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Evaluating Walkability Across Contemporary Neighborhoods in Islamabad-Rawalpindi Metropolitan Area, Pakistan

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A Thesis submitted in the Partial Fulfillment
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Disclaimer

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Saman Tariq

Signature

Dedication

" Dedicated to my late father Maj. Tariq Iqbal

who would have been very proud to see his

daughter succeed in all spheres of life"

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Evaluating Walkability Across Contemporary Neighborhoods in Islamabad Rawalpindi Metropolitan Area

Abstract

Asian cities were always termed as “cities for walkers” since people were highly dependent on active travel modes (i.e., walking and cycling) for everyday activities. However, as cities grew, rapid urban expansions brought forth unprecedented challenges in the Global South context. One of the significant consequences of these sprawls was the mainstreaming of motorized vehicles, which increased environmental issues (i.e., air pollution, global warming, etc.) and decreased pedestrian safety (i.e., increased road accidents and fatalities). Regardless of several issues in car-oriented planning, minimal attention is being given to this domain in Pakistani cities. New suburban developments and their contemporary neighborhood designs have increased reliance on private car ownership, generally changing walking behaviors amongst residents. Walking is losing importance as a mode choice despite health and environmental benefits, thereby handing over the urban setting to motorized vehicles. In light of this situation, there is a dire need to investigate the underlying causes of this shift of mobility pattern. Therefore, this research seeks to address this issue by carefully evaluating walkability across contemporary neighborhoods in Pakistani cities. The goal is to analyze existing environmental features and resident perception of these features concerning walkability. The results indicate that the comfort variable within both neighborhoods is weak and needs immediate intervention to improve walking levels, followed by accessibility, safety, and pleasurability. Recommendations are drawn in detail for all four variables under examination. Thoughtful implementation of macro and micro-scaled interventions may improve the walkability of contemporary neighborhoods in Pakistani cities and promote human-centric neighborhood designs for improved safety, comfort, and livability.

Keywords: *walkability, walkable cities and neighborhood, sustainable mobility, sustainable urban development*

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Acronyms and Abbreviations

DHA	Defence Housing Authority
IMI	Irvine Minnesota Inventory
SPACES	Systematic Pedestrian and Cycling Environmental Scan
NEWS	Neighborhood Environment Walkability Scale
IPAQ	International Physical Activity Questionnaire
N	Sample size
I.S	Indicator score
B.E.	Built Environment
P.B.E	Perceived Built Environment
IMI-A	Irvine Minnesota Inventory - Accessibility
IMI-S	Irvine Minnesota Inventory – Safety
IMI-C	Irvine Minnesota Inventory – Comfort
IMI-P	Irvine Minnesota Inventory – Pleasurability
NEWS-A	Neighborhood Environment Walkability Scale - Accessibility
NEWS -S	Neighborhood Environment Walkability Scale – Safety
NEWS -C	Neighborhood Environment Walkability Scale – Comfort
NEWS-P	Neighborhood Environment Walkability Scale – Pleasurability

1. Introduction

The planning and design for improving walkability are receiving much attention due to associated health, economic and social benefits. Initially emerged because of environmental concerns, walkability within cities has now gained considerable importance in development plans laid forward by governments to achieve sustainability goals. Regardless of widely acknowledged benefits, many countries in the global south are still relying on and institutionalizing motorized vehicular modes. With a limited understanding of long-term consequences and ignoring pedestrian-centric planning, the walkability dimension has started to disappear from many neighborhoods. Cities in totality are being handed over to motorized vehicles and this relative inattention to humans suggest that either pedestrian are not considered a salient part of the environment or transportation system, or they are too pedestrian to require significant financing of research, planning, and design (Lo, 2009; p: 147). This limited view of pedestrian-oriented planning was never the same throughout history.

1.1. WALKABILITY: THE PAST AND PRESENT

Walkability had always been an essential component in cities before the advent of automobiles. Streets in the pre-industrial times were designed to support human mobility either by foot or by slow-moving vehicles such as carts and wagons to carry out everyday activities. The density and diversity of multiple activities were closely knit together, supported by a continuous pathway network to make human movement easy and safe. During the middle ages, the design of cities was commendable in terms of walkability, where roughly everything was accessible within half a mile from the central town square. This kind of model is still seen in Urbino, Italy, where approximately 30,000 people are inhabited within an area of 300 acres. Cities during the Industrial era also exhibited relatively better walkability since most working class could not gain access to carriages or carts. However, the changes in ideology targeting efficiency and productivity right after this period caused significant challenges. The advent of the high-speed transportation system to help save time caused a shift from slow mobility to high-speed mobility. The period of the 1920s saw an end to the walkable city due to high-speed motorization. To accommodate spaces for automobiles, the closely-knit dense patterns of cities started to open up, creating barriers for the free movement of pedestrians. Ignoring pedestrian needs led to streets losing their essence, serving only as a link between two destinations instead of supporting public life. (Southworth, 2005).

In the post-industrial cities, particularly after the 1950s, the human dimension had disappeared entirely, and it became a grave challenge for pedestrians and cyclists to navigate through space freely and safely. The streets developed after the 1950s mainly exhibited weak and discontinuous street networks with many cul-de-sacs. The building block sizes were often too large and could not offer multiple route choices with segregated land-uses. Most streets were usually overscaled, and pathway networks discontinuous with inadequate provision of walking infrastructure, causing a barrier to human mobility. This bleak picture of cities and their morphology indicated that the entire system supported only one set of users, i.e., motorists. (Southworth and Ben-Joseph, 2003). Some researchers claim that most of this change in urban landscape appeared due to relative inattention to street design compared to road design. Formerly, transportation and civil engineers were trained to consider the context and landscape aspects while expanding road networks.

However, clear-cut boundaries started to develop between urban design and transportation planning, creating adverse impacts on pedestrians' needs and comfort. The beginning of the 1940s demarcated the profession into two directions; those dealing with place-based design and those concerned with transportation planning technicalities. While urban and landscape designers analyzed micro-level variables such as design and form, transportation planners were more concerned with macro-level variables such as capacity, volume, flow rate, demand, trip origin/destination. One adverse effect on this demarcation was

Fig 1. Pedestrian infrastructure quality in most cities of Pakistan
Source: Walkabilityasia

that transportation planners rarely considered built environment attributes, quality, and user perceptions since pedestrians negatively impact traffic speeds at streets and crossings (Ramsey, 1990). The consequence for overlooking the needs of all types of users significantly modified urban environments. Although some transportation planners acknowledge that micro-level design characteristics positively correlate to walking, only a few have taken this detail into account. Mostly urban design variables are omitted from studies due to data limitation and expertise. Compared to studies on vehicular transportation, very little information is available to understand the needs of pedestrians and cyclists at neighborhood and city scales (Southworth, 2005). As a result of this inattention, we are getting more and more roads that serve as a link between places but rarely get such links that allow pedestrians or cyclists to claim and own them as equally as car drivers do.

1.2. WALKABILITY: THE CASE OF PAKISTANI CITIES

The phenomenon which is prevalent in present-day Asian cities is not less than what is mentioned above. Asian cities have always associated themselves as “cities for walkers” since people relied on active mobility such as walking and cycling as a mode of travel for everyday activities. However, new and unprecedented challenges have emerged in the Global South context with the mainstreaming of motorized vehicles. Rapid urban expansions have led to unprecedented growth in the number and use of private vehicles. To meet consumer demands, planners and transportation engineers seek to provide more road space for motorized vehicles. Although this approach does address the short-term issue of traffic congestion, it causes other unavoidable challenges. On the one hand, this increases vehicular ownership, and this growing motorization causes severe environmental challenges such as high levels of air pollution, reliance on fossil fuels, and increased global warming. On the other hand, motorized vehicles claim urban environments resulting in high pedestrian fatalities, accidents, and exposure of pedestrians to air pollution. Despite these issues, minimal attention is paid to counter this problem, and immediate intervention is required.

Fig 2. Walkability ratings for city of Islamabad
Source:IUCN.org

Asian Development Bank surveyed Walkability and Pedestrian Facilities in 13 different Asian cities in which Karachi, Pakistan, was also a subject of investigation. The study derived walkability ratings for all selected study areas through field surveys to assess the quality of pedestrian facilities and overall walking environment. The overall survey result indicated that the median walkability rating for all 13 cities was only around 58.43 out of 100. While interviewing pedestrians and their preferences, it was revealed that 41% of respondents term the quality and condition of pedestrian facilities as “bad” or “worse.” Moreover, 67% of the respondents were inclined to shift their walking trips to motorized vehicles if walking conditions did not improve

Similarly, another walkability survey conducted for Islamabad, Pakistan, by Clean Air Initiatives for Asia Cities indicated that the average walkability rating for the entire city is only 60 out of 100 for different parameters set forth during the investigation (fig.2). The major issues identified in this survey indicated were lack of adequate infrastructure facilities, path obstructions, encroachments, under/misuse of walking facilities, and traffic safety, including motorcyclist behavior. The outcome of this survey was quite surprising since Islamabad is the only city in Pakistan that has been developed according to a formalized and regulated master plan with considerable attention given to pedestrians according to development plans laid forward by Greek planner Constantine Doxiadis. As a general conclusion to these surveys, it was revealed that measures and institutions promoting pedestrians and walking environments are generally not very impactful. The lack of relevant policies and political intentions towards this goal has led to deficits in pedestrian infrastructure facilities and city-scale amenities. The example mentioned above highlights how ignoring pedestrian facilities and infrastructure can overall reduce walkability. These issues strongly influence walking behaviors amongst Pakistani individuals and are evident in their daily lifestyles. Pakistan is the 9th most obese country globally, and around 3.4 million Pakistani's died only because of obesity in 2010 (Siddiqui et al.,2018). Research conducted on a sample of 19000 subjects by researchers of the University of Glasgow, University of Manchester, and Khyber Medical College University revealed that 29% of the Pakistani population, in general, is obese regardless of age and other indicators. Two out of three reasons identified for this issue were lack of exercise and high dependency on motorized vehicles for commuting. (Laar et al., 2020). Does this pose a serious inquiry into why physical activity levels especially walking, is a prevailing concept in Pakistani cities regardless of multiple health and environmental benefits?

1.3. RESEARCH OBJECTIVE

Although it is widely agreed that numerous factors come into play that dominates an individual or a group walking levels or characteristics, many researchers and scholars agree that one of the most driving factors that moderates physical activity such as walking in the neighborhood design. New suburban developments in Pakistani cities and their contemporary neighborhood designs bring in numerous unprecedented challenges. While the rest of the world is moving towards compact vertical developments with mixed-used functions, favoring higher residential density and designing for enhanced accessibility, facilities, safety, and aesthetics, neighborhood designs and planning in Pakistani cities are contrary. During the early days of Pakistan's inception, the "garden city" concept was the widely accepted planning model, and many neighborhoods quickly adopted it. Prime examples of these developments include Gulberg and Islamabad City. These low-rise suburban development patterns with excessive housing and minimum provision of extra facilities are still prevalent in many housing schemes, which lead to suburban sprawls. Reaching out to these suburban communities has caused a drastic increase in private car ownership, increasing reliance on motorized vehicles, and changing walking behaviors amongst residents. Walking is losing importance as a mode choice despite health and environmental benefits, thereby handing over the urban setting to motorized vehicles. In light of this situation, there is a dire need to understand the underlying problems resulting in this shift of mobility pattern. Hence, this study addresses this issue by carefully analyzing walkability across contemporary neighborhoods in Pakistani cities. Here, the intent is to evaluate existing planning practices to push for human-centric neighborhood design and reclaim the urban environment for human activities once again, which will be done by carefully analyzing factors hypothesized to affect neighborhood walkability. Literature in the walkability domain suggests that five urban and non-urban variables influence walking behaviors: feasibility, accessibility, safety, comfort, and pleasurability. Along with these, an additional layer of perception and behavior dominates an individual's or group's decision towards walking. Hence keeping these factors in mind, this research seeks:

- *To **evaluate environmental features of contemporary neighborhoods** in relation to walkability*
- *To **evaluate resident perception** regarding their neighborhood's environmental features in relation to walkability*
- *To **recommend improvements in environmental feature**s to promote walking.*

1.4. RESEARCH QUESTIONS

The following research questions will be answered during this research:

- *How are the **existing environmental features** of contemporary neighborhoods in relation to walkability?*
- *How do **residents perceive the environmental features** of their neighborhoods in relation to walkability?*
- *How to **improve neighborhood environmental features** to promote walking?*

2. Theoretical Framework

2.1. WALKABILITY: WHAT IS IT?

Before discussing walkability within urban neighborhoods, it is essential to discuss how different researchers approach the term. An extensive body of literature explains what walkability is and how to situate the term appropriately to operationalize the concept. No clear consensus has been put forward to create a universal definition of the term, but broadly, two ideas are elaborated in the existing literature.

According to Forsyth (2015): One school of thought sees walkability as the outcome of walkable environments, i.e., walkable places are lively, sociable, and support outdoor physical activities. Many researchers support this ideology, indicating that pedestrian-centric approaches such as mixed-use functions, sidewalks, landscaping elements, and active building frontages can draw people to walk, emphasizing sociability outcomes (Jacob, 1961; Whyte, 1980; Gehl, 1987). They are supporters of aspects such as liveliness, vitality, sociability, or vibrancy. It will be safe to say that this idea of walkability resonates with the concept of "placemaking." However, placing the notion of access to services, facilities, and job-related activities changes the dimension of this definition, giving birth to the second school of thought. The most conventional ideology sees walkability as a means through which walking is enabled or supported and provides spatial connectivity across time and space while being traversable, compact, safe, etc. According to Southworth (2005, p. 248)

> "*Walkability is the extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the*

network."

Fig 3. The built environment attributes and quality of a walkable neighborhood Source:Mortgagemedia.com

This definition addresses four main aspects of walkability: Accessibility, Comfort, Safety, and Pleasurability. He further adds that any environment incorporating these aspects can be categorized as "highly walkable." Another definition offered by Jane's Walk (2013) viewing walkability as an objective and subjective assessment states:

"Walkability is a quantitative and qualitative measurement of how inviting or un-inviting an area is to pedestrians" (Jane's Walk, 2013)."

These two definitions provide a clear understanding of the measurement of walkability. First, it can be assessed quantitatively while looking at attributes of the built environment (fig. 3). Second, it points out qualitative measurement, i.e., perception of their built environment. Hence, we will be dealing with walkability at both levels collectively.

2.2. UNDERSTANDING THE WALKABLE NEIGHBORHOOD:

To improve walkability within an urban setting, it is crucial to define the geographic or demographic boundaries set forth by literature for the term "The Walkable Neighborhood." A thorough literature review suggests that a walkable neighborhood's population density and spatial extents vary significantly. Since a walkable neighborhood is pictured dependent upon pedestrian movement, a specific population density could be serviced by foot or by accessing a nearby transit stop. As an ideal case scenario, a walkable neighborhood has a range of 5000 to 1000 inhabitants (Talen and Koschinsky, 2013) but this

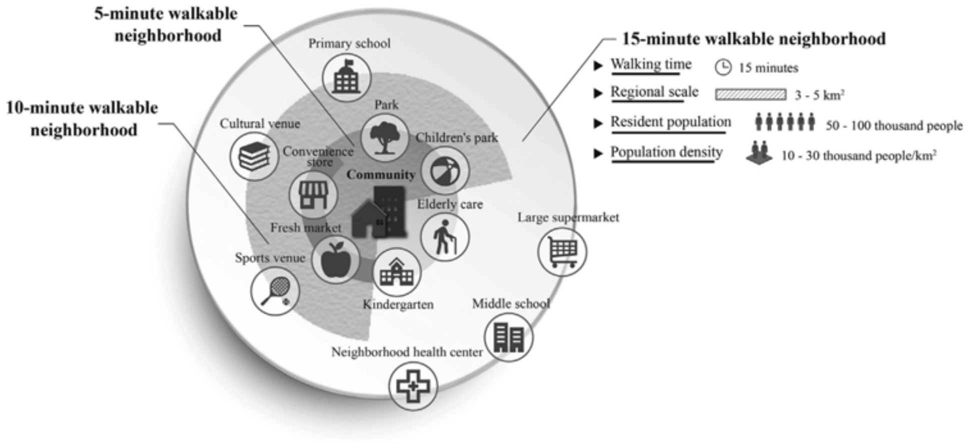


Fig.4: Conceptual diagram of the idea of the walkable neighborhood
Source: Weng et al., 2019

number can surely variate depending upon where the neighborhood exists, i.e., in an urban center or a suburban area. The 20th-century garden city design by Letchworth housed 10,000 residents per neighborhood, whereas Clarence Perry's "neighborhood unit" housed 5000 residents. Present-day New Urbanists use the range of 5000 to 1000 inhabitants as an optimum population for an urban village or walkable neighborhood. The concept of a walkable neighborhood is even translated into many measurable attributes to be evaluated. The measures of a walkable neighborhood have been tested widely with playful concepts such as "popsicle test" (a neighborhood is considered walkable if an 8-year-old can safely buy a popsicle and can return on his/herself before it melts) or "20-minute neighborhood" (Larabee, 2008). However, a generally accepted concept implies that a neighborhood with high walkability is considered to facilitate daily life services and amenities within 0.25 to 0.5 miles from one's home or everything is available within 5 to 15 minutes (fig.4). This rule to date is valid and helps to demarcate a geographic boundary of a walkable neighborhood.

2.3. WALKABILITY: A DOMAIN

The past 20 years have seen a substantial decline in walking rates amongst individuals to access nearby transportation and means for leisure and recreation. The reliance on the sedentary lifestyles of individuals is causing significant health challenges and high rates of obesity. The dramatic decrease in walking trips has alarmed public health and medicines professionals as multiple former studies indicated a strong correlation of physical activity levels to increased risk of heart diseases, strokes, and other health issues (Centers for Disease Control and Prevention, 1999). Not only this, professionals from disciplines such as architecture, planning, and sociology were also troubled by this issue since many believed this could adversely impact the sense of community and quality of life within cities. To counter this issue, researchers from these domains started identifying factors that affected a person's activity levels; however, the scope of their investigations followed a disciplinary approach. For example, health researchers were focused on studying individual-level characteristics and walking behaviors, whereas planning researchers were trying to figure out correlations of physical environment variables and physical activity levels, and so on (Alfonzo, 2005).

Until recently, health researchers and urban planners started to broaden the scope of their studies and stepped beyond their disciplines and expertise. While the aspect of walking in urban surroundings had been studied previously (Frank and Pivo, 1994; Handy, 1996a), planners started to look beyond the physical aspects of the built environment to comprehend individual and group level demographics as control variables. Similarly, health researchers started analyzing the role of the built environment in influencing walking (in addition to individuals and group-level characteristics) to access nearby recreational and exercise facilities. This breakthrough in walkability research was the first step in acknowledging the idea that promoting walkability within an urban setting was not possible while looking at the problem in isolation. Adopting a narrow approach to a multi-scaled problem such as the decline of walking rates had led to a limited understanding of underlying factors; therefore, a more comprehensive body of research termed "walkability" literature emerged. Therefore, professionals from varied backgrounds such as transportation planning, urban design, psychology, and sustainability study this effect thoroughly, using a transdisciplinary approach (Talen and Koschinsky, 2013) to advance the walkability dimension.

The result of this collective exploration highlighted that neighborhood walkability is highly dependent on both quantitative and qualitative measures. Quantitative measures include "macro-scale" elements that make part of an urban form, such as mixed land-uses, street network, building density, block and street length, population density, etc. Qualitative measures, on the other hand, rely on small "micro-level" features of the built environment such as quality of pedestrian paths, building facades, presence of trees, availability of street furniture, street lighting, visually pleasing elements of the environment, perceived safety from crime and traffic, liveliness, sense of place, etc. (Ledraa, 2015). The above features clearly show that the built environment's macro and micro-level attributes can intensely affect an individual's walking behavior, supplementing various claims of why neighborhood walkability is crucial for consideration during planning and design. In the field of public health, dense urban neighborhoods show high walkability and physical activity levels in comparison to a sprawling neighborhood (Rodriguez et al., 2006) which ultimately reaches the goal of being an "Active Community" (Doyle et al.,2006). The housing policy literature emphasizes social diversity as a critical consideration and states that easy access to transportation and jobs, land-use mix diversity, and housing variety create social diversity. (Nyden, 1998). From a sustainability perspective,

> "*Walkability is the foundation for a sustainable city; without it, resourceful conservation will not be possible. Like bicycling, walking is a "green" mode of transport" (Southworth, 2005, pg. 24).*

Improving neighborhood walkability can solve ecological degradation supporting active travel, reducing carbon footprint, and energy consumption (Ewing et al., 2010; Southworth, 2005). Finally, studies from sociology suggest that neighborhoods with high walkability show strong social capital due to resident trust, bonding, and communal participation (Rogers et al., 2010; Leyden, 2003) and better exchange and sociability (Brown and Cropper, 2001). To discuss existing literary works in detail, it is vital to cluster them according to their main categories. Here we will elaborate on transportation, urban planning, design, psychology, and health due to their relation with walkability and assess what evaluations (i.e., objective or subjective) have been studied previously.

2.3.1. Transportation Planning:

Literature in this category primarily relies upon objective assessments and identifies a strong correlation between neighborhood traffic planning and walking behaviors. Neighborhoods with high walkability have better provision and Accessibility to facilities (such as groceries, shops, cafes, etc.) such that they can be reached within 10-20 mins or 1-2 miles by walk. (Southworth, 2005). Distance to Destination is a relevant factor affecting choice whether to walk or take the car, above others such as weather condition, physical inability, or crime safety (Handy, 1996; FuniHashi 1985). Research showed that 70% of residents were willing to walk 500 feet to carry out everyday activities, and their willingness changed with an increase in the distance such that 40% agreed to walk 1/5 a mile and only 10% agreed to walk half a mile. (Southworth, 1997). Street Connectivity is a significant factor influencing walking (Boarnet and Crane, 2001). It is calculated by the number of intersections present per km along with cul-de-sacs within a neighborhood. It is usually seen that streets with more intersections and fewer cul-de-sacs encourage pedestrians to walk more (Krizek 2000). When streets follow a grid pattern, barriers to walking reduce, directly influencing origin and destinations times. High connectivity is symbolic of linear or straight-line routes. In addition to connectivity, grid patterns offer alternate routes, increasing route choice (Saelens et al., 2003a). Regardless of providing an internally connected pedestrian network, the absence of Transit Facilities within a neighborhood will always increase auto-mobile usage even if it supports other aspects and is well-designed in terms of neighborhood design (Cervero 2002). Linkage to other modes of transport such as buses or trains will provide better mobility and connectivity. (Southworth, 2005). A study analyzing the impact of introducing a light-rail transit on the walking behaviors of nearby residents in a regional neighborhood reported a positive association between the two (MacDonald et al., 2010). Proximity to the workplace was a strong indicator of transport-related walking in women (Cerin et al., 2007). Factors such as the presence and absence of Sidewalks and Pathways can overall encourage or discourage walking (Alfonzo, 2005). Roads with wide lanes and high-speed traffic with no sidewalks and long distances between crossings were dangerous and inadequate for pedestrians (Hanzlick et al., 1999). Traffic Calming strategies include reduced street widths, speed limits, crosswalks/signage overall increased street activities and pedestrian volumes (Frank et al., n.d.; Clark and Dornfeld, 1994). The study conducted in the Netherlands showed that calming traffic measures reduced accidents by about 20 - 70% depending on the locality and its urban form (Pucher and Dijkstra, 2003).

2.3.2. Urban Planning and Design:

This category relies on a combination of objective and subjective assessments. Walking has been a subject of examination for quite a long since it appears to be influenced by neighborhood design (Shay et al., 2006). The walkable neighborhood has been correlated with many measurable attributes for evaluation. These attributes have evolved significantly in the last few years to study the impact of neighborhood design on traveling mode choice (Frank et al., 2010). and health outcomes such as obesity (Saelens et al., 2003b). An urban design and block-level quality are said to be relevant perimeter that encourages pedestrian movement. Factors such as the presence of street streets, adequate sidewalks, blank walls, building frontages, parking lots, traffic volumes, and street connectivity play a vital role (Talen and Koschinsky, 2013). Effective urban design can enhance sociability and walkability within an urban setting, and it has a direct impact on human behavior and attitude (Yaseen, 2017). Studies highlight a strong relation between compactness, mixed land uses, building density, diversity of housing types, and open space provision (Durand et al., 2011). Density is also considered a very promising variable and is calculated using indicators such as population density, number of dwellings, and places of employment (Wells and Yang, 2008). Higher Building Density and Mixed-Uses have been strongly correlated with physical activities (Frank and Pivo, 1994). Land-Use Diversity, especially near commercial areas, showed more excellent walking rates amongst nearby residents (Cervero and Kockelman, 1997). Land use mix is measured by the availability and number of different facilities, and it is often seen that people tend to walk more when different land uses such as residential, commercial, schools, recreation exist. One study conducted in Iran showed that more public parks within a neighborhood increase physical activity levels such as walking among women (Andrews and Shahrokni 2014). Diversity and Complexity within a built environment have also been associated with user preference (Nasar, 1983; Herzog, 1992). The Perception of Environmental Aesthetics strongly correlates with higher walking rates (Ball et al., 2001). Streetscapes play a vital role in neighborhood walkability. They are often measured by features such as street lighting, well-paved and designated walkways for pedestrians, and availability of attractive landscape views or building facades (Bourdeaudhuij et al., 2003). Street Trees indicated high walkability compared to streets without trees in a residential neighborhood (Stamps, 1997). Well-maintained Public Spaces have also been identified as the source of communal gatherings and meetings, facilitating walking and social interaction between varied social classes (Roberts, 2007). Provision of Amenities such as purposefully placed street benches and chairs within an urban environment facilitates social interaction. Sharing the same sitting facilities provides an opportunity to communicate. Providing secondary services such as planters, chairs, or stoops in the public plazas also sufficed the purpose, leading to higher walkability (Gehl, 2013).

2.3.3. Psychology:

Purely dependent on subjective assessments, an extensive body of literature focuses on perceptions and behaviors towards walking. Research highlights that both objective and perceived environmental characteristics are correlated with physical activity behavior (Brownson et al., 2004). Susan Handy states that

> *"because the pedestrian sees, hears, smells and feels much of the surrounding environment, urban form is likely to play a greater role in the choice to walk" (Handy, 1996).*

Many studies in this domain have tried to identify similarities between objectively assessed environmental attributes (such as using GIS, Walking Audit Tools) in comparison to subjectively assessed environmental attributes (surveys, interviews, mental mapping) (Brownson et al., 2009). These studies have found that resident perceptions do not correlate with objective assessments in many cases, creating a new dimension for investigation (Hoehner et al., 2005). Neighborhood perception has been found to have a solid link to walking behavior, and, in many studies, researchers focus on specific target groups (such as children) in varied environments (such as schools) to relate how perception will impact physical activity levels (Humpel et al., 2004). Some studies showed gender variations in walking. For example, Hume et al. (2007) showed that neighborhood perception was a substantial factor in girls walking to school. Other studies also suggest perception of walking has a direct influence on walking behavior. For example, more walking was recorded in individuals who acknowledged the benefits of walking (Lund, 2003). Researchers scoring streets for movement across four European countries showed that people were willing to walk extra 160m on streets marked as "pleasant" during good weather (Westerdijk, 1990). .

A significant body of literature has studied safety from two aspects; perceived safety from traffic and crime. Literature in the domain of traffic safety suggests that the number of children walking or cycling to school has decreased over 40% in the past 20 years (Killing-sworth and Lamming, 2001). The reason identified for this change relates to children's safety from traffic. Therefore, cities are developing "paths to school" programs to provide safe street access to school children (Southworth, 2005). The "The Safe Routes to School Program" initiated and operational in Odense, Denmark, reduced 85% of children's traffic accidents (Untermann, 1990). A study also indicated that children's physical activity was recorded more in urban settings with a cul-de-sac layout than grid layout due to less traffic flow (Tappe et al., 2013). One study found that fear of crime was solely responsible for psychological distress amongst residents (Scheweitzer et al., 1999). An unsafe environment having a fear of crime and insecurity is negatively correlated with walking levels amongst residents (Foster and Giles-Corti, 2008; Villaveces et al., 2012). A study analyzing the effects of fear on resident exercise levels found a decline in the number based on the resident perception of safety (Ross, 2000). therefore, the presence of people walking or sitting was strongly affecting walking levels. Proper lighting was a factor for increased perception of safety and creating a more walkable setting (Ball et al., 2001; Foster et al., 2010). Moreover, places with high walkability were considered safer, i.e., attributes such as mixed-land uses, high building density, and fewer vehicles were perceived as safer by pedestrians, enhancing walkability and social capital (Burton and Mitchell, 2006). Moreover, such places allowed residents to interact more and develop connections amongst themselves and with the urban spaces, due to which their walking rates increase as opposed to areas having segregated social activities (Leyden, 2003). Increased walking levels in a community can enhance familiarity and sense of ownership, increasing compassion and responsiveness (Jackson, 2003a). Many environmental attributes are linked to perceived safety; for example, vandalism, graffiti, poorly maintained spaces, litter can induce fear in public (Hope and Hough, 1988; Maxfield, 1987). To counter these impacts, Kuo et al. (1998) found that tree plantation and grass maintenance activities had influenced the sense of safety of many inner-city residents. Studies showing psychological barriers to walking include time limitation and responsibility of young children. Similarly, a study on sidewalks showed that physical activity levels in older people having access to safe and barrier-free sidewalks were more than older people living in neighborhoods having unsafe sidewalks with walking obstacles (Booth et al., 1997).

To summarize, it is crucial to analyze all the aspects surrounding the term walkability to suggest improvements. It will be nearly impossible to study one aspect without taking into consideration its counterpart. Since built environmental features are strongly correlated with walking levels, evaluating neighborhood de-

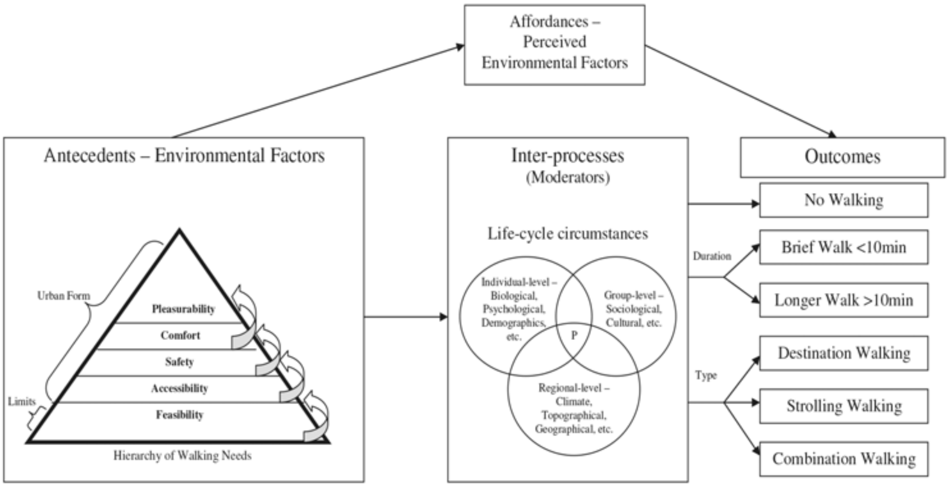


Fig.5: The Heirarchy of Walking Needs Model within the Socio Ecological Framework
Source: Alfonzo, 2005

tation, urban design, planning, and health research.

2.4. CONCEPTUAL FRAMEWORK

While walking posits multiple benefits to health and the environment, the declining number of individuals walking for everyday activities is an alarming situation. To identify and investigate reasons for this change, researchers at the University of California, Irvine, explored factors that dominated an individual's walking behavior and choices. Researcher Mariela Alfonzo (2005) argued that declining walking rates could not be examined by adopting a narrow disciplinary approach and needed a transdisciplinary theoretical model to identify the effect of individual, group, regional, and environmental characteristics on walking behaviors. To address this gap, she first proposed a hierarchy of walking needs model in which both urban and non-urban variables were considered (fig.5). She organized these urban variables into a hierarchy and argued that the order of these needs dominates walking. Based on the theory of human motivation proposed by Maslow (1954), which states that walking needs are "organized into a hierarchy of prepotency" (p.83), she hypothesized that the same ideology could be applied to individuals when they make decisions related to walking. In her opinion, the lower order needs have to be met for an individual to choose to fulfill higher-order needs. i.e., the need for accessibility needs to be met before safety and so on. In line with this argument, she developed a broader socio-ecological model which highlighted an individual's decision-making process related to walking. She further stated that the hierarchy of walking needs alone does not individually address a person's walking decision. Instead, it should be coupled with additional elements such as perceived and life cycle circumstances to understand the process better. The components and details of this framework include:

2.5. THE HIERARCHY OF WALKING NEEDS MODEL:

This model is based on environmental factors referred to as antecedents and is broken down into five levels considered before walking. She argues that an individual will not consider a higher-level order if the primary level is not met. For instance: an individual might not consider walking through an area if it is unsafe, even when it offers pleasant views. In order words, a person might not consider walking through an area if they feel that it is not safe, even if the area offers a pleasant walking experience. Also, she added that the hierarchy does not represent that all levels need to be met before an individual decides to walk, walking process can occur at any level based on individual preference. An individual need for accessibility may be partially met, but for them, safety is more of a concern to decide whether to walk or not. Therefore, it is also possible that the levels developed within the model may not always follow the strict order; instead, some exceptions can be made. The components of the model and its hierarchy are illustrated in figure.6 and explained in detail below.

2.5.1. Non-Urban Variable:

i. ***Feasibility:*** It is the most basic level of need within the hierarchal model. It refers to the practicality or viability of a walking trip, i.e., to assess whether a particular trip is feasible by walking. This need for feasibility may impact an individual's choice for both destinations and stroll walking. For destination trips, feasibility controls whether to go on foot or use any other travel mode for strolling trips. It can affect the decision of whether one wants to walk or not for the sake of recreation. Factors influencing feasibility generally included constraints

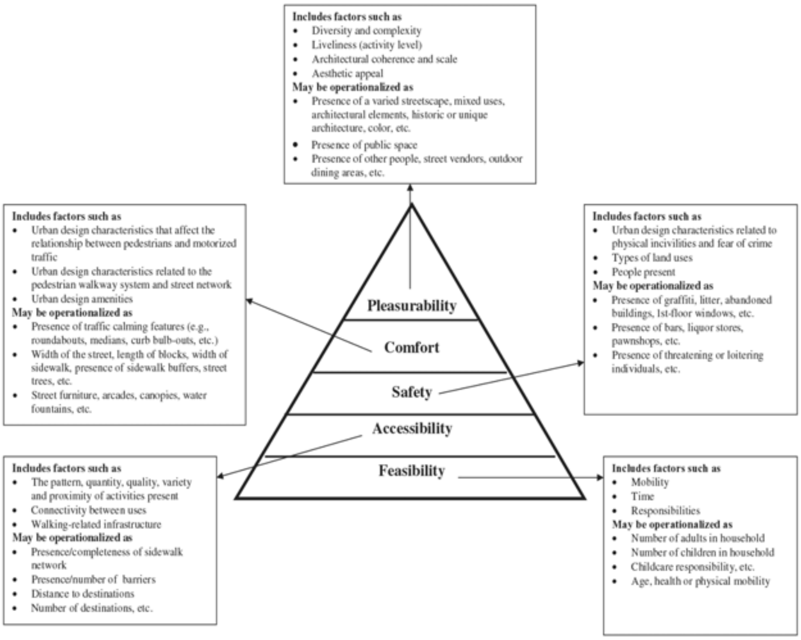


Fig.6: The Heirarchy of Walking Need Model and description of indicators for both urban and non-urban variables.
Source: Alfonzo, 2005

of time (Booth et al., 1997), mobility as in physical and health condition (Ball et al., 2000), and family responsibilities (Dieleman et al., 2002).

2.5.2. Urban Variables:

- ***Accessibility:*** It constitutes macro-level urban features such as the pattern, network, variety, proximity, quantity, quality of activities, and connectivity between different uses (Handy, 1996b). It may include micro-scale elements like sidewalks, pathways, trails, and features that motivate someone to walk. It can also include actual or perceived walking barriers; actual barriers include mysterious land uses such as a gated community or a natural feature such as a river, whereas perceived barriers can be wide roads that seem life-threatening to cross. Accessibility also included the number of destinations available within an easy walking distance and various land-uses within an area. The perception of distance to destination can be a significant factor affecting walking for destination trips (Southworth, 1997; Black et al., 2001); however, it may not affect significantly in the case of strolling trips. (Handy, 1996b)

- ***Safety:*** Safety refers to whether an individual feels safe from street crime. Certain land uses, the presence of individuals or groups, or even the urban form of an area can render an individual perceived safety. The need for safety might affect strolling trips taken for the sake of leisure or recreation as this is an optional activity. Urban variables that may render a person feeling of safety can include graffiti, garbage, vandalism, abandoned buildings, or even poorly maintained housing (Hope and Hough, 1998; Perkins et al., 1986). The presence of land-uses such as bars or liquor stores may also lower perceived safety levels. The presence of street lighting, yard decorations, and private plantings (Perkings et al., 1992), signs of outdoor activities in residential areas (Brown and Altman, 1983) have been associated with reducing perceived safety from crime. The presence of narrow streets, non-residential uses, and stores also increased sense of safety amongst some users (Perkins et al., 1993)

- ***Comfort:*** This refers to an individual's level of ease and convenience. A person's walking comfort is strongly influenced by various environmental factors that strongly encourage or discourage walking. Overall the attributes of the built environment that may impact the relationship between a pedestrian and motorized vehicle include calming traffic elements, width and lengths of the street, speed limits, speed bumps, and presence of buffers (Clark and Dornfeld, 1994). Traffic volumes have also been associated with resident satisfaction (Appleyard, 1981). Other factors include conditions of the walkway system (such as sidewalk maintenance and widths), urban design features (canopies or arcades), facilities and amenities (street benches and fountains).

- ***Pleasurability*** refers to the level of attractiveness of an area that can enhance a person's walking experience and assess how enjoyable an area is to walking. Indicators such as diversity, liveliness, scale, density, complexity, and aesthetic elements make walking enjoyable, increasing user satisfaction. Streetscapes, urban design, and architecture elements may enhance the feeling of pleasure for an individual. Elements that may enhance a person's walking experience include various mixed uses, street trees, public spaces, appealing architecture, modern and historic, colorful spaces, outdoor dinner areas, etc. Concerning these factors and elements, research also suggests that the presence of mixed land usage and buildings with active ground frontage were positively correlated to walking (Cervero and Kockelman 1997). Setbacks also play a vital role in generating a pleasurable walking experience; only 1.9% of people walked in new areas around buildings with a more significant setback than older areas with more minor setbacks, where 5.9% walked. sss

2.5.3. Perceived Environmental Factors:

The model emphasizes that user affordance of these five levels acts as a mediator between the antecedents and the outcome. Affordance refers to whether an environment possesses the attributes that can support a particular behavior. An individual's perceptions and habits can determine whether they will afford to carry a walking activity. For example, a similar setting can offer different experiences, i.e., for one individual, the aspect of safety should be met to walk in contrast to another individual. Thus, a person's perception regarding a particular walking activity can impact overall walking behaviors. A study revealed that those who perceived the environmental features of their neighborhoods as more favorable were 16% more likely to indulge in walking than those who rated their neighborhood environment as moderate.

2.5.4. Lifes Cycle Circumstances:

The model states that life cycle circumstances also affect a person's walking choice in addition to antecedents and affordance. Life cycle circumstances include individual-level characteristics (i.e., age, gender, income, etc.), group-level characteristics (i.e., cultural and social factors), regional-level characteristics (i.e., climate, geography). These circumstances act as a moderator to gain walking outcome. For example, a reasonably health-conscious person will ultimately start walking even at lower hierarchal levels in the model than a person who does not value health. Similarly, a person with high motivation might start walking early than an individual with less motivation level; therefore, they might need a higher-order to boost their motivation.

2.5.5. Walking Outcomes:

The last component of the model is the walking outcome. Here the researcher has presented types of walking based on the determinants of duration and time. Three kinds of outcomes may appear; no walking, brief walking (less than 10 minutes), or prolonged walking (more than 10 minutes). Similarly, for typology, there is either destination walking (which is mainly concerning transportation), strolling walking (done for leisure and recreation), and finally, combination walking (i.e., a mix of both destination and strolling walking)

To summarize the theory presented by Alfonzo, walkability within an urban setting is highly dependent on three major factors; built environmental factors, perceived environmental factors, and life-cycle circumstances. Considering this discussion, built environment and perceived environment play a substantial role in determining walkability within a setting. Therefore, this research will seek to evaluate the first two factors in Pakistani neighborhoods using this model. New developments generate sub-urban sprawls because cities are growing in uncontrollable sizes with no boundaries or city centers. This phenomenon has increased reliance on motorized vehicles to move within these developments, causing a decline in active mobility. These new suburban neighborhoods are now only accommodating car users with no or limited attention to pedestrians. From this perspective, it is imperative to understand how well these neighborhoods function in active mobility, such as walking. How readily are the services or amenities distributed so that everyday activities can be carried out by foot? How conveniently can one access a nearby transportation stop to avail more mobility options? How safely can pedestrians move around these communities without being run down by high-speed traffic or the fear of street crime? How sound is the neighborhood in building aesthetics, greenery provisioning, and shade to provide a pleasant walking experience for individuals? In other words, it is more important than ever to evaluate the built environment of these neighborhoods in terms of their capacity to support and promote walking. Therefore, this research will address this issue by evaluating macro and micro-level environmental features of neighborhoods linked to walkability based on Alfonzo's Hierarchy of Walking Needs Model. Since the urban variables associated with walking are accessibility, safety, comfort, and pleasurability, I would be using these scales to evaluate the quality of built environmental factors. Moreover, since the model does not address which attributes to analyze to study perceived environmental factors, this will be analyzed using a different approach and methodology.

3. Research Methodology

3.1. STUDY AREA

An appropriate case study area was selected to gain desired outcomes and carry out relevant research work. Furthermore, a mixed methodology using both quantitative data collection and analysis tools and qualitative indicator assessments were employed to address the main research question associated with the topic.

3.1.1. Relevance and Issue:

As discussed previously, contemporary neighborhoods in Pakistan still follow the garden city concept; selecting neighborhoods for investigation was primarily based upon this criterion. To undergo this research, two neighborhoods selected as case study sites were Bahria Town, Rawalpindi/Islamabad, and Defence Housing Authority (DHA), Islamabad. These neighborhoods are part of the Islamabad Rawalpindi Metropolitan Area and started to develop along city peripheries. They were developed as sub-urban gated communities during the same timeline (i.e., from 2003 onwards) to revolutionize housing planning models. Bahria Town is an Islamabad-based private real estate company that develops and owns the housing market in Pakistan. Divided into multiple phases, it is the most prominent gated community housing 100,000 individuals and many other projects across many cities in Pakistan. On the other hand, Defence Housing Authority (DHA), Islamabad, is divided into five parts and is administered by the Pakistan Armed Forces Welfare Department, which primarily provides residences for retired military personnel. Both neighborhoods are regarded as one of the most expensive communities in the Islamabad-Rawalpindi Metropolitan Area and house medium to high-income groups indicating that formalized planning models somewhat target a particular social group.

Although developed alongside one another, there is a stark difference in planning ideologies between both neighborhoods. Since a private developer runs Bahria town, it places a high focus on commercialization. In this view, Bahria Town offers mixed-used functions such as multiple land-uses, several housing options, high-quality facilities/amenities, making the housing scheme attractive for individuals who can afford a specific living (fig.7). On the other hand, since DHA focuses more on providing a place for living, it has fewer facilities and amenities and houses more residential typology (fig.8). Although the provisioning of services in Bahria Town is far more attractive than DHA, safety & security levels in the latter neighborhood are reported to be better, as discussed by some residents. These minor differences and similarities have overall improved the housing experience in Pakistan. From a broader perspective, both housing schemes and neighborhoods have been rendered successful. Their popularity and demand have allowed their developers to replicate the same housing ideology on a national scale targeting other big cities like Lahore, Karachi, Peshawar, etc. Hence, it will be safe to say that Pakistan's future will witness more Bahria Towns and DHA's.

Fig. 7: Aerial view of Bahria Town Phase 8
Source: Bahriatown.com

Fig.8: Aerial view of DHA-2, Islamabad
Source: Flicker/arsiphotography

As mentioned earlier, these gated communities are developed far away from the city center; there is always a struggle in accessing these high-class neighborhoods. Their development along city peripheries has both advantages and disadvantages. Since the land prices in these outskirts were considerably lower, the developers found an opportunity to buy and develop it from an investment viewpoint. On the other hand, potential buyers were advertised that these communities would ensure high-quality living standards with minimum traffic and congestion issues, away from the city hustle. However, from an opposing viewpoint, distance away from the city center with no formalized transportation systems promoted motorized vehicles. This ideology has increased dependence on vehicle ownership, caused frequent traffic movements, and decreased pedestrian activities, thereby slowly changing walking behaviors within individuals.

From this point of view, it is imperative to comprehend how well these gated communities function in active mobility. How much walking can they support so that the individuals can carry out everyday activities easily? In other words, it is more important than ever to evaluate the built environment of these neighborhoods in terms of their capacity to support and promote destination or leisure walking. Given the numerous benefits of pedestrian-oriented developments, it is essential to assess how sustainably these developments can grow and provide for their residents.

3.1.2. Site Selection

Two areas were selected from both neighborhoods for walkability analysis to fulfill the objectives of this study. Bahria Town, Islamabad, is divided into 8 phases, and phase 4 was selected for investigation (fig.9). On the other hand, DHA phase 2 is divided into different sectors ranging from A to J. The site of investigation from DHA was chosen to be sector E (fig.10). The reason for the selection of phase 4 from Bahria and sector E from DHA revolved around the following reasons:

- First, both of these areas had the most significant number of services/ amenities such as cinemas. gymnasiums, restaurants etc. The presence of diversity and variety of services is an indicator of enhanced walkability. Hence, the researcher aimed to analyze whether more facilities supported more walking within an urban setting.

- Secondly, the income range for this phase/sector residents was similar, targeting medium to high-income groups.

- Third, while viewing this phase/sector through google earth, it was apparent that the urban typology of both these areas was alike. Placement of a circular commercial area alongside a residential area represented common

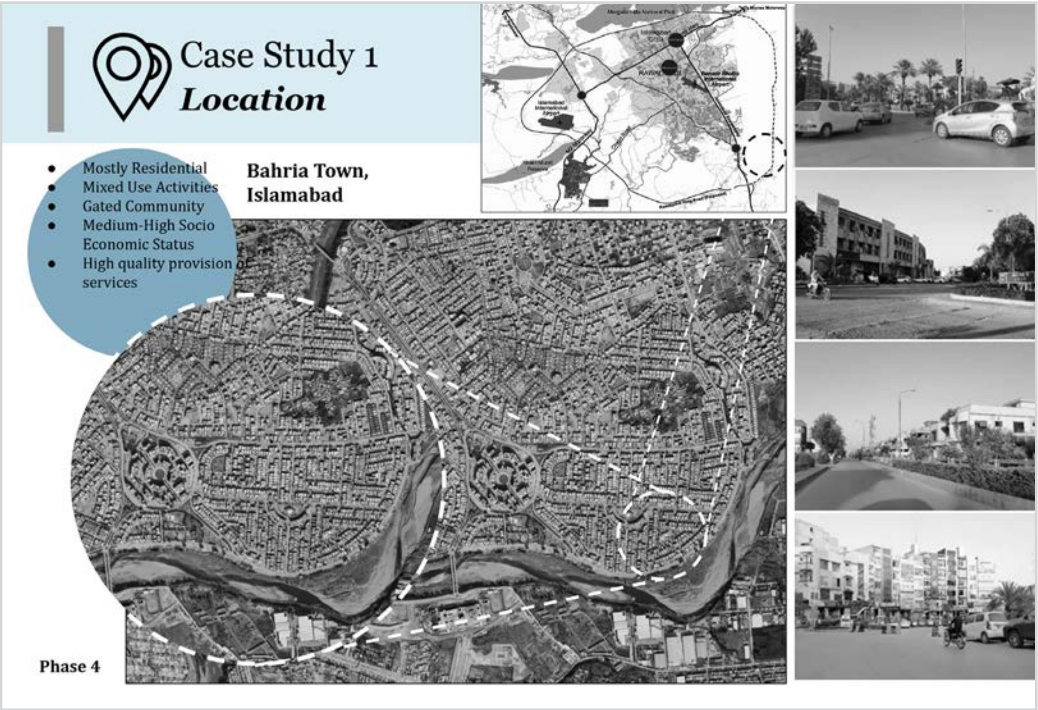


Fig.9: Geographical location of Bahria Town, Phase 4 alongwith context of the area
Source: Googlesatelliteimagery + Author

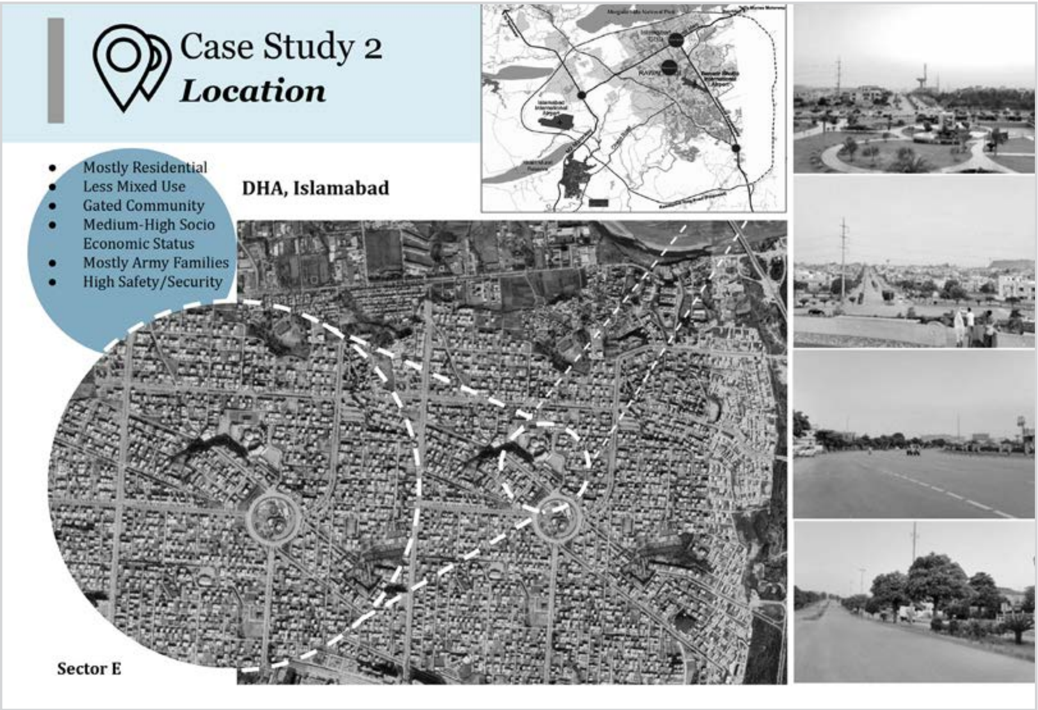


Fig.10: Geographical location of DHA Phase 2 and sector E alongwith context of the area
Source: Googlesatelliteimagery + Author

traits.

- Finally, a walkable neighborhood is estimated to be around 0.5-1 mile in area. Therefore, this phase/sector more or less followed the same size.

Hence keeping this context in mind and the future possibility of these schemes to expand, this study aims to evaluate neighborhood environmental features which support walking present within this phase/sector of these two neighborhoods. The goal will be to assess how conducive the built environment of these two areas is to walking, the provision/absence of adequate pedestrian facilities, and residents' perception about their neighborhood features.

3.2. DATA COLLECTION TOOLS

The literature mentioned above highlights that many audit tools based on qualitative and quantitative measures evaluate walkability within an urban setting. Since the focus of this research was to assess (a) environmental features potentially linked to walking (b) resident perception about their neighborhood environmental features, three different auditing tools were used. Overall research methdology is illustrate in fig. . The details of the three different datasets created to fulfill the pre-requisites for the Hierarchy of Walking Needs Model within a Socio-Ecological Framework are as follows:

3.2.1. Built Environment Features: Irvine Minnesota Inventory (IMI):

Irvine Minnesota Inventory (IMI) is developed by a team of researchers at the University of California and University of Minnesota and is based upon Alfonzo's theory of the Hierarchy of Walking Needs Model. IMI measures a range of built environment features potentially hypothesized to support walking arranged according to four urban scales. The instruments allow the researcher to observe both macro and micro-level attributes of the built environment. Macro-level characteristics such as street pattern and connectivity, whereas micro-level features include street trees of street furniture and so forth. This tool is based on field observations of the built environment done by the researcher for different segments within a neighborhood setting. This inventory was developed in 2003-2005 due to items used from the SPACES (systematic pedestrian and cycling en-

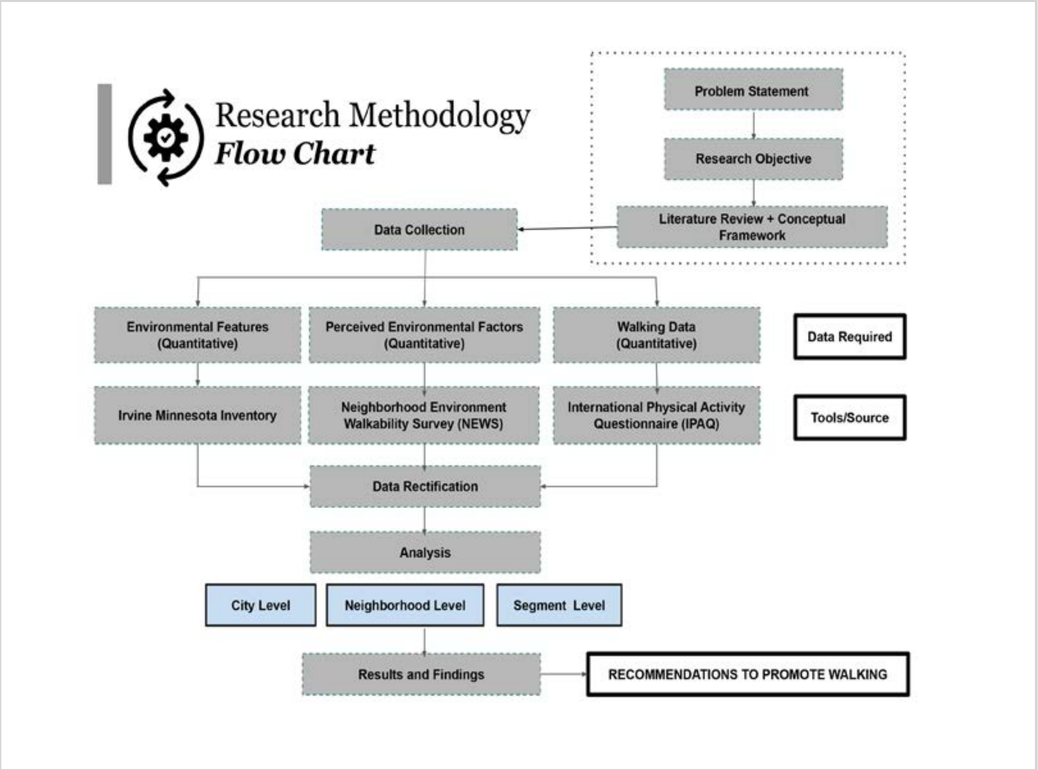
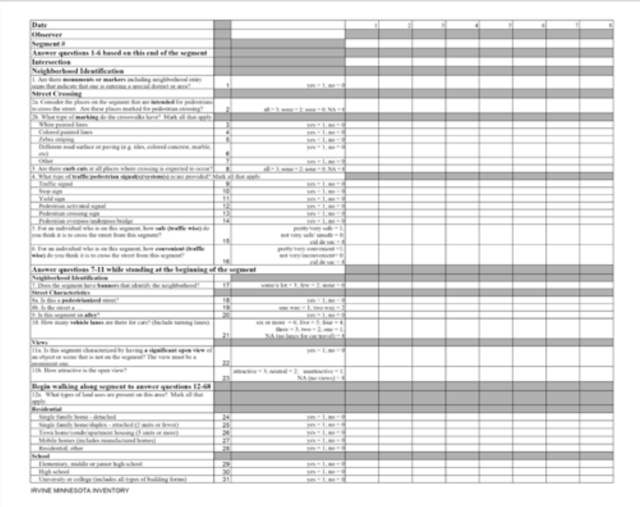


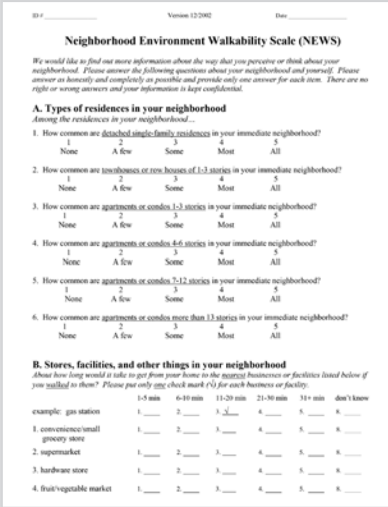
Fig.11: Research methodology and work flow chart
Source: Author

vironmental scan) tool, rigorous literature reviews, focus group sessions, expert panel views, and field testing in 27 different neighborhoods across the United States. Researchers in California typically investigated residential and commercial settings, whereas team Minnesota collected data from Minneapolis Metropolitan Area. Generally, the inventory measured neighborhoods around 0.25-1 miles in size having residential or commercial districts. In total, the list included 162 items that were arranged according to four urban variables: accessibility (62 items), perceived safety from crime (15 items), comfort or perceived safety from traffic (31 items), and lastly, pleasurability (56 items). The items under each variable are elaborated in the appendix. Inter-rater reliability for most items in the inventory was relatively high (with 77% of the items obtaining 80% or higher agreement during California and Minnesota Reliability Tests), showing that the scales within the inventory have a solid basis for development and can be used or modified for this study purpose. The outlook of the inventory and data collection instrument is shown in figure 12.



			1	2	3	4	5	6	7	8
Date										
Observer										
Segment #										
Answer questions 1-6 based on this end of the segment										
Intersection										
Neighborhood Identification										
1. Are there **monuments or markers** including neighborhood entry signs that indicate that one is entering a special district or area?	1	yes = 1; no = 0								
Street Crossing										
2a. Consider the places on the segment that are **intended** for pedestrians to cross the street. Are these places marked for pedestrian crossing?	2	all = 3; some = 2; none = 0; NA = 8								
2b. What type of **marking** do the crosswalks have? Mark all that apply.										
White painted lines	3	yes = 1; no = 0								
Colored painted lines	4	yes = 1; no = 0								
Zebra striping	5	yes = 1; no = 0								
Different road surface or paving (e.g. tiles, colored concrete, marble, etc)	6	yes = 1; no = 0								
Other	7	yes = 1; no = 0								
3. Are there **curb cuts** at all places where crossing is expected to occur?	8	all = 3; some = 2; none = 0; NA = 8								
4. What type of **traffic/pedestrian signal(s)/system(s)** is/are provided? Mark all that apply.										
Traffic signal	9	yes = 1; no = 0								
Stop sign	10	yes = 1; no = 0								
Yield sign	11	yes = 1; no = 0								
Pedestrian activated signal	12	yes = 1; no = 0								
Pedestrian crossing sign	13	yes = 1; no = 0								
Pedestrian overpass/underpass/bridge	14	yes = 1; no = 0								
5. For an individual who is on this segment, how **safe (traffic wise)** do you think it is to cross the street from this segment?	15	pretty/very safe = 1; not very safe/ unsafe = 0; cul de sac = 8								
6. For an individual who is on this segment, how **convenient (traffic wise)** do you think it is to cross the street from this segment?	16	pretty/very convenient = 1; not very/inconvenient = 0; cul de sac = 8								
Answer questions 7-11 while standing at the beginning of the segment										
Neighborhood Identification										
7. Does the segment have **banners** that identify the neighborhood?	17	some/a lot = 3; few = 2; none = 0								
Street Characteristics										
8a. Is this a **pedestrianized** street?	18	yes = 1; no = 0								
8b. Is the street a ...	19	one way = 1; two way = 2								
9. Is this segment an **alley**?	20	yes = 1; no = 0								
10. How many **vehicle lanes** are there for cars? (Include turning lanes).	21	six or more = 6; five = 5; four = 4; three = 3; two = 2; one = 1; NA (no lanes for car travel) = 8								
Views										
11a. Is this segment characterized by having **a significant open view** of an object or scene that is not on the segment? The view must be a prominent one.	22	yes = 1; no = 0								
11b. How attractive is the open view?	23	attractive = 3; neutral = 2; unattractive = 1; NA (no views) = 8								
Begin walking along segment to answer questions 12-68										
12a. What types of land uses are present on this area? Mark all that apply.										
Residential										
Single family home - detached	24	yes = 1; no = 0								
Single family home/duplex - attached (2 units or fewer)	25	yes = 1; no = 0								
Town home/condo/apartment housing (3 units or more)	26	yes = 1; no = 0								
Mobile homes (includes manufactured homes)	27	yes = 1; no = 0								
Residential, other	28	yes = 1; no = 0								
School										
Elementary, middle or junior high school	29	yes = 1; no = 0								
High school	30	yes = 1; no = 0								
University or college (includes all types of building forms)	31	yes = 1; no = 0								

IRVINE MINNESOTA INVENTORY



ID # ______________ Version 12/2002 Date ______________

Neighborhood Environment Walkability Scale (NEWS)

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

A. Types of residences in your neighborhood
Among the residences in your neighborhood…

1. How common are detached single-family residences in your immediate neighborhood?
1 None 2 A few 3 Some 4 Most 5 All

2. How common are townhouses or row houses of 1-3 stories in your immediate neighborhood?
1 None 2 A few 3 Some 4 Most 5 All

3. How common are apartments or condos 1-3 stories in your immediate neighborhood?
1 None 2 A few 3 Some 4 Most 5 All

4. How common are apartments or condos 4-6 stories in your immediate neighborhood?
1 None 2 A few 3 Some 4 Most 5 All

5. How common are apartments or condos 7-12 stories in your immediate neighborhood?
1 None 2 A few 3 Some 4 Most 5 All

6. How common are apartments or condos more than 13 stories in your immediate neighborhood?
1 None 2 A few 3 Some 4 Most 5 All

B. Stores, facilities, and other things in your neighborhood
About how long would it take to get from your home to the nearest businesses or facilities listed below if you walked to them? Please put only one check mark (√) for each business or facility.

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

Fig.12: The Irvine Minnesota Inventory, data collection instrument on built environment data and The Neighborhood Environment Walkability Scale, data collection instrument on neighborhood perception
Source: Activelivingresearch.org

Furthermore, the IMI codebook specifically suggested that the scale could easily be adjusted in other contexts, specially developed countries. For this research, items from this inventory were first modified according to Pakistan's context, and then data on the built environment was collected using this tool. Since the area of the investigation was formerly planned neighborhoods, it was easy to adapt the scale in the local context.

3.2.2. Perceived Built Environment Features: Neighborhood Environment Walkability Scale (NEWS):

Resident perception is an essential prerequisite to study the impact of built environment features on walking levels. Since Alfonzo's Hierarchy of Walking Needs Model did not address or develop an inventory to record perception data, an auditing tool developed by Saelens and Sallis (2002) called Neighborhood Environment Walkability Scale (NEWS) was used to fulfill this gap. The original NEWS survey is an instrument based on 98 questions used to assess residents' perceptions regarding their neighborhood features related to walking or any other physical activity (fig.12). This scale is arranged according to seven variables; residential density, mixed land-uses, walking/biking infrastructure availability, street pattern and connectivity, safety from crime and traffic, neighborhood aesthetics, and resident satisfaction. The scale is designed on a four- and five-point Likert scale to record user perceptions and evaluate neighborhood design features related to walkability. For this study, an abbreviated version of the tool was used, comprising of 65 questions in total. The survey questions were contextualized using a version of NEWS that was modified in the context of India. Since Pakistan and India share many geographical and cultural similarities, adapting the scale according to Pakistan's context was very convenient. Moreover, some variables were grouped into the same domain as Alfonzo's scale to balance both scales. Residential density, mixed land-uses, walking infrastructure, street pattern, connectivity, and resident satisfaction were grouped under the heading of accessibility as the items under these variables were synonymous with Alfonzo's items under the accessibility scale. According to Alfonzo's scale, the other variables such as crime safety, traffic safety, and neighborhood aesthetics were grouped under safety, comfort, and pleasurability.

3.2.3. Walking Data: International Physical Activity Questionnaire (IPAQ):

Finally, to gain data on the walking levels of the residents, a modified version of the International Physical Activity Questionnaire (IPAQ) was used. This scale is a widely used and applied tool that has been in operation since 2000 until now. Due to its easy use and data collection methodology, the scale has been translated into multiple languages. Mainly, the scale explores information relating to physical activity levels such as transport-related physical activity, work-related travel, leisure-time physical activity, sitting time, etc. For this study, IPAQ short form was used, which inquired about residents walking levels in particular. Residents were asked to self-report their daily walking time for all purposes; hence, combination walking was used.
Moreover, they were asked to estimate how many days have they walked in the last week. The intent here was to record their daily walking minutes and then multiply them by the number of days to get their weekly walking minutes. Research on physical activity such as walking suggests that a span of seven days is a good margin to comprehend a person's walking levels. Therefore, the residents reported their walking levels within the last seven days.

3.3. SAMPLING

The following sampling techniques have been used to carry out the research work:

3.3.1. Built Environment Data: IMI

Street segments were used as a unit of analysis to analyze built environment features whose careful selection was requisite to begin the data collection process. Each neighborhood or setting (as termed by the researcher) was divided into multiple segments. Generally, for one setting, a total of 15-20 segments were selected according to literature; however, since my scale was rather significant, 25 segments were selected from both neighborhoods for investigation. (sample size N=50). Based on the Irvine Minnesota Inventory guidelines, a specific methodology was applied to choose streets under examination. At first, the observer was encouraged to drive or walk through the entire setting to observe different segments and the neighborhood environment. The intent here was to analyze all attributes of the setting, such as buildings, intersections, block lengths, segment dead ends, etc. Then a detailed map of the area was created on google maps to demarcate the geographical boundary of the site and mark all potential segments for sampling. Then sampling was initiated from any of the segments represented on the map. However, the choice of the next segment was made if any of these four characteristics varied from the last segment: 1) Land-use; 2) Sidewalk Network; 3) Barriers to Walking; 4) If it is a nice place to walk. The fourth attribute was added so that the observer can subjectively assess whether some locations offer a better walking experience or not. Furthermore, only three adjacent segments were skipped for sampling, and it was mandatory to sample the fourth segment even if it was similar to the one preceding it. This process was repeated for all segments until the data collection was completed.

Data were collected through in-person field observations by walking through the entire setting during March 2021. The data collection process also had a defined methodology. The observer was expected to begin the data entry while standing at the intersection of one of these selected segments. Data entry began by clearly mentioning intersection name and location and answering questions 1-11 from the inventory. Once done, the observer was expected to answer questions 12-56 while walking and observing the segment on both sides. Finally, once the observer reached the other intersection, questions 1-6 were answered. All questions relating to one segment were answered before leaving the segment. The data was directly coded into an excel format provided by the researchers using a Samsung Tablet. Coding within the inventory was primarily in the form of 0=No and 1=Yes to record the presence or absence of multiple items. Furthermore, some items were coded as some/a lot = 3; few = 2; none = 0 and attractive = 3; neutral = 2; unattractive = 1; 0 = no space. For this study, the coding and some questions were modified to be recorded as binary terms, i.e., 0=No and 1=Yes. The purpose of slightly modifying the scale was to get a score for every item within the inventory to assess which item needs improvement for future recommendations. Finally, no item in the inventory was left unanswered, and a response for each item was coded. The same process was repeated for all segments until data on the built environment was collected.

3.3.2. Perception and Walking Data: NEWS And IPAQ

Since data for IMI was collected from different segments, the same segments were used to collect data for NEWS and IPAQ, using a stratified sampling method. To collect perception data, formal permission was attained from relevant authorities of both neighborhoods to conduct this survey. Moreover, residents from both neighborhoods were approached, and a proper consent form was signed, which addressed the study's objective and ensured data protection/privacy. Since both neighborhoods did not have an integrated online system to conduct surveys, a door-to-door survey was carried out during April 2021. Two types of surveys were handed out on separate sheets; 1) NEWS and 2) IPAQ.

Along with these, a general section of the survey asked for information on the socio-demographic profile of the participants. A team of two research assistants helped to approach different households for survey distribution and collection. The goal was to conduct two household surveys per segment, making a total sample size of 50 participants per neighborhood (i.e., N=100 for two neighborhoods). Some residents agreed to participate in the study. However, they could not fill in the surveys due to time constraints. Therefore, 112 surveys were handed out, out of which 100 were received back to gain the required number. No participants were followed up to return the surveys. The survey data was manually entered into an excel file for data processing collectively and individually as per neighborhood.

3.3.3. Participant Socio-Demographic Profiles:

The participants were distributed based on gender, age, education levels, income levels, car ownership. The results from the demographics analysis are illustrated in fig.13 below.

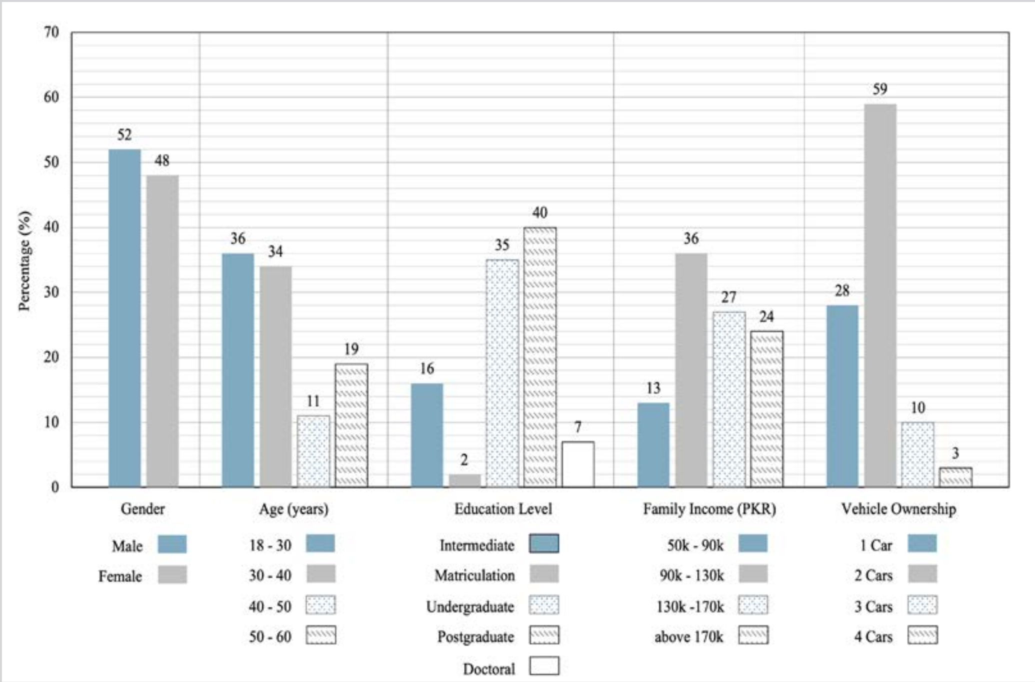


Fig.13: The Irvine Minnesota Inventory, data collection instrument on built environment data neighborhood perception
Source: Author

- ***Gender:*** A total of 100 participants agreed to fill the surveys for this study, out of which, male representation was 52% (N=52), whereas female presentation was 48% (N=48). Overall the ratio of male participants in the study was slightly higher in comparison to female participants.

- ***Age:*** While going through literature studies, it was clearly stated that walking levels could vary between different age groups, i.e., it may be different for children and adults compared to senior citizens due to health constraints. Therefore, to ensure that health wasn't a contributing factor in impacting walking levels, this study targeted adults whose ages ranged between 18 to 65 years. The results of the analysis in fig.13 indicate that out of 100 participants, 36% participants were 18-30 years in age (N=36), 34% participants were 30-40 years (N=34), 19% participants were aged between 50-60 years (N=19), and finally, 11% were between 40-50 years (N=11). This distribution shows that most participants (70%; N=70) were between 18-40 years of age bracket, and there is a lower chance that constraints such as declining health or physical immobility could be a factor

- ***Education Level:*** The education bracket was distributed according to the education system followed within Pakistan. The results in fig.13 indicate that 40% of participants had acquired postgraduate degrees (N= 40), 35% had undergraduate degrees (N=35), 16% had an intermediate degree (N= 16), 7% had doctoral degrees (N=7), and finally, 2% individuals were currently undertaking a matriculation degree (N=2). The results for this survey show that the majority of participants, i.e., 75% had a sound educational background (N= 75). This number is relatively high while comparing it with education levels within Pakistan. Higher education levels may have a significant impact as individuals are more conscious and aware of the numerous health benefits of walking.

- ***Family Income:*** While analyzing that household income levels, it was indicated that 36% of households earned 90,000 to 130,000 PKR monthly (N=36), 27% earned 130,000-170,000 PKR (N=27), 24% earned 170,000 PKR plus (N=24) and finally 13% earned 50,000-90,000 PKR (N=13). A medium-income household in Pakistan can earn an amount between 90,000 to 130,000 PKR monthly. The results in fig.13 that most participants fall under the medium-income bracket (i.e., 36%), and however, a significant percentage falls between upper-middle and high-income groups (i.e., 27% and 24%). To summarize, the study area targets medium to high-income households, representing those contemporary neighborhoods in Pakistan only target a certain social stratum who possess the purchasing powers to invest in private housing schemes and afford a better quality of urban life.

- ***Vehicle Ownership:*** Research by Alfonzo suggested that having a more significant number of cars can indicate lower walking levels; therefore, the number of vehicles owned was also used for socio-demographic analysis. The results show that 59% of households own two cars (N=59), 28% of households own one car (N=28), 10% of households own three cars (N=10), and finally, only 3.0% of households own four cars (N=3). The results in fig.13 indicate that most households are dependent on two cars for mobility (i.e., 59%). In Pakistan, individuals or families can easily afford only one vehicle for commuting, and owning two cars is not an everyday norm.

Hence keeping this factor in mind, the results suggest that vehicular ownership/usage is relatively high in these neighborhoods.

3.4. LIMITATION OF RESEARCH METHODOLOGY

One of the limitations of this study was the absence of face-to-face interviews and frequent interaction with respondents due to current social distancing measures. Although household surveys were carried out, it was challenging to interact with survey respondents directly and gain relevant insights into their walking experiences and needs. Therefore, the data collection was dependent upon survey methods. In my understanding, using a qualitative research methodology could bring in a different output from the one used in this study.

Furthermore, the choice of study site could indeed produce varied outcomes. From the beginning, this thesis argued that evaluating walkability within new contemporary neighborhoods is a must to promote a walking culture. Therefore, the choice of study site revolved around a formally planned neighborhood and only targeted a specific audience. The results might be contrary if the same research argument might be employed in any other neighborhood or socio-economic area/class. Urban morphology and socioeconomic status can be critical drivers of the outcomes of any study. During field observations, it was widely observed that most individuals carried out walking as a means of leisure because of better provisioning of walking infrastructure, enhanced security, and high-end amenities. However, transport-related or job-related walking might be more frequent in lower-income areas where walking is a means of mobility. Therefore, changing the context and site of the study can bring a new dimension to this research. Further researches along these lines can help bring in more clarity.

Moreover, the sample size for this study is relatively small. Since data was collected from street segments according to Alfonzo's sampling methodology, more segments from varied neighborhoods would help strengthen the research outcomes. Finally, increasing the number of participants and gaining their insights would also have added benefits and more validity.

4. Results and Analysis

This chapter begins with evaluating the data collected through the methodology mentioned above. Data gathered using IMI, NEWS, and IPAQ were first streamlined together. The items within IMI were arranged according to the following variables; accessibility, safety, comfort, and pleasurability, whereas the NEWS tool had eight variables in total. Eight variables from the NEWS tool were composited to equate them according to IMI's variables to compare built environment features with perceived environmental features. The reason for this grouping was based according to the items present within the variables. Since items under five variables (i.e., residential density, land-use mix diversity, land-use mix access, street connectivity, walking/cycling infrastructure) from the NEWS tool were equivalent to IMI's accessibility variable items, they were grouped for analysis and comparison. The other three variables from NEWS, i.e., crime safety, traffic safety, and neighborhood surroundings, were equated with safety, comfort, and pleasurability from IMI's scale. The third dataset, i.e., walking, was computed in terms of weekly walking minutes self-reported by the residents.

4.1. MULTI LEVEL ANALYSIS

Since two respondents were selected from each segment to report their perception data, this created a variation between the sample size of NEWS (N=100) and IMI (N=50). For data processing, an average value was taken for each segment so that the sample size between NEWS (N=50) and IMI (N=50) is achieved. The exact process was applied for IPAQ data because it was also self-reported by the residents; therefore, the sample size was reduced from N=100 to N=50 using the average for each segment. Once the data was prepared, it was analyzed on three different levels.

4.1.1. City Level: Variable Level Analysis

The city-level analysis focused on identifying which independent variables (i.e., accessibility, safety, comfort, and pleasurability) strongly correlated with walking. This step was similar to Alfonzo's research approach in which she identified that in the context of the United States, Accessibility and Safety are the most significant variables (Alfonzo et al., 2008), which helped her test the Hierarchy of Walking Needs Model. However, since this research was done in a country like Pakistan, geographically and culturally different, it was unlikely that the same model could be applied. Therefore, the city-level approach is aimed at understanding how the model will contextualize according to Pakistan. Datasets from both neighborhoods were first combined to increase sample size and were later run using Statistical Packages for Social Sciences (SPSS) software version 26.0. To briefly explain, the following tests were run in turn: Descriptive Analysis, Reliability Analysis, and finally, Correlation Analysis.

4.1.2. Neighborhood Level: Indicator Level

The neighborhood-level analysis focused on identifying which indicators from both neighborhoods (i.e., Bahria Town and DHA) need improvement to promote walking and helped draw a comparison between them. A score for each indicator within IMI and NEWS was created; however, since IMI used the Binary scale and NEWS used the Likert Scale, separate scores were developed for both scales. The maximum possible indicator score for IMI is 25 (25 street segments), whereas the maximum possible score for NEWS is 100 and 125 (using 4 and 5 points Likert scale). This methodology helped develop indices for each variable under examination. Separate indices were developed for built environment variables (i.e., accessibility, safety, comfort, and pleasurability) and perceived environment variables (i.e., perceived accessibility, perceived safety, perceived comfort, and perceived pleasurability). Comparing the built environment (B.E) and perceived built environment (P.B.E) indices helped identify how the neighborhoods function in reality and how residents perceive them.

4.1.3. Segment Level: Street Level

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
IMI-ACC	50	0	1	0.312	0.463
IMI-SAF	50	0	1	0.610	0.487
IMI-COM	50	0	1	0.277	0.448
IMI-PLE	50	0	1	0.443	0.496
NEWS-ACC	50	1	5	2.867	1.152
NEWS-SAF	50	1	4	2.836	0.887
NEWS-COM	50	1	4	2.135	0.868
NEWS-PLE	50	1	4	2.807	0.757

Fig.14: Descriptive statistics for all four variables of Irvine Minnesota Iventory (IMI) and Neighborhood Environment Walkabiliy Scale (NEWS)
Source: Author

The segment-level analysis focused on developing a score for each segment from both the neighborhoods and compare them with walking levels per segment. The intent was to identify the streets residents choose to walk more and identify what elements or characteristics make them desirable. Segment selection was made for each variable separately (i.e., accessibility, safety, comfort, and pleasurability) to draw future conclusions about what interventions could make people walk more and why.

4.2. CITY LEVEL: VARIABLE LEVEL ANALYSIS

4.2.1. Descriptive Analysis:

The aim of running descriptive statistics was basically to gain summaries of different variables used within the study. Basic information extracted after running descriptive statistics were; sample size, minimum value, maximum value, mean, and standard deviation values. The results gained from this test are illustrated in fig.14 and show that the sample size or street segments selected for this study were 50 (i.e., N=50). All IMI variables (i.e., Accessibility, Safety, Comfort, and Pleasurability) were used as independent variables, whereas NEWS variables were considered mediators. The result indicates that the minimum value for IMI

Reliability Analysis

Variables	Cronbach's Alpha	Items
IMI-ACC	0.734	40
IMI-SAF	0.608	11
IMI-COM	0.617	28
IMI-PLE	0.795	43
NEWS-ACC	0.901	46
NEWS-SAF	0.894	6
NEWS-COM	0.865	6
NEWS-PLE	0.849	6

Fig.15: Reliability analysis for all four variables of Irvine Minnesota Iventory (IMI) and Neighborhood Environment Walkabiliy Scale (NEWS)
Source: Author

variables is 0, and the maximum value is one since the coding was done using a binary scale. Moreover, mean values for all variables suggest IMI pleasurability has the highest value, whereas IMI comfort has the lowest. Similarly, the minimum value is 1, whereas the maximum value is five, indicating a 4- and 5-point Likert scale was used. The mean values for perceived comfort are the lowest, i.e. (2.135), whereas perceived pleasurability has the highest mean score (2.867). Standard deviation values for both tools range from 0.4 to 0.8, respectively.

4.2.2. Reliability Analysis:

A reliability test usually measures the internal consistency of the measuring instrument. Measuring reliability is an essential prerequisite for using any scale because when there are no measurement errors, the test output can be verified as more reliable (Newman, 2003). Keeping this in mind, the items for all four variables of IMI and NEWS, i.e., accessibility, safety, comfort, and safety, were entered in SPSS for reliability testing. As mentioned earlier, the original items for IMI accessibility, IMI safety, IMI comfort, and IMI pleasurability were 62, 15, 31, and 56; this number was reduced. The new items in each variable for IMI accessibility, IMI safety, IMI comfort, and IMI pleasurability were 40, 11, 28, and

Correlation Analysis

	IMI_A	IMI_S	IMI_C	IMI_P	NEWS_A	NEWS_S	NEWS_C	NEWS_P
IMI_A	1							
IMI_S	.216	1						
IMI_C	.230	.488**	1					
IMI_P	.453**	.245	.393**	1				
NEWS_A	.427**	.073	-.134	.241	1			
NEWS_S	.287*	.310*	.135	.189	.308*	1		
NEWS_C	.023	.407**	.300*	-.056	.064	.114	1	
NEWS_P	.161	.030	-.085	.216	.401**	.123	.024	1
IPAQ	.509**	.427**	.277	.332*	.414**	.385**	.327*	.362**

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Fig.16: Correlation Analysis between all variables under examination. All variables are highly correlated except for B.E Comfort.
Source: Author

43, respectively. Similarly, the NEWS accessibility, NEWS safety, NEWS comfort, and NEWS pleasurability were 46, 6, 6, and 6, respectively. The results for Cronbach alpha values for each scale are reported in figure 15. While interpreting the results mentioned above, it can be seen six variables have a reliability value equal to or greater than 0.7, whereas two variables have a value less than 0.7. The minimum acceptable value for this test is 0.6. Items having a value less than 0.6 are automatically omitted by the SPSS software, which is why the number of items for each scale reduced (i.e., items for accessibility reduced from 62 to 40). Generally, scales with a value equal to or greater than seven are considered highly reliable. The above table indicates that out of eight variables, the scale for six variables is highly reliable. It is still acceptable for the other two variables since the value is smaller than 0.7 but is higher than 0.6.

4.2.3. Correlation Analysis:

A correlation analysis was carried out to analyze the strength of relationships between three variables under examination; IMI variables, NEWS variables, and IPAQ (weekly walking minutes) reported by participants. Since the hypothesis suggests that built environment variables play a substantial role in affecting walking levels, IMI variables were computed as independent variables, and walking was computed as a dependent variable. Moreover, since this relationship could not be analyzed without considering the socio-ecological framework in which the process occurs, mediating variables, i.e., NEWS variables, were also computed against walking to see if they play any role.

The result from figure 15 suggests that walking has a high correlation with built environment accessibility (IMI_A), safety (IMI_S), and perceived accessibility (NEWS_A). It has a moderate correlation with built environment pleasurability (IMI_P) and perceived comfort (NEWS_C) and perceived pleasurability (NEWS_P) and has a weak/insignificant correlation with built environment comfort (IMI_C). In order words, improving accessibility indicators within both neighborhoods will strongly impact walking levels, followed by safety and then pleasurability. Comfort indicators in both neighborhoods are not supporting walking levels; therefore, recommendations need to be provided for this variable. This output is slightly different from Alfonzo's Hierarchy of Walking Needs Model because Accessibility and Safety follow the same order, but Comfort and Pleasurability have exchanged places. In other words, walking levels are weakly being influenced by the presence or absence of comfort indicators.

NEIGHBORHOOD LEVEL: ACCESSIBILITY			
Built Environment		Perceived Built Environment	
Bahria	Accessibility Index = 348	Bahria	Accessibility Index = 3278
DHA	Accessibility Index = 277	DHA	Accessibility Index = 3247.5

Fig.17: Comparison of Accessibility Index within both neighborhoods;results indicate that Bahria has higher B.E and P.B.E Accessibility Index than DHA.
Source: Author

4.3. NEIGHBORHOOD LEVEL: INDICATOR LEVEL ANALYSIS

To carry out the neighborhood level analysis, scoring was done for each IMI and NEWS indicator. The maximum possible indicator score for IMI is 25 (25 street segments), whereas the maximum possible score for NEWS is 100 and 125 (using 4 and 5 points Likert scale). The scoring process facilitated the development of an index for each variable. A total of eight indices were created; four for IMI and four for NEWS, respectively. Comparison of indices values and individual indicators presented a complete picture of how well one neighborhood is functioning compared to the other or which indicators are weak in both neighborhoods that require immediate intervention. To highlight the difference of indicator score (I.S) within both neighborhoods, a percentage difference for each indicator was also calculated while keeping Bahria Town as a reference. Moreover, indicator score (I.S) is computed in bar charts for clear visual interpretation.

4.3.1. Accessibility

Figure 17 shows the sum of accessibility indicators for both built environment (B.E) features (using IMI tool) and perceived built environment (P.B.E) features (using the NEWS tool). The values of the Accessibility Index for the B.E and P.B.E in Bahria Town are 348 and 3278, whereas, in DHA, these values are 277 and 3247.5, respectively. This indicates that Accessibility Index in Bahria is higher as compared to DHA. In other words, more service facilities are available in Bahria Town, and the residents perceive them in the same manner.

The detail of individual indicator scoring (I.S) as per neighborhoods is illustrated

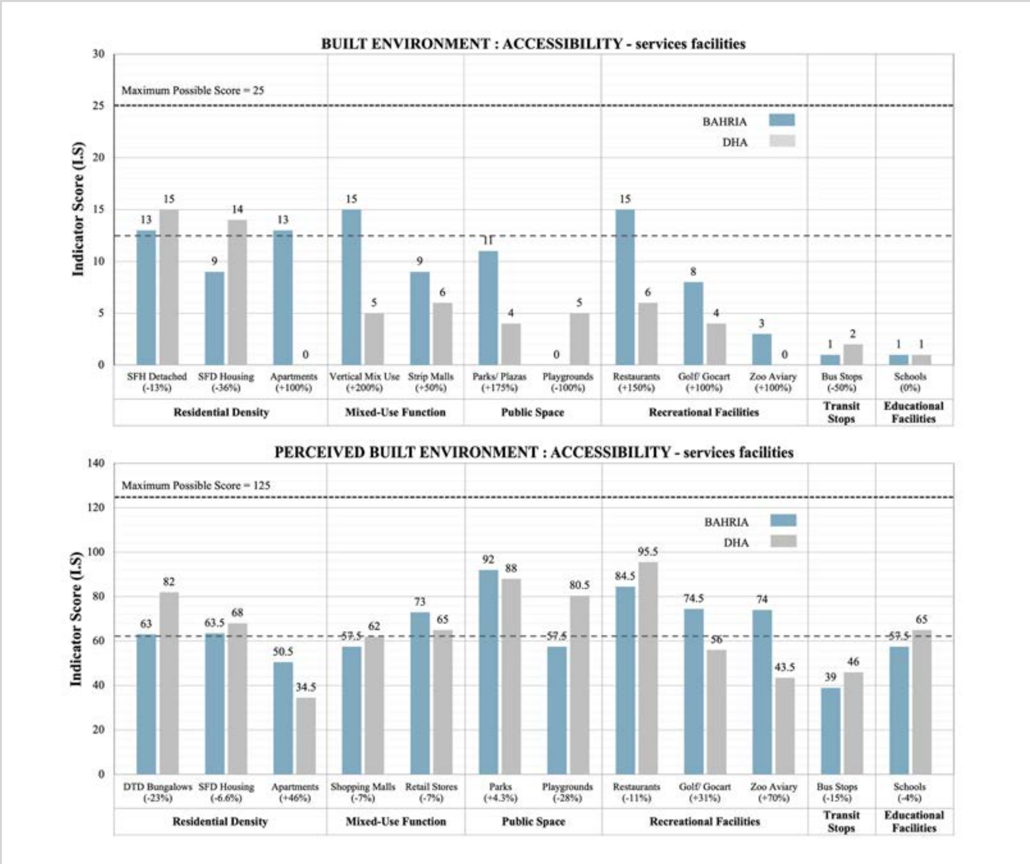


Fig.18: B.E and P.B.E Accessibility Indicator Score for both neighborhoods in terms of service facilities
Source: Author

in figure 17. For the B.E data, the indicator score (I.S) represents the frequency of service facility, i.e., out of 25 segments, how many segments feature a specific dwelling type or service facility (for example, single-family detached housing or restaurants). This value gives an understanding of land use provided on the segment and indicates their quantity. An indicator score >=12.5 (50%) is considered adequately serviced for B.E. data for this study. For the P.B.E data, the indicator score (I.S) represents the resident's perception of access to a particular facility, i.e., the time required to access a particular service facility by walk. A higher score represents that residents perceive that service facility to be highly accessible. For this study, indicator score >= 62.5 (50%) is considered moderately to highly accessible; any value less than this threshold value would need recommendations and improvement. Following the process mentioned above, a detailed comparison of indicator scores was conducted to analyze high scores in Bahria Town and DHA and calculate a percentage difference between neighborhood indica-

Fig.19: Higher residential density in Bahria Town
Source: Author

tors. Figures with stark differences were highlighted and reasoned. Finally, an overall comparison of weak indicators in both neighborhoods was also done, and recommendations are provided for improvement.

- ***Higher Residential Density:*** From fig.18, actual and perceived residential densities are following the same trend. B.E data suggests that Bahria has 13% less detached family housing, 36% less attached family housing, and 100% more apartments/flats than DHA. In fact, out of 25 segments, 13 segments (I.S<=12.5) in Bahria have apartment buildings compared to DHA, which has none. It means that in comparison to DHA, Bahria has a higher residential density and focuses on dense development patterns, aiming to accommodate diverse residents by providing multiple housing options(fig 18). However, in terms of P.B.E, even though DHA does not have any apartments in the study area (I.S=0), the P.B.E score suggests that few residents still perceive their neighborhood to have vertical housing options (I.S=34.5).

Fig.20: Quality of mixed use function in Bahria Town
Source: Author

- ***Mixed-Use Function:*** B.E data from fig.18 suggests that Bahria Town provides significantly more functions; it has twice vertical mixed-use buildings and 50% more strip malls a/c to DHA (fig.20).In terms of P.B.E, the indicator score for shopping malls and retail stores suggests that residents in both neighborhoods perceive 50%-60% ease of access to these facilities (I.S=57.5 for Bahria and I.S=62 for DHA). In other words, these services are moderately accessible by walking; focusing on mixed-use development patterns could significantly improve the perception of accessibility of services.

- ***Public Space:*** The B.E data from fig.18 suggests that Bahria has +175% more public space (parks, plazas, meetings spaces) than DHA, but in terms of P.B.E data, there is no visible difference. Residents of both neighborhoods perceive their public spaces to be highly accessible by walking. (I.S=92 for Bahria and I.S=88 for DHA). However, there is a stark difference in this value regarding one particular service facility, i.e., playgrounds. The B.E data represents that Bahria has no playgrounds for children and youth, and residents strongly perceive this deficit (I.S=57.5 for Bahria and I.S=80.5 for DHA) by giving a score less than 62.5 (50%). In response to this, it was observed that most streets are closed using barriers to limit the traffic flow and convert them into play streets for children (fig.21)

Fig.21:Lack of designated playgrounds for children in Bahria Town.
Source: Author

- ***Recreational Facilities:*** From fig.18, B.E data shows Bahria Town has better recreational facilities, such as 150% more restaurants, +100% more golf/go-kart/theatre facilities, +100% more zoo/bird aviary in comparison to DHA (fig.22). The resident's perception of such services follows the same trend, especially in zoo/aviary (I.S=74 for Bahria and I.S=43.5 for DHA). However, there is an anomaly in the perception of restaurant facilities. The P.B.E data suggests that both residents perceive restaurants to be highly accessible by walk regardless of weak B.E score for DHA. It indicates that residents from both neighborhoods are satisfied with the quality, access, and quantity of restaurants provided in their neighborhoods.

Fig.22: Recreational facilities such as neighborhood bird aviary in public parks
Source: Author

Fig.23: View of DHA showing the difference in height and hilly terrain in some sections
Source: Author

- ***Lack of Transit Stops:*** It was generally observed that both neighborhoods lacked bus stops/taxi stands in particular. Fig.18 shows that out of 25 segments, only one segment in Bahria Town and two segments in DHA had a transit stop. These transit stops were not facilitated with designated shade or infrastructure to enhance their visibility. Moreover, clear signage and schedule were also missing. Similarly, residents also highlighted weak access to transit facilities in their perception data, indicating the lack of integrated transit facilities within both neighborhoods (I.S=57.5 for Bahria and I.S=65 for DHA).

- ***Fewer Educational Facilities:*** The B.E data from fig.17 highlights that there is only one primary school in Bahria and one elementary school in DHA in the area of study. While looking at the P.B.E data, it is visible that resident's perception of access to these facilities is also only 50% (I.S=57.5 for Bahria and I.S=65 for DHA). In other words, residents perceive weak access to educational facilities by walk in their immediate surroundings, especially for children enrolled in primary or elementary schools.

- ***Hilly Terrain:*** The B.E data from fig.24 suggests that Bahria has an advantage that most segments are flat or semi-flat terrain, making it easy to walk compared to DHA (I.S=8 for Bahria and I.S=18 for DHA). Hilly terrain could be considered a barrier to walking since it might limit residents to engage in vigorous physical activity, unlike walking (fig.23).Concerning P.B.E data, it is evident that residents in DHA perceive slightly more inclination in their seg-

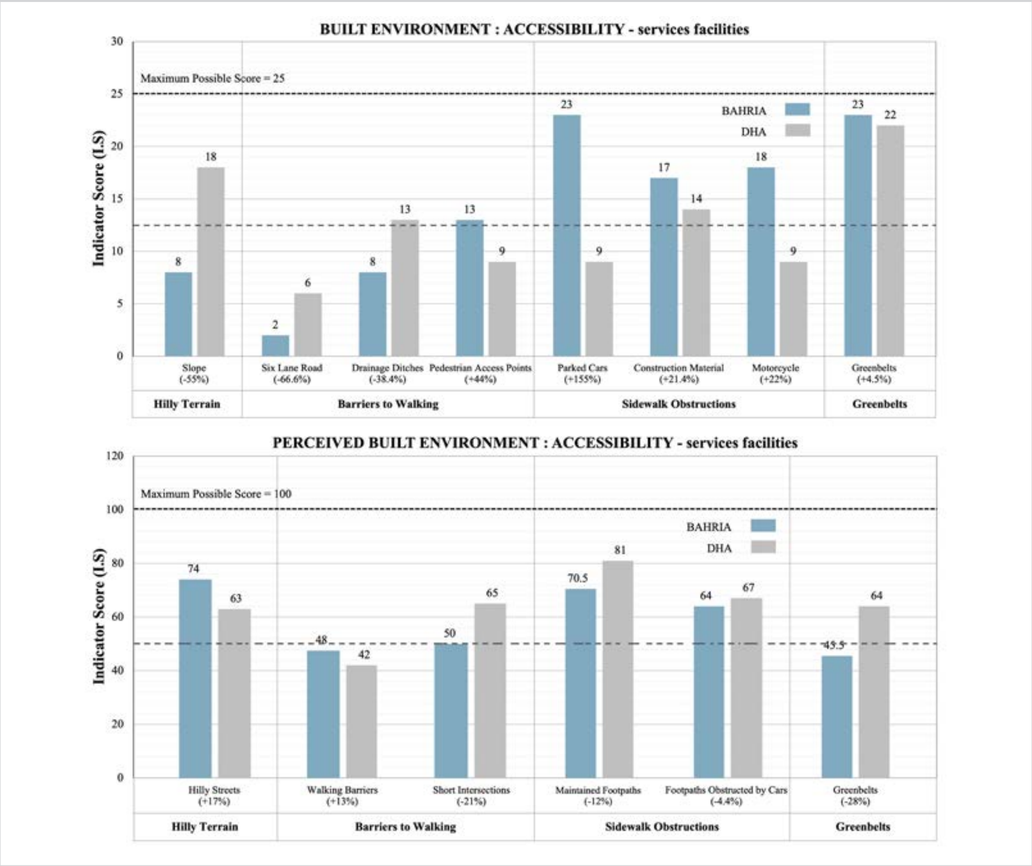


Fig.24: B.E and P.B.E Accessibility Indicator Score for both neighborhoods in terms of walking barriers
Source: Author

ment's a/c Bahria regardless of stark B.E data. (I.S=74 for Bahria and I.S=63 for DHA; reverse code item)

- ***Barriers to Walking:*** The B.E data from fig.24 suggests that in comparison to DHA, Bahria Town has 66% fewer six-lane roads, 38% fewer drainage ditches, and has 44% more access points in segments, indicating that barriers to walking are more in DHA (fig.25). However, in terms of P.B.E, the data suggests that residents from both neighborhoods perceive 50% barriers to walking, such as wide roads, drainage grills, etc. (I.S=48 for Bahria and

Fig.25: Continuous drainage lines of main roads a barriers to walking or crossing
Source: Author

Fig.26: Sidewalk obstruction by cars and trash bins in Bahria Town.
Source: Author

I.S=42 for DHA). Similarly, residents perceive that their neighborhoods do not have short intersections (I.S=50 for Bahria and I.S=65 for DHA). This value represents that not having enough intersections could render pedestrian movement and not efficiently stop cars on traffic signals. Therefore, further investigation needs to be done

- ***Sidewalk Obstructions:*** B.E data from fig.24 suggests that sidewalk barriers or encroachments are a salient feature of Bahria Town. It has 155% more parked cars, 21.4% more construction material, and 22% more motorcycles as obstacles on sidewalks than DHA (fig.26).In terms of P.B.E data, it is visible that residents in both neighborhoods have given a high score to footpath maintenance (I.S=70.5 for Bahria and I.S=81 for DHA). However, the value suddenly drops to 60-65% (I.S=64 for Bahria and I.S=67 for DHA) when it comes to obstructions. It indicates that residents perceive their sidewalks to be moderately encroached. Moreover, the P.B.E data also suggests that residents perceive more obstruction in Bahria a/c to DHA.

Fig.27: Continuous greenbelts alongside sidewalks in both neighborhoods
Source: Author

- ***Presence of Green Belts:*** Although the B.E data from fig.24 suggests that out of 25 segments, on an average, 22 segments in both neighborhoods have greenbelts presents on them (fig.27), when it comes to P.B.E data, it is apparent that residents do not perceive them and they do not function as a buffer from heavy traffic. (I.S=45.5 for Bahria and 64 for DHA). Moreover, the value of perceived greenbelts in Bahria is starkly low in comparison to DHA.

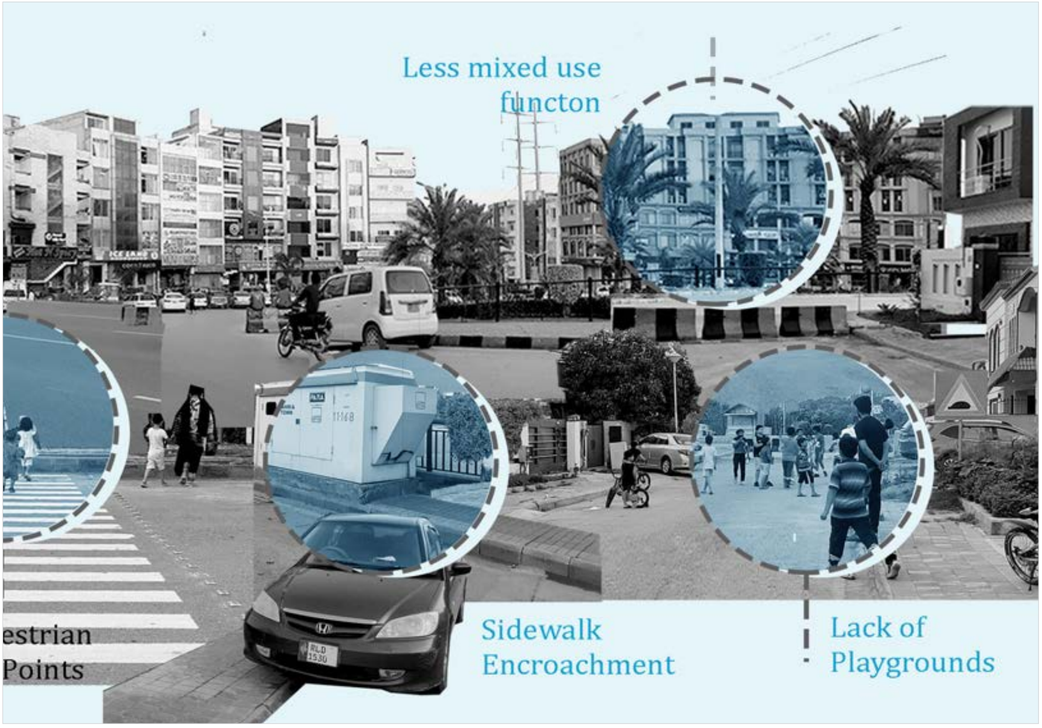


Fig.28: Visual illustrating summary of accessibility issues in both neighborhoods.
Source: Author

NEIGHBORHOOD LEVEL: SAFETY			
Built Environment		**Perceived Built Environment**	
Bahria	Safety Index = 156	**Bahria**	Safety Index = 403.5
DHA	Safety Index = 180	**DHA**	Safety Index = 439.5

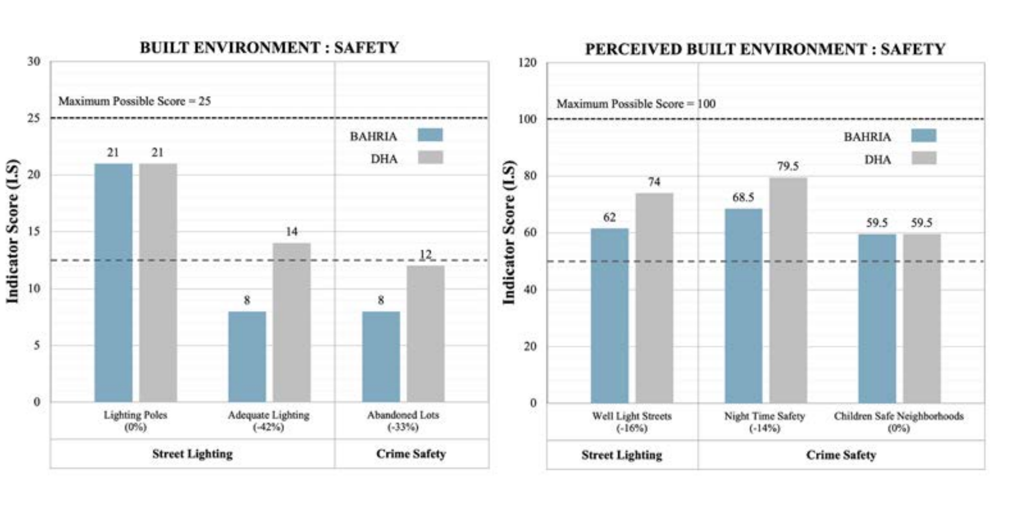


Fig.29: Images showing B.E and P.B.E Safety Index and Safety Indicator Score for both neighborhoods; results indicate DHA has higher B.E and P.B.E Safety Index in comparison to Bahria Town.
Source: Author

4.3.2. Safety

The results in fig.29 for Safety Index indicate that DHA has higher B.E and P.B.E safety index values (i.e., 180 and 439.5) than Bahria Town (i.e., 156 and 403.5), respectively. The details of safety indicators and their acquired scoring are illustrated in the table.

- ***Street Lighting:*** B.E data from fig.29 suggests that out of 25 segments, 21 segments in both neighborhoods have lighting poles, but when it comes to assessing whether the lighting is adequate, it is evident that only eight segments in Bahria and 14 segments in DHA are well illuminated. In other words, Bahria has 42% less street lighting than DHA. When it comes to P.B.E data, it is evident that residents have also scored their lighting adequacy to about 60%-70% in both neighborhoods. (I.S=62 for Bahria and

Fig.30: Fear of crime leads residents to used barbed wires on their boundary walls in Bahria Town.
Source: Author

74 for DHA. This feeling of low lighting level at night time may affect the perception of safety amongst residents.(fig.30)

- ***Crime Safety:*** Empty lots or vacant buildings can contribute to lower the perception of safety amongst residents (fig.31). Moreover, abandoned buildings/buildings under construction could be used for illegal activities if not for adequate lighting and security levels. The results from the B.E data suggest that although Bahria Town has 33% fewer vacant lots, residents feel less nighttime safety from crime in Bahria Town than DHA (I.S=68.5 for Bahria and 79.5 for DHA). This result can relate to the logic provided above, that better-illuminated streets provide an enhanced sense of safety and security. Moreover, it can also be seen that both neighborhoods have comparatively low indicator scores for children safe neighborhoods (I.S=59.5 for both neighborhoods). It indicates that regardless of high-security levels and intent to provide adequate street lighting, parents still perceive weak safety levels for children, especially during night-time.

Fig.31: Vacant lots and ongoing construction activities as a source of elevating fear of crime in Bahria Town.
Source: Author

4.3.3. Comfort:

The results from the Comfort Index suggest that B.E comfort and P.B.E comfort in both neighborhoods are almost the same (i.e., 192 and 198), respectively. However, there is a stark difference in the perception of comfort within each neighborhood. Residents of Bahria Town perceive an issue in their comfort levels compared to DHA (271.5 and 369). Overall comfort levels in DHA have a higher value, but generally, the B.E scoring for comfort variable has significantly less

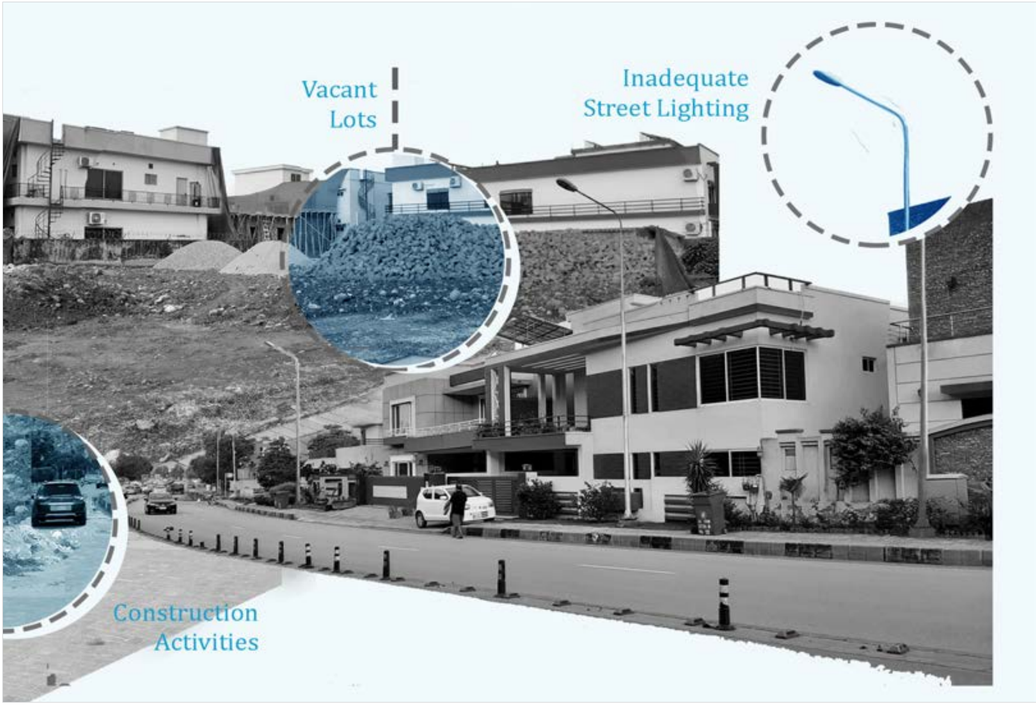


Fig.32: Visual illustrating summary of safety issues in both neighborhoods.
Source: Author

NEIGHBORHOOD LEVEL: COMFORT			
Built Environment		**Perceived Built Environment**	
Bahria	Comfort Index = 192	**Bahria**	Comfort Index = 271.5
DHA	Comfort Index = 198	**DHA**	Comfort Index = 369

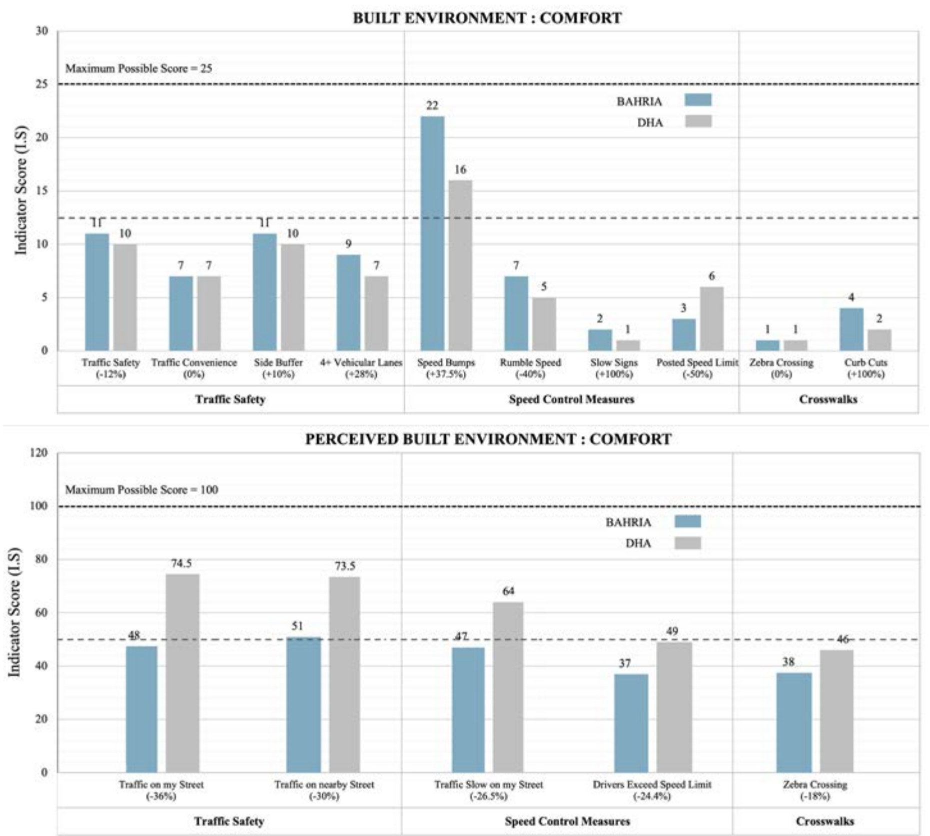


Fig.33: Images showing B.E and P.B.E Comfort Index alongwith Comfort Indicator Score for both neighborhoods; results indicate Bahria and DHA has similar B.E Comfort Index but there is a stark difference in P.B.E Comfort Index.
Source: Author

value in both neighborhoods, suggesting that this variable is the weakest out of all four and requires dire interventions. Individual indicator scoring and summary of comfort variable are as follows:

Traffic Safety: B.E data from fig.33 for traffic safety shows that out of 25 segments, on average, seven segments in Bahria and DHA have 4+ vehicular lanes. It is quite a high number for a residential area with tertiary roads. Moreover

Fig.34: Wide roads and 4+ vehicular lanes are a general design standard for both neighborhoods in most segments.
Source: Author

from fig.34, the road width per lane was more expansive than the global standard (current road widths are 30.4 m, 18.2 m, and 12.7 m, respectively). Similarly, analyzing traffic safety highlights that only seven segments are traffic-wise safe and convenient for pedestrians to cross. Similarly, only a few segments in both neighborhoods characterize sidewalk buffers (I.S=11 for Bahria and I.S=10 for DHA). However, P.B.E data suggests that regardless of more or less similar B.E conditions, residents in Bahria perceive 36% more traffic on their street streets and 30% more traffic on nearby streets, making it difficult for them to walk (I.S=48 for Bahria and I.S=74.5 for DHA; reverse code item). This difference indicates that traffic flow and frequency rates are higher in Bahria Town a/c DHA

- ***Speed Control Measures:*** B.E data from fig.33 suggests that out of 25 segments, 22 segments in Bahria and 16 segments in DHA have speed bumps (fig.35). It means that speed bumps are used as the significant speed controlling measure followed by rumble speed (I.S=7 for Bahria and I.S=5 for DHA). No other traffic controlling measure was evident in both neighborhoods. When it comes to P.B.E data, it is evident that regardless of efforts to slow down traffic, residents of Bahria Town perceive 26% more traffic speed in the neighborhood than DHA. (I.S=47 for Bahria and I.S=64 for DHA; reverse code item). Similarly, the residents in Bahria also perceive 24.4% of most drivers exceed the speed limit in their neighborhood a/c to DHA. (I.S=37 for Bahria and I.S=49 for DHA; reverse code item)

Fig.35: Extensive use of speed bumps and rumble speeds are traffic control measures
Source: Author

- Apart from neighborhood comparison, an indicator level analysis showed that various neighborhood indicators were missing in the neighborhood design that would readily increase pedestrian comfort and safety.

Fig.36: Extensive use of speed bumps and rumble speeds are traffic control measures
Source: Author

- ***Crosswalks:*** B.E. data from fig.33 suggests that out of 25 segments, only one crosswalk was available within both neighborhoods (I.S=1 for Bahria and I.S=1 for DHA). The results were reasonably astonishing since, without crosswalks/ zebra crossing stripes, it is almost impossible to cross busy junctions, especially when vehicular lanes are more than four(fig.36).Moreover, the P.B.E data suggests that residents also reported the same phenomena and gave a very weak score (<=50) to the presence of crosswalks/zebra crossings in their neighborhood (I.S=38 for Bahria and I.S=46 for DHA)

- ***Traffic Signals:*** From fig.33, since both neighborhoods are gated communities, only one traffic signal is present in total. (I.S=1 for Bahria and I.S=0 for DHA). The one present in Bahria was not even operational, and for DHA, a strong focus is placed on placing traffic circles to regulate speed limits, but drivers rarely slow down or stop at intersections to give way to pedestrians. Such design approaches create walking/crossing difficulty for pedestrians.

Fig.37: Posted signages only focussing on car oriented traffic and only present on main segments.
Source: Author

- ***Posted Speed Limits:*** Finally, only three segments in Bahria and six segments in DHA had posted speed limits to help control traffic speed. (I.S=3 for Bahria and I.S=6 for DHA). Hence, this might be why drivers exceed speed limits since there is no posted speed signage (fig.37)

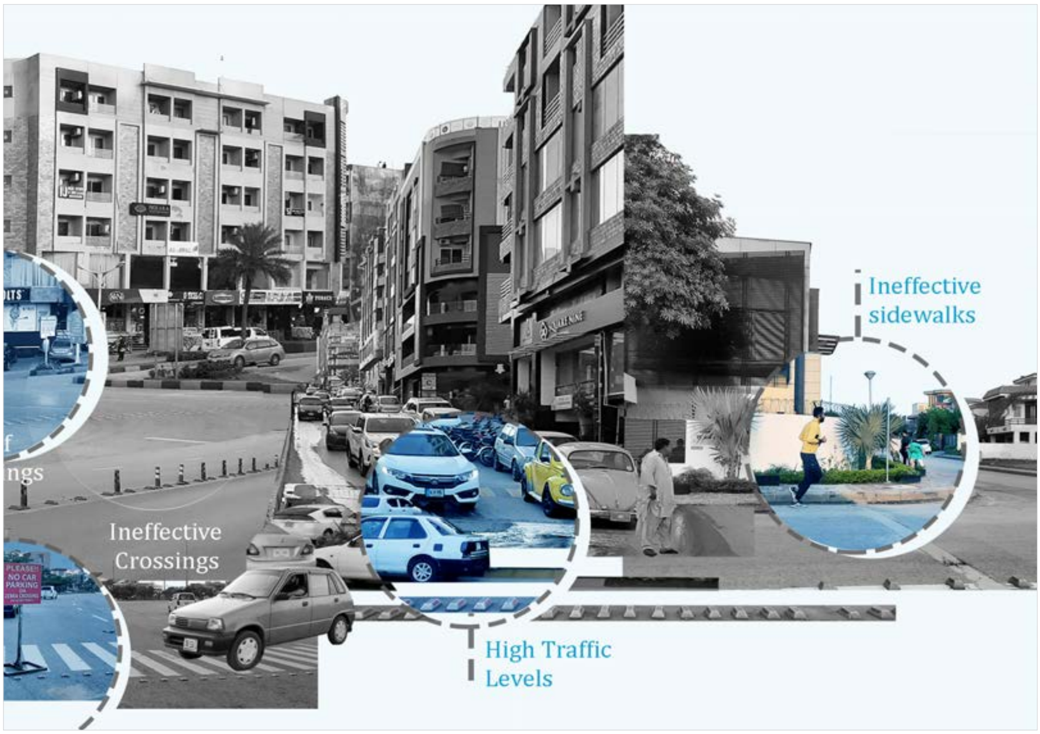


Fig.38: Visual illustrating summary of comfort issues in both neighborhoods.
Source: Author

Fig.39: Curb cut design and depleting quality on most segments in Bahria
Source: Author

- ***Curb Cuts:*** The B.E data suggest that out of 25 segments, only four segments in Bahria Town and two segments in DHA had proper curb cuts on intersections. (I.S=4 for Bahria and I.S=2 for DHA). Sidewalk height in Bahria Town was almost six inches that only reduced while passing in front of the porch of any house. The overall design created a very uncomfortable height difference which was frequently occurring, lowering pedestrian comfort (fig.39). Curb-curbs had a comparatively improved design in DHA with minor height differences.

4.3.4. PLEASURABILITY:

The results obtained from Pleasurability Index indicate that Bahria Town has more B.E pleasurability indicators than DHA (i.e., 544 and 410). However, in regards to P.B.E, residents from both neighborhoods more or less have the same levels of perception of these features. Bahria has a slightly higher value in comparison to DHA. The details of perception indicators are listed in the table below:

Fig.40: Arbitrary placement of street trees giving shade on roads instead of pedestrian right of way.
Source: Author

- ***Street Trees:*** From fig. 41, the B.E data suggests that most segments are characterized by streets trees (I.S=21 for Bahria and I.S=20 for DHA), the shading quality of these trees varies significantly. Out of 25, only 16 segments in Bahria and eight segments in DHA provide adequate tree shading on the pedestrian right of way. (I.S=16 for Bahria and I.S=8 for DHA). It indicates that tree placement or canopy size needs careful reconsideration to enhance pedestrian comfort (fig.40). Moreover, comparing these values to P.B.E data, it is evident that

NEIGHBORHOOD LEVEL: PLEASURABILITY			
Built Environment		Perceived Built Environment	
Bahria	Pleasurability Index = 544	**Bahria**	Pleasurability Index = 425.5
DHA	Pleasurability Index = 410	**DHA**	Pleasurability Index = 432

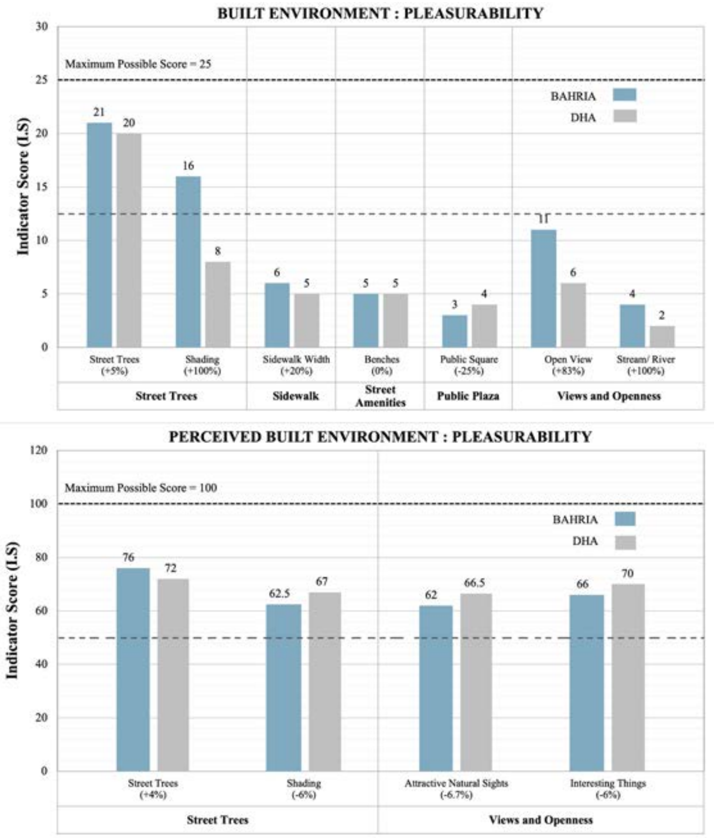


Fig.41: Images showing B.E and P.B.E Pleasurability Index alongwith Pleasurability Indicator Score for both neighborhoods; results indicate Bahria and DHA has similar P.B.E Pleasurability Index when there is a stark difference in B.E Pleasurability Index.
Source: Author

residents have also given a high score (<=70) to the presence of trees in their neighborhoods; however, when it comes to the perception of shading, this value drops between 60%-65%. In other words, residents perceive that their sidewalks do not provide adequate shading to walk comfortably. It is safe to say that shading levels are insufficient for both neighborhoods, considering the temperature zone of the city.

- ***Sidewalk Width:*** B.E data from fig.40 suggests that only six segments in Bahria and five segments in DHA had adequate widths for sidewalks (I.S=6 for Bahria and I.S=5 for DHA). Sidewalk width in both neighborhoods was less than the standard followed worldwide (less than 2m). Having a narrow sidewalk in both neighborhoods does not allow ease of pedestrian movement due to which people walk on roads instead, which renders them unsafe (fig.42).

Fig.42: Sidewalk quality and width showing narrow design
Source: Author

- ***Public Plaza's:*** Fig.40 shows that apart from green spaces/parks, very few places were available for general public gatherings or meetings to host any public event/festival. Only three segments in Bahria and four segments in DHA had small public plazas (I.S=3 for Bahria and I.S=4 for DHA). The inclusion of such open plazas can enhance social meetings/gatherings and encourage people to go outdoors, increasing their walking levels (fig. 43).

Fig.43: quality of public plaza‘s and street furniture
Source: Author

- ***Views and Openness***: The B.E data from fig.40 suggests Bahria is characterized by 83% more open views (I.S=11 for Bahria and I.S=6 for DHA) along with the presence of a nearby stream/river (I.S=4 for Bahria and I.S=2 for DHA) in comparison to DHA. However, constant construction activities and poor integration of landscapes in the design lower the perception of residents about natural features in their neighborhood (fig.44) Residents from both neighborhoods have rated 60%-65% to natural sights in their neighborhoods (I.S=62 for Bahria and 66.5 for DHA).

Fig.44: Visual barrier in natural landscape sites in
Source: Author

Fig.45: Visual illustrating summary of pleasurability in both neighborhoods.
Source: Author

Fig.46: Segments with high accessibility score lined with multiple service facilities
Source: Author

4.4. SEGMENT LEVEL: STREET LEVEL ANALYSIS

The segment-level analysis focuses on understanding which segments from both neighborhoods have a high scoring for each variable under examination. This analysis aims to understand which characteristics or elements of some segments made them desirable for residents. In other words, why were some residents using some segments more frequently than the other ones? The intent here was to recommend improvements in lacking segments to support walking to its full potential. For this analysis, the value of indicators was summed up for each segment which developed a score. This score was then compared to walking levels in that same segment. The data from the segment score was translated into GIS maps, and a scale was developed for each variable indicating high, medium, and weak segment scores for both B.E and P.B.E data. A solid line was used to represent B.E data, whereas a dashed line represents P.B.E data. The higher the score for both B.E and P.B.E data, the darker the color of the line segment. This process helped visualize the location of various segments, and their attributes were assessed qualitatively.

4.4.1. Accessibility:

Figure.47 illustrates the score for accessibility variable for various segments against walking levels on these segments. The results from Bahria Town indicate that segments with high B.E and P.B.E scores are usually the ones near the civic center, which is the central commercial hub of Bahria (fig.46). It indicates that proximity to commercial centers influences the perception of accessibility amongst various residents, contributing to increased walking levels. A similar

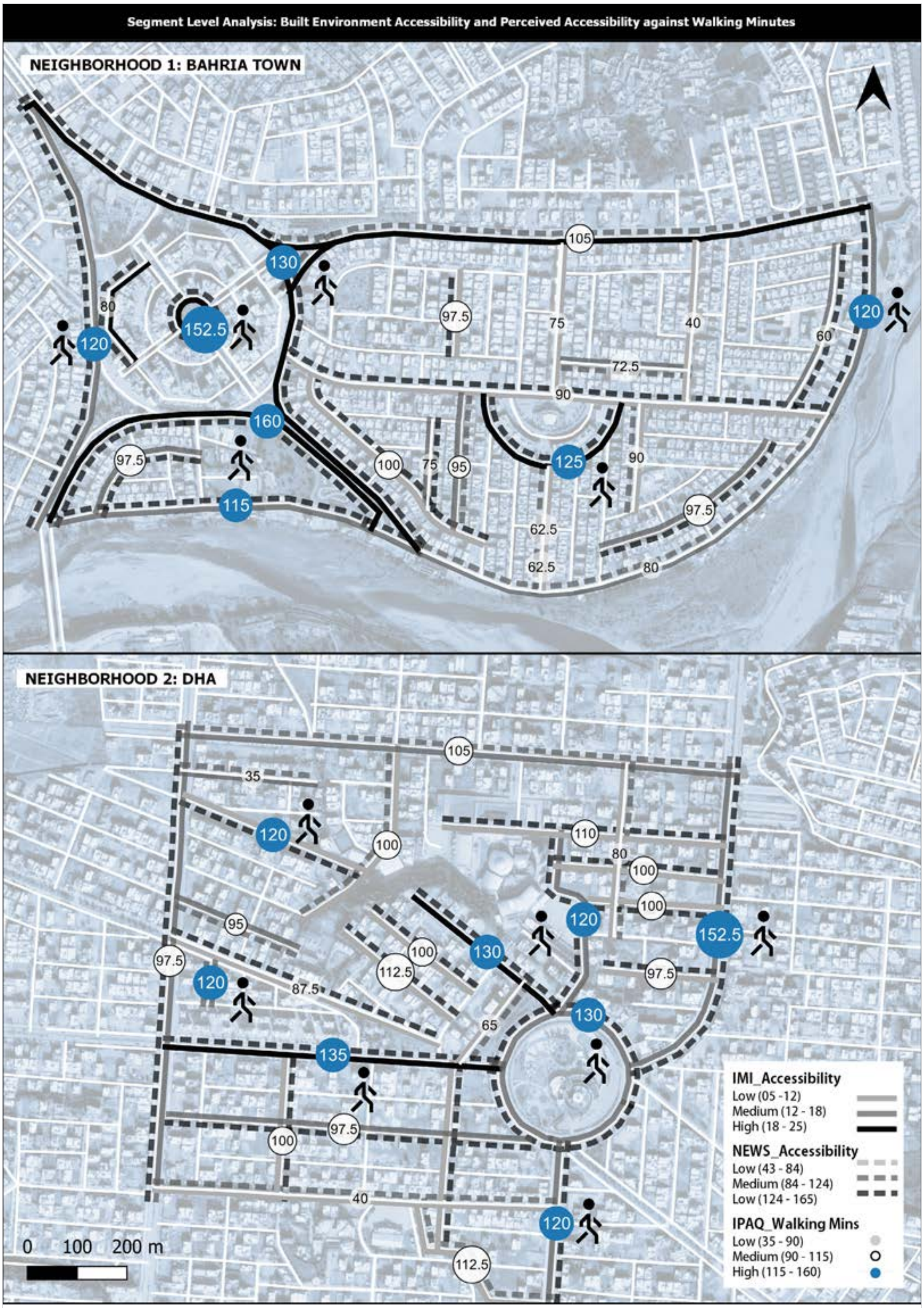


Fig.47: Image showing segments with highest B.E and P.B.E Segment Score for Accessibility Variable.
Source: Author

62

Fig.48: Character of segments with enhanced safety and security levels in relation to P.B.E data.
Source: Author

trend is seen for DHA; walking is higher on segments with more service facilities or near segments having more services. Therefore, it can be concluded that having more accessibility indicators on various segments can allow people to walk more for destination trips.

4.4.2. Safety:

Figure.49 illustrates the score for the safety variable for various segments against walking levels on these segments. The B.E data and P.B.E data illustrate that residents perceive more safety in DHA than Bahria Town (the same as neighborhood-level analysis). However, there is a need to understand which segments are performing better in terms of safety. While analyzing the streets highlighted in the figure, it is evident that segments having better safety scoring in Bahria Town are mostly those that have some ongoing commercial activity (fig.48). In this case, B.E and P.B.E segment scores are higher for major roads and arteries. The segment score for internal/residential roads was reasonably low. It could relate to the idea that main roads have a high provision of service facilities, enhanced lighting systems, are always crowded with a constant flow of pedestrians and drivers, which could elevate a person’s sense of safety. For DHA, relatively all segments have a high scoring for both B.E and P.B.E data. It indicates that DHA offers enhance safety and security in terms of B.E indicators and perception of the B.E.

4.4.3. Comfort:

While analyzing the segment score for comfort variable against walking levels, it is evident from fig.46 that B.E scores in both neighborhoods are very weak.

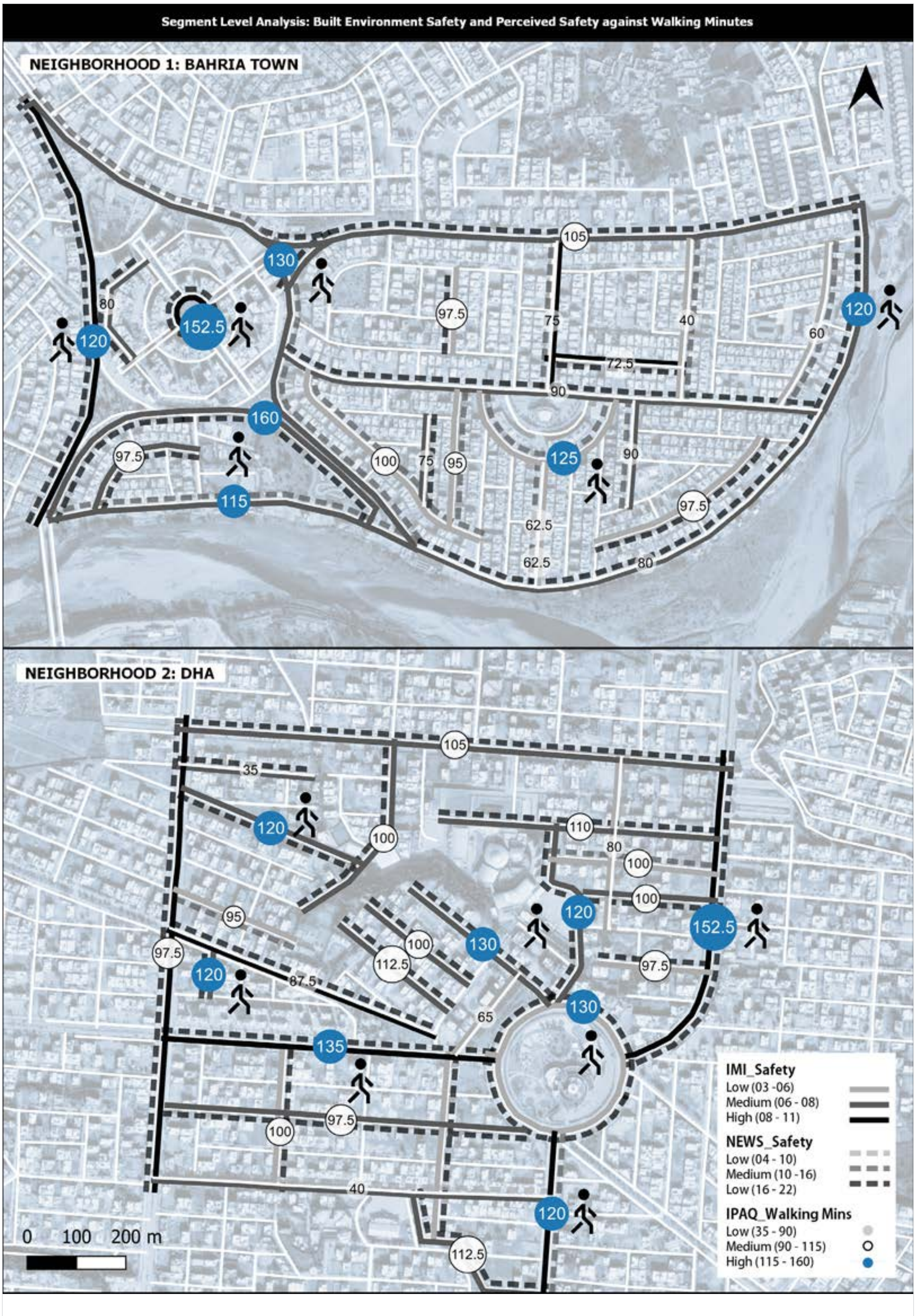


Fig.49: Image showing segments with highest B.E and P.B.E Segment Score for Safety Variable.
Source: Author

Fig.50: Images showing condition and unavailability of comfort indicators in both neighborhoods
Source: Author

In other words, both neighborhoods do not possess enough comfort indicators that may positively impact walking levels (fig.50).While analyzing the attributes of segments with relatively moderate B.E comfort, it can be seen that comfort scores are moderate on main roads within both neighborhoods. It can be justified because since traffic levels are usually higher on main roads or secondary links, there is a solid focus on lowering traffic speeds using elements such as speed bumps, rumble speed, etc. However, regardless of high traffic and ineffective speed control measures, walking levels are still higher on these links. While analyzing why these links favor walking regardless of high traffic, it was observed that there were two common traits in these segments. First, all these segments are connected to a commercial facility directly or indirectly. Second, since main roads are traffic-intensive, a narrow sidewalk buffer (service lane, green belt, cars) exists on these segments. It could be a contributing factor in enhancing comfort levels for some residents (fig.51) Hence sidewalk buffer is a vital element that is influencing walking levels amongst various residents. All sorts of calming traffic measures were mainly absent for other segments, indicating a strong focus on main links and neglecting tertiary links. Finally, in terms of P.B.E, the results somehow vary. Regardless of the same B.E characteristics, residents of Bahria Town perceive an overall weak level of comfort in comparison to DHA. It could relate to high traffic levels, as stated previously, because of high-end service provisioning and incoming traffic from other parts of the city.

Fig.51: Image showing sidewalk buffer on some sugments characterized by high walking levels.
Source: Author

4.4.4. Pleasurability:

Segment score from fig.52 indicates that in terms of pleasurability variable that both neighborhoods are

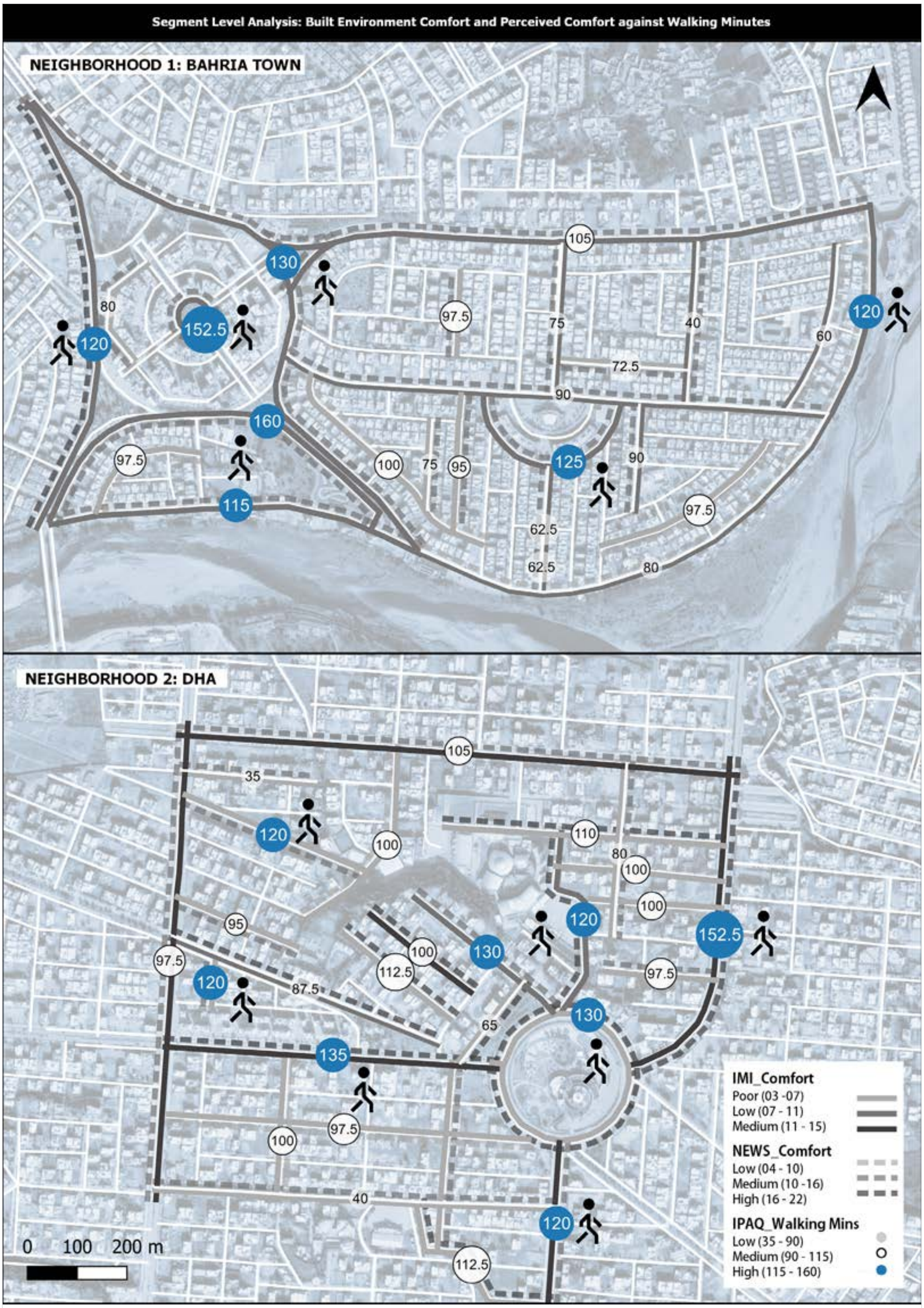


Fig.52: Image showing segments with low to medium B.E and P.B.E Segment Score for Comfort Variable.
Source: Author

performing almost on the same level regarding B.E. However, regarding P.B.E, residents in DHA perceive their surroundings to be more pleasing than Bahria Town. While analyzing which segments have high scoring and what features make them more pleasing, two segments in Bahria Town had parks, green spaces as a functional element. One segment even featured a small zoo/bird aviary. These were explicitly minor streets, which might also offer a retreat from busy traffic junctions. Moreover, these streets were also converted into playstreets for children using road barriers. This indicated that parents or adults might find such streets a good walking site because of no traffic, better green elements, and children playing on the streets (fig.53). One segment has a walkway around the river edge, followed by many restaurants/go-kart racing facilities, while another has a line of dense street trees and a small public park. Moreover, architecturally pleasing bungalows characterized most segments. For DHA, the most distinctive feature was a central park with many green elements and multiple service facilities such as restaurants/coffee shops (fig.54). Similarly, one segment presented a panoramic city view at night due to the hilly terrain on which the neighborhood sits. Finally, one segment was lined with thick, dense trees providing high-quality shading. These factors might be a contributing element in encouraging walking amongst users that are inclined towards leisure walking.

Fig.53: Barriers placed on road ends to utilize streets for children activity.
Source: Author

Fig.54: Aerial view of central park greenery and public space amenities.
Source: Author

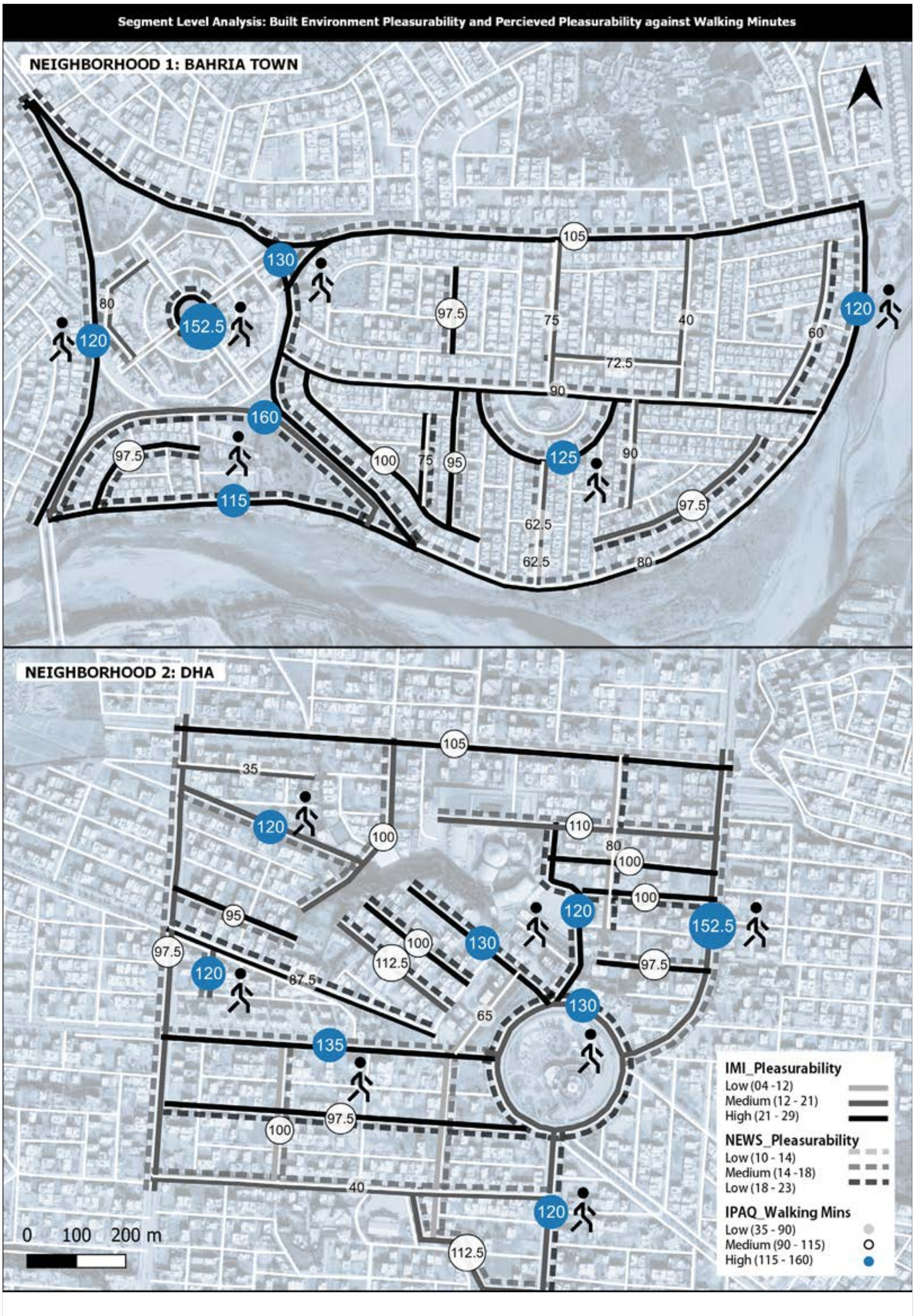


Fig.55: Image showing segments with high B.E and P.B.E Segment Score for Pleasurability Variable.
Source: Author

5. Conclusion

To draw meaningful future recommendations, it is essential to summarize existing findings/results according to different levels on which the analysis was carried out and recommend which kind of indicator interventions can improve each variable for both B.E and P.B.E . Therefore, a summary of different levels of analysis is as follows:

5.4.1. City Level Analysis

- The city-level analysis showed that walking has a high correlation with built environment accessibility (IMI_A), safety (IMI_S), and perceived accessibility (NEWS_A). It has a moderate correlation with built environment pleasurability (IMI_P) and perceived comfort (NEWS_C), and perceived pleasurability (NEWS_P) and has a weak/insignificant correlation with built environment comfort (IMI_C). In order words, improving accessibility indicators within both neighborhoods will strongly impact walking levels, followed by safety and then pleasurability. Comfort indicators in both neighborhoods are not supporting walking levels.

5.4.2. Indicator Level Analysis

- ***Accessibility:*** Bahria Town has better accessibility scoring for both built environment and perceived built environment variables than DHA. It is apparent that since Bahria Town was designed with a commercial mindset to attract revenue and investors, it provides better services, recreational facilities, and housing quality. Provisioning of better facilities and widespread services contributes to making people walk more in Bahria than DHA.

- ***Safety:*** DHA outperforms Bahria concerning perceived safety, although built environment indicators in both neighborhoods are almost the same. It may be due to less traffic flow from other parts of the city and a robust military presence. Since DHA is controlled by military personnel, entry and exit are strictly monitored, enhancing resident safety.

- ***Comfort:*** Comfort indicators within both developments are very weak and need immediate attention as they render pedestrian safety more than pedestrian comfort. A strong focus has always been placed on developm¬¬ents within Pakistan that prioritize allocating more road space to cars than pedestrians. Since both of these developments were established along the same timeline, they follow more or less the same planning model. Comfort indicators are primarily absent or are in a very depleting condition in both neighborhoods.

- ***Pleasurability:*** Both neighborhoods are performing almost on the same levels for indicators present under this variable. Both of them have their distinctive features, equally contributing to enhancing the walking experience of their residents. Minor recommendations shall be provided.

5.4.3. Segment Level Analysis:

- The segment-level analysis shows that some variables are highly influencing walking levels in both neighborhoods. The accessibility variable is by far the most influential. Residents living alongside segments characterized by higher service facilities are reporting higher walking levels. Similarly, some variables are also influencing others in regards to the outcome. For example, safety is being influenced by accessibility. Segments characterized by higher service facilities are not just providing services but are also elevating people's perception of safety. Similarly, pleasurability segment level analysis also shows the neighborhood design attributes influence people to walk for leisure and recreation. Finally, the comfort shows that people on walking on segments with fewer indicators. It indicates that their safety is at high risk, and without proper neighborhood intervention likelihood of road accidents would increase.

5.1. REFLECTIONS AND RECOMMENDATIONS

Collective recommendations are drawn for both neighborhoods according to the variables under examination and their indicators with an intent to reflect on B.E data and P.B.E data directly. Moreover, these reflections help devise recommendations that are streamlined as immediate, medium-term, and long-term interventions.

5.1.1. Accessibility:

- ***Residential Density:*** An analysis of the urban development pattern followed within both neighborhoods indicates that Pakistan's contemporary neighborhoods still rely on low-rise sub-urban developments and have regulations on vertical constructions. Although this development type could offer a luxurious suburban lifestyle with maximized dwelling size, front gardens, and personal parking garages, they are not sustainable in the long run. An analysis of both neighborhoods illustrates that 60%-70% of land use is designated for residential use. Frequent provisioning of single-family dwellings tends to consume surplus land, accommodate only a particular socio-economic class (upper-middle- or high-income households who could afford a house), and even force residents to use cars because of less feasibility to commute by foot, ultimately lowering walkability. One recommendation to counter this issue is to increase apartments and decrease the provisioning of single-family houses. Including apartments would offer diverse housing types for people of different socio-economic classes, increase residential density (both by population and dwellings), and support a compact development pattern. Many studies highlight a strong relation between compactness, building density, and diversity of housing types (Durand et al., 2011) which ultimately supports physical activity levels such as walking (Frank and Pivo, 1994). It could be a vital solution to current practice as residents strongly perceive that Bahria has fewer apartments, and the ones present in DHA are far from the inner sectors (such as B, C, D) and could not be easily reached by walking. However, it will be highly challenging to convince people to adapt to vertical mid-rise housing options. Unlike Karachi and Lahore, Islamabad-Rawalpindi Metropolitan Area has adopted a horizontal expansion model having two-story residential dwellings; residents idealize "single-family homes" as the epitome of living compared to apartment living. Therefore, a shift in mental psychology would surely take time, but meanwhile, an effort to promote compact developments is imperative to promote walkability within urban settings

- ***Mixed-Use Function:*** Providing multiple services within easy walking distance is challenging when adopting a horizontal expansion pattern. An analysis of both neighborhoods indicates that strict zoning patterns are being followed and implemented with a clear demarcation of land uses falling into three major categories: residential, commercial, recreational, etc. This kind of orthodox development pattern could not compete with the evolving dynamics of overgrowing neighborhoods and cities. To counter this ideology, it is imperative that instead of physically segregating land-uses, both neighborhoods should focus on revising zoning policies to push for mixed-use development patterns providing commercial, official and retail activities adjacent to residential areas. Residents living in neighborhoods having land-use diversity and in the vicinity of commercial areas have reported higher walking rates (Cervero and Kockelman 1997). During the field research, it was observed that although Bahria Town did make a slight effort to work on these principles by providing a civic center with mixed-use functions, DHA is completely lagging with less variety or diversity of services. Similar results were obtained from residents of both neighborhoods where they highlighted only 50%-60% access to service facilities by walk, which could relate to the strict zoning patterns as a contributing factor to this perception outcome. Another general observation during field surveys indicates that the scale and design of one phase/sector within Bahria and DHA is between 0.6 – 0.9 miles in length, with one or more commercial centers located centrally. Ideally, a walkable neighborhood is hypothesized to be within a 0.25 to 0.5-mile context area and should provide adequate service facilities on this scale. So, comparing this value to the size of neighborhoods under examination indicates that sector/phase distribution within contemporary neighborhoods in Pakistan is already overscale. Therefore, allocating only one or two strictly zoned commercial hubs per sector is not viable as it may only be accessible to residents living nearby. Instead, dispersing services in small commercial centers or adopting mix-use development principles could encourage people to carry out daily activities on foot. The proximity of various service facilities such as grocery shops, retail stores, offices spaces, restaurants, parks, etc., could generate vibrancy, drive people to walk more, and boost the local economy, allowing Pakistani neighborhoods to become engines of growth.

- ***Lack of Integrated Transit System:*** While analyzing the perception of access and availability of public transit within these communities, residents from both neighborhoods highlighted a lack of integrated transit systems (such as BRT's, taxis, auto, etc.). Similarly, investigating socio-demographic profiles of residents identified that, on average, every household owned two cars, indicating both neighborhoods are highly car-dependent. The Pakistan Bureau of Statistics data illustrates that the number of registered cars, jeeps, and wagons had increased from 1.7 million in 2010 to 3.7 million in 2019, almost three times all across Pakistan, and private vehicles such as motorbikes and cars accounted for 87% of Pakistan's transport share in 2018. These alarming figures indicate the unavailability of different transportation modes and the high car-oriented culture prevalent in society. The rapid growth in car ownership could relate to the boom of private housing developments on city peripheries. Due to high-end service provisioning, these neighborhoods succeed in attracting upper-middle or high-income social groups capable of affording two or three cars for everyday commuting, and thus the absence of a transit facility is usually not a deciding factor. The investment-driven developers also tend to overlook transit-related accessibility issues and expand their developments as far as possible. Consequently, cars become the prime mode of transportation, and hence a high focus is placed on allocating expansive road space to drivers instead of pedestrians. This car-oriented planning firmly embedded in these neighborhoods needs careful intervention even if the residents could afford to commute using motorized vehicles because such ideologies are socially, environmentally, and economically unsustainable.

- The field survey showed that Bahria Town had started a private shuttle service that transports low-income workers/residents from different phases to the neighborhood's main gate (approximately 20-25 minutes by walk). For DHA, a transport service called SWVL started operating recently, picking residents from designated stations and dropping them off at their jobs/educational institutes (mainly outside the neighborhood). These two facilities are somehow trying to fill in this gap but are not operating efficiently since first; private entities run them; therefore, the network lines/reach is limited. Second, not having an integrated public transit system promotes car usage and discourages transportation-related walking. Therefore, in my understanding, no immediate solution could improve issues related to transit facilities since the scope extends beyond neighborhood level and up to city level. However, neighborhood-level experimentation could be carried out to assess improvements in walking levels within residents. If currently operating shuttle services could expand their networks internally and designate transit stops within both neighborhoods to familiarize residents with the transport network and schedules provided within their community, this might encourage them to walk more and use other modes of sustainable transit options.

- No public BRT or shuttles are currently operating next to these sus-urban developments (except for informalized transport networks). Therefore, it can be a step forward in revolutionizing transit systems within and around these neighborhoods. Moreover, these systems could be integrated with the city transport network in the longer term, allowing residents to commute freely; however, high-quality public-private partnerships are necessary to implement such plans. Currently, the government is trying to expand the existing Pakistan Metro Bus System by installing feeder buses into the network that would transport residents from designated areas to main metro lines in phase 1. Ironically, no such feeder buses are targeting these contemporary neighborhoods, either because they don't feel the necessity to connect to these developments due to their socio-economic class, or the ridership might be less since people are more habitual of using cars. Nevertheless, the neighborhood level experiment could be a starting point of assessing how these residents perceive transport-related walking and could be a way forward to connect to the public transit system in the longer run.

- ***Lack of Playgrounds:*** While analyzing the provisioning of playgrounds, it was highlighted that residents in Bahria Town perceive that their neighborhood lacks playgrounds for children of all ages. As a response to this unavailability, most residential streets were closed off with barriers to limit traffic flow, and they were being used as play streets to facilitate social interaction. It is undoubtedly a great approach since streets are reclaimed for women and children and provide room for physical activity as studies indicate that cul-de-sac layouts support higher physical activity in children due to less traffic flow (Tappe et al., 2013). However, this approach did not provide space for vigorous physical activities (such as basketball, football, etc.) essential for youth's mental and physical development. Therefore, future developments must set aside a commercial mindset and allocate ample space to public spaces as parks, plazas, or even playgrounds. Studies illustrate that neighborhood perception can strongly influence walking levels, especially in children (Humpel et al., 2004). Going outdoors, being involved in moderate physical activity could change one's perspective about walking and physical health. More walking was recorded in individuals who acknowledged the benefits of walking (Lund, 2003). Therefore, initiatives need to be incorporated early to push for a society that adopts a walking culture.

- ***Fewer Primary/Secondary Schools:*** While asking residents about the perception of schools in their community, it was highlighted that residents perceive less availability of educational institutes. In my understanding, adequately providing and locating primary schools within residential areas could significantly impact walking levels amongst children. If children are encouraged to walk to school from an early age, it could enormously elevate their perception of walking, which directly influences walking behavior (Lund, 2003). Not having sufficient schools in the locality indicates that walking to school is not a mainstream concept. A vast body of literature suggests that many cities worldwide are investing in projects such as "paths to school" to provide safe street access of children to schools. (Southworth, 2005). Similarly, "The Safe Routes to School Program" implemented in Odense, Denmark, focused on improving neighborhood design for children going to school, which ultimately reduced 85% of children's traffic accidents (Untermann,1990). In my opinion, neighborhoods in Pakistan should learn from these examples. Thoughtful neighborhood design in terms of the street network, sidewalks design, safety from traffic, and careful placement of such facilities could be a driver of change. These tiny measures taken at grassroots levels could be a way forward in enhancing walkability within urban settings.

- ***Sidewalk Obstructions:*** While analyzing resident perception regarding their neighborhood sidewalks, residents highlighted moderate encroachment level (60%-65% score) by cars, motorcycles, construction material,

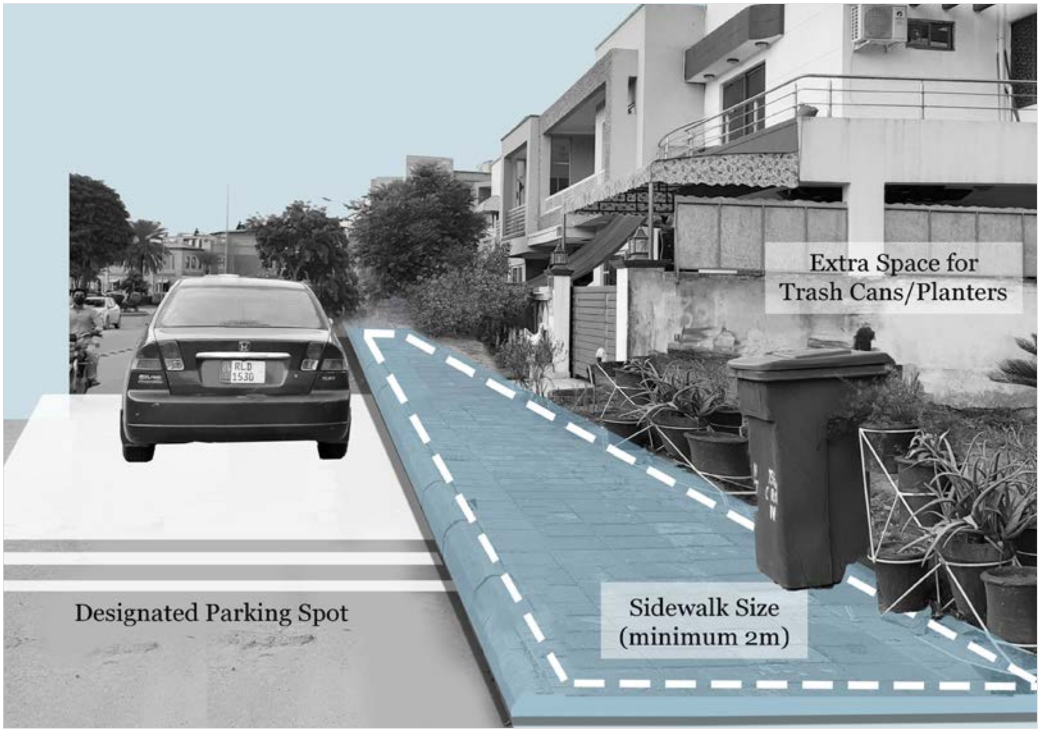


Fig.56: Visual illustrating intermediate solution to avoid sidewalks encroachments by increasing sidewalk size and allocation onsite parking

and trash bins. However, while analyzing the walking behavior patterns of residents during field research, it was apparent that most sidewalks were empty (even if not encroached), and people chose to walk on the edge of the road regardless of high traffic levels. In my opinion, this behavior pattern is mainly associated with the perception of sidewalks and the design itself. Residents from both neighborhoods and other parts of the city chose to walk on the roads since they perceive that road spaces are always clear for car movement. There are rare chances that any of the indicators highlighted above would obstruct them; therefore, a general change in walking behavior is witnessed amongst residents originating from this context. However, this approach is not feasible for the longer run, as one study indicated that walking levels were higher in older adults whose neighborhoods had safe and barrier-free sidewalks than those living with walking obstacles (Booth et al., 1997). To counter this perception and revert people's movement to designated sidewalks, it is essential to put recommendations to remove all sorts of obstructions currently underway. One solution for sidewalks encroached by cars and motorbikes is to allocate parallel parking spots on most segments (fig.56). Since current road widths are vast (road width:

100’, 60’ and, 40’), there is a high possibility to include designated parking spots which could limit sidewalk encroachment. This approach would reduce encroachment and provide a buffer for pedestrians using sidewalks, enhancing safety. For unsupervised construction material, policy intervention might be a solution. Ongoing construction sites should be strictly advised not to obstruct the right of way for pedestrians. Bahria management could play a part in this and devise penalties for such violations. Carefully demarcating construction areas with necessary infrastructure could also limit sidewalk obstruction through construction material. Finally, for the trash cans, one solution could be that residents should be advised to include them in designated green belts in front of their houses and play a part in ensuring that they do not obstruct sidewalks for walking. Or communal trash cans per segment could also be introduced whose position is fixed and designated. In this way, the streetscapes would also enhance, and there would be fewer chances of encroachment.

- ***Barriers to Walking:*** While inquiring residents about the perception of walking within their neighborhood, they highlighted 50% of walking barriers (such as wide roads, drainage lines, etc.). At the same time, they gave weak scores to short road junctions in their neighborhood. It indicates that they strongly perceive their roads as broad with infrequent junction, which lowers the possibility of crossing, serving as a barrier. This design ideology again resonates with the fact that since the developer’s design is for only one set of users, the need and requirements of pedestrians are undermined. Most segments follow an expansive design scale with a minimum of 4 lanes extending up to 6 lanes regardless of tertiary road classification. Hence it is natural that these roads, along with continuous drainage lines, might be perceived as barriers to walking or crossing. To solve the issue, it is crucial to acknowledge that road is a shared space with equal or even more representation given to pedestrians, cyclists, motorcyclists, and then cars. When this mindset prevails in planners, then automatically, the design criteria would change. As a short-term intervention, increasing the number of designated crossings (both at intersections and mid-block) could help people navigate quickly and enhance their perception of shorter road junctions (fig.57). It is usually seen that streets with more intersections encourage pedestrians to walk more (Krizek 2003). Moreover, adding pedestrian islands could be a viable solution for wider roads (especially for DHA). It

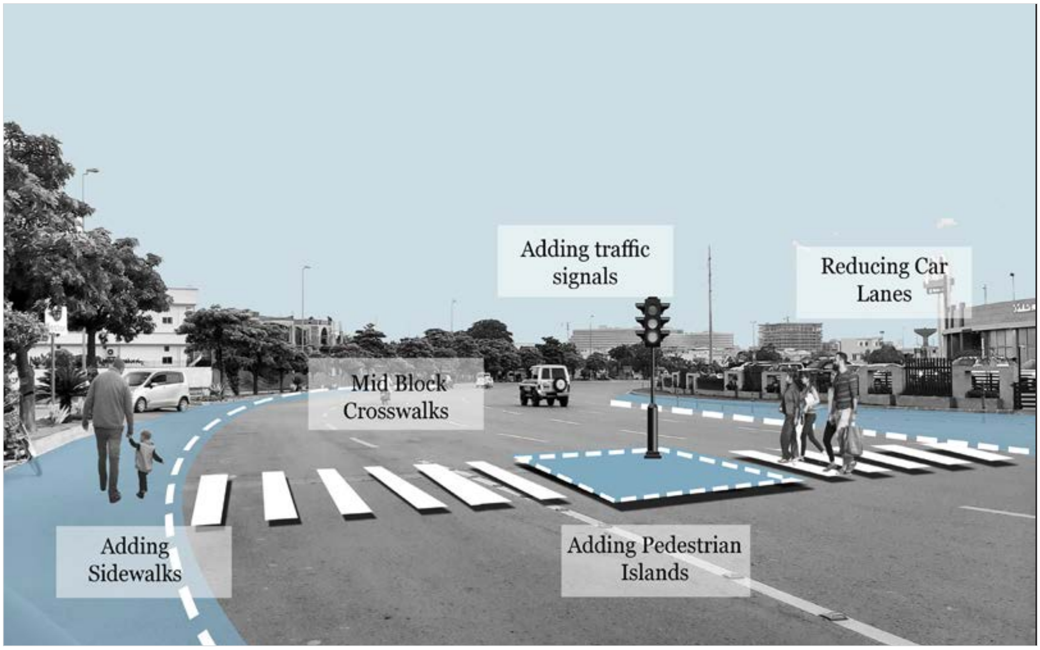


Fig.57: Visual illustrating solution to barriers to walking such as wide roads, pedestrian access points and lack of crossings.
Source: Author

could help reduce the perceived width of roads and improve the pedestrian network. Finally, if drainage ditches are present due to passing canals/ drainage lines, pedestrian accessibility points should be added to allow free movement of pedestrians. As a long-term solution for future expansion, planners (especially in DHA) should consider redistributing road space, providing fewer cars and more space for walkers/cyclists. This strategy could be a vital step in improving walkability.

- ***Green Belts:*** As a general design standard followed within Pakistan, all residential buildings possess boundary walls and narrow green strips that run on the entire segment decorated as per the house owner's aesthetics. When residents were asked about the availability of greenbelts on their segments, most of them agreed about their presence; however, when asked about whether they provide a buffer from traffic, the perception score instantly dropped to 45.5% in Bahria but was 64% in DHA. The further investigation highlighted that DHA had service lanes/drainage lines running on most segments, providing a buffer from busy traffic elevating residents' perception of traffic safety. However, this was not the case in Bahria, regardless of higher traffic levels as identified earlier. Although these green belts add to the aesthetic value of most segments, they do not function as a buffer or enhance traffic comfort. There is a dire need to reconsider their placement and redefine their function. Therefore, one short-term solution could be to reduce road widths (100' or 60') and add narrow green belts lined with trees/plantation (in addition to existing green strips) that could function as a buffer between the sidewalk and the main road. It will not just enhance the visual outlook but would also function as a calming traffic measure. Another idea could be to entirely switch places between green belts and sidewalks and add a shy space between the sidewalk and boundary wall. Nevertheless, both designs will contribute to improving pedestrian safety and elevating the walking experience.

5.1.2. Safety:

- ***Crime Safety:*** Although continuous security patrol is an essential feature, both neighborhoods gave a weak score to safe children (59%), and Bahria ranked even lower in nighttime safety than DHA. In my understanding, the perception of children's unsafe neighborhoods and nighttime unsafety relates to various factors. First, growing crime rates and children abduction cases in the country have risen lately. Even in high socio-economic areas, incidents are being reported frequently, rendering people's sense of safety. Second, since Bahria receives more citizens from other parts of the city than DHA, residents in Bahria point to higher fear of crime. The authorities running these developments also have a role to play in residents' perceptions. Since DHA is operated by military personnel, it is unlikely that anyone could enter without prior checking or a valid purpose. It might be one factor that residents in DHA reported a better perception of nighttime safety.

- Although this issue has multiple aspects and needs consideration at policy and design levels, some measures could elevate residents' perception of safety. During the field survey, it was observed that only 50% of segments were well illuminated, even when all segments had lighting poles. Similarly, residents reported weak (60%) street lighting in their neighborhood, especially in Bahria. Proper lighting is a factor for increased perception of safety and creating a more walkable setting (Ball et al., 2001; Foster et al., 2010). Therefore, to enhance perceived safety and improve walking levels, one strategy should improve lighting levels within both neighborhoods.

With well-illuminated streets and continuous police patrolling, it is unlikely for street crimes to take place.

- Moreover, careful urban design strategies could also elevate people's sense of safety. As stated earlier, if the number of public spaces increases, it would allow people to go outside, bringing liveliness and movement in most streets and spaces. The presence of people walking or sitting is negatively correlated with the perception of fear. A neighborhood with the hustle and bustle would allow residents to interact and indulge in social activities, improving their neighborhood ambiance and achieving safe environments for themselves and their children. Therefore, social capital and communal living could play a part in achieving children-safe neighborhoods. Once this motive is sufficed, it will naturally lead to increased walking levels amongst varied age groups.

5.1.3. Comfort

- ***Crosswalks:*** While While analyzing the perception score, residents from both neighborhoods highlighted the weak (35%-50%) presence of crosswalks. With such widths, the absence of designated crosswalks increases the chance of fatal accidents and limits free pedestrian movement. During the field research, many residents were seen jaywalking on most segments. It has become such a common practice that even pedestrians do not hesitate to show up in front of the cars or even point out to the driver to slow down so that they may cross. Two factors dominate this behavior; first, four-way crossings or even zebra crossings are rare. Even if they exist on certain roadways, most people are not accustomed to using them or know how to use them. New developments tend to include a minimal quantity of pedestrian crossing infrastructure; however, lack of maintenance decreases their visibility, making them ineffective over time.

- Similarly, existing zebra crossings are rarely coupled with pedestrian islands or access points. Therefore, most pedestrians willing to use them have to jump off medians/green belts to get to the zebra crossing itself. This inefficient design strategy usually psychologically limits the presence of zebra crossing and their function. Moreover, only placing crossings without including pedestrian-activated signals or pedestrian signage is not practical.

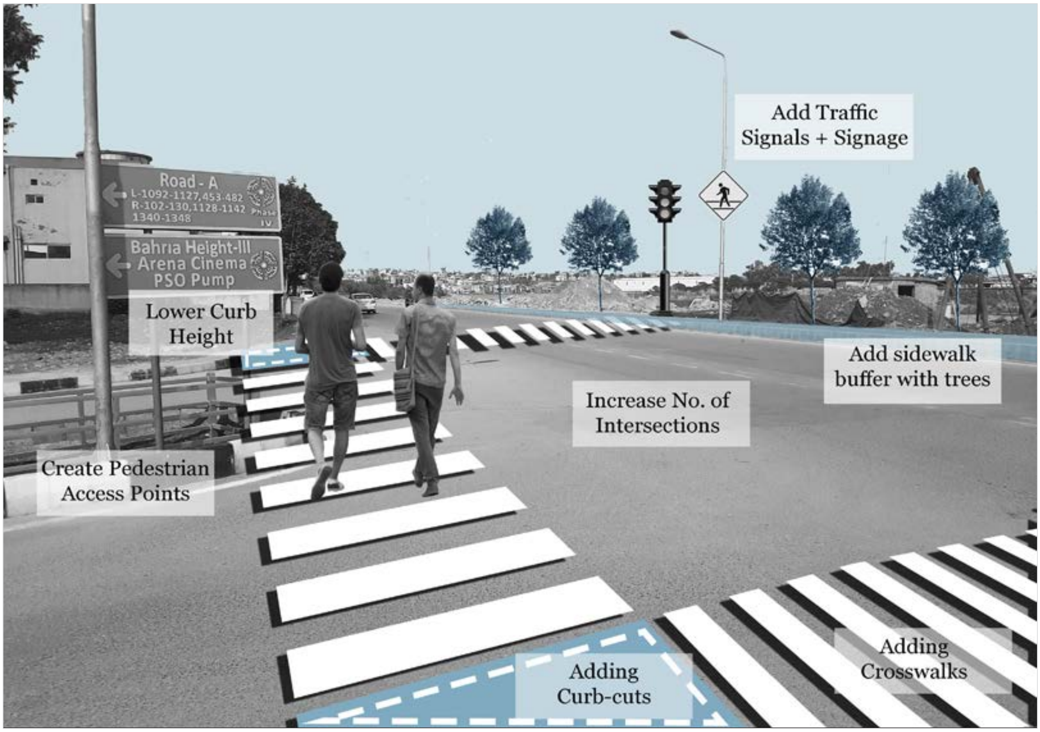


Fig.58: Visual illustrating proposed intersection design in both neighborhoods
Source: Author

Similarly, when crosswalks are absent, it is unlikely that curb-cuts would exist. Currently, both neighborhoods have elevated curb-cuts, around 3-6 inches high, only to limit car encroachment. This design approach provides ineffective curb cuts and makes the neighborhood inaccessible and unfriendly for diverse users. Second, the drivers also do not psychologically perceive crosswalks while driving. It is common for drivers to stop precisely on the crosswalk instead of a few meters before it. Sometimes, even when drivers see a pedestrian crossing, they would not slow down even if they use a designated crossing. This behavior highlights a lack of traffic education, but unfortunately, no traffic regulations or penalties are implemented for this kind of violation. As a result, walkers do not claim their road share leading to jaywalking, and cars do not respect their presence. Although this is a deeply rooted issue, these newly developed neighborhoods should add visible crosswalks, pedestrian islands, and pedestrian signage to address this problem fig.Frequent placement of crosswalks on both intersections and as mid-block crossing would force cars to stop and give way to pedestrians (fig.58).

- Although yet not introduced in Pakistan, there is a potential for pedestrian-activated signals to be installed in these high-end neighborhoods. Since developers tend to make their communities unique, installing such automated systems could enhance the outlook of their neighborhoods, help elevate pedestrian safety and make these neighborhoods even more attractive for newcomers. Overall, immediate attention is required for this indicator since, with no crossings, it is unlikely that a neighborhood could support walking.

- ***Traffic Safety:*** While asking residents about perceived traffic within their neighborhoods, residents in Bahria provided a weak score (50%), indicating high traffic levels within their neighborhoods compared to DHA. The reason for this perception is strongly related to the accessibility indicators. Since Bahria Town offers diverse service facilities (such as restaurants, theatres, and golf city), it is common for people living in other parts of the city to go to Bahria for recreational activities. Although it is an excellent means of generating revenue and making the housing scheme a popular choice for future inhabitants, it compromises residents' traffic safety levels, especially children. Since the neighborhood lacks a play area/ground and children utilize streets for social interaction, incoming traffic is a significant issue. It is why streets are closed off with barriers to limit external traffic into residential areas. In my understanding, it will be pretty challenging to limit the traffic flow from other parts of the city since the neighborhood is not accessible by a transit facility. However, measures could be taken to enhance traffic safety for residents. For example, some zones have the potential to be pedestrianized (such as civic center). Pedestrianizing such an area with a constant human flow would facilitate social interaction, prioritize pedestrians and discourage car use. The residents will also be encouraged to walk to these areas, decreasing car usage. Another measure that could contribute to enhancing traffic safety is undoubtedly the street design. If careful consideration is given to slow down traffic and improve sidewalk design such as buffers, perception of traffic safety could improve significantly.

- ***Speed Control Measures:*** In addition to high traffic levels in Bahria, residents also pointed out the high speed of traffic and drivers exceeding speed limits within their neighborhood. Relating P.B.E to B.E attributes indicates that both neighborhoods heavily rely on speed bumps and rumble speeds to slow down traffic on various sections within the segment. Placing such elements might be a good approach, but they should be coupled with other strategies to ensure traffic speed is under control. Firstly, both neighborhoods rarely have traffic signals to regulate the traffic flow. The absence of signals allows drivers to maintain a steady driving speed which ultimately renders pedestrian movement. During the field survey, it was also noted that drivers rarely slowed down at intersections or mid-segments, even when speed control measures were present. It indicates a lack of consideration of drivers regarding other road users, therefore apart from providing built environment solutions, traffic education is also a vital part such that an effort should be placed on endorsing drivers to drive slowly. Secondly, regarding exceeded driving speed, in my understanding, this behavior correlates with the absence of adequate traffic signage and no fear of breaking traffic rules. The B.E data indicates that both neighborhoods lack posted speed limits and slow signs, which effectively regulate traffic speed; therefore, it is inevitable for such issues to arise.

- In my understanding, the root cause of this issue relates to the inadequate provisioning of traffic signals. Adding signals makes driving difficult, creates room for including crosswalks, and adds more intersections that naturally slow downs traffic. Therefore, wherever possible, traffic signals should be installed to halt traffic for a few minutes, allowing pedestrians to cross safely. Secondly, both neighborhoods lacked clear and visible signage giving a variety of instructions. Visible signage must be incorporated to regulate traffic flow and ensure drivers maintain speed limits. Literature suggests traffic calming strategies such as reduced widths, speed limits, crosswalks, and signage overall increased street activities and pedestrian volumes (Frank et al., n.d.; Clark and Dornfeld, 1994). Finally, it is also crucial to consider all sets of users and their road requirements. Currently, both neighborhoods had signage designated to regulate or guide car traffic (such as speed limit). No signages were present for guiding pedestrian movement or demarcating pedestrian right of the way. Hence careful consideration is required in this area, and management authorities need to acknowledge the presence of different road users and their design requirements.

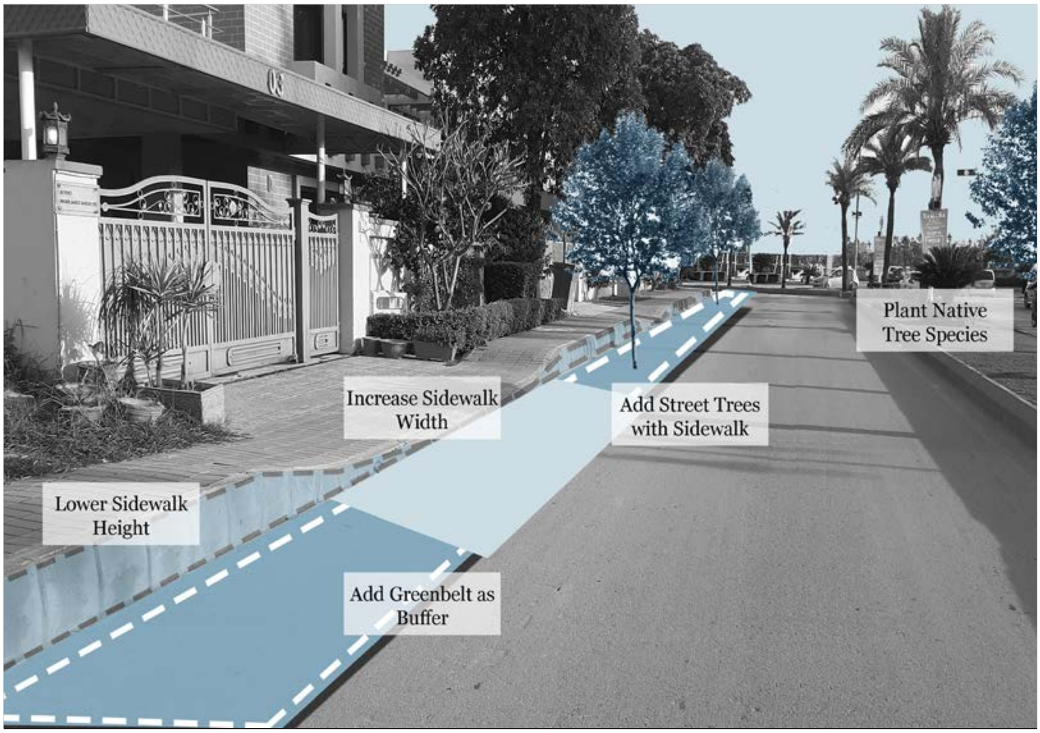


Fig.59: Visual illustrating proposed pleasurability interventions in both neighborhoods
Source: Author

5.1.4. Pleasurability:

- ***Street Trees:*** While analyzing the street trees within both neighborhoods, it was evident that 90% of segments had street trees on them; however, the score for trees providing shade on the right of way of pedestrians was only about 50%. Similarly, while asking residents about the perception of street trees within their neighborhoods, they also scored 60%-65% on the adequacy of tree shading. It is pretty ironic that regardless of the conscious effort of neighborhood greening, the trees do not function as a shading element. During the field survey, it was noted that Bahria has a considerably higher number of trees than DHA. However, most tree plantations are done arbitrarily only to enhance the visual appearance of the neighborhoods. The street trees in Bahria were mostly planted on-road medians similar to the ones in DHA. Although they indeed add to the neighborhood aesthetics, it is advantageous that they serve a dual purpose. In a country like Pakistan, where the temperature during summer lies between 35-40 centigrade, tree shading should be prioritized during urban design (fig.59).

Without adequate tree shading, it gets utterly impossible even to walk half a mile with such intense heat and humidity. During the field survey, it was also learned that Bahria Management does not allow plantation of trees having big canopy size on greenbelts outside residential homes, as it costs them more maintenance and disrupts the view of housing facades.

- In my understanding, this policy should also be reconsidered since having an extensive tree canopy indicates better shade provisioning. Moreover, if a previous recommendation regarding adding a designated sidewalk buffer is implemented, it creates room to plant street trees that shade pedestrian walkways. Hence a dual purpose can be facilitated with only one intervention. Finally, another observation highlights that major junctions in Bahria had mostly palm trees planted which are not native to this country. The choice of planting foreign trees on such a large scale indicates the developer's mindset. For this housing to demarcate itself as luxurious and assure residents that they are being offered housing that could compete with the U.A.E standard, a high focus is placed on planting exotic trees (such as palm), especially on the central boulevards. It is undoubtedly the first image of the neighborhood as soon as you enter and therefore indicates that street trees function far more than just trees with deep symbolic meanings. I believe an alternative approach should be followed in this case. A focus should be placed on planting local indigenous species to support natural habitats for flora and fauna, especially in Bahria. For DHA, most trees were still growing, but they also lacked a considerable canopy size from current observation. Hence, careful consideration needs to be taken regarding the number and location of planting street trees to serve a bigger purpose, as the presence of street trees is strongly correlated with walking levels in residential neighborhoods (Stamps, 1997).

- ***Sidewalk Width:*** While analyzing the sidewalks present, it was evident that both neighborhoods were characterized by the poor condition of sidewalks, specially Bahria Town. The overall design, maintenance, and path quality are below satisfactory. While asking residents about the sidewalks within their neighborhoods, they scored a 70%-80% on their maintenance. This result is quite the opposite of expected, but their perception is justified when you consider the overall context in which the neighborhoods are situated. Cities in Pakistan have a poor quality of infrastructure provisioning for pedestrians. When residents score their perception of sidewalks or any other pedestrian infrastructure, they compare it with the provisioning that exists in the city (predominantly low-income areas). As a reference to them, this score automatically goes higher, but when you analyze its use, it is evident that pedestrian infrastructure is rarely functional. From an urban planner/designers' perspective, there were many issues regarding the pedestrian infrastructure within both neighborhoods. The sidewalk height is modified to around 6 inches to avoid cars or motorcycles from encroaching. At the same time, the width of sidewalks allows only one person to walk comfortably; hence many individuals were seen walking on the roads during the field survey. With such height and low widths, there is always psychological distress of tripping down from the sidewalks; therefore, unconsciously, one finds it easy to walk on the road instead. Moreover, the sidewalks do not follow a constant height and are reduced on some sections to allow cars to move into residential garages and then elevate again, creating a very unpleasant walking experience.

- Therefore, in my understanding, an immediate solution to overcome this issue is first to increase the widths of the sidewalks. Given the current road space, it is easily possible to implement this. Literature suggests that a minimum of 5-6 feet sidewalks is required for two persons to walk comfortably (APA 280). Moreover, the width could increase according to the high-volume pedestrian locations with a minimum of 12 feet to a maximum of 20 feet (Alexander et al.). Therefore, careful consideration in this regard is required. Lowering the height from 6 inches to around 2-3 inches can enhance the perception of accessibility and pedestrian comfort. If designated on-street parking is provided, as stated earlier, there should not be a need to encroach sidewalks which could help lower their height. Finally, it should be a practice to carry out annual maintenances of texture and pavements. Usually, since the developments are still expanding, ongoing construction activities affect sidewalk quality. Therefore, there must be a conscious effort to maintain sidewalks for better use and function.

- ***Public Squares:*** The built environment data suggests that few public plazas/squares were available for general public gatherings apart from green spaces or parks. Literature suggests that providing well-maintained public spaces serve as the source of communal gatherings, facilitating walking and social interaction between varied social classes (Roberts, 2007). While pushing for neighborhoods to move towards medium to high-density housing and mixed-use development patterns, it is also imperative to include public squares or plazas within future urban developments. Currently, it is widely observed that since most residents own single-family homes which provide space for having a personalized garden, the outdoor culture in Pakistan is reasonably weak. It is unlikely for people (especially women) to go out and sit in public spaces just for socially interacting or enjoying the weather; instead, they choose to stay indoors for social interaction, which impacts their physical activity levels, such as walking. Moreover, the male presence strongly dominates current public spaces (except for family parks: as they are family zones), especially in my country's context. Therefore, an effort should be placed on mainstreaming accessible public squares within new developments to promote an outdoor culture and motivate people to walk more, positively impacting walkability.

- ***Street Facilities:*** While analyzing the quality of urban design amenities, it was evident that both neighborhoods lack street amenities such as street furniture, chairs and water coolers/fountains. Only a few benches were installed that too in public parks (or, in this case: family parks). Similarly, compared to residents' perception of how interesting their neighborhood is while walking, residents gave a 60%-70% score on the walking experience. It indicates that both neighborhoods are not focused on improving urban design indicators that can elevate walking experiences. Providing amenities such as purposefully placed planters, chairs, or stoops in the public plazas within an urban environment facilitates social interaction and leads to higher walkability (Gehl, 2013). Therefore, apart from providing them only in designated park spaces, a focus should be placed on including them in public spaces, sidewalk buffers, and even under street trees. These detailed micro-level interventions could enhance the overall urban quality of the area and significantly contribute to placemaking, which is a driver of increased walkability. Moreover, the terrain is also an essential factor that could significantly reduce one's walking motivation. A neighborhood like DHA developed on hilly terrain must include such elements to allow pedestrians to rest while walking. However, they should be coupled with activities which could make walking or even sitting interesting.

- ***Views and Openness:*** While inquiring residents about natural sights in their neighborhood, both residents provided a weak perception score (62%-66%)for this indicator. A strong focus is placed on the neighborhood's architectural characteristics, including attractive homes, boundary walls, and building design; however, minimal attention is given to natural landscaping elements. Researchers scoring streets for movement across four European countries showed that people were willing to walk extra 160m on streets marked as "pleasant" during good weather. (Westerdijk,1990). While analyzing both neighborhoods, it was evident that the river characterizes one neighborhood, and the other has some high viewpoints. The Soan River runs on one of its edges; many residents walked on this segment during the field survey. The initial master plan represents that this area was to be developed as a green stripe, but currently, one can observe that slowly buildings have started to elevate on this segment (currently Corniche road), thereby blocking river view and lowering walking experience many residents. Therefore, it is imperative that the developer set aside a commercial approach and use this opportunity to provide better walking spaces for residents. There is a strong potential to develop this area as a walking corridor having a proper walking/jogging track, elevating native trees, and enhancing the overall ambiance of the neighborhood. Sometimes revenue generation does not solely rely on providing better services; instead, the urban quality of an area such as green spaces, squares, and public parks could also attract new residents. Moreover, for DHA, a couple of segments offer a panoramic view of the city (because of hilly terrain); these spots can be developed as viewpoints with adequate street furniture and trees. These interventions could enhance the presence of natural sights within both neighborhoods elevating and increasing walking levels.

To summarize, it is evident from the above discussion that out of all four variables, the variable that needs significant intervention is the comfort variable since comfort indicators within both neighborhoods are almost absent. For the other three variables, careful urban interventions could enhance their presence and perception. From the detailed analysis listed above, it is evident that improving walkability within a neighborhood or community could not be approached directly or linearly. Multiple dimensions need to be addressed individually or collectively to make a neighborhood "walkable." Sometimes improvement in one indicator serves only one purpose, but sometimes, it could address three issues at a time. Therefore, in my understanding, applying these interventions should start at the micro-level or segment level within both neighborhoods. Interventions such as reducing road widths, adding traffic signals, crosswalks, pedestrian islands, increasing sidewalk widths, sidewalk quality, streets trees, street lighting, and placing street furniture could be immediate interventions. As an experiment, existing neighborhoods should focus on implement these strategies and assess the difference in walking levels within the community. It would be interesting to see how the residents perceive these changes and interact with the environment. Visible improvement in walking levels could be a step forward to push towards intermediate or long-term solutions such as increasing residential density, creating mixed-use function, integrating transit systems, locating schools and playgrounds thoughtfully, etc., for future developments. Hence, to push for a human-centric neighborhood that relies on walking as a mode of transport and leisure, it is essential to intervene with the built environment's micro and macro-level attributes, assess how residents perceive these attributes, and look for conscious measures to improve their perception.

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ثمن طارق

v تقييم "قابلية السير" عبر الأحياء المعاصرة في منطقة العاصمة إسلام أباد روالبندي ، باكستان

نبذة مختصرة

كان يُطلق على المدن الآسيوية دائمًا اسم ,,مدن المشاة" نظرًا لأن الناس كانوا يعتمدون بشكل كبير على أوضاع السفر النشطة (مثل المشي وركوب الدراجات) في الأنشطة اليومية. ومع ذلك ، عندما بدأت المدن في النمو ، أدت التوسعات الحضرية السريعة إلى ظهور العديد من التحديات غير المسبوقة في سياق الجنوب العالمي. كانت إحدى العواقب الرئيسية لهذه الامتدادات هي تعميم المركبات الآلية التي زادت من المشكلات البيئية (مثل تلوث الهواء ، والاحترار العالمي وما إلى ذلك) وتقليل سلامة المشاة (أي زيادة حوادث الطرق والوفيات). بغض النظر عن العديد من القضايا في التخطيط الموجه للسيارة ، يتم إيلاء اهتمام محدود للغاية لهذا المجال في المدن الباكستانية. أدى بدء التطورات الجديدة في المناطق شبه الحضرية وتصميمات الأحياء المعاصرة إلى زيادة الاعتماد على ملكية السيارات الخاصة بشكل عام لتغيير سلوكيات المشي بين السكان. على الرغم من العديد من الفوائد الصحية والبيئية ، فإن المشي يفقد أهميته كخيار للوضع وبالتالي يتم تسليم البيئة الحضرية للمركبات الآلية. في ضوء هذا الموقف ، هناك حاجة ماسة للتحقيق في المشكلات الأساسية التي تسبب هذا التحول في نمط التنقل. لمعالجة هذه المشكلة ، يسعى هذا البحث إلى تقييم إمكانية المشي بعناية عبر الأحياء المعاصرة في المدن الباكستانية. الهدف هو تحليل الميزات البيئية الحالية وإدراك السكان لهذه الميزات من أجل تقييم مقدار المشي الذي تدعمه هذه الأحياء في الواقع؟ سيساعد هذا في رسم توصيات لتحسين إمكانية المشي في الأحياء المعاصرة في المدن الباكستانية وسيعزز تصميمات الأحياء التي تتمحور حول الإنسان لتحسين السلامة والراحة والعيش.

إقرار

هذه الرسالة مقدمة في جامعة عين شمس وجامعة شوتجارت للحصول على درجة العمران المتكامل والتصميم المستدام. إن العمل الذي تحويه هذه الرسالة قد تم إنجازه بمعرفة الباحث سنة ...

هذا ويقر الباحث أن العمل المقدم هو خلاصة بحثه الشخصي وأنه قد اتبع الإسلوب العلمي السليم في الإشارة إلى المواد المؤخوذه من المراجع العلمية كلٌ في مكانه في مختلف أجزاء الرسالة..

وهذا إقرار مني بذلك،،،

التوقيع:

الباحث: **ثمن طارق**

التاريخ:08/12/2021

تقييم "قابلية السير" عبر الأحياء المعاصرة في منطقة العاصمة إسلام أباد روالبندي ، باكستان

مقدمة للحصول على درجة الماجستير في العمران المتكامل والتصميم المستدام

أثمن طارق

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التوقيع

تاريخ المناقشة:...............

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جامعة عين شمس

جامعة شتوتجارت

08/12/2021

جامعة عين شـــــمس

جامعة شتوتجارت

تقييم "قابلية السير" عبر الأحياء المعاصرة في منطقة العاصمة إسلام أباد روالبندي ، باكستان

رسالة مقدمة للحصول على درجة الماجستير في العمران المتكامل والتصميم المستدام

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