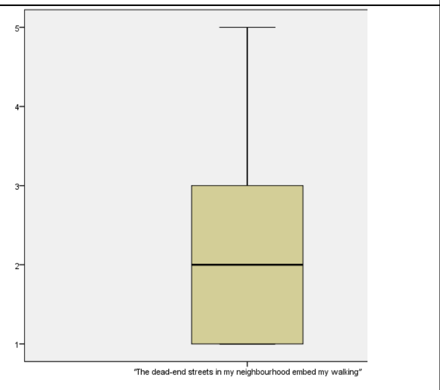


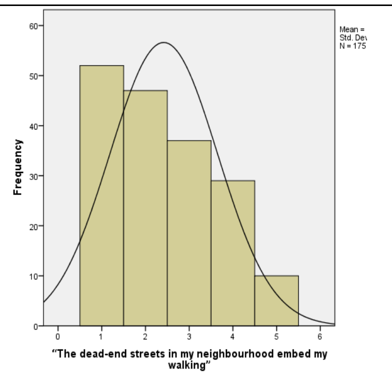
StDfclt

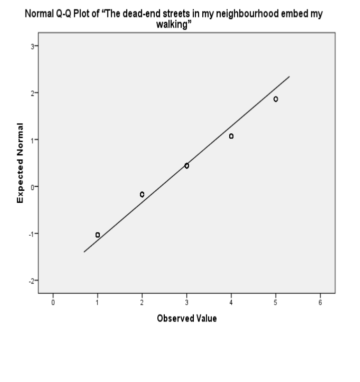




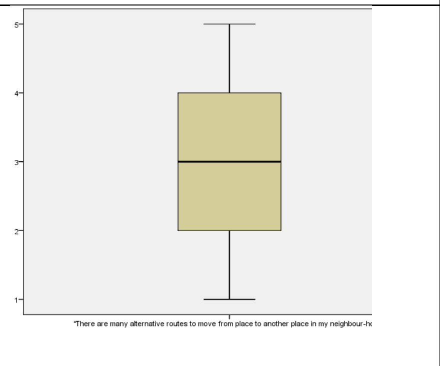
CalDeSec

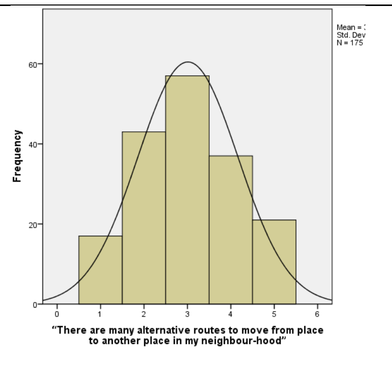


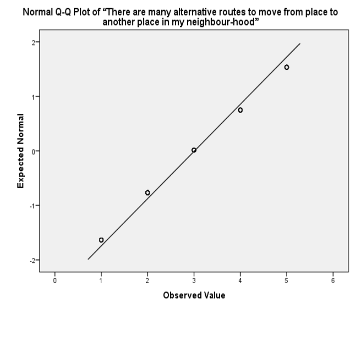




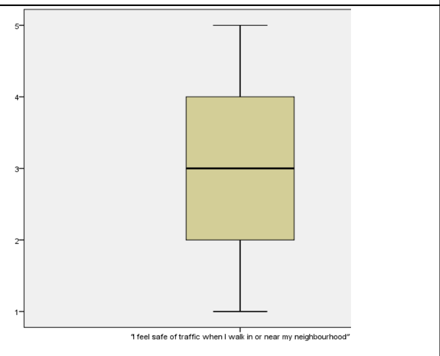
AltRout

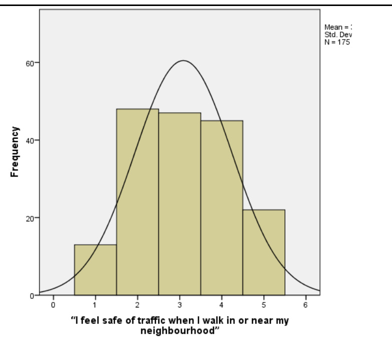


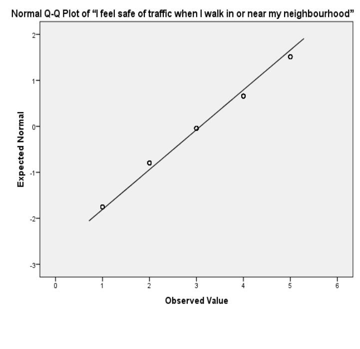




TrfcSafe







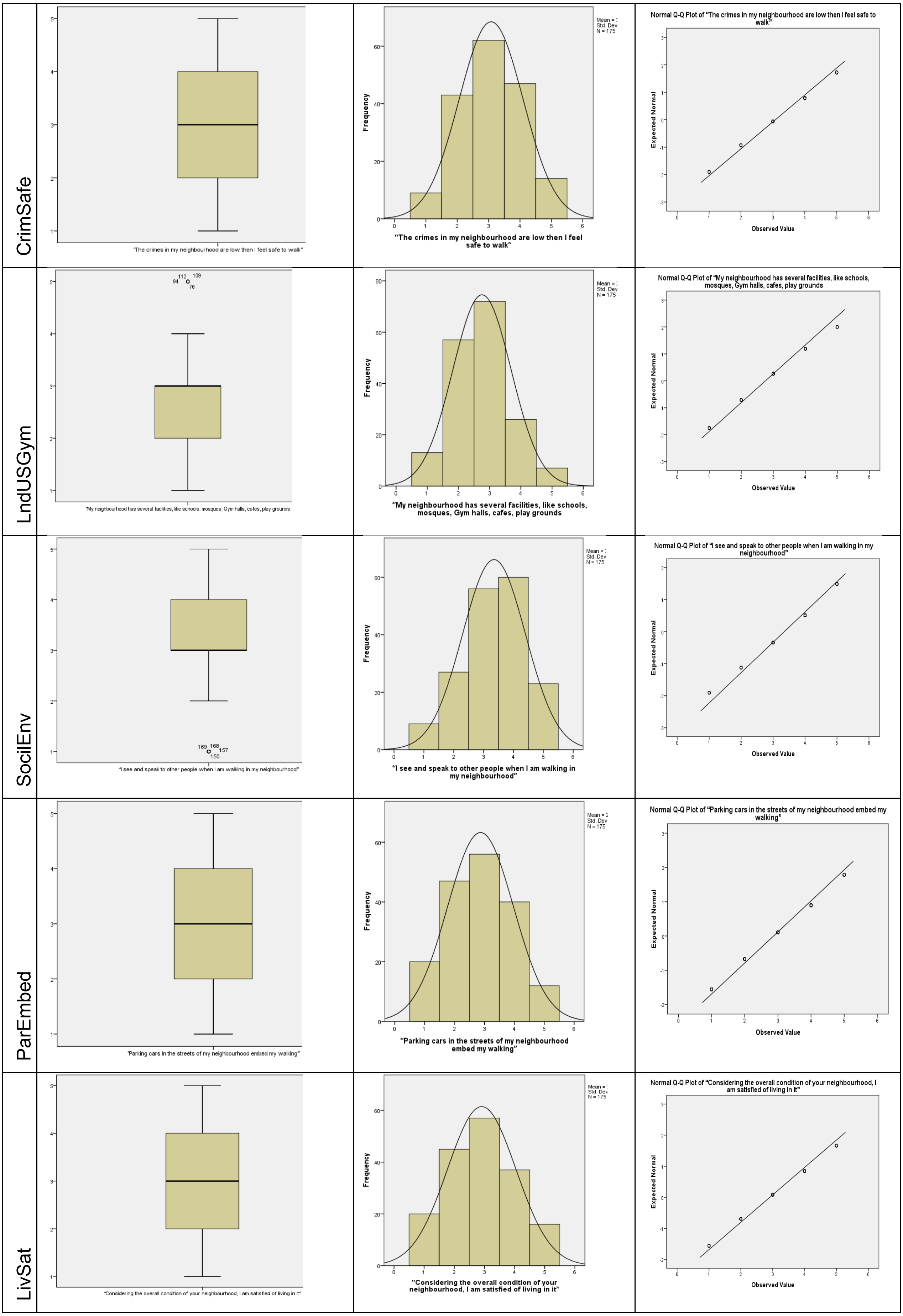


Figure 10-3: Test of normal distribution of the mediation variables of the perceived environment

10.6 Appendix (6) : the mediation tests based on Hayes (2016) with SPSS

10.6.1 (Model 1): mediation modelling with the total walking distance

The indirect effect of X on Y through Mi

The ai paths are computed based on equation (7-1):

a1 path is the effect magnitude of walkability index on attitude to walk related to health benefits (AtWkHt), was significant, F (1, 173) = 19.936, p<.001, R^2 = .1033, the effect coefficient b=.5226, t (173) = 4.4650, p<.001. Accordingly, path a1: M1=10.3029+0.5226X;

a2 path is the effect magnitude of walkability index on Attitudinal beliefs of walking related to time saving (AtWkTim), F (1, 173) = 33.7698, p<.001, R^2 = .1633, the effect coefficient b=.5425, t (173) = 5.8112, p<.001. Accordingly, path a2: M2=9.1314+0.5425X;

a3 path is the effect magnitude of walkability index on Attitudinal beliefs of walking related to safety (AtWkSaf) was significant as well, F (1, 173) = 68.982, p<.001, R^2 = .2851, the effect coefficient b=.8108, t (173) = 8.3055, p<.001. Accordingly, path a3: M3=9.9943+0.8108X;

a4 path is the effect magnitude of walkability index on subjective norms of walking related to people (SNWkPep), was significant, F (1, 173) = 19.936, p<.016, R^2 = .1828, the effect coefficient b=.2530, t (173) = 2.4449, p<.001. Accordingly, path a4: M4=11.4229+0.2530X;

a5 path is the effect magnitude of walkability index on perceived walking control related to proximity of destinations (PCWkProx), F (1, 173) = 17.5517, p<.001, R^2 = .3035, the effect coefficient b=.4847, t (173) = 4.1895, p<.001. Accordingly, path a5: M5=12.7829+0.4847X;

a6 path is the effect magnitude of walkability index on perceived walking control related to streets design (PCWkEss) was significant as well, F (1, 173) = 11.1789, p<.001, R^2 = .0607, the effect coefficient b=.3333, t (173) = 3.3435, p<.001. Accordingly, path a6:M6=11.5257+0.3333X;

a7 path is the effect magnitude of walkability index on the perceived walking control related to diversity of destinations (PCWkDiv), F (1, 173) = 35.1976, p<.001, R^2 = .1691, the effect coefficient b=.6776, t (173) = 5.9328, p<.001. Accordingly, path a7: M7=12.7486+0.6776X;

a8 path is the effect magnitude of walkability index on Intention to walk (IntWalk) was significant as well, F (1, 173) = 12.2876, p<.001, R^2 = .07, the effect coefficient b=.3553, t (173) = 3.5054, p<.001. Accordingly, path a8: M8=13.0057+0.3553X.

<u>The bi paths are computed based on equation (7-2):</u>

In order, b1, b2, b3, b4, b5, b6, b7 and b8 represent the paths of the direct effects of the beliefs-based measures respectively. Although, mediators' direct effect (paths bi) on the dependent variable (total walking distance per a week TotWkDis) is unconsidered directly in total effect, it contributes to produce the indirect effect throughout the interaction with the direct effect of predictor on the mediators (ai paths). The summary of the regression model of mediators plus predictor, walkability index showed a significant effect on the total distance of walking per a week, F (9, 165) = 21.975, p<.001, and approximately 55% of the variance in total walking distance was accounted for by the predictors, R^2 = .55. Although, the effect coefficient was mixed of significant and non-significant effect of the different paths, those the less than significant paths of effects still able to be used for the next stage because the other parts (ai) of these paths are all significant. Precisely, for b1 path, b=.1842, t (165) = 5.0599, p<.001, for b2 path, b=.0562, t (165) = 1.3565, p>.05, b3 path, b=-.0812, t (165) = -1.9662, p>.05, b4 path, b=.0927, t (165) = 2.3313, p>.05, b5 path, b=.1073, t (165) = 2.4207, p<.05, b6 path, b=.0434, t (165) = 0.9247, p>.05, b7 path, b=-.0575, t (165) = 1.5961, p>.05, and for b8 path, b=-.0207, t (165) = -.5527, p>.05.

10.6.2 (Model 2): mediation modelling with the total number of walking journeys

The indirect effect of X on Y through Mi

The ai paths are computed based on equation (7-1)

a1 path is the effect magnitude of walkability index on attitude to walk related to health benefits (AtWkHt), was significant, F (1, 173) = 19.936, p<.001, R^2 = .1033, the effect coefficient b=.5226, t (173) = 4.4650, p<.001. Accordingly, path a1: M1=10.3029+0.5226X.

a2 path is the effect magnitude of walkability index on Attitudinal beliefs of walking related to time saving (AtWkTim), F (1, 173) = 33.7698, p<.001, R^2 = .1633, the effect coefficient b=.5425, t (173) = 5.8112, p<.001. Accordingly, path a2: M2=9.1314+0.5425X.

a3 path is the effect magnitude of walkability index on Attitudinal beliefs of walking related to safety (AtWkSaf) was significant as well, F (1, 173) = 68.982, p<.001, R^2 =

.2851, the effect coefficient *b*=.8108, *t* (173) = 8.3055, *p*<.001. Accordingly, path a3: M3=9.9943+0.8108X.

a4 path is the effect magnitude of walkability index on subjective norms of walking related to people (SNWkPep), was significant, *F* (1, 173) = 19.936, *p*<.016, R^2 = .1828, the effect coefficient *b*=.2530, *t* (173) = 2.4449, *p*<.001. Accordingly, path a4: M4=11.4229+0.2530X.

a5 path is the effect magnitude of walkability index on perceived walking control related to proximity of destinations (PCWkProx), *F* (1, 173) = 17.5517, *p*<.001, R^2 = .3035, the effect coefficient *b*=.4847, *t* (173) = 4.1895, *p*<.001. Accordingly, path a5: M5=12.7829+0.4847X.

a6 path is the effect magnitude of walkability index on perceived walking control related to streets design (PCWkEss) was significant as well, *F* (1, 173) = 11.1789, *p*<.001, R^2 = .0607, the effect coefficient *b*=.3333, *t* (173) = 3.3435, *p*<.001. Accordingly, path a5:M5=11.5257+0.3333X.

a7 path is the effect magnitude of walkability index on Perceived walking control related to diversity of destinations (PCWkDiv), *F* (1, 173) = 35.1976, *p*<.001, R^2 = .1691, the effect coefficient *b*=.6776, *t* (173) = 5.9328, *p*<.001. Accordingly, path a7: M7=12.7486+0.6776X.

a8 path is the effect magnitude of walkability index on Intention to walk (IntWalk) was significant as well, *F* (1, 173) = 12.2876, *p*<.001, R^2 = .07, the effect coefficient *b*=.3553, *t* (173) = 3.5054, *p*<.001. Accordingly, path a8: M8=13.0057+0.3553X.

The bi paths are computed based on equation (7-2):

In order, b1, b2, b3, b4, b5, b6, b7 and b8, respectively represent the paths of direct effects of the beliefs-based measures on the dependent variable. Although, mediators' direct effect (paths bi) on the dependent variable (total number of walking minutes per a week TotWkMin) is unconsidered directly in total effect, it contributes to produce the indirect effect throughout the interaction with the direct effect of the predictor (X) on the mediators (ai paths). The summary of the regression model of the mediators plus the predictor (walkability index) showed a significant effect on the total number of walking journeys per a week, *F* (9, 165) = 9.5375, *p*<.001, and approximately 34% of the variance in total walking distance was accounted for by the predictors, R^2 = .342. Although, the significance of effects of the mediators was mixed of significant and non-significant effects, those the less than significant paths of effects still able to be used for the next stage because the other parts (ai) of these paths are all significant. Thus, the paths of effect of the mediators on the dependent variable include b1 path, b=.1202, $t(165)$=2.8969, p<.05, for b2 path, b=.0844, $t(165)$=1.7876, p>.05, b3 path, b=-.0425, $t(165)$=-.9035, p>.05, b4 path, b=.0849, $t(165)$=1.8733, p>.05, b5 path, b=.0454, $t(165)$=.8997, p>.05, b6 path, b=.0930, $t(165)$=1.7403, p>.05, b7 path, b=.1152, $t(165)$=2.8083, p<.05, and for b8 path, b=-.0395, $t(165)$=-.9263, p>.05.

10.6.3 (Model 3): mediation modelling with the total number of walking minutes

The indirect effect of X on Y through Mi

The ai paths are computed based on equation (7-1)

a1 path is the effect magnitude of walkability index on attitude to walk related to health benefits (AtWkHt), was significant, F (1, 173) = 19.936, p<.001, R^2 = .1033, the effect coefficient b=.5226, t (173) = 4.4650, p<.001. Accordingly, path a1: M1=10.3029+0.5226X.

a2 path is the effect magnitude of walkability index on Attitudinal beliefs of walking related to time saving (AtWkTim), F (1, 173) = 33.7698, p<.001, R^2 = .1633, the effect coefficient b=.5425, t (173) = 5.8112, p<.001. Accordingly, path a2: M2=9.1314+0.5425X.

a3 path is the effect magnitude of walkability index on Attitudinal beliefs of walking related to safety (AtWkSaf) was significant as well, F (1, 173) = 68.982, p<.001, R^2 = .2851, the effect coefficient b=.8108, t (173) = 8.3055, p<.001. Accordingly, path a3: M3=9.9943+0.8108X.

a4 path is the effect magnitude of walkability index on subjective norms of walking related to people (SNWkPep), was significant, F (1, 173) = 19.936, p<.016, R^2 = .1828, the effect coefficient b=.2530, t (173) = 2.4449, p<.001. Accordingly, path a4: M4=11.4229+0.2530X.

a5 path is the effect magnitude of walkability index on perceived walking control related to proximity of destinations (PCWkProx), F (1, 173) = 17.5517, p<.001, R^2 = .3035, the effect coefficient b=.4847, t (173) = 4.1895, p<.001. Accordingly, path a5: M5=12.7829+0.4847X.

a6 path is the effect magnitude of walkability index on perceived walking control related to streets design (PCWkEss) was significant as well, F (1, 173) = 11.1789, p<.001, R^2 = .0607, the effect coefficient b=.3333, t (173) = 3.3435, p<.001. Accordingly, path a5:M5=11.5257+0.3333X.

a7 path is the effect magnitude of walkability index on Perceived walking control related to diversity of destinations (PCWkDiv), F (1, 173) = 35.1976, p<.001, R^2 = .1691, the effect coefficient b=.6776, t (173) = 5.9328, p<.001. Accordingly, path a7: M7=12.7486+0.6776X.

a8 path is the effect magnitude of walkability index on Intention to walk (IntWalk) was significant as well, F (1, 173) = 12.2876, p<.001, R^2 = .07, the effect coefficient b=.3553, t (173) = 3.5054, p<.001. Accordingly, path a8: M8=13.0057+0.3553X.

The bi paths are computed based on equation (7-2)

In order, b1, b2, b3, b4, b5, b6, b7 and b8, respectively represent the paths of the direct effects of the beliefs-based measures on the dependent variable. Although, mediators' direct effect (paths bi) on the dependent variable (total number of walking journeys per a week TotWkFrq) is unconsidered directly in total effect, it contributes to produce the indirect effect throughout the interaction with the direct effect of predictor on the mediators (ai paths). The summary of the regression model of mediators plus predictor (walkability index) showed a significant effect on the total walking minutes per a week, F (9, 165) = 9.5375, p<.001, and approximately 34% of the variance in total walking distance was accounted for by the predictors, R^2 = .342. Although, the effect coefficient was mixed of significant and non-significant effects of the different paths, those the less than significant paths of effects still able to be used for the next stage because the other parts (ai) of these paths are all significant. Precisely, for b1 path, b=3.9530, t (165) = 3.8769, p<.05, for b2 path, b=-.8650, t (165) = -.7451, p>.05, b3 path, b=-1.3421, t (165) = -1.1598, p>.05, b4 path, b=.9309, t (165) = .8356, p>.05, b5 path, b=2.5908, t (165) = 2.0879, p<.05, b6 path, b=1.9568, t (165) = 1.4899, p>.05, b7 path, b=.0015, t (165) = .0015, p>.05, and for b8 path, b=.7739, t (165) = .7389, p>.05.

10.6.4 (Model 4): Mediation of the perceived environment factors with the total walking distance

The indirect effect of X on Y through Mi

The ai paths are computed based on equation (7-1)

a1 path is the effect magnitude of walkability index on (M1) "I think that my neighbourhood is a pleasant place to walk" (PlsntPls), was not significant, F (1, 173) = 2.9421, p>.05, R^2 = .017, the effect coefficient b=.0333, t (173) = 1.7153, p>.05. Accordingly, path a1: M1=2.9657+0.0333X.

a2 path is the effect magnitude of walkability index on (M2) “I think that my neighbourhood is a safe place to walk” (SafePls), F (1, 173) = 36.5275, p<.001, R^2 = .174, the effect coefficient b=.1281, t (173) = 6.0438, p<.001. Accordingly, path a2: M2=3.1200+0.1281X.

a3 path is the effect magnitude of walkability index on (M3) “I think that the local shops in your neighbourhood satisfy my daily needs” (ShopSat); was significant as well, F (1, 173) = 74.9074, p<.001, R^2 = .3022, the effect coefficient b=.1727, t (173) = 8.6549, p<.001. Accordingly, path a3: M3=3.1714+0.1727X.

a4 path is the effect magnitude of walkability index on M4) “Local shops in my neighbourhood are within easy walking distance of my home” (ProxDist), was significant, F (1, 173) = 48.3754, p<.001, R^2 = .2185, the effect coefficient b=.1224, t (173) = 6.9552, p<.001. Accordingly, path a4: M4=3.9943+0.1224X.

a5 path is the effect magnitude of walkability index on (M5) “Streets in my neighbourhood are difficult to walk in!” (StDfclt), F (1, 173) = 71.3893, p<.001, R^2 = .2921, the effect coefficient b=.1795, t (173) = 8.4492, p<.001. Accordingly, path a5: M5=3.0171+0.1795X.

a6 path is the effect magnitude of walkability index on (M6) “The dead-end streets in my neighbourhood embed my walking” (CalDeSec) was significant as well, F (1, 173) = 260.0531, p<.001, R^2 = .6005, the effect coefficient b=.3385, t (173) = 16.1262, p<.001. Accordingly, path a6: M6=2.4171+0.3385X.

a7 path is the effect magnitude of walkability index on (M7) “There are many alternative routes to move from place to another place in my neighbourhood” (AltRout) was significant as well, F (1, 173) = 229.2845, p<.001, R^2 = .57, the effect coefficient b=.3088, t (173) = 15.1421, p<.001. Accordingly, path a7: M7=3.0114+0.3088X.

a8 path is the effect magnitude of walkability index on (M8) “I feel safe of traffic when I walk in or near my neighbourhood” (TrfcSafe) was significant as well, F (1, 173) = 261.9837, p<.001, R^2 =.6023, the effect coefficient b=.3173, t (173) = 16.1859, p<.001. Accordingly, path a8:M8=3.0857+3.0857X.

a9 path is the effect magnitude of walkability index on (M9) “I see and speak to other people when I am walking in my neighbourhood” (SocilEnv) was significant as well, F (1, 173) = 67.6593, p<.001, R^2 = .2811, the effect coefficient b=.1982, t (173) = 8.2255, p<.001. Accordingly, path a9: M9=3.3486+0.1982X.

a10 path is the effect magnitude of walkability index on (M10) "Considering the overall condition of your neighbourhood, I am satisfied of living in it" (LivSat) was significant as well, F (1, 173) = 79.4322, p<.001, R^2 =.3147, the effect coefficient b=-.2258, t (173) = -8.9125, p<.001. Accordingly, path a10:M10=2.9086+(-0.2258) X. The bi paths are computed based on equation (7-2)

In order, b1, b2, b3, b4, b5, b6, b7, b8, b9 and b10 respectively stand for the direct effects of the mediators on the dependent variable.

Although, mediators' direct effect (paths bi) on the dependent variable (total walking distance per a week TotWkDis) is unconsidered directly in total effect, it contributes to produce the indirect effect throughout the interaction with the direct effect of the predictor X on the mediators (ai paths). The summary of the regression model of mediators plus the predictor X (walkability index) showed a significant effect on the total walking distance per a week, F (11, 163) = 17.5241, p<.001, and approximately 54% of the variance in total walking distance was accounted for by the predictors, R^2 = .5418. Although, the effect coefficient was mixed of significant and non-significant effects of the different paths, those the less than significant paths of effects still able to be used for the next stage because the other parts (ai) of these paths are all significant. Precisely, for b1 path, b=.3595, t (163) = 1.6655, p>.05, for b2 path, b=.7333, t (163) =3.1119, p<.01, for b3 path, b=.4037, t (163) = 3.0023, p<.01, for b4 path, b=.7442, t (163) = 3.0023, p<.01, for b5 path, b=.0107, t (163) =.0566, p>.05, for b6 path, b=.4161, t (163) = 2.1840, p<.05, for b7 path, b=.2081, t (163) = 1.0591, p>.05, for b8 path, b=0.0661, t (163) = 1.0591, p>.05, for b9 path, b=.1159, t (163) = .7370, p>.05, and for b10 path, b=.0427, t (163) = .2729, p>.05.

Path of direct effect c`:

The c` paths are computed based on equation (7-3)

The direct effect of walkability index X on the total number of walking journeys c` was significant, b=-.0028, t (163) = -.0245, p>.05.

The total indirect effect:

The total indirect effect is computed based on equation (7-4)

Then the total effect = indirect effect (Table 7-20) 0.4661+ direct effect (c`) -0.0028=0.4633

For the test the regression analysis was conducted to find the total effect of X on Y without mediators:

Do (X → M → Y) path plus (X → Y) path equals the total effect (c)?
c path (Figure 7-1), regression analysis showed that the total effect magnitude of walkability index on walking outcome (total walking distance) is significant, F (1, 173) = 59.2131, p<.001), R^2 = .255, the effect coefficient b=0.4633, t (173) = 7.695, p<.001.

10.6.5 (Model 5): Mediation test of the perceived environment factors with the total number of walking journeys

The ai paths are computed based on equation (7-1)

a1 path is the effect magnitude of walkability index on (M1) "I think that my neighbourhood is a pleasant place to walk" (PlsntPls), was not significant, F (1, 173) = 2.9421, p>.05, R^2 = .017, the effect coefficient b=.0333, t (173) = 1.7153, p>.05. Accordingly, path a1: M1=2.9657+0.0333X.
a2 path is the effect magnitude of walkability index on (M2) "I think that my neighbourhood is a safe place to walk" (SafePls), F (1, 173) = 36.5275, p<.001, R^2 = .174, the effect coefficient b=.1281, t (173) = 6.0438, p<.001. Accordingly, path a2: M2=3.1200+0.1281X.
a3 path is the effect magnitude of walkability index on (M3) "I think that the local shops in your neighbourhood satisfy my daily needs" (ShopSat); was significant as well, F (1, 173) = 74.9074, p<.001, R^2 = .3022, the effect coefficient b=.1727, t (173) = 8.6549, p<.001. Accordingly, path a3: M3=3.1714+0.1727X.
a4 path is the effect magnitude of walkability index on M4) "Local shops in my neighbourhood are within easy walking distance of my home" (ProxDist), was significant, F (1, 173) = 48.3754, p<.001, R^2 = .2185, the effect coefficient b=.1224, t (173) = 6.9552, p<.001. Accordingly, path a4: M4=3.9943+0.1224X.
a5 path is the effect magnitude of walkability index on (M5) "Streets in my neighbourhood are difficult to walk in!" (StDfclt), F (1, 173) = 71.3893, p<.001, R^2 = .2921, the effect coefficient b=.1795, t (173) = 8.4492, p<.001. Accordingly, path a5: M5=3.0171+0.1795X.
a6 path is the effect magnitude of walkability index on (M6) "The dead-end streets in my neighbourhood embed my walking" (CalDeSec) was significant as well, F (1, 173) = 260.0531, p<.001, R^2 = .6005, the effect coefficient b=.3385, t (173) = 16.1262, p<.001. Accordingly, path a6: M6=2.4171+0.3385X.
a7 path is the effect magnitude of walkability index on (M7) "There are many alternative routes to move from place to another place in my neighbourhood"

(AltRout) was significant as well, F (1, 173) = 229.2845, p<.001, R^2 = .57, the effect coefficient b=.3088, t (173) = 15.1421, p<.001. Accordingly, path a7: M7=3.0114+0.3088X.

a8 path is the effect magnitude of walkability index on (M8) "I feel safe of traffic when I walk in or near my neighbourhood" (TrfcSafe) was significant as well, F (1, 173) = 261.9837, p<.001, R^2 =.6023, the effect coefficient b=.3173, t (173) = 16.1859, p<.001. Accordingly, path a8:M8=3.0857+3.0857X.

a9 path is the effect magnitude of walkability index on (M9) "I see and speak to other people when I am walking in my neighbourhood" (SocilEnv) was significant as well, F (1, 173) = 67.6593, p<.001, R^2 = .2811, the effect coefficient b=.1982, t (173) = 8.2255, p<.001. Accordingly, path a9: M9=3.3486+0.1982X.

a10 path is the effect magnitude of walkability index on (M10) "Considering the overall condition of your neighbourhood, I am satisfied of living in it" (LivSat) was significant as well, F (1, 173) = 79.4322, p<.001, R^2 =.3147, the effect coefficient b=-.2258, t (173) = -8.9125, p<.001. Accordingly, path a10:M10=2.9086+(-0.2258) X.

The bi paths are computed based on equation (7-2)

In order, b1, b2, b3, b4, b5, b6, b7, b8, b9 and b10 respectively stand for the direct effects of the mediators on the dependent variable. Although, mediators' direct effect (paths by) on the dependent variable (total number of walking journeys per a week TotWkFrq) is unconsidered directly in total effect, it contributes to produce the indirect effect throughout the interaction with the direct effect of the predictor X on the mediators (ai paths).

The summary of the regression model of the mediators (Mi) plus the predictor (X: walkability index) showed a significant effect on the total number of walking journeys per a week, F (11, 163) = 12.6472, p<.001, and approximately 46% of the variance in total number of walking journeys was accounted for by the predictors, R^2 = .4605. Although, the effect coefficient was mixed of significant and non-significant effects of the different paths, those the less than significant paths of effects still able to be used for the next stage because the other parts (ai) of these paths are all significant. Precisely, for b1 path, b=.2789, t (163) = 1.1392, p>.05, for b2 path, b=.8285, t (163) =3.1000, p<.01, for b3 path, b=.4569, t (163) = 1.7529, p>.05, for b4 path, b=.5171, t (163) = 1.8393, p>.05, for b5 path, b=-.0906, t (163) =-.4232, p>.05, for b6 path, b=.3813, t (163) = 1.7648, p>.05, for b7 path, b=.0882, t (163) =.3957, p>.05, for b8 path, b=-.0932, t (163) = -.4146, p>.05, for b9 path, b=.0810, t (163) = .4541, p>.05, and for b10 path, b=-.0478, t (163) = .5421, p>.05.

Path of direct effect c`:

The c` path is computed based on equation (7-3)

The direct effect of walkability index X on the total number of walking journeys c` was significant, b=-.0028, t (163) = -.0245, p>.05.

The total in direct effect:

The total in direct effect is computed based on equation (7-4)

Then the total effect = indirect effect (Table 7-21) 0.3949+ direct effect (c`) 0.0699=0.4648

For the test the regression analysis was conducted to find the total effect of X on Y without mediators:

Do (X → M → Y) path plus (X → Y) path equals the total effect (c)?

c path (Figure 7-1), regression analysis showed that the total effect magnitude of walkability index on walking outcome (total walking distance) is significant, F (1, 173) = 53.1323, p<.001), R^2 = .235, the effect coefficient b=0.4648, t (173) = 7.695, p<.001.

10.6.6 (Model 6): Mediation of the perceived environment factors with the total walking minutes

The indirect effect of X on Y through Mi

The ai paths are computed based on equation (7-1)

a1 path is the effect magnitude of walkability index on (M1) “I think that my neighbourhood is a pleasant place to walk” (PlsntPls), was not significant, F (1, 173) = 2.9421, p>.05, R^2 = .017, the effect coefficient b=.0333, t (173) = 1.7153, p>.05. Accordingly, path a1: M1=2.9657+0.0333X.

a2 path is the effect magnitude of walkability index on (M2) “I think that my neighbourhood is a safe place to walk” (SafePls), F (1, 173) = 36.5275, p<.001, R^2 = .174, the effect coefficient b=.1281, t (173) = 6.0438, p<.001. Accordingly, path a2: M2=3.1200+0.1281X.

a3 path is the effect magnitude of walkability index on (M3) “I think that the local shops in your neighbourhood satisfy my daily needs” (ShopSat); was significant as well, F (1, 173) = 74.9074, p<.001, R^2 = .3022, the effect coefficient b=.1727, t (173) = 8.6549, p<.001. Accordingly, path a3: M3=3.1714+0.1727X.

a4 path is the effect magnitude of walkability index on M4) "Local shops in my neighbourhood are within easy walking distance of my home" (ProxDist), was significant, F (1, 173) = 48.3754, p<.001, R^2 = .2185, the effect coefficient b=.1224, t (173) = 6.9552, p<.001. Accordingly, path a4: M4=3.9943+0.1224X.

a5 path is the effect magnitude of walkability index on (M5) "Streets in my neighbourhood are difficult to walk in!" (StDfclt), F (1, 173) = 71.3893, p<.001, R^2 = .2921, the effect coefficient b=.1795, t (173) = 8.4492, p<.001. Accordingly, path a5: M5=3.0171+0.1795X.

a6 path is the effect magnitude of walkability index on (M6) "The dead-end streets in my neighbourhood embed my walking" (CalDeSec) was significant as well, F (1, 173) = 260.0531, p<.001, R^2 = .6005, the effect coefficient b=.3385, t (173) = 16.1262, p<.001. Accordingly, path a6: M6=2.4171+0.3385X.

a7 path is the effect magnitude of walkability index on (M7) "There are many alternative routes to move from place to another place in my neighbourhood" (AltRout) was significant as well, F (1, 173) = 229.2845, p<.001, R^2 = .57, the effect coefficient b=.3088, t (173) = 15.1421, p<.001. Accordingly, path a7: M7=3.0114+0.3088X.

a8 path is the effect magnitude of walkability index on (M8) "I feel safe of traffic when I walk in or near my neighbourhood" (TrfcSafe) was significant as well, F (1, 173) = 261.9837, p<.001, R^2 =.6023, the effect coefficient b=.3173, t (173) = 16.1859, p<.001. Accordingly, path a8:M8=3.0857+3.0857X.

a9 path is the effect magnitude of walkability index on (M9) "I see and speak to other people when I am walking in my neighbourhood" (SocilEnv) was significant as well, F (1, 173) = 67.6593, p<.001, R^2 = .2811, the effect coefficient b=.1982, t (173) = 8.2255, p<.001. Accordingly, path a9: M9=3.3486+0.1982X.

a10 path is the effect magnitude of walkability index on (M10) "Considering the overall condition of your neighbourhood, I am satisfied of living in it" (LivSat) was significant as well, F (1, 173) = 79.4322, p<.001, R^2 =.3147, the effect coefficient b=-.2258, t (173) = -8.9125, p<.001. Accordingly, path a10:M10=2.9086+(-0.2258) X.

The bi paths are computed based on equation (7-2)

In order, b1, b2, b3, b4, b5, b6, b7, b8, b9 and b10 respectively stand for the direct effects of the mediators on the dependent variable. Although, mediators' direct effect (paths by) on the dependent variable (total walking minutes per a week TotWkMin) is unconsidered directly in total effect, it contributes to produce the indirect effect throughout the interaction with the direct effect of the predictor X on the mediators (ai paths).

The summary of the regression model of the mediators (Mi) plus the predictor (X: walkability index) showed a significant effect on the total walking minutes per a week, F (11, 163) = 8.8794, p<.001, and approximately 38% of the variance in total walking minutes was accounted for by the predictors, R^2 =.3747. Although, the effect coefficient was mixed of significant and non-significant effects of the different paths, those the less than significant paths of effects still able to be used for the next stage because the other parts (ai) of these paths are mostly significant. Precisely, for b1 path, b=14.7084, t (163) = 2.5046, p<.05, for b2 path, b=-.7967, t (163) =-.1243, p>.05, for b3 path, b=13.0937, t (163) = 2.0942, p<.05, for b4 path, b=25.4799, t (163) = 3.7783, p<.001, for b5 path, b=1.5268, t (163) =.2974, p>.05, for b6 path, b=6.7096, t (163) = 1.2946, p>.05, for b7 path, b=4.0427, t (163) =.7561, p>.05, for b8 path, b=-6.4816, t (163) = -1.2024, p>.05, for b9 path, b=1.4082, t (163) = .3292, p>.05, and for b10 path, b=5.9870, t (163) =1.4064, p>.05.

Path of direct effect c`:

The c` path is computed based on equation (7-3)

The direct effect of walkability index X on the total walking minutes per week c` was non-significant, b=1.3547, t (163) =.4381, p>.05.

The total indirect effect

The total indirect effect is computed based on equation (7-4)

Then the total effect=indirect effect (Table 7-22) 6.4316+direct effect (c) 1.3547=7.7862

For test, the regression analysis was conducted to find the total effect of X on Y without mediators:

Do (X → M → Y) path plus (X → Y) path equals the total effect (c)?

c path (Figure 7-1), regression analysis showed that the total effect magnitude of walkability index on walking outcome (total walking distance) is significant, F (1, 173) = 53.1323, p<.001), R^2 = .1328, the effect coefficient b=7.7862, t (173) = 5.1472, p<.001.

10.7 Appendix (7): The determination tests based on regression analyses

Table 10-1: Prediction test of the Block density (BlkDnS2) scale 400-meter radius

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std. Er.		B	Std. Er.		B	Std. Er.	
1	(Constant)	-14.64	1.56	.000	-14.352	1.57	.000	-7.539	1.83	.000
	Blocks density 400-meter R	21.71	2.31	.000	21.281	2.33	.000	11.179	2.71	.000
2	(Constant)	-13.8	2.04	.000	-13.181	1.97	.000	-8.382	2.55	.001
	Blocks density 400-meter radius	21.343	2.32	.000	19.594	2.23	.000	11.817	2.90	.000
	(Mo1) Age categories of respondents	-.154	.064	.017	-.209	.062	.001	-.105	.080	.190
	(Mo2) How much is your approximate monthly income?	.013	.052	.805	.081	.050	.107	-.046	.065	.480
	(Mo3) Work Status DM1 Employee	-.460	.224	.042	.088	.216	.686	.136	.280	.629
	Work Status DM3 Free Business	-.318	.223	.156	.424	.215	.050	.056	.278	.841
	Work Status DM4 House keeper	-.545	.226	.017	-.418	.217	.056	.192	.282	.496
	Work Status DM5 Student	.224	.295	.448	.326	.284	.253	.384	.368	.299
	(Mo4) Do you practice any type of sport or regular exercise?	.493	.210	.020	.219	.202	.281	.547	.262	.039
	(Mo5) Body Mass Index	.006	.037	.865	.009	.035	.802	.028	.046	.546
	(Mo6) How many total cars that your family have?	-.061	.092	.509	-.053	.089	.553	-.050	.115	.664
	R^2	.464			.503			.164		
	R^2 change	.127			.179			.075		

Table 10-2: Prediction test of the Housing unites density on scale 400x400-meter

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardize d Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-1.579	.182	.000	-1.530	.185	.000	-.997	.207	.000
	Houses density 400x400m	.055	.006	.000	.054	.006	.000	.035	.007	.000
2	(Constant)	-1.264	1.03	.219	-1.587	.996	.113	-2.113	1.23	.088
	Houses density 400x400m	.056	.006	.000	.051	.006	.000	.040	.008	.000
	(Mo1) Age categories of respondents	-.165	.065	.012	-.218	.063	.001	-.121	.078	.124
	(Mo2) How much is your approximate monthly income?	.027	.053	.608	.093	.051	.070	-.032	.063	.613
	(Mo3) Work Status DM1 Employee	-.505	.226	.027	.047	.220	.832	.103	.272	.704
	Work Status DM3 Free Business	-.412	.226	.071	.343	.220	.121	-.038	.272	.889
	Work Status DM4 House keeper	-.542	.228	.019	-.416	.222	.062	.201	.274	.465
	Work Status DM5 Student	.127	.297	.671	.234	.289	.420	.347	.357	.332
	(Mo4) Do you practice any type of sport or regular exercise?	.552	.213	.010	.269	.207	.194	.608	.256	.019
	(Mo5) Body Mass Index	.013	.037	.727	.013	.036	.717	.047	.045	.301
	(Mo6) How many total cars that your family have?	.020	.095	.833	.017	.092	.851	.027	.114	.810
	R^2	.453			.484			.211		

	R^2 change	.123	.174	.080

Table 10-3: Prediction test of the commercial land use diversity (LUDiv1S2) scale 400-meter radius

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
	Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-4.364	.520	.000	-4.303	.523	.000	-1.984	.599	.001
	Diversity of all commercial land use 400-meter radius	5.366	.634	.000	5.291	.638	.000	2.439	.731	.001
2	(Constant)	-3.103	1.187	.010	-3.422	1.136	.003	-2.009	1.461	.171
	Diversity of all commercial land use 400-meter radius	5.146	.620	.000	4.772	.593	.000	2.478	.763	.001
	(Mo1) Age categories of respondents	-.142	.066	.033	-.199	.063	.002	-.096	.081	.242
	(Mo2) How much is your approximate monthly income?	.003	.054	.957	.072	.051	.162	-.053	.066	.426
	(Mo3) Work Status DM1 Employee	-.440	.231	.059	.106	.221	.633	.145	.285	.611
	Work Status DM3 Free Business	-.250	.230	.277	.485	.220	.029	.102	.282	.719
	Work Status DM4 House keeper	-.553	.233	.019	-.424	.223	.059	.185	.287	.519
	Work Status DM5 Student	.235	.305	.442	.338	.292	.249	.373	.375	.321
	(Mo4) Do you practice any type of sport or regular exercise?	.450	.217	.040	.180	.207	.388	.517	.267	.054
	(Mo5) Body Mass Index	-.010	.038	.785	-.006	.036	.877	.013	.046	.777
	(Mo6) How many total cars that your family have?	-.116	.094	.222	-.102	.090	.259	-.086	.116	.459
	R^2	.429			.477			.136		
	R^2 change	.136			.192			.075		

Table 10-4: Prediction test of the commercial land use without parking, wholesale, and workshops 400-m

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
	Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)	Unstandardized Coefficients			Unstandardized Coefficients			Unstandardized Coefficients		
		B	Std.	Sig.	B	Std.	Sig.	B	Std.	Sig.
1	(Constant)	-3.162	.334	.000	-3.090	.338	.000	-1.728	.391	.000
	Diversity of Retails land use 400-meter radius	4.039	.419	.000	3.946	.424	.000	2.207	.491	.000
2	(Constant)	-2.754	1.080	.012	-3.011	1.044	.004	-2.501	1.34	.065
	Diversity of Retails land use 400-meter radius	4.029	.427	.000	3.678	.413	.000	2.390	.533	.000
	(Mo1) Age categories	-.160	.064	.013	-.214	.062	.001	-.111	.080	.165
	(Mo2) How much is your approximate monthly income?	.018	.051	.726	.086	.050	.087	-.042	.064	.517
	(Mo3) Work Status DM1 Employee	-.473	.222	.035	.076	.215	.724	.128	.277	.645
	Work Status DM3 Free Business	-.353	.221	.112	.392	.214	.068	.028	.276	.920
	Work Status DM4 House keeper	-.542	.224	.016	-.415	.216	.056	.196	.279	.485
	Work Status DM5 Student	.207	.292	.479	.309	.282	.276	.382	.364	.296
	(Mo4) Do you practice any type of sport or regular exercise?	.516	.208	.014	.239	.201	.237	.566	.260	.031
	(Mo5) Body Mass Index	.013	.036	.730	.014	.035	.687	.035	.046	.441
	(Mo6) How many total cars that your family have?	-.032	.092	.730	-.027	.089	.764	-.027	.114	.812
	R^2	.474			.509			.181		

	R^2 change	.125	.175	.076

Table 10-5: Prediction test of the non-residential land use diversity (LUDiv3S2) of 400-meter radius scale

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	3.574	.403	.000	3.514	.406	.000	1.732	.470	.000
	Diversity of non-residential land use 400-meter radius	-7.287	.812	.000	-7.164	.818	.000	-3.532	.946	.000
2	(Constant)	4.296	.910	.000	3.435	.873	.000	1.594	1.13	.160
	Diversity of non-residential land use 400-meter radius	-7.066	.804	.000	-6.521	.772	.000	-3.654	.999	.000
	(Mo1) Age categories of respondents	-.148	.065	.024	-.204	.063	.001	-.100	.081	.216
	(Mo2) How much is your approximate monthly income?	.008	.053	.884	.076	.051	.132	-.050	.065	.450
	(Mo3) Work Status DM1 Employee	-.449	.227	.050	.097	.218	.656	.141	.282	.618
	Work Status DM3 Free Business	-.283	.226	.212	.455	.217	.037	.081	.281	.774
	Work Status DM4 House keeper	-.549	.229	.018	-.421	.220	.057	.189	.284	.508
	Work Status DM5 Student	.233	.299	.437	.335	.287	.246	.380	.372	.308
	(Mo4) Do you practice any type of sport or regular exercise?	.471	.213	.029	.199	.205	.332	.531	.265	.046
	(Mo5) Body Mass Index	-.002	.037	.965	.002	.036	.954	.020	.046	.660
	(Mo6) How many total cars that your family have?	-.089	.093	.338	-.078	.089	.382	-.070	.115	.548
	R^2	.448			.492			.149		
	R^2 change	.131			.185			.075		

Table 10-6: Prediction test of the Number of the retail shops on scale 400-meter radius

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-5.279	.729	.000	-5.055	.739	.000	-3.934	.777	.000
	Number of Retail 400m	.025	.003	.000	.024	.003	.000	.019	.004	.000
2	(Constant)	-3.985	1.463	.007	-3.874	1.41	.007	-5.221	1.624	.002
	Number of Retail 400m	.024	.004	.000	.021	.004	.000	.021	.004	.000
	(Mo1) Age categories of respondents	-.151	.071	.034	-.204	.068	.003	-.119	.078	.130
	(Mo2) How much is your approximate monthly income?	.023	.057	.689	.089	.055	.109	-.029	.063	.649
	(Mo3) Work Status DM1 Employee	-.520	.246	.036	.035	.237	.883	.083	.273	.762
	Work Status DM3 Free Business	-.381	.246	.124	.376	.238	.116	-.057	.273	.834
	Work Status DM4 House keeper	-.556	.247	.026	-.429	.239	.075	.197	.275	.475
	Work Status DM5 Student	.021	.322	.947	.139	.311	.656	.275	.358	.443
	(Mo4) Do you practice any type of sport or regular exercise?	.530	.231	.023	.246	.223	.272	.619	.256	.017
	(Mo5) Body Mass Index	-.016	.040	.693	-.014	.039	.711	.038	.045	.396
	(Mo6) How many total cars that your family have?	.002	.104	.987	-.003	.101	.973	.047	.115	.683

	R^2	.357	.400	.207
	R^2 change	.123	.185	.078

Table 10-7: Prediction test of the Number of the retail shops (RetShS3) scale 600-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-2.875	.329	.000	-2.779	.334	.000	-1.88	.370	.000
	Number of Retail 600m	.009	.001	.000	.009	.001	.000	.006	.001	.000
2	(Constant)	-2.466	1.12	.030	-2.642	1.094	.017	-3.141	1.33	.019
	Number of Retail 600meter radius	.009	.001	.000	.008	.001	.000	.007	.001	.000
	(Mo1) Age categories of respondents	-.164	.066	.014	-.216	.064	.001	-.122	.078	.120
	(Mo2) How much is your approximate monthly income?	.027	.053	.608	.093	.052	.073	-.030	.063	.631
	(Mo3) Work Status DM1 Employee	-.511	.230	.028	.042	.223	.852	.097	.271	.720
	Work Status DM3 Free Business	-.414	.230	.074	.342	.223	.128	-.049	.272	.857
	Work Status DM4 House keeper	-.544	.232	.020	-.418	.225	.065	.201	.273	.464
	Work Status DM5 Student	.101	.302	.737	.211	.293	.473	.332	.356	.352
	(Mo4) Do you practice any type of sport or regular exercise?	.553	.216	.011	.270	.210	.201	.614	.255	.017
	(Mo5) Body Mass Index	.009	.038	.816	.009	.037	.807	.047	.045	.299
	(Mo6) How many total cars that your family have?	.024	.097	.808	.020	.094	.835	.037	.114	.747
	R^2	.436			.469			.215		
	R^2 change	.123			.175			.080		

Table 10-8: Prediction test of the Nodes intensity on scale 400-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-1.943	.229	.000	-1.877	.232	.000	-1.279	.256	.000
	Nodes density 400-meter R	.633	.072	.000	.611	.073	.000	.417	.080	.000
2	(Constant)	-1.494	1.068	.164	-1.770	1.04	.090	-2.452	1.257	.053
	Nodes density 400-meter R	.642	.076	.000	.573	.074	.000	.477	.090	.000
	(Mo1) Age categories of respondents	-.163	.066	.015	-.216	.064	.001	-.122	.078	.120
	(Mo2) How much is your approximate monthly income?	.027	.054	.609	.093	.052	.074	-.030	.063	.633
	(Mo3) Work Status DM1 Employee	-.512	.231	.028	.041	.224	.855	.096	.271	.723
	Work Status DM3 Free Business	-.414	.231	.075	.342	.224	.128	-.050	.272	.853
	Work Status DM4 House keeper	-.545	.232	.020	-.418	.225	.065	.201	.273	.464
	Work Status DM5 Student	.097	.303	.749	.207	.294	.483	.330	.356	.356
	(Mo4) Do you practice any type of sport or regular exercise?	.553	.217	.012	.269	.210	.203	.615	.255	.017
	(Mo5) Body Mass Index	.008	.038	.835	.008	.037	.826	.047	.045	.300
	(A11) How many total cars that your family have?	.024	.097	.808	.020	.094	.836	.038	.114	.737

	R^2	.433	.466	.215
	R^2 change	.122	.175	.080

Table 10-9: Prediction test of the Nodes intensity (NodDnS3) scale 600-meter radius

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardize d Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-1.327	.294	.000	-1.246	.296	.000	-1.241	.296	.000
	Nodes density 600-meter R	.464	.100	.000	.436	.100	.000	.434	.100	.000
2	(Constant)	1.150	1.186	.333	.712	1.135	.531	-1.403	1.25	.263
	Nodes density 600-meter R	.382	.104	.000	.318	.100	.002	.458	.110	.000
	(Mo1) Age categories of respondents	-.126	.076	.099	-.181	.073	.014	-.105	.080	.190
	(Mo2) How much is your approximate monthly income?	.008	.062	.903	.074	.059	.209	-.035	.065	.585
	(Mo3) Work Status DM1 Employee	-.504	.265	.059	.051	.254	.841	.082	.280	.769
	Work Status DM3 Free Business	-.274	.265	.303	.476	.254	.063	-.011	.280	.970
	Work Status DM4 House keeper	-.574	.267	.033	-.445	.256	.083	.186	.281	.511
	Work Status DM5 Student	-.031	.348	.929	.095	.333	.777	.217	.367	.556
	(Mo4) Do you practice any type of sport exercise?	.460	.249	.067	.181	.239	.449	.587	.263	.027
	(Mo5) Body Mass Index	-.055	.043	.195	-.050	.041	.219	.014	.045	.762
	(Mo6) How many total cars that your family have?	-.080	.112	.474	-.080	.107	.455	.013	.118	.910
	R^2	.250			.313			.168		
	R^2 change	.139			.215			.070		

Table 10-10: Prediction test of the Streets intensity (StDnS2) scale 400-meter radius

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardize d Coefficients		Sig.	Unstandardiz ed Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-3.599	.432	.000	-3.468	.438	.000	-2.455	.48	.000
	Street density 400-meter radius	.011	.001	.000	.011	.001	.000	.007	.00	.000
2	(Constant)	-2.986	1.21	.015	-3.075	1.18	.010	-3.770	1.4	.008
	Street density 400-meter radius	.011	.001	.000	.010	.001	.000	.009	.00 2	.000
	(Mo1) Age categories of respondents	-.161	.067	.018	-.213	.065	.001	-.122	.07 8	.120
	(Mo2) How much is your approximate monthly income?	.027	.055	.622	.093	.053	.081	-.029	.06 3	.645
	(Mo3) Work Status DM1 Employee	-.517	.235	.029	.037	.228	.870	.091	.27 1	.737
	Work Status DM3 Free Business	-.410	.235	.083	.347	.228	.130	-.057	.27 2	.835
	Work Status DM4 House keeper	-.547	.236	.022	-.421	.229	.068	.200	.27 3	.465
	Work Status DM5 Student	.073	.308	.814	.185	.299	.537	.314	.35 6	.379
	(Mo4) Do you practice any type of sport or regular exercise?	.550	.221	.014	.266	.214	.216	.619	.25 5	.016
	(Mo5) Body Mass Index	.002	.039	.957	.002	.037	.947	.045	.04 5	.313

	(Mo6) How many total cars that your family have?	.022	.099	.825	.017	.096	.860	.044	.114	.699
	R^2	.413			.448			.215		
	R^2 change	.122			.177			.080		

Table 10-11: Prediction test of the Streets intensity (StDnS3) scale 600-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-1.474	.479	.002	-1.351	.481	.006	-1.712	.475	.000
	Street density 600-meter R	.005	.001	.002	.004	.001	.005	.005	.001	.000
2	(Constant)	1.754	1.273	.170	1.308	1.213	.282	-1.386	1.328	.298
	Street density 600-meter R	.003	.001	.039	.002	.001	.095	.005	.002	.001
	(Mo1) Age categories of respondents	-.114	.078	.147	-.170	.074	.023	-.096	.081	.239
	(Mo2) How much is your approximate monthly income?	-.002	.063	.972	.066	.060	.278	-.042	.066	.529
	(Mo3) Work Status DM1 Employee	-.486	.273	.076	.068	.260	.794	.090	.284	.752
	Work Status DM3 Free Business	-.208	.272	.446	.536	.259	.040	.032	.284	.911
	Work Status DM4 House keeper	-.582	.274	.035	-.452	.261	.085	.179	.286	.533
	Work Status DM5 Student	-.028	.357	.938	.100	.340	.770	.202	.373	.589
	(Mo4) Do you practice any type of sport or regular exercise?	.417	.256	.105	.142	.244	.561	.560	.267	.037
	(Mo5) Body Mass Index	-.073	.043	.094	-.066	.041	.112	-.001	.045	.984
	(Mo6) How many total cars that your family have?	-.134	.114	.244	-.129	.109	.239	-.020	.119	.870
	R^2	.210			.283			.140		
	R^2 change	.157			.238			.069		

Table 10-12: Prediction test of the Link-node ratio (LNRS2) on scale 400-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	2.032	5.723	.723	3.075	5.72	.592	-10.01	5.67	.079
	Link-Node Ratio 400-meter radius	-.952	2.682	.723	-1.441	2.68	.592	4.695	2.65	.079
2	(Constant)	9.635	5.596	.087	9.925	5.29	.063	-7.574	5.94	.205
	Link-Node Ratio 400-meter radius	-3.008	2.553	.240	-3.503	2.41	.149	3.991	2.71	.143
	(Mo1) Age categories of respondents	-.099	.078	.208	-.158	.074	.035	-.080	.083	.338
	(Mo2) How much is your approximate monthly income?	-.017	.064	.784	.052	.060	.387	-.055	.068	.419
	(Mo3) Work Status DM1 Employee	-.444	.275	.108	.105	.260	.686	.117	.292	.689
	Work Status DM3 Free Business	-.106	.273	.699	.625	.258	.017	.121	.290	.677
	Work Status DM4 House keeper	-.588	.277	.035	-.458	.262	.082	.169	.294	.566
	Work Status DM5 Student	.043	.361	.906	.167	.342	.625	.219	.384	.568
	(Mo4) Do you practice any type of sport or regular exercise?	.352	.257	.173	.085	.243	.727	.502	.273	.068
	(Mo5) Body Mass Index	-.087	.043	.045	-.077	.041	.060	-.022	.046	.632

	(Mo6) How many total cars that your family have?	-.220	.113	.054	-.204	.107	.058	-.092	.120	.445
	R^2	.196			.280			.092		
	R^2 change	.195			.278			.080		

Table 10-13: Prediction test of the Link-node ratio (LNRS3) on scale 600-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	6.248	1.50	.000	6.353	1.50	.000	.887	1.57	.575
	Link-Node Ratio 600-meter radius	-2.828	.681	.000	-2.875	.680	.000	-.402	.714	.574
2	(Constant)	8.916	1.64	.000	7.965	1.55	.000	1.94	1.85	.294
	Link-Node Ratio 600-meter radius	-2.838	.632	.000	-2.751	.598	.000	-.464	.712	.516
	(Mo1) Age categories of respondents	-.108	.074	.149	-.167	.070	.019	-.077	.084	.357
	(Mo2) How much is your approximate monthly income?	-.018	.060	.765	.052	.057	.358	-.061	.068	.369
	(Mo3) Work Status DM1 Employee	-.420	.260	.109	.126	.246	.609	.143	.293	.628
	Work Status DM3 Free Business	-.105	.258	.684	.620	.244	.012	.163	.291	.577
	Work Status DM4 House keeper	-.578	.262	.029	-.448	.248	.073	.170	.295	.565
	Work Status DM5 Student	.156	.343	.651	.270	.324	.406	.288	.386	.457
	(Mo4) Do you practice any type of sport or regular exercise?	.354	.243	.148	.090	.230	.695	.476	.274	.084
	(Mo5) Body Mass Index	-.066	.041	.113	-.056	.039	.152	-.020	.046	.666
	(Mo6) How many total cars that your family have?	-.227	.106	.033	-.207	.100	.040	-.130	.119	.279
	R^2	.278			.354			.082		
	R^2 change	.187			.260			.080		

Table 10-14: Prediction test of the External connectivity (ExtConS2) scale 400-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-2.344	.268	.000	-2.267	.272	.000	-1.522	.303	.000
	External connectivity 400x400meter	169.525	18.87	.000	163.932	19.162	.000	110.06	21.27	.000
2	(Constant)	-1.956	1.086	.073	-2.191	1.055	.039	-2.730	1.28	.035
	External connectivity 400x400meter	172.221	20.06	.000	154.119	19.487	.000	125.75	23.7	.000
	(Mo1) Age categories of respondents	-.164	.066	.014	-.217	.064	.001	-.122	.078	.120
	(Mo2) How much is your approximate monthly income?	.027	.053	.607	.094	.052	.072	-.031	.063	.627
	(Mo3) Work Status DM1 Employee	-.510	.229	.027	.043	.223	.848	.099	.272	.717
	Work Status Free Business	-.414	.229	.073	.342	.223	.127	-.047	.272	.863
	Work Status DM4 House keeper	-.544	.231	.020	-.417	.224	.064	.201	.273	.464
	Work Status DM5 Student	.107	.301	.723	.215	.292	.462	.336	.356	.347
	(Mo4) Do you practice any type of sport or regular exercise?	.553	.215	.011	.270	.209	.199	.613	.255	.017
	(Mo5) Body Mass Index	.010	.038	.794	.010	.037	.786	.047	.045	.298

	(Mo6) How many total cars that your family have?	.023	.096	.810	.019	.094	.835	.035	.114	.758
	R^2	.440			.472			.214		
	R^2 change	.122			.175			.080		

Table 10-15: Prediction test of the Block compactness on scale 400x400-meter

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardize d Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	.413	1.166	.724	.625	1.16	.592	-2.037	1.15	.080
	Block compactness 400x400meter	-.952	2.682	.723	-1.441	2.68	.592	4.695	2.65	.079
2	(Constant)	4.520	1.583	.005	3.970	1.49	.009	-.789	1.68	.639
	Block compactness 400x400meter	-3.008	2.553	.240	-3.503	2.41	.149	3.991	2.71	.143
	(Mo1) Age categories of respondents	-.099	.078	.208	-.158	.074	.035	-.080	.083	.338
	(Mo2) How much is your approximate monthly income?	-.017	.064	.784	.052	.060	.387	-.055	.068	.419
	(Mo3) Work Status DM1 Employee	-.444	.275	.108	.105	.260	.686	.117	.292	.689
	Work Status DM3 Free Business	-.106	.273	.699	.625	.258	.017	.121	.290	.677
	Work Status DM4 House keeper	-.588	.277	.035	-.458	.262	.082	.169	.294	.566
	Work Status DM5 Student	.043	.361	.906	.167	.342	.625	.219	.384	.568
	(Mo4) Do you practice any type of sport or regular exercise?	.352	.257	.173	.085	.243	.727	.502	.273	.068
	(Mo5) Body Mass Index	-.087	.043	.045	-.077	.041	.060	-.022	.046	.632
	(Mo6) How many total cars that your family have?	-.220	.113	.054	-.204	.107	.058	-.092	.120	.445
	R^2	.311			.290			.135		
	R^2 change	-			-			-		

Table 10-16: Prediction test of the Pedestrian Catchment Area (PCAS2) scale 400-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	7.790	.857	.000	7.651	.864	.000	3.852	1.000	.000
	Pedshed 400-meter radius	-.114	.013	.000	-.112	.013	.000	-.056	.015	.000
2	(Constant)	8.337	1.067	.000	7.156	1.025	.000	3.744	1.328	.005
	Pedshed 400-meter radius	-.111	.012	.000	-.102	.012	.000	-.059	.015	.000
	(Mo1) Age categories of respondents	-.150	.065	.022	-.206	.062	.001	-.102	.081	.208
	(Mo2) How much is your approximate monthly income?	.009	.052	.858	.078	.050	.124	-.048	.065	.459
	(Mo3) Work Status DM1 Employee	-.453	.226	.047	.094	.217	.665	.140	.282	.621
	Work Status DM3 Free Business	-.294	.225	.192	.445	.216	.041	.073	.280	.795
	Work Status DM4 House keeper	-.548	.228	.017	-.420	.219	.057	.190	.284	.504
	Work Status DM5 Student	.231	.298	.439	.332	.286	.247	.382	.371	.305
	(Mo4) Do you practice any type of sport or regular exercise?	.478	.212	.025	.205	.204	.315	.536	.264	.044
	(Mo5) Body Mass Index	.001	.037	.977	.004	.035	.901	.023	.046	.622
	(Mo6) How many total cars that your family has?	-.080	.093	.388	-.070	.089	.433	-.064	.115	.582

		Total walking distance	Total walking journeys	Total walking minutes
	R^2	.454	.496	.154
	R^2 change	.129	.183	.075

Table 10-17: Pedestrian route directness ratio on scale 400-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	6.077	2.57	.020	6.404	2.57	.014	96.182	157.804	.54
	Pedestrian route directness ratio 400-meter radius	-8.211	3.48	.019	-8.652	3.47	.014	116.945	213.126	.58
2	(Constant)	10.09	2.58	.000	9.374	2.44	.000	189.99	160.656	.23
	Pedestrian route directness ratio 400-meter radius	-9.543	3.24	.004	-9.614	3.06	.002	103.380	202.053	.61
	(Mo1) Age categories of respondents	-.101	.077	.191	-.160	.073	.029	-2.320	3.438	.50
	(Mo2) How much is your approximate monthly income?	-.020	.062	.749	.050	.059	.393	3.000	2.594	.24
	(Mo3) Work Status Employee	-.428	.269	.114	.120	.254	.637	13.341	16.135	.41
	Work Status DM3 Free Business	-.090	.267	.735	.636	.252	.012	9.752	15.641	.53
	Work Status House keeper	-.585	.271	.032	-.454	.256	.078	20.564	17.179	.23
	Work Status DM5 Student	.103	.354	.772	.222	.334	.507	23.183	21.393	.28
	(Mo4) Do you practice any type of sport or regular exercise?	.343	.252	.174	.079	.238	.740	-2.603	2.214	.24
	(Mo5) Body Mass Index	-.080	.042	.061	-.070	.040	.084	-25.76	5.685	.00
	(Mo6) How many total cars that your family have?	-.236	.110	.033	-.217	.104	.038	96.182	157.804	.54
	R^2	.230			.312			.081		
	R^2 change	.198			.277			.079		

Table 10-18: Pedestrian route directness ratio on scale 600-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	15.284	3.96	.000	15.599	3.96	.000	1.559	4.13	.706
	Pedestrian route directness ratio 600-meter radius	-19.851	5.15	.000	-20.260	5.14	.000	-2.025	5.36	.706
2	(Constant)	18.296	3.72	.000	17.126	3.51	.000	2.951	4.17	.480
	Pedestrian route directness ratio 600-meter radius	-20.228	4.77	.000	-19.697	4.51	.000	-2.596	5.35	.628
	(Mo1) Age categories of respondents	-.106	.075	.157	-.166	.071	.020	-.077	.084	.360
	(Mo2) How much is your approximate monthly income?	-.019	.061	.759	.052	.057	.366	-.061	.068	.370
	(Mo3) Work Status Employee	-.421	.262	.110	.126	.248	.612	.141	.294	.632
	Work Status DM3 Free Business	-.101	.259	.698	.625	.245	.012	.162	.291	.578
	Work Status DM4 House keeper	-.580	.264	.029	-.449	.249	.074	.170	.296	.567
	Work Status DM5 Student	.147	.345	.670	.262	.326	.422	.282	.387	.467
	(Mo4) Do you practice any type of sport or regular exercise?	.351	.245	.154	.087	.232	.706	.477	.275	.085
	(Mo5) Body Mass Index	-.068	.041	.100	-.059	.039	.136	-.021	.046	.648
	(Mo6) How many total cars that your family have?	-.230	.106	.032	-.210	.101	.039	-.129	.119	.282
	R^2	.269			.347			.081		

	R^2 change	.190	.264	.080

Table 10-19: Prediction test of the Clustering coefficient of destinations on scale 400-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-2.780	.725	.000	-2.838	.724	.000	-.284	.755	.708
	Clustering coefficient of destinations 400-meter	59.553	15.45	.000	60.779	15.42	.000	6.074	16.09	.706
2	(Constant)	-.111	1.294	.932	-.798	1.223	.515	.589	1.450	.685
	Clustering coefficient of destinations 400-meter	60.683	14.33	.000	59.091	13.54	.000	7.788	16.06	.628
	(Mo1) Age categories of respondents	-.106	.075	.157	-.166	.071	.020	-.077	.084	.360
	(Mo2) How much is your approximate monthly income?	-.019	.061	.759	.052	.057	.366	-.061	.068	.370
	(Mo3) Work Status DM1 Employee	-.421	.262	.110	.126	.248	.612	.141	.294	.632
	Work Status DM3 Free Business	-.101	.259	.698	.625	.245	.012	.162	.291	.578
	Work Status DM4 House keeper	-.580	.264	.029	-.449	.249	.074	.170	.296	.567
	Work Status DM5 Student	.147	.345	.670	.262	.326	.422	.282	.387	.467
	(Mo4) Do you practice any type of sport or regular exercise?	.351	.245	.154	.087	.232	.706	.477	.275	.085
	(Mo5) Body Mass Index	-.068	.041	.100	-.059	.039	.136	-.021	.046	.648
	(Mo6) How many total cars that your family have?	-.230	.106	.032	-.210	.101	.039	-.129	.119	.282
	R^2	.243			.313			.080		
	R^2 change	.164			.230			.079		

Table 10-20: Prediction test of the Clustering coefficient of destinations on scale 600-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-2.655	.437	.000	-2.652	.437	.000	-.855	.478	.075
	Clustering coefficient of destinations 600-meter	77.102	12.52	.000	77.028	12.52	.000	24.836	13.69	.072
2	(Constant)	-.506	1.146	.660	-1.082	1.087	.321	-.225	1.344	.867
	Clustering coefficient of destinations 600-meter	73.346	11.78	.000	69.423	11.17	.000	24.662	13.82	.076
	(Mo1) Age categories of respondents	-.121	.071	.090	-.179	.067	.009	-.083	.083	.321
	(Mo2) How much is your approximate monthly income?	-.011	.057	.843	.059	.054	.281	-.060	.067	.376
	(Mo3)Work Status Employee	-.421	.248	.091	.124	.235	.599	.149	.291	.610
	Work Status Free Business	-.152	.246	.537	.575	.233	.015	.152	.288	.599
	Work Status House keeper	-.568	.250	.024	-.438	.237	.066	.175	.293	.550
	Work Status DM5 Student	.205	.327	.531	.314	.310	.313	.330	.383	.390
	(Mo4) Do you practice any type of sport or regular exercise?	.385	.232	.099	.120	.220	.586	.484	.272	.077
	(Mo5) Body Mass Index	-.043	.040	.278	-.035	.038	.350	-.009	.047	.847
	(Mo6) How many total cars that your family have?	-.193	.101	.057	-.173	.095	.071	-.123	.118	.297
	R^2	.344			.410			.098		

	R^2 change	.164	.230	.079

Table 10-21: Prediction test of the Gini Coefficient of the betweenness degree on scale 400meter radius

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-.759	.241	.002	-.781	.240	.001	-.010	.248	.968
	Gini Coefficient of betweenness 400-meter radius	1.380	.416	.001	1.420	.416	.001	.018	.429	.967
2	(Constant)	2.049	1.089	.062	1.290	1.029	.210	.949	1.208	.433
	Gini Coefficient of betweenness 400-meter radius	1.456	.386	.000	1.432	.365	.000	.079	.429	.854
	(Mo1) Age categories of respondents	-.104	.076	.170	-.163	.071	.023	-.077	.084	.363
	(Mo2) approximate monthly income?	-.019	.061	.752	.051	.058	.379	-.061	.068	.373
	(Mo3) Work Status DM1 Employee	-.423	.265	.112	.124	.250	.620	.138	.294	.639
	Work Status DM3 Free Business	-.095	.262	.717	.631	.248	.012	.160	.291	.583
	Work Status DM4 House keeper	-.582	.266	.030	-.451	.252	.075	.169	.296	.569
	Work Status DM5 Student	.131	.348	.707	.248	.329	.452	.271	.387	.485
	(Mo4) Do you practice any type of sport or regular exercise?	.347	.248	.163	.083	.234	.723	.478	.275	.084
	(Mo5) Body Mass Index	-.073	.042	.082	-.063	.039	.112	-.023	.046	.624
	(Mo6) How many total cars that your family have?	-.234	.108	.032	-.214	.102	.037	-.126	.120	.292
	R^2	.254			.333			-		
	R^2 change	.194			.270			-		

Table 10-22: Prediction test of the Gini Coefficient of the straightness degree on scale 400-meter radius

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-1.371	.156	.000	-1.333	.158	.000	-.823	.180	.000
	Gini Coefficient of straightness 400-meter radius	26.872	2.808	.000	26.115	2.849	.000	16.121	3.249	.000
2	(Constant)	-1.116	.996	.264	-1.477	.967	.128	-1.828	1.220	.136
	Gini Coefficient of straightness 400-meter radius	27.298	2.932	.000	24.670	2.846	.000	18.090	3.592	.000
	(Mo1) Age categories of respondents	-.165	.064	.011	-.218	.062	.001	-.118	.078	.134
	(Mo2) How much is your approximate monthly income?	.025	.052	.630	.092	.050	.070	-.035	.063	.581
	(Mo3) Work Status Employee	-.495	.223	.028	.056	.217	.796	.112	.273	.682
	Work Status Free Business	-.399	.223	.075	.353	.216	.104	-.018	.273	.948
	Work Status DM4 House keeper	-.541	.225	.017	-.414	.218	.059	.200	.275	.469
	Work Status DM5 Student	.160	.293	.585	.265	.284	.354	.365	.359	.311
	(Mo4) Do you practice any type of sport or regular exercise?	.544	.210	.010	.263	.203	.197	.595	.257	.022
	(Mo5) Body Mass Index	.016	.037	.664	.016	.036	.647	.044	.045	.327
	(Mo6) How many total cars that your family have?	.008	.093	.935	.007	.090	.936	.010	.114	.930
	R^2	.469			.500			.203		
	R^2 change	.123			.173			.079		

Table 10-23: Prediction test of the Frontage quality index of the high betweenness street SFMODRBS2 scale

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	3.908	.431	.000	3.784	.437	.000	2.488	.489	.000
	Frontage quality index of high betweenness street 400-meter	-.151	.017	.000	-.147	.017	.000	-.096	.019	.000
2	(Constant)	4.343	.910	.000	3.449	.884	.000	1.849	1.088	.091
	Frontage quality index of high betweenness street 400-meter radius	-.154	.017	.000	-.138	.017	.000	-.110	.021	.000
	(Mo1) Age categories of respondents	-.165	.065	.012	-.218	.063	.001	-.121	.078	.122
	(Mo2) How much is your approximate monthly income?	.027	.053	.607	.093	.051	.070	-.032	.063	.618
	(Mo3) Work Status DM1 Employee	-.507	.227	.027	.045	.221	.837	.102	.272	.708
	Work Status Free Business	-.413	.227	.071	.342	.221	.123	-.041	.272	.880
	Work Status House keeper	-.543	.229	.019	-.416	.222	.063	.201	.274	.464
	Work Status DM5 Student	.120	.298	.687	.228	.290	.433	.344	.357	.337
	(Mo4) Do you practice any type of sport or regular exercise?	.553	.214	.011	.270	.207	.195	.609	.255	.018
	(Mo5) Body Mass Index	.012	.037	.746	.012	.036	.736	.047	.045	.299
	(Mo6) How many total cars that your family have?	.021	.095	.823	.018	.093	.843	.030	.114	.793
	R^2	.450			.481			.212		
	R^2 change	.123			.174			.080		

Table 10-24: Prediction test of the Frontage index of the medium betweenness street on scale 400-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	4.112	.533	.000	3.949	.541	.000	2.951	.577	.000
	Frontage quality index of medium betweenness street 400-meter radius	-.177	.023	.000	-.170	.023	.000	-.127	.025	.000
2	(Constant)	4.962	.987	.000	3.976	.955	.000	2.501	1.12	.026
	Frontage quality index of medium betweenness street 400-meter radius	-.175	.025	.000	-.154	.024	.000	-.145	.028	.000
	(Mo1) Age categories of respondents	-.155	.069	.026	-.208	.067	.002	-.121	.078	.124
	(Mo2) How much is your approximate monthly income?	.025	.056	.656	.091	.054	.096	-.029	.063	.651
	(Mo3) Work Status DM1 Employee	-.520	.241	.033	.035	.233	.881	.086	.272	.753
	Work Status DM3 Free Business	-.396	.242	.103	.362	.234	.124	-.060	.272	.827
	Work Status DM4 House keeper	-.552	.243	.024	-.425	.235	.072	.198	.274	.470
	Work Status DM5 Student	.041	.316	.897	.156	.306	.610	.291	.357	.416
	(Mo4) Do you practice any type of sport or regular exercise?	.540	.227	.018	.256	.219	.245	.620	.256	.016
	(Mo5) Body Mass Index	-.008	.039	.841	-.007	.038	.855	.042	.045	.353
	(Mo6) How many total cars that your family have?	.012	.102	.903	.007	.099	.942	.048	.115	.677
	R^2	.381			.420			.212		
	R^2 change	.122			.181			.079		

Table 10-25: Prediction test of the Frontage quality index of the low betweenness on scale 400-meter radius

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	2.789	.306	.000	2.703	.311	.000	1.749	.350	.000
	Frontage quality index of low betweenness street 400-m	-.136	.015	.000	-.132	.015	.000	-.085	.017	.000
2	(Constant)	2.956	.838	.001	2.243	.840	.008	.862	1.05	.416
	Frontage quality index of low betweenness street 400-meter radius	-.113	.015	.000	-.106	.015	.000	-.079	.019	.000
	(Mo1) Age categories of respondents	-.165	.060	.007	-.218	.061	.000	-.121	.076	.113
	(Mo2) How much is your approximate monthly income?	.095	.049	.056	.142	.050	.005	.016	.062	.796
	(Mo3) Work Status DM1 Employee	-.574	.211	.007	-.002	.211	.991	.054	.266	.841
	Work Status DM3 Free Business	-.437	.212	.040	.325	.212	.127	-.053	.267	.842
	Work Status DM4 House keeper	-.444	.213	.039	-.346	.214	.108	.270	.269	.318
	Work Status DM5 Student	.044	.278	.874	.176	.279	.530	.289	.351	.411
	(Mo4) Do you practice any type of sport or regular exercise?	.389	.202	.055	.154	.202	.448	.496	.254	.053
	(Mo5) Body Mass Index	.014	.035	.695	.014	.035	.691	.047	.044	.288
	(Mo6) How many total cars that your family have?	-.382	.080	.000	-.271	.080	.001	-.261	.100	.010
	R^2	.456			.486			.211		
	R^2 change	.123			.174			.080		

Table 10-26: Prediction test of the Enclosure ratio of the high betweenness street, 400-meter radius

	Models: 1, 2, and 3	Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	-17.11	1.770	.000	-16.71	1.792	.000	-9.47	2.076	.000
	Enclosure ratio high betweenness street 400-meter	6.176	.638	.000	6.030	.646	.000	3.418	.749	.000
2	(Constant)	-16.75	2.280	.000	-15.77	2.206	.000	-10.98	2.844	.000
	Enclosure ratio high betweenness street 400-meter	6.180	.653	.000	5.635	.632	.000	3.720	.814	.000
	(Mo1) Age categories of respondents	-.161	.064	.012	-.215	.062	.001	-.112	.079	.160
	(Mo2) How much is your approximate monthly income?	.019	.051	.710	.087	.050	.083	-.041	.064	.525
	(Mo3) Work Status Employee	-.476	.222	.033	.073	.215	.734	.126	.277	.649
	Work Status Free Business	-.360	.221	.105	.386	.214	.073	.021	.276	.938
	Work Status House keeper	-.542	.223	.016	-.415	.216	.057	.196	.279	.482
	Work Status DM5 Student	.202	.292	.489	.304	.282	.283	.381	.364	.297
	(Mo4) Do you practice any type of sport or regular exercise?	.520	.208	.013	.243	.201	.230	.570	.260	.030
	(Mo5) Body Mass Index	.014	.036	.709	.015	.035	.671	.037	.045	.421
	(Mo6) How many total cars that your family have?	-.026	.092	.780	-.021	.089	.810	-.022	.114	.846
	R^2	.475			.509			.184		

	R^2 change	.124	.174	.076

Table 10-27: Prediction test of the Enclosure ratio of the medium betweenness street on scale 400-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	2.166	.312	.000	2.152	.313	.000	.824	.349	.019
	Enclosure ratio medium betweenness street 400-m	-1.633	.230	.000	-1.622	.230	.000	-.621	.257	.017
2	(Constant)	3.716	.959	.000	2.909	.913	.002	1.229	1.148	.286
	Enclosure ratio medium betweenness street 400-m	-1.547	.219	.000	-1.452	.208	.000	-.615	.262	.020
	(Mo1) Age categories of respondents	-.129	.069	.064	-.186	.066	.005	-.087	.083	.294
	(Mo2) How much is your approximate monthly income?	-.007	.056	.907	.063	.053	.235	-.058	.067	.389
	(Mo3) Work Status DM1 Employee	-.426	.242	.079	.119	.230	.605	.149	.289	.606
	Work Status DM3 Free Business	-.186	.239	.439	.544	.228	.018	.137	.286	.632
	Work Status DM4 House keeper	-.562	.243	.022	-.433	.231	.063	.179	.291	.540
	Work Status DM5 Student	.222	.318	.486	.328	.303	.280	.349	.381	.360
	(Mo4) Do you practice any type of sport or regular exercise?	.407	.226	.073	.141	.215	.513	.494	.270	.069
	(Mo5) Body Mass Index	-.031	.039	.432	-.024	.037	.521	-.001	.046	.977
	(Mo6) How many total cars that your family have?	-.167	.098	.091	-.149	.093	.111	-.113	.117	.336
	R^2	.378			.437			.110		
	R^2 change	.152			.214			.077		

Table 10-28: Prediction test of the Enclosure ratio of the low betweenness street on scale 400-meter radius

Models: 1, 2, and 3		Total walking distance			Total walking journeys			Total walking minutes		
Singular and composed models: 1 (only the predictor) 2 (the predictor + moderators)		Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.	Unstandardized Coefficients		Sig.
		B	Std.		B	Std.		B	Std.	
1	(Constant)	.622	.294	.036	.660	.294	.026	-.188	.298	.528
	Enclosure ratio low betweenness street 400-m	-.500	.228	.030	-.530	.228	.021	.151	.231	.514
2	(Constant)	3.801	1.091	.001	3.04	1.031	.004	.900	1.188	.450
	Enclosure ratio low betweenness street 400-m	-.595	.213	.006	-.603	.201	.003	.103	.232	.658
	(Mo1) Age categories of respondents	-.100	.077	.193	-.160	.073	.029	-.077	.084	.362
	(Mo2) How much is your approximate monthly income?	-.020	.062	.749	.050	.059	.395	-.059	.068	.385
	(Mo3) Work Status DM1 Employee	-.429	.270	.114	.119	.255	.641	.131	.294	.656
	Work Status DM3 Free Business	-.090	.267	.736	.637	.253	.013	.151	.291	.606
	Work Status DM4 House keeper	-.585	.271	.032	-.454	.256	.078	.168	.296	.570
	Work Status DM5 Student	.098	.355	.784	.218	.335	.517	.249	.387	.520
	(Mo4) Do you practice any type of sport or regular exercise?	.343	.252	.175	.079	.238	.741	.484	.275	.080
	(Mo5) Body Mass Index	-.081	.042	.058	-.071	.040	.080	-.024	.046	.598
	(Mo6) How many total cars that your family have?	-.235	.110	.034	-.217	.104	.039	-.117	.120	.329
	R^2	.027			.030			.002		
	R^2 change	.199			.278			.079		

10.8 Appendix (8): The format of the assessment of the frontage quality

The format of the assessment of the frontage quality
Surveyor's name: Date:
Use listed questions for the assessment of the sampled façade.
Assess the visible architecture features in 100-meter length façade, such as entrances, arch, freeze, column, or ornament? For each six elements indicate one degree on the scale below: **__1__: __2__: __3__: __4__: __5__: __6__: __7__**
For each architecture typology in the 100-meter length façade include house, shop, general service (like a mosque or doctor's practice), wholesale, workshop, office building, and parking indicate one degree on the scale below: **__1__: __2__: __3__: __4__: __5__: __6__: __7__**
Based on your experience, how much percentage the openness, which could be the windows, or window-shops in the 100-meter length façade? For each percentage of the following options include 0-15%, 16-30%, 31-45%, 46-60%, 61-75%, 76-90%, and 91-100% indicate one degree on the scale below: **__1__: __2__: __3__: __4__: __5__: __6__: __7__**
What is the maintenance level of the 100-meter length façade? (1) very poor (2) poor (3) under maintenance (4) medium (5) good (6) very good (7) excellent
What is the intensity of the architectural details in the 100-meter length façade ? (1) very poor (2) poor (3) under-construction (4) medium (5) good (6) very good (7) excellent

10.9 Appendix (9): The format of the blocks survey

	The format of the blocks survey of Al- …………… neighbourhood						
	Surveyor's name:			Date:			
	Information about the structure of the block						
	Block No.	No. of plots	Built-up plots	Vacant plots	No. of floors		
	Information about housing units typologies						
	Front-yard	Courtyard	Backyard	No yard			
	Information about the non-residential land uses of the block						
	No. of retails	No. of workshops	No. of wholesale stores	No. of schools	No. of mosques	Governmental buildings	No. of Parking

The End of the thesis … 19 April 2018