FACTORS AFFECTING WALKABILITY IN THE BUILT ENVIRONMENT OF SARGODHA CITY

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Thesis Acceptance Certificate

Certified that copy of thesis titled "FACTORS EFFECTING WALKABILITY IN THE BUILT ENVIRONMENT OF SARGODHA CITY" written by Mr Arslan Ahmed (Registration No. Fall 2017-U&RP 00000205892) of Urban & Regional Planning (NIT-SCEE) has been vetted by the undersigned, found complete in all respects as per NUST Statutes/Regulations, is free of plagiarism, errors and mistakes and is accepted as partial fulfilment for the award of MS Degree. It is further certified that necessary amendments as pointed out by GEC members of the scholar have also been incorporated in the said thesis.

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Name of Supervisor: Dr. Abdul Waheed

Date: _____

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Date: _____

Signature (Dean / Principal): _____

Date: _____

Dedicated to

My family, my beloved wife, my kids, my teachers and my friends

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(Arslan Ahmed)

Abstract

In the recent past, motorized modes of transport, especially single/dual occupancy modes of transport, i.e. car, motorbike, etc., are being considered a liability in transportation systems worldwide as they have several environmental, social, and health issues related to them. Our cities transportation system largely depends upon single/dual occupancy mode of transport, and there is a dire need of introducing more sustainable transportation patterns. We can achieve this goal if we take a fresh start by aligning our efforts, i.e. policies, infrastructure development, and public awareness programs, towards a sustainable transportation model in our cities. One of the key impediments in achieving sustainability goals for our cities is transportation sustainability. We can achieve this by adapting three transportation modes, i.e. walking, bicycling, and public transit. Combining these three transport modes can make an effective transportation system that can be sustainable environmentally and economically. At the same time, it will have social and health benefits for citizens.

The study mainly focuses on analysing the existing Built environment, i.e. pedestrian walkways, Street lights, Public transport services, etc., of Sargodha city and thus formulating a scale for measuring transportation sustainability for cities of Pakistan. The study will formulate/devise practices and policies to be implemented by the City administration to achieve sustainable transportation. Literature review, interviews, analysis of existing infrastructure, and current practices will be Baseline for establishing a scale for measuring transportation sustainability. The other part of the research is the study of 380 questionnaire surveys, which will identify the facilities and barriers in adopting Walkability as the mode of transportation. Mean Value method and Principal Component Analysis (PCA) will be utilised for said purpose

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1. Introduction

In the last two decades, urbanisation is the fastest-growing phenomenon in Asian Cities. Out of all the Asian cities, Pakistan has the highest rate in terms of urbanisation. (Sustainable Urbanization, 2019). As per the United Nations population estimates, almost half of the country will be urbanised by 2025 (Sustainable Urbanization, 2019). Rapid urbanisation in cities resulted in major challenges like reduced mobility and increased hazards on roads due to increased motorisation (Bhattacharyya & Mitra, 2013). These challenges have convinced urban planners to make efforts towards Walkable cities from Motorized cities (Bhattacharyya & Mitra, 2013). To make the cities more sustainable, Walkability is the key to this phenomenon. Walkability has effective solutions for various socio-economic, environmental, and psychological issues (Bhattacharyya & Mitra, 2013). To have a safe, secure, congestion-free, pollution-free, and fatalities free cities walkability phenomenon is the way to achieve it (Bhattacharyya & Mitra, 2013).

All of us want a safe, secure, hazard-free, pollution-free, and healthy environment around us. Motorisation has caused lots of pressure on the cities mass transit system. Pakistani cities, especially old city centres, are generally designed for Walking and cycling with narrow streets. Rapid urbanisation has caused motorisation causing issues like lack of accessibility, severe traffic congestions, roadside accidents and increased pollution level in the air (Bhattacharyya & Mitra, 2013). In the Urban form of any city, streets and open spaces are of vital importance. Rapid urbanisation has reduced open spaces and congestion of streets, resulting in less motivation for neighbourhood residents to walk. (Rahman, Shamsuddin, & Ghani, 2015). Developed nations have started planning their cities based on the basic principle of Walkability. They have produced positive results in less pollution, more accessibility, socio-economic benefits, and less fatal

neighbourhoods. However, developing nations are still struggling in solving these issues. Almost all Pakistani cities are expanding rapidly and are currently facing these issues. Walkability has a lot of socio-economic and health benefits (speck, 2018). Thus, there is a dire need to focus on these aspects in terms of Pakistani cities.

1.1. Problem Statement

Thomas S Monson stated that "When performance is measured, performance improves and the rate of improvement accelerates".

Sargodha city has a total population of 700,095, making it the 12th largest city in Pakistan. (Sarodha Population 2020, 2020). Currently, the city is expanding rapidly, which necessitates immediate attention on its transportation infrastructure to make it more sustainable. A thorough literature review study reveals that no such study has been carried out in the past to measure the transportation sustainability of the city, especially in terms of Walkability. In the world's modern cities, much work has been carried out regarding formulating tools / Frameworks to measure Walkability.

1.2. Objectives

Keeping in view the above-mentioned considerations, the study's main objective is to suggest measures to improve walkability practices in Sargodha, Pakistan.

The sub-objectives of the study are as follows:

i. To investigate factors affecting Walkability

ii. To get a public perception regarding Walkability

iii. To suggest measures to improve Walkability

2. Literature Review

2.1. Walkability in Built Environment

Walking is the first form of sustainable urban transport. Before the advent of transportation technology in the 19th century, most cities were planned to support Walkability.

The term Walkability means the level to which the neighbourhood's built environment is helpful to people who prefer walking. Walkability largely benefits the health of people living in the neighbourhood and increases the city neighbourhood's liveliness (Wang & Yang, 2019). Walkability in the built environment is valuable for two major reasons. Firstly the benefits of Walkability are related to people's mental and physical health. Secondly, benefits are associated with the environmental condition of the built environment and improved services for people (Wang & Yang, 2019). Walkability in the built environment largely depends on three major factors, i.e. Street connectivity, Residential density, and Land use mix (Wang & Yang, 2019). Among the others that have a positive co-relation with Walkability are pedestrian infrastructure and walkable distances.

The relationship of Walkability with people's life can be better understood by doing a comprehensive study related to Walkability.

2.2. Built Environment

The built environment is perceived as a feature where people spend most of their time, i.e. home, parks, school, offices, etc. Additionally, various other physical features of urban design, i.e. sidewalks, street lights, traffic density, the directness of pathways, etc. All these factors mentioned comes under the umbrella of the Built Environment. (Ferrer, Ruiz, & Mars, 2015)

2.3. Purpose of Walkability

Walkability in a built environment can be of two major categories

1. For Leisure (Gym, park, strolling, Beach)
2. For Utilitarian purposes (For work)

In our study, we will analyse both types of Walkability.

2.4. Elements of Walkability

Walkability is categorized into two main groups (Rafiemanzelat, 2017)

1. Streetscape

Streetscape include the visual presentation factors of an environment like roads, number of buildings, building space, sidewalk areas, green patches, etc. it is also regarded as a micro-level environment mostly used by public health researchers (Southworth, 2005)

2. Functional environment

Functional environment refers to the structural elements necessary to form a city (Fitzsimons, 2013) divides the functional environment into three basic categories. The following flow chart briefly represents the elements of Walkability.

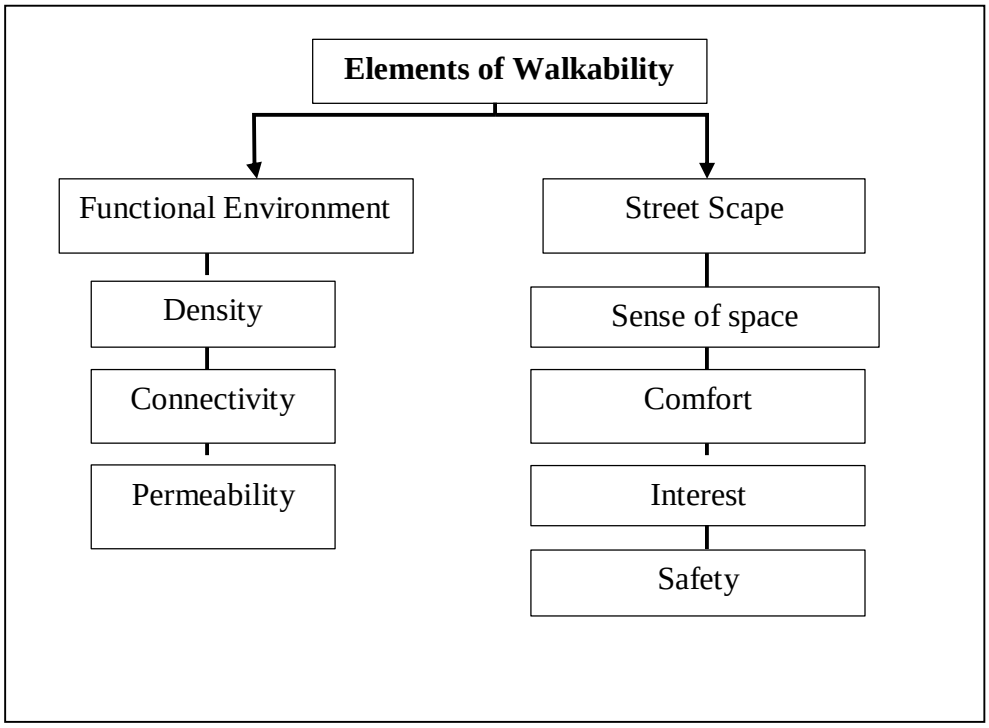

Figure 1 Elements of neighborhood walkability

2.5. Type of Land Uses in Built Environment

In a Built environment, there is various type of land uses, i.e. residential, industrial, educational, recreational, market area, etc. Integration of different land uses in a built environment has a very significant impact on Walkability. Mixed land uses in a Built environment have a direct relation with Walkability (Ferrer et al., 2015)

2.6. Factors Affecting Walkability in Built Environment

In recent years, the issues regarding Walkability in the built environment have become an important concern for urban researchers. Walkability is a diverse subject depending upon the variety of factors related to the scope of research like public health, social and economic, etc. Various factors in a built environment have an impact on Walkability in terms of sustainability

and smart growth of cities. Following are three major factors affecting Walkability in the built environment.

1. Land-use type

The mixed land side refers to a suitable combination of all sorts of physical space (homes, offices, parks, markets, etc.) within an area, therefore, appropriate for all physical activities. In an urban design context, a walkable street is one that has high access to different urban activities. (Southworth, 2005)

2. Street Connectivity

The physical form of any city can be determined from two basic elements, i.e. paths and nodes. People use paths or streets to move in a city where nodes are junctions or place breakpoints. A well-designed path can be used by every citizen and is easily accessible. High street connectivity determined through the continuity of sidewalks and footpaths in an urban region is directly relative to Walkability. (Andrew Devlin, 2009)

3. Residential density

Density indicates the travelling behaviour of an area by estimating the difference between the destinations using transport. The travel time and distance in compact neighbourhoods reduce by the use of cars; therefore an active transport means, i.e. walking, should be promoted in such high dense areas. (Andrew Devlin, 2009)

Other factors affecting Walkability in a Built environment are listed below (Ferrer et al., 2015)

1. Physical Attributes
2. Aesthetic Attributes

3. Economic Attributes

4. Environmental Attributes

5. Administrative Attributes

6. Behavioural Attributes

2.7. Importance of Walkability in Urban Environment

Due to increased urbanisation, the city structures are expanding uncontrollably thus, affecting the green lands and natural resources. The concept of 'compact and efficient' cities has been introduced to limit urban sprawling, which has social and environmental constraints on highly dense cities. In 2000, American Planning Association joined Walker Association, including 19 countries, and proposed the concept of smart growth in modern cities. Thereby walking was considered to be implemented as a counteractive measure having immediate impacts on social, environmental, and health aspects (Tong, 2016). The following flow chart in figure 2 represents Walkability concerning diverse aspects of society.

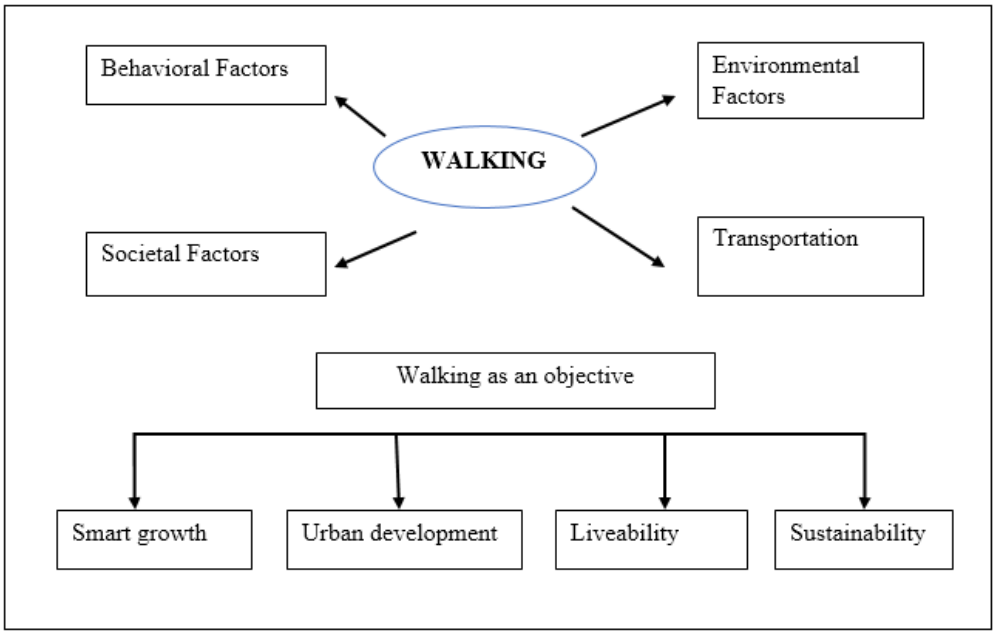

Figure 2 Relationship between walkability and society

2.8. Walking as a non-motorized transportation mode

Walking is the most basic mode of travelling adopted by human beings from the beginning of their lives. Even after the advancement in the mode of transportation, we will always be relying on our two feet to use any automobile. (Litman, 2012) stated that transportation policies and public approaches play a more significant role in the use of non-motorized transportation. According to a study at the Center for Transport Studies, University College London, 5 to 10% of people in London use cars for recreational activities merely (Mackett, 2000). Table1 presented a list of cities where people adopted walking as a means of travelling. (Litman T. , 2008)

Table 1. List of cities with a high percentage of walking as a transportation mean

Name of city	Walking (%)	Population
Amsterdam	47	718,000
Copen Hague	47	562,000
Barcelona	32	1,643,000
Vitoria	66	215,000
Groningen	58	170,000

A Canadian public survey indicates that 58% community is interested in using walking as a means of transportation while 85% use it for leisure activities. However, in an American survey, 38% of people desire walking to their workstations, and 85% choose to walk for a healthy lifestyle. Table 2 presented a survey of motorised and non – motorised modes of travelling in developed countries (Litman T. , Evaluating Non-Motorized Transportation, 2012).

Table 2. List of countries with a high percentage of non-motorized transportation

Country Name	Car usage (%)	Walking (%)
United States of America	84	2
United Kingdom	62	3
Canada	74	1
France	54	0
Germany	52	0
Sweden	36	4
Austria	39	8
Switzerland	38	4

2.9. Negative effects of car dependency

Most of automobiles are invented in the early 1900s by the end of World War II. With the increase in the active use of automobiles, the cities began to be shaped according to the ease of automobile access. The destructed cities of the war began to revolutionise, and automobiles came into the limelight due to less noise and pollution over the rail train system besides occupying less space and carry more load. Random urban sprawling due to personal automobile usage causes decentralisation of cities, breaking the connectivity between land use and transportation. (Cimen, 2001)

Car dependency is defined as excessive and incorrect use of a car itself (Okullu, 2007). The proportion of disadvantages of the use of personal cars then began to increase over its benefits. Table 3 presented the negative impact of car dependency on a country's society, environment, and economics. (Kentworthy, 1999)

Table 3. The negative impact of car dependency

Social	Environmental	Economic
• Less communication • Loss of public safety • Loss of street life	• Traffic problems • Noise and air pollution • Oil vulnerability • Urban sprawl • Smog • Emission of toxic gases and chemicals • Increase in greenhouse gases	• High infrastructure cost • Loss of productive rural lands • Congestion costs • Costs from pollution and accidents

The main objective of city life is friendship, exchange of knowledge & material goods. Now cities have become more mechanical with low quality of life. In recent years researchers indicate that pedestrian movement is a form of socialisation and quality of life in urban city centres. Pedestrianisation helps social interaction and liveability in cities. (David, 1995)

2.10. Measuring walkability in urban regions

In the past, several different approaches were used to measure the relationship between the built environment and physical activities like walking. These methods are based on the measurement of physical environmental variables. Following are some of the approaches used to measure the built environmental variables (Ross C. Brownson, 2009)

1. Self-support questionnaires

2. Archival records
3. Institutional records
4. Observational measures from audits
5. Environment audit
6. Consideration of spatial definitions
7. Qualitative neighbourhood measurement
8. GIS technology

(Reid Ewing, 2009) presented three methods of measuring Walkability. These are direct or indirect objective methods, and direct or indirect subjective methods are mixed. Following table 4 represents the details of these methods.

Table 4. Methods of measuring Walkability

Walkability	Objective measurement	Subjective measurement
Direct measurement	Walkability audit (direct field observation)	Interviews and survey walks
Indirect measurement	Evaluation of data using GIS	Evaluation of built environment based on design qualities

2.11. International Assessment Tools and Research Trends on Walkability

In the early years, research on walkable environment is initiated to facilitate public health. Later on, guidelines and theories were generated for urban design and planning linked with the pedestrian-friendly environment.

(Ewing R. , 1999) presents a manual on the classic urban design specification. The manual proposes an urban design checklist for an effective walking environment. The design specification

features are divided into three basic categories, i.e. essential features, highly desirable features, and nice additional features.

(Edwards, 2008) provides a guidebook titled "A healthy city is an active city" published by WHO in Europe. It provides planning tools for the development of healthy cities by encouraging physical activities in the citizens. Four basic strategies suggested in the manual are reducing urban sprawl, ease of access to parks, beaches, etc, development of green spaces and health care facilities. Regional Transport Authority of London develops a project known as Transport for London (TFL). It aims at developing a walkability index for London city using the space syntax method of pedestrian movement analysis (Stonor, 2002).

(Farideddin Peiravian, Development and application of the Pedestrian Environment Index (PEI), 2014) developed a computable model, Pedestrian Environment Index (PEI), for assessing pedestrian friendliness in an urban neighbourhood. The index is PEI based on four components, i.e. land-use diversity, commercial density, population density, and intersection density. The PEI is available to MPO's and urban planners, but it is still region-specific.

Transport Research Laboratory in London developed a software PERS to determine the walking score. Currently, it is being utilised by UK and Australia based studies. Similarly, two other web-based applications, i.e. walkanomics and walkscore, provides the application of walkability evaluation (Choi, WALKABILITY AS AN URBAN DESIGN PROBLEM, 2012)

A global walkability index was developed based on various variables, i.e. street connectivity, urban form, residential density, etc. Its main aim was to develop a walkability index to measure the Walkability of streets. Another aim was to develop a list of cities based on pedestrian-friendly

environment (Lawrence D. Frank, Many Pathways from Landuse to Health: Associations between Neighborhood Walkability and Active Transportation, Body Mass Index, and Air Quality, 2006)

(Albey, 2011) used another method known as Community Street Review (CSR) to predict Walkability. In this method, pedestrians were asked to rate a sidewalk crossing based on several factors developed by the author. CSR method profits both the community and the modern researchers. (FRUIN, 1971) introduced a qualitative method known as Loss of Service (LOS) to evaluate pedestrian performance. This method is extensively used by Transport Research Board, Highway Capacity Manual (HCM 2000).

2.12. Sustainable transportation

The concept of a sustainable transportation system was introduced in 1960. Researchers like William Whyte and Jane Jacob tried to reform urban spaces in terms of social, economic, and environmental sectors (Ghadimkhani, 2011). The basic aim was to design a walkable urban area with the least damage to the environment and utilising minimum cost. In 1992 a concept of 'smart growth' was introduced in North America similar to "compact cities" and "urban intensification in Europe. Smart transportation was one component of smart growth. It advocates livable cities with increasing access to public places by using non-motorized means to transports. It also encourages long term sustainability in urban designs by promoting walking, pedestrian-friendly streets, parks, mixed land use, etc. (Erkip, 2020)

New urbanism is a set of urban design values like traditional neighbourhood design (TND), transit-oriented development (TOD). A group of planners, architects, and environmentalists organised a Conference for New Urbanism (CNU) in 1993. Its principles are similar to the smart growth of cities and promote the reformation of urban policies. (GERRIT KNAAP, 2005).

2.13. Past Frameworks in Literature

In literature, different approaches have been found to determine transport sustainability in terms of walking and cycling. (Shiliang Su, 2019) proposed a five-step walkability framework using past frameworks from the literature. The conceptual model consists of five components i.e. connectivity, serviceability, accessibility, suitability, and perception. It is based on the idea to develop a new methodology to access street walkability of the developing countries as the existing frameworks are usually pertinent to western countries. Each of the five components is further divided into the following 13 indicators.

1. Local integration
2. Global integration
3. Global mean depth
4. Simpson's diversity index
5. Entropy
6. Destination density
7. Pedestrian width
8. Slope
9. Curvature
10. Green space coverage
11. Green space quality
12. Perceived greenery
13. Perceived enclosure

The framework is applied to a populous Hangzhou city of China, indicating that increased mixed land use is the practical formulation of walkable streets.

Another street walkability tool, 'SWATCH', was developed to analyse pedestrian route choice based on street environment (Yigitcanlar, 2018). SWATCH consists of two main components as Built environment characteristics and quality of the built environment.

Built environment characteristics and quality are divided into three subcategories as mentioned below;

1. Sidewalk characteristics
2. Land use along sidewalks
3. Traffic environment along sidewalks

Built environment quality is categorised into four subgroups as;

1. Functionality
2. Safety
3. Destination
4. Aesthetics

Each of the above-mentioned categories has culminated into 22 indicators. The main purpose of this tool is to provide planners and researchers with an effective means of data collection. Besides knowing the Walkability of an area, it is also important to understand which factors of street networks affect the pedestrian behaviour to tradeoff between alternate routes. The study was also applied to Brisbane, Australia validating 90% of street indicators.

Similarly, (Terri J. Pikora, 2002) provides a neighbourhood walkability framework for determining the physical features of the environment correlated with walking. Both walking for transport and walking for recreation are included in the said framework.

Robert Cervero first presented a 3D walkability framework to investigate the travel mode choice of San Francisco residents in 1997. The main goal of the framework was to introduce a compact model in support of non-motorized means of travel, thereby encouraging a pedestrian-friendly environment across the USA. The three principal components of the framework are density, design, and diversity. The first two components are divided into the following six indicators as mentioned below;

1. Population density
2. Employment density
3. Accessibility to jobs
4. Street network design
5. Pedestrian facility design
6. Site design

The 3D framework is then extended to a 5D framework (Pikora TJ, 2006) by including 21 new indicators. The following two more components are added to the previous 3D framework;

1. Destination accessibility
2. Distance to the transit station

Recently, 7C's walkability framework is presented in the literature by (Filipe Moura, 2017). The framework can be applied in altered areas providing good examining of pedestrian street amenities. The main objective of this framework is to provide "indicators of accessibility and attractiveness of pedestrian environment" in urban street walkable designs. The framework is comprised of the following seven components;

1. Connectivity

2. Convenience
3. Comfort
4. Conviviality
5. Conspicuousness
6. Coexistence
7. Commitment

All of the above components are divided into 17 indicators classified into two groups;

1. Street auditing indicators
2. GIS-based indicators

Similarly, (Céline Chakhtoura, 2016) presented a composite framework for the evaluation of sustainable urban transport strategies of large cities. This framework provides an in-depth assessment of existing transport plan outcomes and presents an applicable set of indicators for both developed and developing countries. The proposed framework consists of 16 components and more than 30 indicators selected through previous studies of Melbourne, Lyon, and Taipei frameworks. This framework is applied to evaluate sustainability achievement in four out of seven urban transport plans of the city of Paris based on their goals and objectives. In short, this framework will help in the evolution of certain indicators to fill gaps within transportation plans in large cities.

Several tools and frameworks are available in the literature to measure Walkability based on pedestrians' built environment and travelling behaviour. However (Geoffrey A.Battista, 2019) presented a pedestrian-oriented analytical framework. It is based on the fact that pedestrians who

use the street in everyday life can provide better reconciliation of social and physical components of walkable streets than any other street audit tool.

(Mohammad Taleai, 2017) presented a novel walkability assessment model to evaluate pathways Walkability at street segments. The author uses a two-step approach. In the first step, residents specify a walkability index score for street segments using the analytical hierarchical process (AHP) method based on the following five criteria;

1. Street connectivity
2. Access to public transit
3. Land use mix
4. Green spaces
5. Housing density

In the second step, a 3D GIS tool is used to evaluate streets based on two criteria, i.e. presence of shades and availability of landmarks. The model is applied in the two neighbourhoods of Tehran's capital city. The model greatly contributes to the making of walkability maps for the city.

Indicators are defined as numerical measures of sustainability (H. Haghshenas, 2012). An appropriate set of indicators are always needed by policymakers, planners, and decision support groups to evaluate certain laws, frameworks (H. Gudmundsson, 2012). (Deepty Jain, 2017) provided a set of 32 sustainable transport indicators, particularly for Indian cities. The author's main aim is to prepare a framework for low carbon mobility plans in Indian cities. The four components of the framework are as follows;

1. Social
2. Economic

3. Environmental

4. Activity

The results indicate that urban landforms, infrastructure development, and pricing policy should be focused to achieve sustainability in the transportation sector.

(Arlie Adkins, 2017) proposed a conceptual framework analysing the socioeconomic factors of Walkability. The framework investigates the effect of built environment features on the Walkability of different social groups like low-income population, ethnic minorities, individual household characteristics, disadvantaged communities, low educated groups, poverty, etc. The author highlighted some barriers like increase in crime rate, social behaviour, child protection, joint community disorder, etc., negatively affect the built environment, thereby decreasing the Walkability.

(ABDULLA, 2019) developed a detailed framework on Walkability in city centres of developing countries. The framework is designed in two phases. In phase I, walkability components are determined with special reference to Libya's Tripoli city centre area using the Delphi method. In phase II, a questionnaire-based survey is conducted based on four classes; resident's survey, professionals (planners, policymakers) surveys, site observations, and focus group study. The framework is divided into the following four components and 72 indicators based on four streets of the city centre;

1. Pedestrian facilities

2. Safety and security facilities

3. City management and planning facilities

4. Social and cultural activities

The results indicate that a change in resident's behaviour, increase in sitting areas, and improved street facilities can enhance Walkability in the city centres.

2.14. Areas of Application of Walkability practices

Vast areas of society can become potential zones where walkability practices can be applied. Walkability brings a positive environment for social, environmental, and economic conditions in an urban neighbourhood. Walking brings people closer, strengthening the bonds of the neighbourhood. Less use of automobiles reduces carbon emission, conveyance costs, air pollution and noise pollution. The current lifestyle has brought many health issues like cardiovascular diseases and obesity etc., which can be greatly reduced by adopting physical activities and a healthy lifestyle. Besides multi-disciplinary fields, the prominence of Walkability in the urban design field and built environment is exclusive. The following flow chart in figure 3 represents the relation of walkability application in different fields.

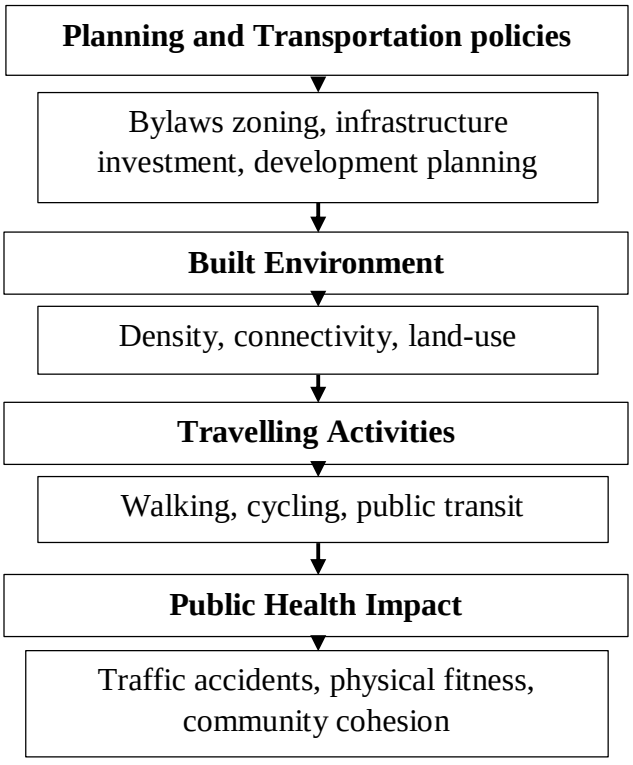

Figure 3 Walkability in diverse fields of life

3. Materials & Methodology

3.1. Sustainable cities and Walkability

Sustainability is defined as a means to fulfil human needs without conceding the needs of future generations. Like every other field, it is also used as a tool for combating urban development. (Diyanah Inani Azmi, 2012). The history of urbanisation dates back to 1910 when Clarence Perry introduced the concept of Neighborhood to resolve transportation issues in urban city centres. The basic aim of the Neighborhood Concept is to provide easy transit facilities to people. For example, five minutes walk from homes to schools, parks, and markets, etc. Nowadays, the perception of sustainable transportation has become the principle of sustainable neighbourhood designs. Unplanned urban sprawl is causing less dense areas leading to an increase in the use of automobiles.

Walking is generally defined as how much the built environment is pedestrian-friendly. Besides being adopted as a remedy for health problems (respiratory diseases, heart issues, obesity), it is now considered an important trait for sustainable urban space. According to (Karim, 2012) Malaysian people choose to walk less than 200 meters before getting to their vehicles. (Lawrence D. Frank, 2006) stated that Walkability is a human dependent behaviour. Another study by (Justin Thielman, 2015) defines “walkability as transport walking”. (Nadha Hassen, 2016) describes the street as a potential part of the built environment. Walkability in city centres can be enhanced by improving street infrastructure such as sidewalks, street connectivity, street lighting, crosswalks, etc.

3.2. The active Transportation system in South Asian Countries

Southeast Asia comprises 11 countries, including Pakistan, China, India, Indonesia, Philippines, Singapore, etc. Most of the countries of the region are still in the developing phase in terms of economic stability. According to the Association of Southeast Asian Nations (ASEAN), the region's total population will increase by 720 million by 2030. The region's small cities with around 2 million will help generate a combined GDP of 40%. (Pengjun Zhao, 2019). With the increase in population, the cities of the region will expand from small and midsized towns to become metropolitan. Asian cities are conventionally known for walking and cycling, where people mostly rely on foot for going to work, shopping, schools, and other daily activities. (Thuzar, 2011). Southeast Asia is specifically an unlike region in terms of socio-cultural, economic, and geographic context. Cities of this region develop explicitly of a sustainable economy and smart urban infrastructure, losing city liveability (Yap Kioe Sheng, 2012). Table 5 shows relative statistics of motorisation and the increase in the population.

Table 5. Relationship between Motorization and population growth across developing countries from 1980 - 2000

	For the year 2000		**Percentage change from 1980 to 2000**	
Countries	Passengers car (per thousand population)	GDP per capita (dollars)	Passengers car (per thousand population)	GDP per capita
Pakistan	7.47	514	198.80	50.29
China	6.94	1065	1209.43	345.61

Bangladesh	0.52	353	246.67	46.47
Indonesia	14.48	788	240.71	102.05
Malaysia	15.22	3927	63.66	112.50
Nepal	1.96	225	269.81	60.71
Philippines	28.46	1002	104.60	1.31
Singapore	103.05	22770	50.79	155.15
Thailand	43.38	1998	197.12	148.51
Srilanka	16.88	823	112.59	92.29

Presently, rapid urbanisation is causing negative impacts on urban transport issues such as air and noise pollution, increase traffic congestion, accidents and GHG emissions etc. (James Leather, 2011). A case study of metropolis Karachi Pakistan shows that rapid urbanisation growth leads to unplanned land use and motorisation. Modal split Statistics shows that paratransit has increased 15% from 1987 to 2004, whereas no research was found on city walkability (Intikhab Ahmed Qureshi, 2007). According to (Tiwari, 1999) the expansion and modern developments of cities will lead to issues of land use, traffic congestion and transportation. For example, the data collected from 14 different sites of Delhi showed that the vehicles of 0.60m to 2.6m share the same road; the one-lane road is saturated by 616 cars passing improper traffic channelisation and speed control limits per hour.

(Guenter Emberger, 2008), carried out a comparative study for the implementation of urban transport sustainability practices of the European Union in Southeast Asian countries. He concluded that the seven main barriers to the sustainable transportation system in the Southeast Asian region are; political system, private vehicle usage, resident's behaviour, societal issues,

economic issues and misapplication of technology. The population growth rate between European cities and Southeast Asian cities differ by 0.2% annually. The public transit system in large cities of Europe comprises of bus and truck-based transit systems, whereas in Asia, several forms of low-quality transits like rickshaws, taxis, motorcycles etc., are used.

Moreover, the people of South Asian regions are status quo and consider unsustainable transportation like car ownership as a symbol of success (BIYIK, 2020). Cycling and walking are considered only for low-income families. Lack of knowledge about the impacts of motorization on environments is also observed in Southeast Asian people.

Regarding sustainable urban transport of the Southeast region, previous researchers only focus on smart use of paratransit, land use, energy consumption and traffic issues, whereas no specific work has been carried out in terms of street walkability and amenities. (Pengjun Zhao, 2019) carried an analytical study in 26 cities in Southeast Asia under the ASEAN smart cities network (ASCN) for both drivable and walkable street networks. The results indicate that 22 out of 26 towns have direct drivable routes, whereas Jakarta, Mandalay and Makassar have average walkable ways. Singapore is regarded as highly walkable city. The percentage of drivable versus walkable streets are presented in the following table 6.

Table 6. Comparison of drivable and walkable streets in developing cities of Southeast Asia

City name	Total DSN length (m)	Full WSN length (m)	% of DSN vs WSN
Bangkok	120.9	197	15
Cebu	136	181	26.1
Hanoi	115	182	45.9
Jakarta	126	139	-6.4

Kuala Lumpur	120	206	82.1
Makassar	124	137	-5.1
Phuket	85	104	18
Manila City	146	180	24.2
Singapore	110	252	103.3
Vientiane	89	108	2.9

Another study was conducted by (Gota) in 9 Southeast Asian countries (Pakistan, China, India, Indonesia, Mongolia, Nepal, Philippines, Srilanka and Vietnam), including 15 cities, to determine the walkability trend among citizens. More than 4500 pedestrians were interviewed to collect the data. The results showed that pedestrians are disturbed by the unavailability of proper street infrastructure, and 81% of respondents wanted to shift to motorised transport modes. Hong Kong is the only city suitable for walking, whereas five cities (Chennai, Bangalore, Kathmandu, Jakarta, and Karachi) are categorized as not walkable. Nine cities (Colombo, Kota, Lanzhou, Hanoi, Davao, Cebu, Ulaanbaatar, Metro Manila, Ho Chi Minh) were considered in the waiting to walk category.

One of the core challenges of expanding cities is sustainable urban development, including sustainable transport infrastructure. The transportation system is one of the main pillars of urban growth and economy (Pengjun Zhao, 2019). Unfortunately, every South Asian country has an exclusive government, social and cultural norms, geography, climate, economic system, and technological advancement.

3.3. Measuring barriers and drivers for Walkability

With the increase in the quality evidence of walking in a built environment, policymakers are more inclined towards making an effective pedestrian environment. Many contrasting barriers and motivators have been found in the literature on sustainable transportation (SMT) (Filipe Moura, 2017). Certain constraints like public behaviour, absence of proper administration, pollution issues etc., are most effective in declining the trend of active transportation (James Leather, 2011). According to (Peolla Paula, 2018), the main barrier to walking is people's attitude toward having personal cars as a symbol of prosperity. A comparative study conducted in Starkville, Mississippi, stated aesthetics have the most constructive effect on neighbourhood walking, whereas social environments are a barrier (Choi Lu, 2015). Although 60 to 70% use walking as a medium for transit in India's small and medium developing cities, cities still lack infrastructure and budget for pedestrian development (Krambeck, 2006). According to a study conducted by Asian Development Bank, it is found that urban planning organizations of Asian cities mainly focuses on improving traffic flow in towns and neglecting the needs of pedestrians (James Leather, 2011). Hence, with all the identified factors affecting the usage of sustainable modes of transportation, there are some strategies to promote this behaviour.

3.4. Study Area

The area selected for the present study is Sargodha city, located in Punjab province of Pakistan, also known as the city of Eagles. The total area of the city district is 5854 km^2. It is the 12^{th} largest city of Pakistan with regards to its population. According to the 2015 census of Pakistan, the city's total population is 3,397,000, with a population density of 4300 per km^2 and an urban population of 956,000 (Omar Riaz, 2017). The estimated population of the city in 2020 is 862,227. Sargodha is one of those five cities that were expanded through proper planning (Sargodha City Profile).

The city district's total built-up area increases from 61.86 km to 152.07 km from980 from 2003 (Sajjad Hussain Sajjad, 2015).

In the said research, the city is divided into the following three major areas;

1. Cantonment area
2. CBD (Commercial markets)
3. Blocks / Satellite town area

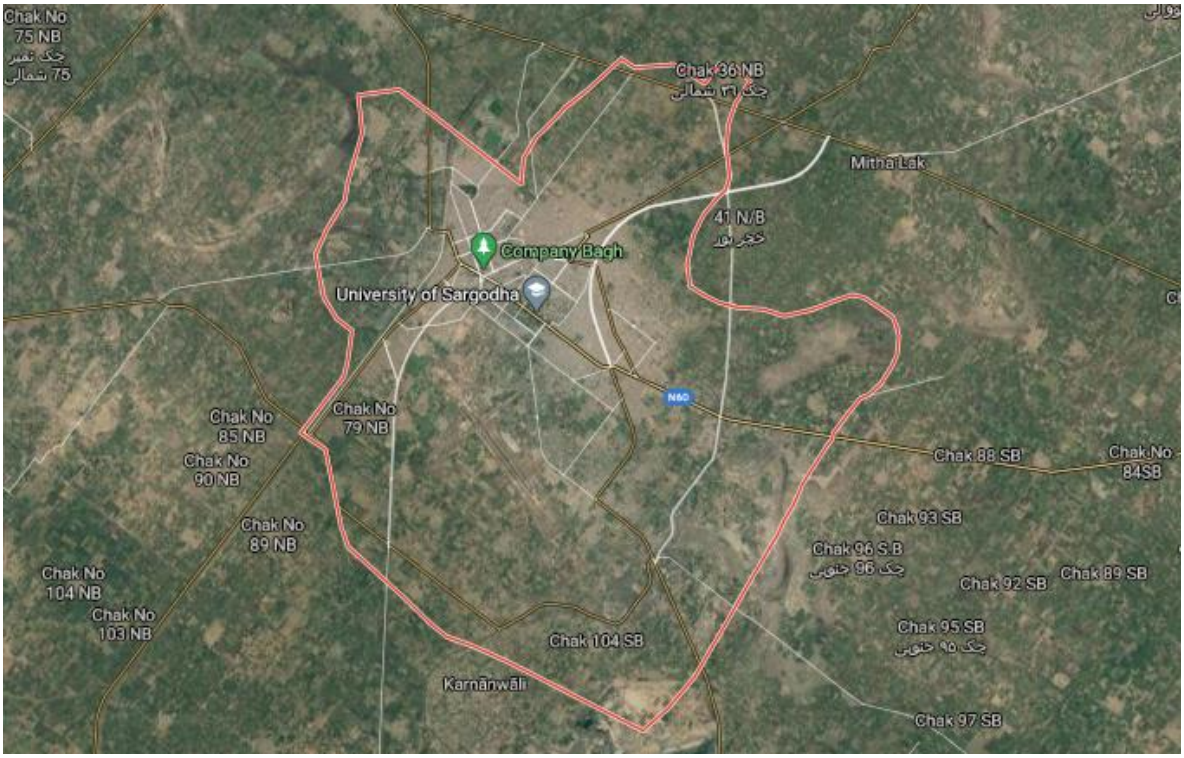

Figure 4 Location map of Sargodha city

Presently, the urban transport facilities of the city are not adequate. The city lacks an effective public transit system. Due to the mix of motorized and non-motorized transportation overall major roads major commercial areas face traffic congestion. Limited off-street parking areas and non-

availability of footpaths along roads force residents to use roads for vehicles parking. Furthermore, the city is also lacking traffic signals.

3.5. Survey design

The design of the present research study consists of only one piece of equipment mentioned below;

- Survey Questionnaire

3.5.1. Checklist of indicators

An index of 80 indicators has been formulated from the literature based on the following six attributes of neighbourhood walkability;

1. Awareness
2. Behavioural attributes
3. Physical attributes
4. Aesthetic attributes
5. Security and safety attributes
6. Health attributes

From the checklist, 47 indicators have been included in the questionnaire to evaluate the Walkability of the said study area by the respective residents. After the accumulation of data from treatment areas of the city, a comparison shall be made highlighting the separate lagging areas. To help urban planners and policymakers, results shall also be compared with the international standards derived from the literature to compare the present study area with the international cities practising Walkability.

3.5.2. Benchmarks for indicators from literature

Several criteria's have been developed worldwide to evaluate the walkability of the built environment using different tools. Every tool has its strength and weaknesses. For example, the Walking Sustainability Assessment Form (WSAF) is a tool public health professionals use to access the aptness of walkways and roads for walking (James Emery, 2003). Similarly, Pedestrian Environment Data Scan (PEDS) is a comprehensive tool used by planners to measure environmentally-friendly features of Walkability (Kelly J. Clifton, 2007). Active Neighborhood Checklist offer street-level features of a neighbour used to measure the physical activity of an area (Hoehner, 2100).

The checklist developed in the present study includes the criteria from these recognized tools and frameworks. The first indicator is the **width of walkways** is another important parameter of street furniture design used as an indicator in the present study. The effectiveness of walkway width makes it suitable for walking (Shiliang Su, 2019). The presence or absence of walkways do not utterly fulfil the evaluation criteria; instead, the width of walkways play a significant role in the rate of sidewalk usage. (Zohreh Asadi-Shekari, 2014) recommended that the width of the footpath should be between 1.8m to 2.4m or 1.5meters.

Nowadays, modern town planners and urban developers are working hard on implementing sustainability principles of urban regions. Over the past decade, walking and physical activities have weakened progressively in most cities of the world; therefore, modern urban planners are working hard to implement sustainability principles like walking in urban spaces. Many different researchers from the field of social sciences, transportation engineering, urban planning etc., had used different approaches to measure the walkability of the built environment. According to (Krambeck, 2006) besides congested walking paths, one of the main problems reducing

walkability in neighbourhoods. So the **presence or absence of walkways** is included as an indicator in a said research study. Another factor related to sidewalks is the **presence of alternate routes for walking**. They have narrow lanes between buildings, access lanes connecting cul-de-sacs through parks or other public areas etc.

Another very important indicator included in the said research is the **presence of pedestrians on the streets**. (Filipe Moura, 2017) One of the most important factors in promoting Walkability in any metropolitan city is pedestrian count (the percentage of residents willing to walk). Similarly, the **portion of roads with or without sidewalks** as used by (Krambeck, 2006) can also be used as an indicator for evaluating Walkability in the existing condition of a city.

Walking culture can be promoted in a neighbourhood if serviceability is improved (Shiliang Su, 2019). Street amenities should cover a radius of 0.25 miles in an area (Farideddin Peiravian, 2014). The extent of the **presence of garbage cans and dust bins** (Zohreh Asadi-Shekari, 2014) is one of the many street facilities used as an indicator with the following criteria;

1. No presence of trash cans
2. Provision of trash cans at every 200m to 400m.
3. Trash cans to be placed at 25metrer centre to centre spacing near public areas like playgrounds, cafeterias etc.
4. Trash cans to have a minimum clearance of 1.2m from street amenities like benches, bus stops etc.
5. Regular emptying of trash bins.

The **presence of changing rooms and showers** facilities near playgrounds, parks and jogging tracks plays a vital role in stimulating a physically active lifestyle. The provision of changing rooms' facilities is also an evaluating indicator in the said research study (Gallagher, 2014).

An important administrative indicator that hinders walking is the lack of funds designated by the city administration for sustainable transportation and preferring other projects over these active transportation modes. The **lack of funds allocated for pedestrians** (Krambeck, 2006) is also included in the present study. The data for this indicator shall be obtained from administrative personals.

Many Asian countries have only 15 -20% total space for transport infrastructure. According to (James Leather, 2011), many countries have started working towards sustainable development goals like the 10th Malaysian Plan includes **a** pedestrian-friendly development approach. The Philippines Presidential Administrative Order stated that space for pedestrian traffic is equally important as car lanes. Similarly, Singapore crafted a people-oriented land transport plan for their neighbourhood. Besides, Bangladesh, Mongolia, India, Sri Lanka, Indonesia are also working on projects for achieving a physically active environment. In America, Robert Wood Johnson Foundation spent 84 million dollars implementing active living programs (Dijkstra, 2011). Therefore the **public awareness about sustainable development** is included as an indicator in said research.

Availability of benches along pathways is another street amenity included in the list of indicators. The presence of resting areas or bars along the sidewalk help reduces social and environmental issues. (Zohreh Asadi-Shekari, 2014) recommended the following criteria for provision of sitting areas;

1. Benches should be placed at every 200m to 400m distance interval and provided at every bus stop station.
2. The minimum distance of the bench from the face of the curb should be 0.6m and 9 meters from the intersection.
3. Benches should be covered with shade
4. A minimum space of 1.2 meters should be provided at the ends of the sitting areas for wheelchairs and strollers.

Another indicator is the **fear of crimes and theft** on the street, including pick-pocketing, mugging etc. According to (Dijkstra, 2011) American roads are more dangerous for pedestrians than people using vehicles. In 2001, the fatality rate of American pedestrians was 23 times more than car occupants. In comparison, they are six times and three times more likely to get killed than Dutch and German pedestrians, respectively. Netherlands and Germany are now providing safe suburban developments. To measure this indicator, it is necessary to have zero crime rate on the streets. The presence of high-security surveillance of roads and buildings through CCTV cameras can also be adopted to reduce the crime rate and make the cities more liveable. (Gallagher, 2014). The presence of security guards and patrolling police on the streets, Wi-Fi locations, charging ports and display of security numbers on boards can also serve the purpose (Terri J. Pikora, 2002). In addition to fear of theft and robbery, **stray dogs and other animals on the street** make it difficult for people to use the roads.

Inefficient urban designing results in a limiting pedestrian-friendly environment. The presence of telephone poles, electricity poles, trees, open or closed sewers, temporarily parked cars, and construction material in the centre of walkways are permanent obstructions difficult to remove. In contrast, vendors and side cafes are welcomed temporary obstacles impacting the walking

behaviour of a neighbourhood (Krambeck, 2006). Proper allocation of these types of obstructions should be included in urban street designing. The **presence of obstacles** affects the width of walkways and is included as an indicator in said research. Following criteria have been described by (Krambeck, 2006) for evaluating effective width of walkways based on the presence of obstructions;

1. Obstructions completely block walkways.
2. Pedestrians find the walkways inconvenient if effective sidewalk width < 1meter.
3. Walkways are mildly inconvenient if effective sidewalk width ≤ 1meter.
4. Presence of minor obstacles,
5. No obstructions are present on walkways.

Besides the great benefits of walking, pedestrians are always at risk of accidents (Filipe Moura, 2017). Therefore **the number of casualties** is included as an indicator in the present study. Similarly, the **presence of heavy traffic on roads** with walkways is another safety indicator. According to (Todd Litman, Pedestrian and Bicycle Planning Guide to Best Practices, 2009), the railing should be provided at the sides of the walkways to avoid collisions. Traffic control devices like speed bumps, roundabouts, chicanes and proper marking of lanes for walking, cycling and vehicles must be present to control heavy traffic and collisions (Terri J. Pikora, 2002).

The **presence of buffer zones** is an indicator of a pedestrian-friendly environment (Zohreh Asadi-Shekari, 2014) and is included in the evaluation criteria for the said study. Buffers between roads and pathways are of two types: hard protectors including fences, trees and hedges and soft pads consisting of grass patches and landscapes. According to (Zohreh Asadi-Shekari, 2014) a buffer zone can have a minimum width of 1.8m to 2.4m.

The Systematic Pedestrian and Cycling Environment Scale (SPCES) presents a 5D framework for a walkable environment: esthetics (Shiliang Su, 2019). Landscape elements like trees, plants, and parks offer appealing and attractive scenery to the eyes of residents. It also presents a sense of evenness in an area providing easy path directions for pedestrians (Reihaneh Sadat Hajmirsadeghi, 2012). The criteria of the **presence of trees** are also included as an indicator in the present study. According to (Litman, 2012) the following criteria should be considered:

1. The width of the planting strip should be 6 feet from the edge of the curb to the edge of the sidewalk.
2. Trees should be planted at an interval of 20, 30, 40 and 50 feet.
3. Trees should be trimmed to about 9 feet in height and form a canopy.

The **presence of shades on pathways** is another important indicator. The provision of shades on walkways provide a sense of comfort to pedestrians and helps to improve the walking environment (James Leather, 2011). The following four criteria have been mentioned by (Krambeck, 2006) to protect pedestrians from a harsh climate.

1. Presence of temporary awning.
2. Presence of permanent awning
3. Presence of arcade
4. Presences of trees.

Provision of outdoor drinking water places along walkways, parks and open spaces encourage the usage of that place (Özgür Göçer, 2019). According to (Rachel A Millstein, 2013), **drinking fountains** is one of the street amenities that has a positive effect on Walkability, therefore included in the indicator list. The criteria of drinking fountains, as defined by (Zohreh Asadi-Shekari, 2014)

is to place drinking water fountains in sheltered areas at a centre to centre distance of 400m and at 0.6m away from pedestrian walkways.

The **presence of drainage holes** along roads and walkways is also included in the list of observed indicators. These drainage holes provide easy drainage of rainwater from streets and protect them from erosion and damage. If such drainage holes are not present or less in the required number, water will accumulate on the roads causing discomfort to pedestrians. According to (Litman, 2012) drainage grates should be placed outside the route of pedestrian paths, whereas those grated located in the pathways should have an opening of less than 13mm.

Another important indicator related to cleanliness is **dirt and litter on the sidewalks** (Krambeck, 2006). Cleaned walkways give the eyes a sense of pleasure (Filipe Moura, 2017) classified uncleansed streets as poor streets. (Krambeck, 2006) classified street cleanliness into the following five categories.

1. Excess quantity of rubbish and animal dunk causing full obstruction of walkways.
2. A small number of wrappers and other litter causing mild obstruction of walkways.
3. A very small amount of wrappers and rubbish is seen on walkways
4. Trash is very little, causing no hindrance to pedestrians.
5. Pathways are fully cleaned with no litter present.

Besides cleanliness, the **maintenance of sidewalks** is also included as an indicator in the said research. According to (Krambeck, 2006) maintenance of sidewalks is divided into the following categories;

1. The top surface of the sidewalk is broken down to dirt and slush.
2. Only some portions of the top surface are broken

3. The top surface is merely damaged, and it is uneven and bumpy.
4. The top surface is intact but difficult to walk due to grass growing between the tiles.
5. A smooth and presented sidewalk with good maintenance.

The presence of public art is a symbol of heritage. It is a way of engaging people in social, political and verbal communication, so it is considered as an aesthetic indicator in the present study. Public art, landscapes, and architecture come under space design, positively affecting residents' phycology and behavioural practice by reducing their stress levels (Childs, 2006). According to (Rachel A Millstein, 2013) good public art and landscape are promoters of Walkability in a neighbourhood. However, graffiti or damaged walls discourage a pedestrian-friendly environment. Therefore **presence or absence of wall paintings and graffiti** is included in the said research.

The presence of proper lighting conditions is an important physical aspect of streets. Stated that the fact of lightning, especially at night times, a feeling of security and safety but greetings (Reihaneh Sadat Hajmirsadeghi, 2012). The absence of street lights or improper lighting conditions can be a stake for street crimes and injuries, especially for children and women (SL Fowler, 2017). Some of the general criteria mentioned in the literature by (Zohreh Asadi-Shekari, 2014) are;

1. Light poles should be placed at a distance of 0.9meter from the road if the curb is not present.
2. The minimum centre to centre distance of the poles should be 9meter.
3. Obstructions like trees and electricity poles should be avoided.
4. The light should shine all over the walkways

So, the **percentage of walkable roads with street lights** can be used as an indicator for the evaluation of Walkability (Krambeck, 2006)

The material used for constructing walkways and pedestrian paths should be smooth, firm and easy to walk on (Todd Litman, Pedestrian and Bicycle Planning Guide to Best Practices, 2009). According to (Kelly J. Clifton, 2007), the footpaths are made of asphalt, concrete and paving bricks with sand and gravel as resistant material. According to (Bikeway and Trail Design Standards and Planning Guidelines Frederick County Parklands., 2003), the **fabric of the walkways** can be an indicator of Walkability evaluated into the following five categories as:

1. Dirt or sand (least suitable)
2. Gravels or crushed rocks
3. Vegetation cover
4. Paving bricks
5. Concrete or asphalt (most convenient)

An actively walkable neighbourhood is one where people can easily go to their regular places (Southworth, 2005). Besides other street facilities, the level of comfort is also an important aspect of walkable communities. One of the parameters defining ease of pedestrians is the time consumed during walking to ensure daily needs. So **time consumed in walking** for daily activities is also included as an indicator in said research (Richard L. knoblauch, 1996).

Assessment of neighbour design is made through compactness and density of physical form a neighbourhood. A sustainable city has an integrated, compact and dense network of all built forms (Jabareen, 2006). Criteria for **largeness of community** is included in the said research because it highly impacts the mobility of residents. The vastness of the neighbourhood can be determined by

the time people take to travel from one destination to another. It also depends upon the choice of travel mode. (Saelens, 2003) define four characteristics of highly walkable neighbourhoods: a good mix of land use, high population density, good street connectivity, and continuous sidewalks. Other criteria found in the literature to measure neighbourhood walkability are 'link to node ratio' and 'pedestrian route directness. According to (Dill, 2004) LNR (link to node ratio) should be between 1.33-1.46 in traditional neighbourhoods and 1.26-1.37 for the conventional area. Similarly, PRD (pedestrian route directness) should be 1.31-1.39 in traditional settings and 1.35-1.44 in traditional neighbourhoods. Neighbourhoods having a good street network connection, small block sizes, more intersections, fewer cul-de-sacs, and land mix-use provide shorter and direct routes for walking (Gavin Turrell, 2013)

According to (Mai ElSherief, 2015). More than 7800 harassment incidents occur over the street, out of which 50% of cases are reported on highly walkable streets worldwide. Therefore the indicator for **street harassment and bullying** is included as an indicator/barrier in the said research. Urban transportation planners should involve residents, transit service members and travellers in planning and developing a neighbourhood's transit (Carolyn McAndrews, 2006). It will be evaluated based on yes/no criteria in this research.

Public transit is defined as a mode of travel from one point to another or to reach a pickup point of public transit to reach the final destination point (Casey P. Durand, 2016). One of the key roles of public transit is its association to physical activity like walking (distance people walk to access public transportation like bus, train etc.) (Daniels, 2013). So the criteria of **easy access to transit stations** are included in the said research. Different region specified criteria about public transit accessibility by walking has been found in the literature. The walking distance from residential buildings, schools and offices etc., to public transit stations should be 400m (0.25miles) or 800m

(0.5 miles) (SuzanneMavoa, 2012). According to the Ministry of Transport, Sydney, 15 metropolitan transit stations should be 400 m and 800m of 90% of houses of a single neighbourhood unit at day and night, respectively (Daniels, 2013) . (Public Transport Planning Guidelines in Helsinki, 2008) uses 300meter standard distance, whereas (Design and planning guidelines for public transport infrastructure: Bus route planning and transit streets, 2003) uses an average length of 500meter in Perth, Australia.

Continuous increases in the world population have put great pressure on urban growth policies and infrastructure. Sprawling results in limited Walkability and more reliance on vehicles (Mark Stevenson, 2016). (Rebecca Miles, 2008) investigated a close connection between the built environment and physical activities and proved to benefit people with heart diseases, respiratory problems and obesity etc. (Adriana A. Zuniga-Teran, 2017). A study in Ontario, Canada, revealed that people who even walk for utilitarian purposes have less BMI than those who use vehicles (Maria Chiu, 2015). According to (Marc A Adams, 2013) , lack of physical activity is the 4th primary cause of death worldwide. Therefore the criteria for **health benefits of walking** have been included in the said research. It will be evaluated based on yes or no standards.

Weather conditions and seasonal changes also affect the Walkability of a region. Pleasant weather attracts people to walk to their workplaces and nearby neighbourhood areas, whereas harsh weather like sunny days with high temperatures, snow and rainy seasons deters walking (FARNIAN, 2014). Temperatures more than 18 degrees discourages walking in the US. The presence of volatile nitrogen compounds, excess smoke and other harmful chemicals in the air deteriorates the air quality, making walking difficult (Lawrence D. Frank, 2006). So the **effect of climate change and weather conditions** have been included in the said research.

The presence of heavy traffic and high-speed vehicles confuses the pedestrians. People out of safety don't prefer to walk or crossroads in case of dense traffic. Several types of road crossings like the pelican, zebra, and toucan flyovers, underpass, overpass etc., are available in the literature (Pikora TJ, 2006). The indicator for the **presence of pedestrian crossing** has been included in the said research. The company of any of these types of intersections can be used for evaluation.

Similarly, the **presence of road markings** like central road lane, turning lane, area markings with arrows ensures the safety of pedestrians (Poggenhans, Schreiber, & Stiller, 2015) (Albert Baumgartner, 1999). Another similar indicator is the presence of a **gap between footpaths and roads** included in this research study. Raised footpaths or curbs is one way of separating roads and walkways (PURNIMA PARIDA, 2007). A furnishing zone of 1.2m wide and curb with a minimum width of 0.15m and height of 0.01-0.15m is recommended (Zohreh Asadi-Shekari, 2014).

The presence of green spaces like parks and gardens makes the city attractive. Residents living in demanding urban environments are attracted to the quiet and calming atmosphere (AnnVan Herzele, 2003). Most authors specified that parks should be located at a walking time of 5 minutes and 400 meters from the homes. Table 8 has presented standards for green spaces (MIRA-S 2009). However, distance criteria vary from one region to another based on barriers like mobility, health issues, safety, etc. (Grahn, 1991). Therefore the requirements of the **presence of parks and green spaces** have been included in the said research.

Table 7. Criteria for availability of green lands

Functionality	Maximum distance from homes (m)	Minimum surface area (ha)
Residential greens	150	1
Neighbourhood greens	400	10 (park: 5 ha)

Quarter green	800	30 (park: 5 ha)
District greens	1600	60
City green	3200	>200 (smaller towns)
Urban forest	5000	>300 (big cities)

A walkable city is defined as having an inclusive system of public and street facilities (Juriah Zakaria, 2015). New urban planners suggested building shopping centres near transit stations to make walkability effective (STEINER, 1998). So **the presence of shopping centres** at walking distance is also included as an indicator in this research. One criterion found in literature is that all the necessities (banks, shopping malls, pharmacies etc.) should lie within 1000m of the housing areas; however, it can range between 600 to 1200m (Hugh Millward, 2013).

All the benchmarks mentioned above of factors affect the use of Walkability as an active transportation mode.

3.5.3. Questionnaire design for examining residents' perspective

Different researchers have frequently applied survey techniques to measure the attitude of residents regarding walking practices in their community (Özgür Göçer, 2019). In the present research study, a survey technique has been used to collect data from three different city areas. The questionnaire has been divided into four parts. The first part consists of questions related to the socio-demographic attributes of the respondents having both nominal and open-ended questions. The second part consists of inquiries related to the sufficiency of active transportation mode in the city on the five-point Likert scale from "Strongly Agree" to "Strongly Disagree". The third part consists of barriers measuring the limitations of Walkability in the neighbourhood on 5

points Likert scale from “Not at All” to “Fully. The fourth part consists of open-ended suggestions from a resident about improving walking behaviour in their neighbourhoods.

The survey questionnaire is attached in Appendix B. The list of 12 barriers included in the study is shown in table 8.

Table 8. List of obstacles included in the study

code	Barriers
B 01	My physical body stamina doesn’t allow me to walk
B 02	Poor cleanliness condition of footpaths
B 03	I can’t carry a heavy backpack while walking
B 04	Less gap between footpaths and roads make it unsafe
B 05	It is inconvenient to walk due to dresses that I wear
B 06	Large distance between my frequently visited destinations
B 07	The largeness of the neighbourhood discourage me to walk
B 08	The presence of open sewers and gutters beside footpaths discourages me
B 09	The presence of beggars on footpaths discourages me
B 10	The presence of street vendors on footpaths discourages me
B 11	People sitting on footpaths for chit chat discourages me
B 12	The absence of street lights discourages me

3.6. Sampling

The generation of a proper representative sample is an important objective that needs to be achieved in the research. Adequate sample size can greatly affect the relationships and significance of the variables being used as it is one of the four important aspects of research design. Generally,

three criteria need to be fulfilled for the suitable sample size; precision level, confidence level, and variability degree in measured attributes. Different techniques for determining sample size can be found in literature like Cochrane formula, Yamane formula, Glenn's Table. We have used the following Slovin's formula to determine the sample size in our present study.

$$n = \frac{N}{1 + Ne^2}$$

Where n = sample size

N = Population

e = Error tolerance

4. Data Collection and Analysis

4.1. Data Collection

The data for the present study is collected using a survey technique only. The questionnaire data has been compiled using online forms, distributing printed documents in the residents, shopkeepers and homes of all the three different study areas, i.e. cantonment, central business district and satellite town area.

All the data has been gathered from the three areas of the city in the period from March to June.

4.2. Demographics of the survey

The questionnaire was distributed to over 500 randomly found respondents, including residents, shopkeepers, school going students, employees, homemakers, and old age people, with the possibility of equal participation from the three study areas. The received forms made part of the study are 380, out of which 114respondents belong to the Cantonment area, 112 belong to Central Business District (CBD), and 154 respondents belong to the Satellite town/ blocks area. Out of these 380 respondents, 178 were males, and 202 were females.

Table 9. Socio-demographic content of the respondents

Demographic details		**Cantonment**		**Central Business District (CBD)**		**Satellite town/ Blocks**		**Total**	
		114		112		154		380	
		Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Gender	**Female**	52	45.6	65	58	85	55.1	202	53.1
	Male	62	54.3	47	41.9	69	44.8	178	46.8
Age	**12 - 20**	31	27	42	37.5	52	33.7	125	32.8

	20 - 30	42	36.8	39	34.8	70	45.4	151	39.7
	30 - 40	15	13.1	17	15.1	16	10.3	48	12.6
	40 - 50	17	14.9	12	10.7	5	3.2	34	8.94
	>50	10	8.7	2	1.7	2	1.2	14	3.64

4.3. Data standardization

For the questionnaire survey data, to compute the data easily, the information is standardised with a mean of 0 and a standard deviation of 1, known as z-scoring. The formula of z-scoring is shown in the equation below;

$$z = \frac{X - \bar{\bar{X}}}{s}$$

Where,

X = original value of the score

$\bar{\bar{X}}$ = mean of all score

s = standard deviation

4.4. Chi-square Technique

Chi-square is a statistical technique that is used to check the relationship between categorical variables. Pearson chi-square test has been used with Yate's continuity correction in case 2 X 2 matrix to measure the statistical difference in respondents' profiling and perception of people regarding walkability facilities in their neighbourhood areas.

4.5. Cronbach's Alpha

After the data collection, the reliability of the scale is checked by the Cronbach alpha reliability test. It is a widely used test to measure internal reliability. The threshold for Cronbach alpha value is 0.7.

4.6. Mean Score Method

The mean Score method is used to evaluate the walking facilities categorized into the list of 6 different attributes (awareness, physical, behavioural, aesthetic, security, health) like the presence of shady trees, absence or presence of street lights, availability of drinking water beside pathways and absence or presence of road markings etc. among residents of Cantonment, CBD and Satellite town area. The responses from all three areas have been summarized in Figures 6, 7 and 8. The facilities were marked from "1= Not at all" to "5 = extremely aware". The responses from the three study areas have been ranked orderly by a mean square method.

Similarly, the effect of barriers, which hinders the Walkability within a particular neighbourhood, were also marked on a scale of "1 = not at all" to "5 = fully" by the respondents. The results have also been ranked orderly based on the mean score method for all three areas.

4.7. Exploratory Factor Analysis/ Principle Component Analysis

After the data standardisation from the questionnaire survey, factor analysis or principal component analysis was performed to reduce the data size to a more manageable one. It is also used to determine the cluster of variables known as latent variables.

The survey questionnaire was comprised of walkability indicators/ attributes and barriers. Principle component analysis was used on both parts of the questionnaire separately to identify the principle indicators and barriers of Walkability with each neighbourhood of the study area.

However, some initial checks have also been performed to see whether Principal Component Analysis is viable to be used or not.

4.7.1. KMO measure and Bartlett's Test of Sphericity

The first check for Principal Component Analysis includes the Kaiser-Meyer-Olkin (KMO) measure for sample adequacy. The KMO value is recommended to be above 0.5 with the following categorization as mentioned by (Field 2013) in Table 10;

Table 10: KMO measure of sample adequacy

Serial No.	KMO value	Acceptability
1	0.9 – 1.0	Marvelous
2	0.8 – 0.9	Meritorious
3	0.7 – 0.8	Middling
4	0.6 – 0.7	Mediocre
5	0.5 – 0.6	Miserable
6	Below 0.5	Unacceptable

The second check is Bartlett's test for Sphericity to check whether the correlation matrix is the identity or not. If the correlation matrix is the identity matrix, Bartlett's significance value will show a value greater than 0.001, and PCA cannot proceed. However, a significance value less than 0.001 is recommended to move to PCA.

The flow chart for the adopted methodology is shown below in figure 5.

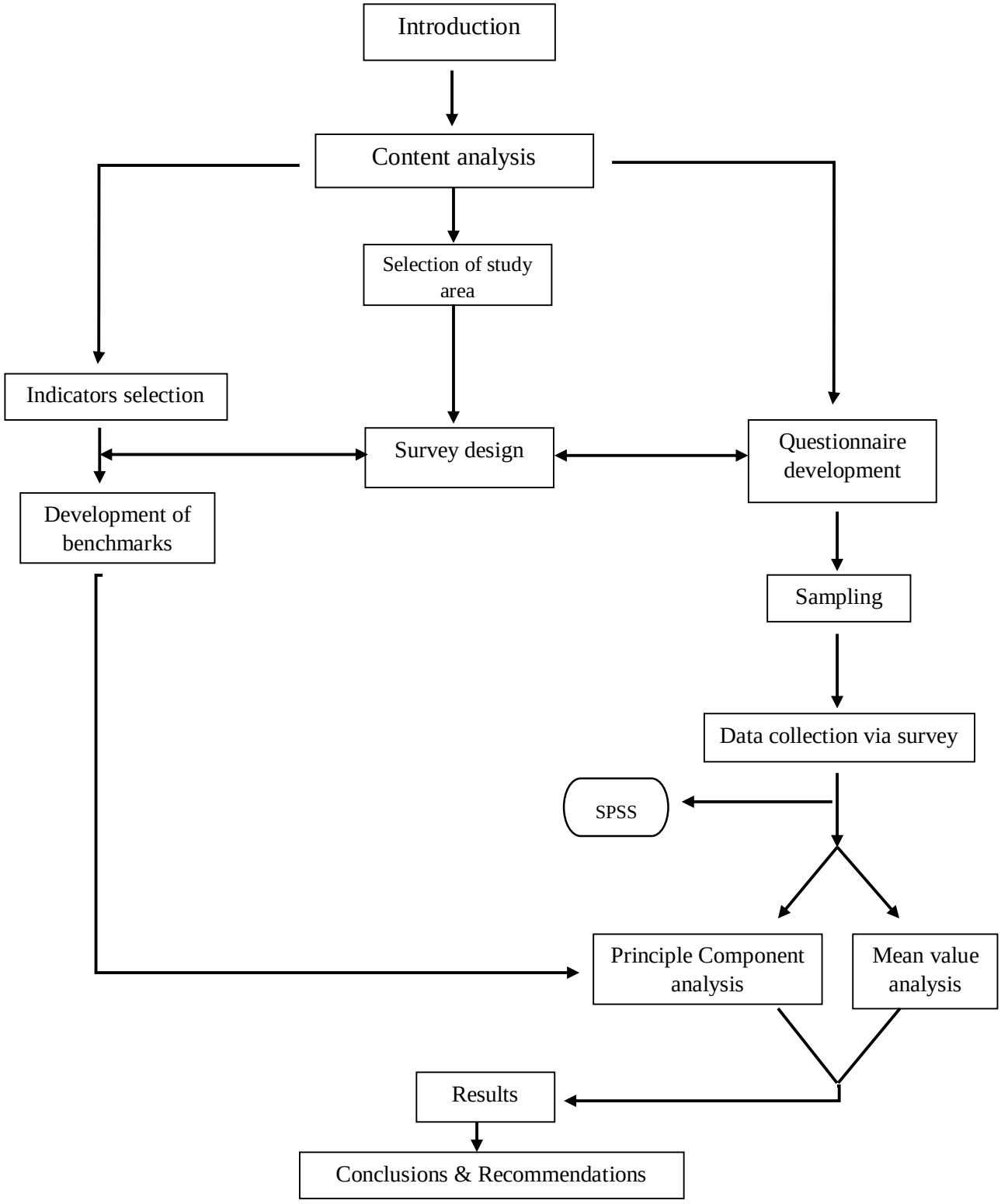

Figure 5: Flow chart of methodology

5. RESULTS AND DISCUSSIONS

5.1. Examining indicators and barriers of city walkability

The hands and obstacles included in the questionnaire are analysed using SPSS. The detail of each is provided below.

5.1.1 Computing residents profiles comparison in Cantonment, Central business district and satellite town/ Block area

The survey revealed that out of 100%, 30% of respondents are from the cantonment area, 30.5% are from the central business district (CBD), and 39% are from the satellite town area. The Chi-square technique is applied to observe the travel mode and alternate travel mode of the residents regarding each of the three study areas of the city.

Table 11: Commuting profiles of respondents

Computing resident's profiles			Cantonment		CBD		Satellite town		Total		Chi-square test	
			114		112		154		380			
			Freq.	%	Freq.	%	Freq.	%	Freq.	%	X^2	p-value
Mode of travel	Car	Yes	65	56	39	33	55	34	159	41	19.874	0.000
		No	51	44	78	66.7	96	63.6	225	58.6		
	Bike	Yes	53	46	72	62	86	57	211	55	9.975	0.007
		No	63	54.3	45	38.5	65	43	173	45.1		
	Foot	Yes	42	36.2	37	32	26	17.2	105	27.3	25.290	0.000
		No	74	63.8	80	68.4	125	82.8	279	72.7		
	Public transit	Yes	44	38	47	40	69	46	160	42	4.19	0.12
		No	72	62.1	70	59.8	82	54.3	224	58.3		

Alternate mode of travel	Alternate_Car	Yes	77	66.4	63	54	89	59	229	60	6.23	0.04
		No	39	33.6	54	46.2	62	41.1	155	40.4		
	Alternate_Bike	Yes	46	38	48	41	58	38	152	40	0.789	0.674
		No	70	60.3	69	59	93	61.6	232	60.4		
	Alternate_Foot	Yes	27	23	39	33	24	16	90	23	21.57	0.000
		No	89	76.7	78	66.7	127	84.1	294	76.6		
	Alternate_Public transit	Yes	41	35	47	40	53	35	141	37	1.895	0.395
		no	75	64.7	70	59.8	98	64.9	243	63.3		
Regularly visited places	School	Yes	54	47	57	49	89	59	200	52	11.21	0.004
	Workplace	Yes	57	49	60	51	61	40	178	46	8.39	0.15
	Leisure	Yes	92	79.3	102	87.	123	81.5	317	82.6	4.90	0.86
	Shopping	Yes	98	85	107	91	117	78	322	84	19.01	0.000

When respondents were asked to identify their present transit mode, it can be seen that in three different areas of the city, 55% of respondents use bikes as their frequent transportation mode, 41% uses cars, 42% uses public transit, and only 27.3% uses non-motorized modes like walking or cycling. It is also revealed that residents of Satellite town mostly use public transportation. In contrast, residents of the cantonment area mostly use cars (56%) or walking (36.2%) relative to the city's CBD and satellite town area. 82.8% of respondents of the Satellite town area do not walk actively for daily activities.

In addition to using daily transportation modes, respondents were asked to mention their alternative transportation modes. The results reveal a shocking fact that only 23% of respondents use walking as their alternative mode of transportation, which is very low; however, 60% of respondents are willing to use cars as an alternative transportation mode. Another good thing is

that 33% of respondents of CBD use walking as their alternative transportation mode, which is more than the cantonment area (23%) and the satellite town area (16%). It can be related to the respondents travel time and distances from home.

When respondents were asked to mention their most frequently visited places, it can be seen that 84% of people travel for shopping and leisure activities in the city and only 52% and 46% people travel for school and offices. It leads to town residents mostly using cars as their present and alternative travel mode for leisure and relaxation activities.

5.1.2. Checking the reliability of the scale

The Cronbach alpha value for the indicators is found to be 0.823, and for barriers, it is found to be 0.810, which is above the specified standard limit of 0.7. The results are shown in Tables 12 and 13, respectively.

Table 12: Cronbach's alpha value for indicators

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on standardizing items	N of Items
.823		47

Table 13: Cronbach's alpha value for barriers

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha is based on standardizing items	N of Items
.810		12

5.1.3. Ranking of indicators and barriers using the mean value method

Mean value analysis is applied to the survey response collected from all three areas of the city. It is used to rank the barriers and indicators which act as hindrances and promoters of city walkability, respectively, based on their mean values.

The mean values of the responses from the data of cantonment, CBD and blocks area are shown in Figures 9, 10 and 11, respectively. The residents of the cantonment area marked the top two barriers that hinder the city walkability as B 01 - My physical body stamina does not allow me to walk and B 05 – inconvenient to walk due to the dresses wear as prominent barriers. Similarly, the border marked by the residents of CBD and satellite town areas are B 01 - My physical body stamina does not allow me to walk.

However, the responses from the same part of the survey, which identify the indicators of the city walkability, have also been analyzed on their mean values. The results from figure 6 show that residents of cantonment marked I 02 – physical and mental benefits of walkability, I 03 – non-motorized means of transportation, I 45 – walking keeps you healthy and active, I 46 – walking reduces chances of getting obese, and I 47 – morning walk keeps you mentally fresh throughout the year as most prominent indicators of walkability. In the same manners, the residents of CBD, in figure 7, marked I 03 – non-motorized means of transportation, I 06 – pedestrians on roads/ footpaths encourages me, I 08 – have no interest in walking as its inappropriate, I 45 – walking keeps you healthy and active, I 46 – walking reduces chances of getting obese and I 47 – morning walk keeps you mentally fresh throughout the year, and the residents of blocks area marked I 45 – walking keeps you healthy and active, I 46 – walking reduces chances of getting obese and I 47 –

morning walk keeps you mentally fresh throughout the year as top marked indicators of walkability in the city.

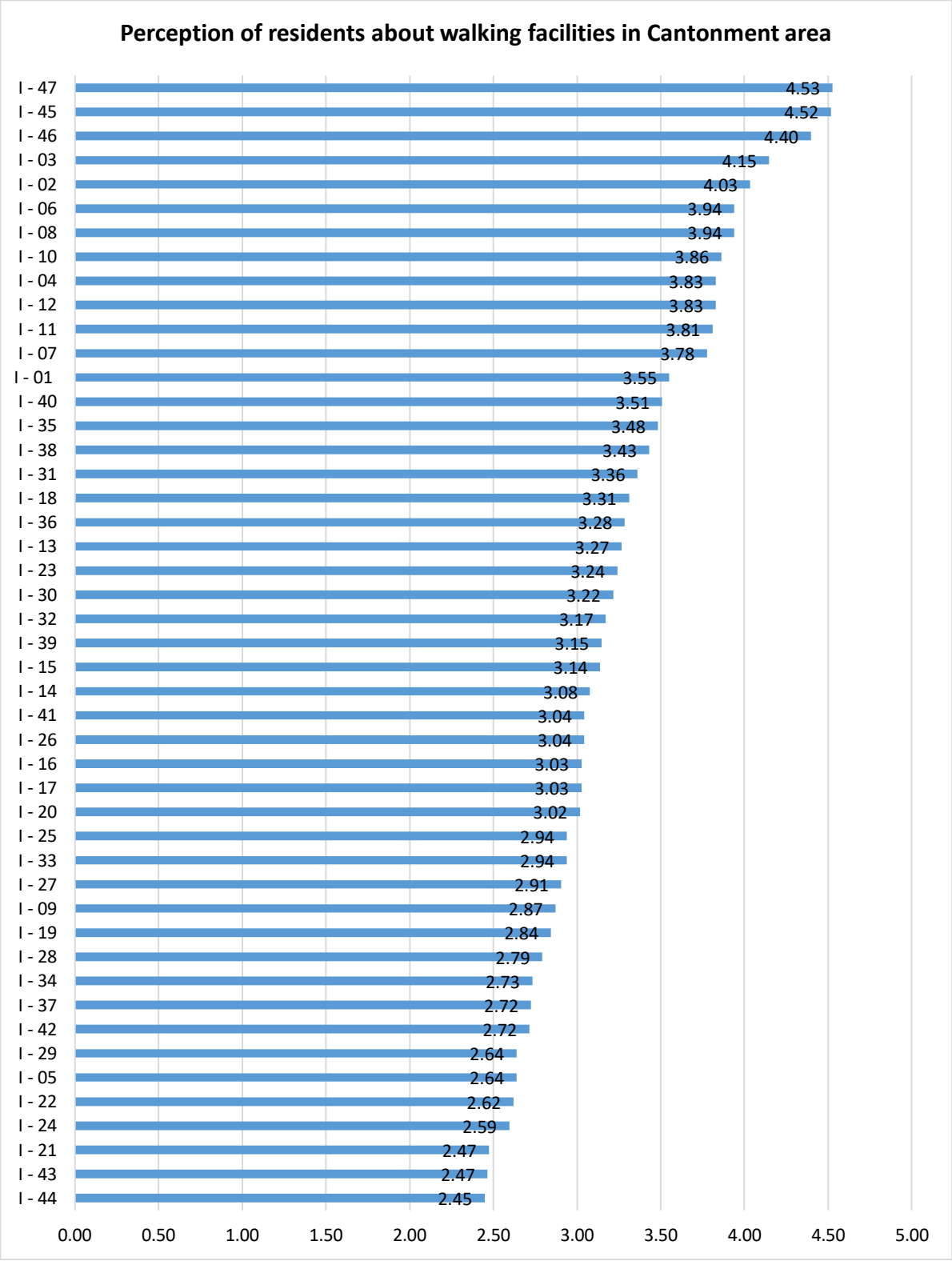

Figure 5 Evaluation of walking facilities by residents of Cantonment area

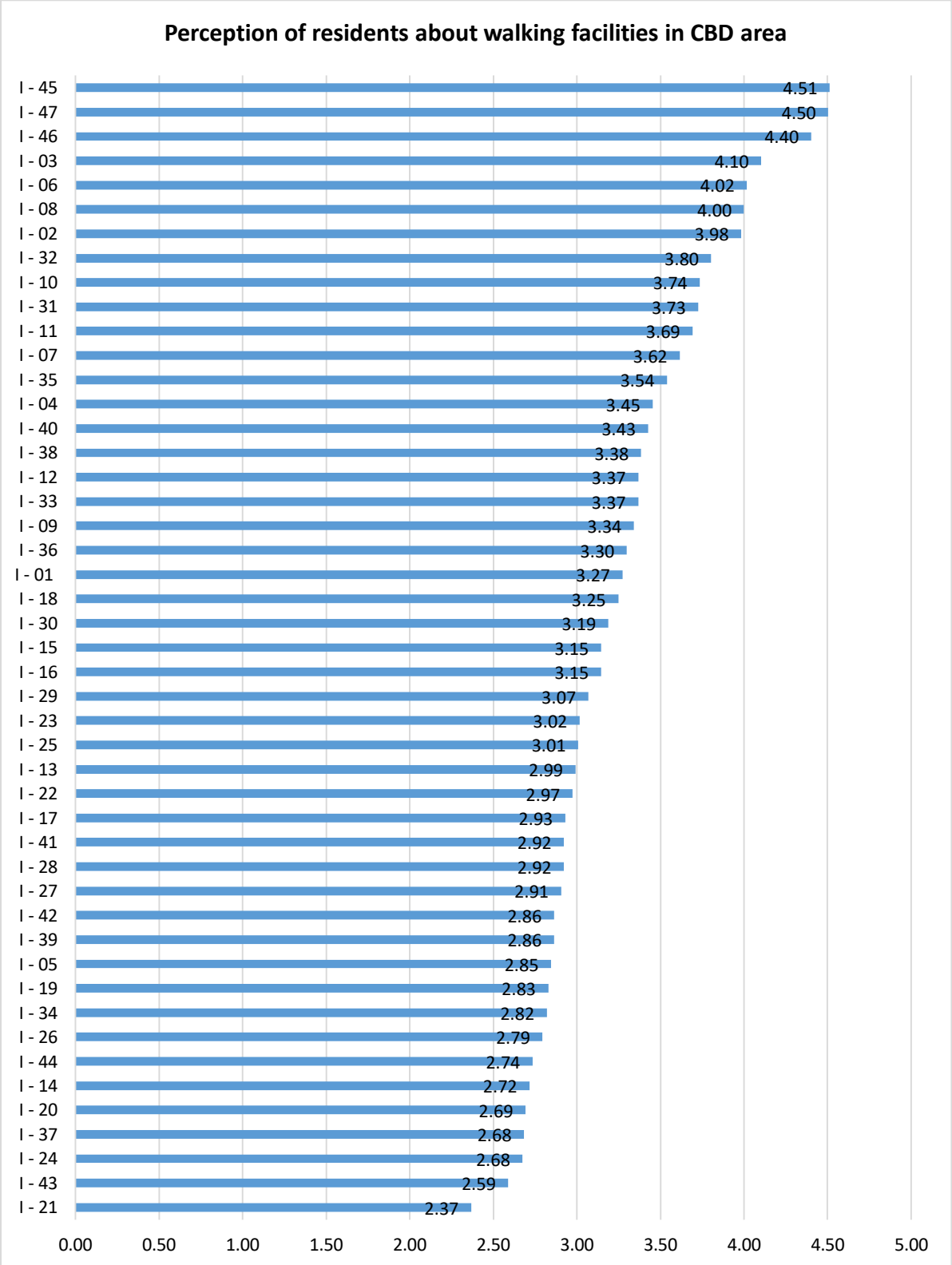

Figure 6 Facilities evaluation by residents of CBD area

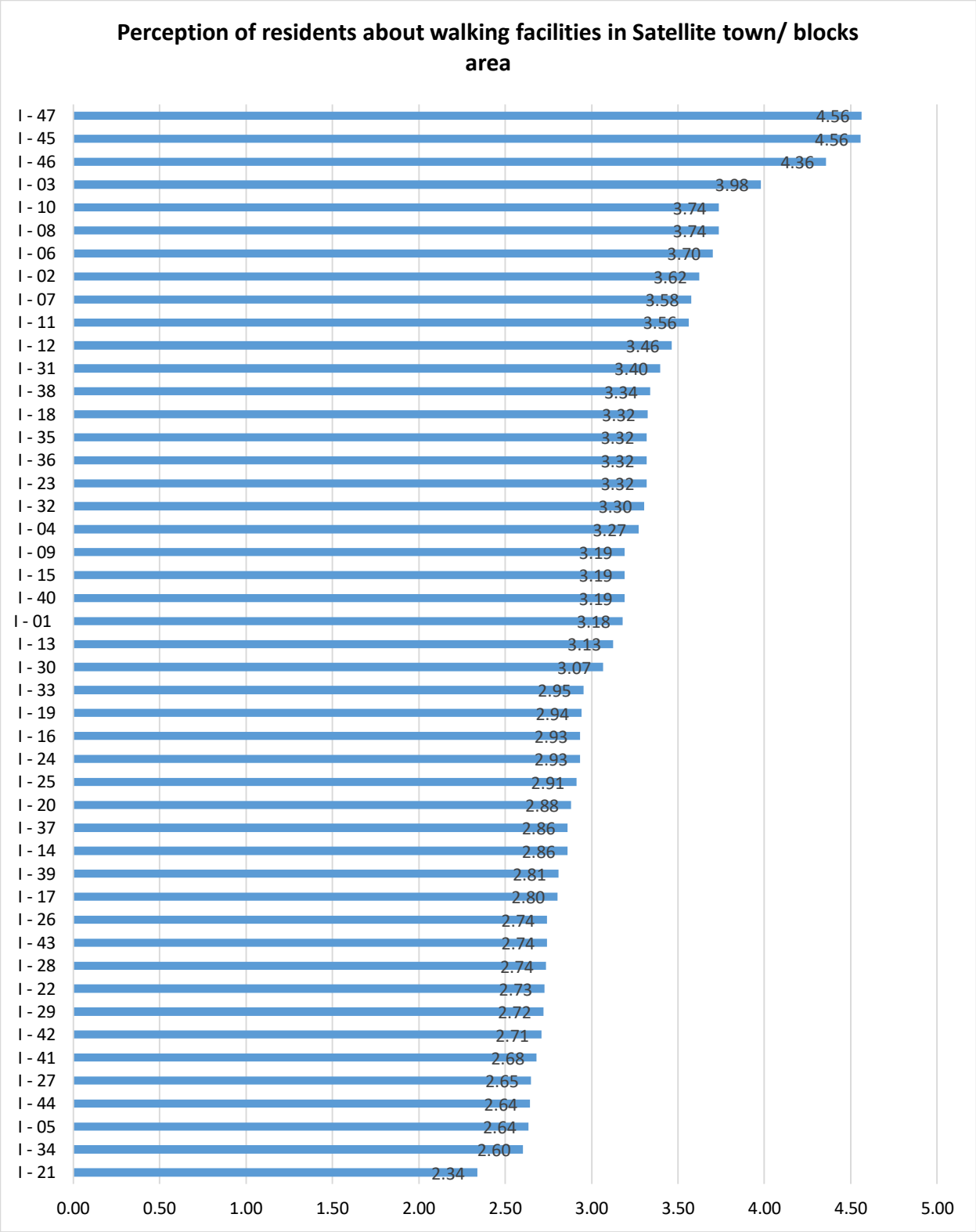

Figure 7 Facilities evaluation by residents of Satellite town/blocks area

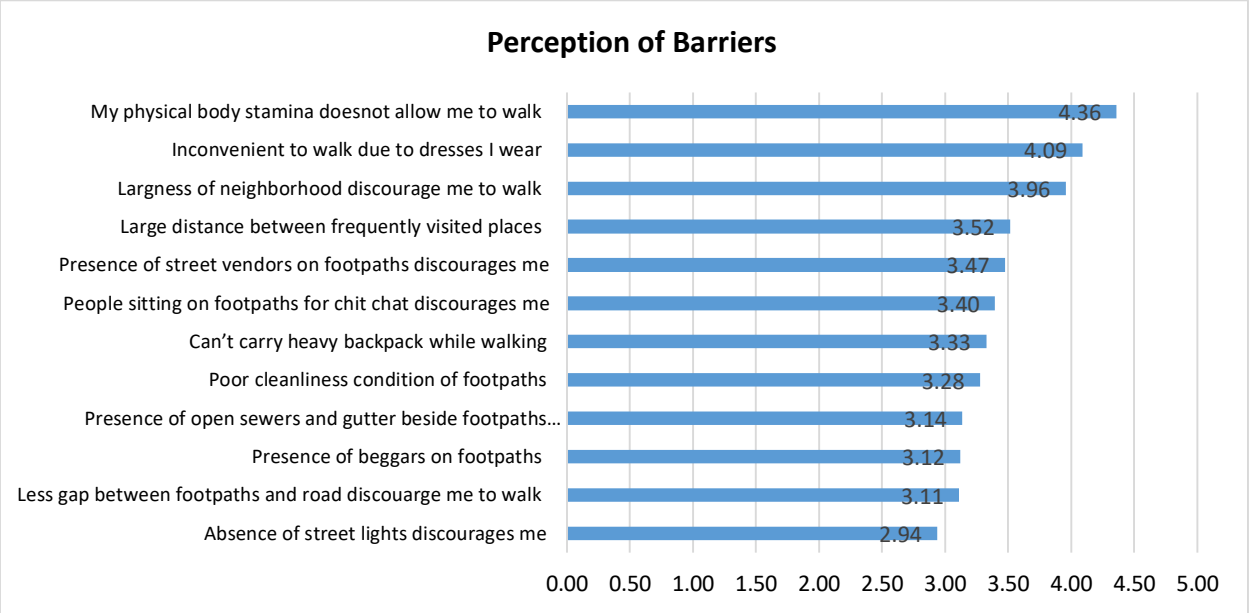

Figure 9 Perception of residents regarding effect of barriers in walkability in Cantonment area

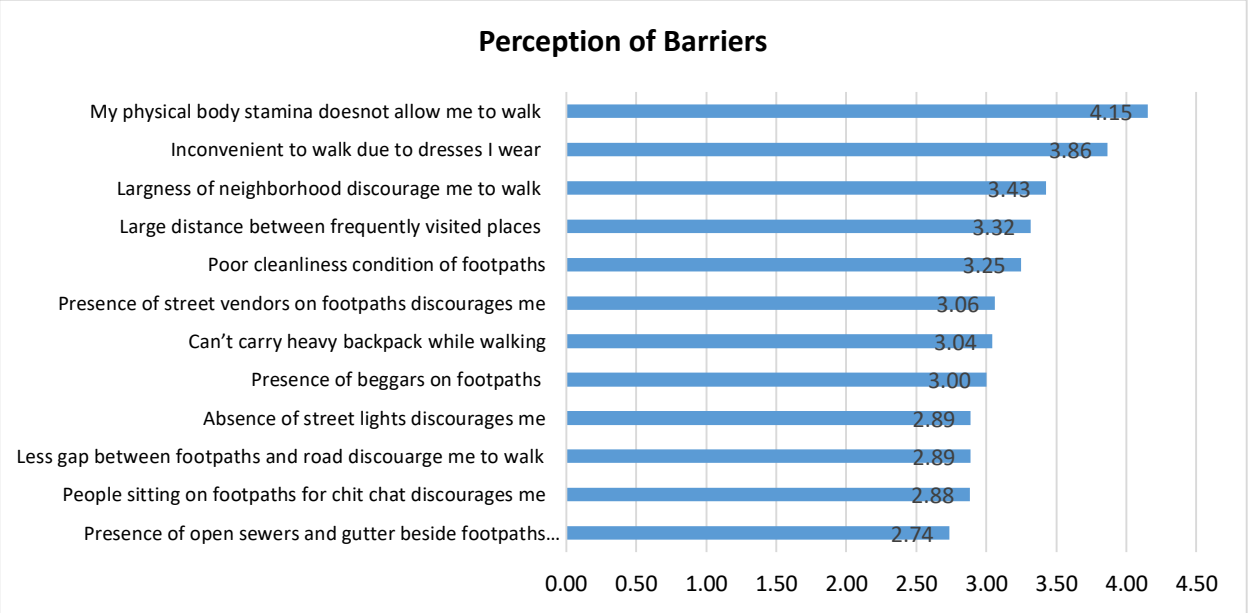

Figure 10: Perception of residents regarding effect of barriers in walkability in Central Business District (CBD) area

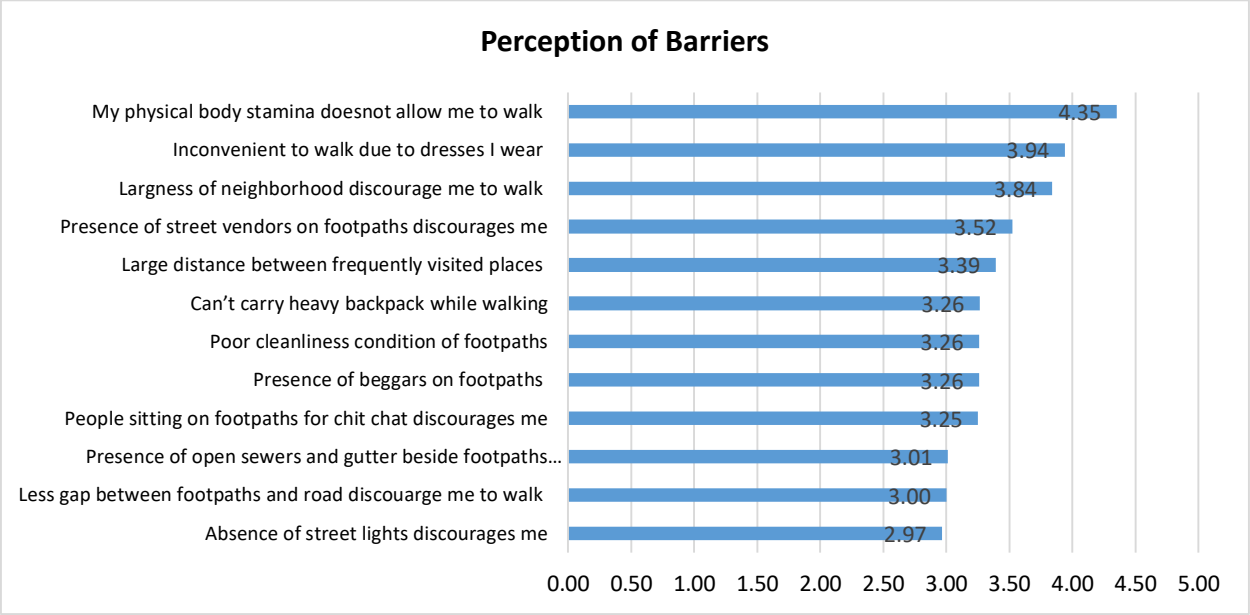

Figure 8: Perception of residents regarding effect of barriers in walkability in Satellite town/ Blocks area

5.1.4. Highlighting barriers and indicators for the evaluation of city walkability

Principle component analysis is used to extract and correlate the variables in latent factors, as discussed below.

5.1.4.1. KMO measures and Bartlett's test

KMO and Bartlett's values for indicators and barriers are shown below in Tables 15 and 16, respectively. It can be seen from both the tables that the KMO value is adequate for sample adequacy, i.e. .826 and .839 for indicators and barriers, respectively. In both cases, Bartlett's test of Sphericity is 6286 and 1157, which is acceptable, and the significance value is 0.000, which is below 0.001. Hence, the correlation matrix is not an identity matrix, and PCA can proceed.

Table 14: KMO measures and Bartlett's values for indicators

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.826
Bartlett's Test of Sphericity	Approx. Chi-Square	6286.550
	Df	1081
	Sig.	.000

Table 15: KMO measures and Bartlett's values for barriers

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.839
Bartlett's Test of Sphericity	Approx. Chi-Square	1157.232
	Df	66
	Sig.	.000

5.1.4.2. Factor extraction for indicators

Based on factor loading using varimax rotations, factor analysis of indicators for city walkability have categorized 47 indicators into 12 lateral factors based on Eigenvalues greater than '01' as shown in table 16. These 12 components explain the total variance of 60.01%, which is acceptable.

Table 16 Factor extraction for indicators

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.226	17.501	17.501	8.226	17.501	17.501
2	4.007	8.525	26.026	4.007	8.525	26.026
3	2.277	4.845	30.871	2.277	4.845	30.871
4	2.079	4.423	35.294	2.079	4.423	35.294
5	2.003	4.262	39.556	2.003	4.262	39.556
6	1.837	3.909	43.464	1.837	3.909	43.464
7	1.564	3.327	46.792	1.564	3.327	46.792
8	1.449	3.083	49.874	1.449	3.083	49.874

9	1.363	2.899	52.774	1.363	2.899	52.774
10	1.231	2.619	55.393	1.231	2.619	55.393
11	1.156	2.460	57.853	1.156	2.460	57.853
12	1.017	2.163	60.015	1.017	2.163	60.015

The 12 groups of factors deduced by factor analysis of indicators for the evaluation of city walkability is shown in table 17.

Table 17: Factor analysis matrix of indicators

INDICATORS		**Factor loadings**										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
I – 27	Green belts are well maintained in my neighbourhood	.774											
I – 26	Green belts are present beside footpaths in my neighbourhood	.753											
I – 14	Footpaths in my neighbourhood are well separated from roads	.674											
I – 13	Footpaths are present in my neighbourhood	.653											
I – 25	A drinking facility is available beside footpaths in my neighbour	.645											
I – 19	Adequate street lights are present in my neighbourhood for walking during the night	.633											
I – 28	Footpaths in my neighbourhood are of good quality	.620											
I – 16	Shady trees are present beside footpaths in my neighbourhood	.593											
I – 15	Climate condition supports walking in my neighbourhood	.588											

I – 20	Adequate resting benches are present beside footpaths in my neighbourhood	.571				
I – 24	An adequate drainage system is present beside roads	.545				
I – 21	Public restrooms are available beside footpaths in my neighbourhood	.500				
I – 02	Physical and mental benefits of walkability		.819			
I – 01	Sustainable development goals		.781			
I – 03	Walkability reduces chances of heart attack and diseases		.748			
I – 04	Non-motorized mode of transport		.701			
I – 11	I don't walk as I get too sweaty and have hygiene issues			.721		
I – 12	Harassing and bullying behaviour in my neighbourhood			.711		
I – 10	People will not give me respect if I walk			.687		
I – 08	Have no interest in walking			.602		
I – 45	Walking keeps you healthy and active				.857	
I – 46	Walking reduces chances of getting obese				.849	
I – 47	Morning walk keeps you mentally fresh				.831	
I – 36	Green spaces are available at walking distance in my neighbourhood					.631
I – 23	Rainwater does not accumulate on footpaths in my neighbourhood					-.598
I – 32	Public transport is well connected with a neighbourhood of the city					.786
I – 31	Availability of public transport					.674

I – 09	Walking is very time consuming	.663									
I – 07	Preference should be given to pedestrians over cars on roads		.772								
I – 06	Pedestrians on roads encourage me		.578								
I – 18	Alternate ways are present in my neighbourhood to reach the destination			-.771							
I – 05	Having own car is a sign of prosperity			.563							
I – 43	Wall chalking/ advertising banners are available in my neighbourhood				-.766						
I – 42	Presence of graffiti/painting on sides of footpaths				.560						
I – 17	Walkways in my neighbourhood are not direct					.752					
I – 39	Stray animals are present on footpaths					.560					
I – 40	The neighbourhood is prone to road crimes						.803				

After factor extraction, the internal reliability of each factor was also checked to see whether all the variables in these 12 factors shows maximum reliability and that internal reliability will not increase if a certain variable is deleted. Consequently, no variable was found, offering the possibility of an increase in internal reliability value if deleted.

5.1.4.3. Interpretation of Indicators

1. Street amenities and serviceability

The street serviceability indicators consist of twelve variables that encourage walkability in the city. The presence of footpaths ($\bar{X}$ = 3.15), climatic condition supports walking ($\bar{X}$ = 3.19), shady trees are present along walkways ($\bar{X}$ = 3.03) are the most prominent variables in this cluster.

Respondents indicate that the presence of walkways and climatic conditions affect their walking behaviour. Literature shows that changing weather patterns have a high impact on resident's activities and commute. Increase temperature frequency and intensity is causing heat strokes, long durations of heatwaves and aridity in summer times makes it difficult for people to walk on streets (Andrew M Fraser, 2016). Similarly, an adequate number of footpaths with shades also enables people to walk more. The results correspond to a similar study conducted in Ahmedabad city of India, showing that shady trees, arcades, and street awnings promotes walkability (Krambeck, 2006).

Other related factors of this cluster are the presence of green belts ($\bar{X}$ = 2.85), maintenance of green belts, separation of footpaths from roads ($\bar{X}$ = 2.83), presence of drinking water facility along walkways ($\bar{X}$ =2.96), presence of street lights along streets ($\bar{X}$ = 2.89), company of resting benches ($\bar{X}$ =2.88) and adequate drainage system beside roads ($\bar{X}$ = 2.77). All of these factors come under the umbrella of street facilities provided by the concerned administration. Suppose shady trees are supplied at a 10 to 40-foot distance (Litman, 2012). In that case, water coolers are installed at 0.6m away from footpaths, and light poles are installed at 0.9m away from the roads (Zohreh Asadi-Shekari, 2014) ; it will make a city more walkable.

Similarly, the administration should also emphasize the separation of roads and walkways. It is important to maintain a minimum distance of 1.2m between streets and sidewalks (Zohreh Asadi-Shekari, 2014) to avoid accidents and crashes between pedestrians and traffic to promote walkability.

2. Public awareness

The respondents also highlighted that they are well aware of the non-motorized modes of transportation ($\bar{X}$ =4.06), physical and mental benefits of walking ($\bar{X}$ =3.84), walking reduces chances of heart attack and diseases ($\bar{X}$ =3.46) and sustainable development goals ($\bar{X}$ =3.28). All the variables of this cluster show the high means values, indicating that respondents are well aware of the active transportation system and its huge benefits on their health. It is the need of the hour to incorporate sustainability practices into the urban development plans of the city to make the towns more worth living.

3. Psychology of residents

I have no interest in walking ($\bar{X}$ =3.87), and people will not respect me if I walk ($\bar{X}$ =3.76) are the most prominent feature of this group marked by the respondents. It can be seen that both these variables have high means, and 41% of respondents disagree that they have no interest in walking and 44% of respondents are status quo in terms of adopting walking as a transit mode.

The other two indicators, I don't walk as I get sweaty and have hygiene issues ($\bar{X}$ =3.66), and harassing and bullying behaviour of residents ($\bar{X}$ =3.50) also have high means. Still, only 15% of respondents agree with these conditions. These indicators correspond to the study conducted in Belgium, where adults were unsatisfied with their neighbourhood due to harassment and crime (Delfien Van Dyck, 2011).

Therefore special attention must be given to change such psychology of the residents and create awareness among people regarding bullying behaviour and showing respect to pedestrians. It is important to understand that the respondent's behavior and psychology are not as big issues as the available street facilities, and city administration should provide proper facilities.

4. Physical fitness

The fourth important group of factors in the list of indicators comes under physical fitness as marked by respondents. It can be seen that morning walk keeps you mentally fresh ($\bar{X}$ =4.52) and walking keeps you healthy and active ($\bar{X}$ =4.52) were marked as high weighted variables by the respondents with the highest equal mean values. A study conducted by (Adriana A. Zuniga-Teran, 2017) in Arizona State indicates similar walkability motivators. Walking reduces the chances of getting obese ($\bar{X}$ =4.35) is the third prominent variable in the list. (Jill Dawson, 2007) highlighted the similar health-related parameters in UK adults.

5. Proper facilities

Green spaces are available at walking distances in my neighbourhood ($\bar{X}$ =3.32), and rainwater does not accumulate on footpaths in my community ($\bar{X}$ =3.31) are the only two indicators clustered in this group. (AnnVan Herzele, 2003) provides a complete framework for the accessibility and availability of parks and green spaces. (Liliane Rioux, 2013) indicated in his study that neighbourhoods with more parks and green spaces attract more residents to walk than neighbourhoods with few parks. Similarly, the accumulation of rainwater on footpaths is also linked with the physical attributes of walking. Both of these variables show high mean values by the respondents and need consideration for better urban design policies and administration.

6. Public transportation

Public transportation is well connected to the neighbourhood of the city ($\bar{X}$ =3.41), and availability of public transit ($\bar{X}$ =3.11) are two variables of this group. Both have almost equally high mean scores, indicating that respondents are well aware of the importance of public transportation and its proximity in their neighbourhood areas. The respondents give the less availability of public

transits high score, so it should be incorporated in the city's planning policy of government transportation department.

7. Time constraint

Walking is very time consuming ($\bar{X}$ =3.14) is the only variable of this group. It can be related to the unavailability of proper street facilities and infrastructure makes walking tiring for the residents in a neighbourhood. Owing to this fact, respondents indicate that walking is a time-consuming task in today's busy lifestyle.

8. Pedestrian-friendly environment

Respondents are highly encouraged by the preference given to pedestrians over cars on roads ($\bar{X}$ =3.63), and pedestrians on the road encourage me ($\bar{X}$ =3.85) variables to walk. Both the variables have high mean values and are positively correlated with walkability. (Filipe Moura, 2017) has used these indicators in terms of total pedestrian count on the streets. Pedestrian environment review System (PERS) has also included pedestrian volume as a user based factor in their model. Similarly, the study showed that large traffic volume and fewer pedestrians on roads make a neighbourhood car dominant, and people feel uncomfortable walking (C. E. Kelly, 2011). Therefore proper sidewalks and walking facilities should be provided in an area to promote walking.

9. Administrative and Personal concerns

The variables included in this factor are alternate ways present in my neighbourhood to reach the destination ($\bar{X}$ =3.31), and having my car is a sign of prosperity ($\bar{X}$ =2.72). It can be seen that the first variable in the group has a high mean and is positively affect the city walkability. In contrast,

the second variable is related to the personal attitude of the residents. (Ester Cerin, 2006) has also used a similar indicator in evaluating residents perception of walkability. According to (Sarah foster, 2008) and (SHRIVER) less street connectivity and fewer route choice along circuitous pathways resist pedestrians to use alternate ways and discourage walking. Therefore respondents give this variable a high mean to be taken into account by policymakers and planners. The other variable of this group is negatively correlated to walkability and is purely an attitudinal constraint, which hinders the usage of active transportation modes.

10. Pleasant and attractive environment

Wall chalking/ advertising banners are available in my neighbourhood ($\bar{X}$ =2.61), and the presence of graffiti/ paintings beside walkways ($\bar{X}$ =2.81) comes under the street aesthetics attributes of walkability. A study conducted in Lille, France shows that the availability of wall paintings and landscapes enhances pedestrian frequency on the sidewalk areas by 56%. (Jean-Christophe Foltête, 2007). It can be assessed from their low mean values that both variables are negatively correlated to walkability in the present study. (Rachel A Millstein, 2013) stated that street art positively affects the residents walking behaviour and reduces environmental stress, whereas bad graffiti, illegal and disordered spray painting on street walls relegates the residents walking behaviour. Such correspondence is also found in our study results; therefore, planners and developers should consider the effect of visible landscapes and architecture.

11. Safety issues

Walkways in my neighbourhood are not direct ($\bar{X}$ =2.91), stray animals are present on footpaths ($\bar{X}$ =2.89) from the group of safety issues during walking. Both of these variables have low mean values and are negatively correlated to walkability. From the literature, it can be reviewed that respondents fear street robbery and theft; therefore, they need to access direct routes to reach their

destination. (Clare Hume, 2009) has used both these indicators in her study for school going children's in Australia and found out that the absence of direct narrow lanes between buildings, more cul-de-sacs reduces city walkability.

Similarly, the presence of stray animals on the roads make the street impractical for walking. These variables make walking difficult, especially for children, women, and older adults, due to personal safety issues. (Terri J. Pikora, 2002).

12. Crime

The neighbourhood is prone to road crimes ($\bar{X}$=) makes up the last component of our analysis. The results show that unsafety from road crimes and the fear of theft discourages respondents from walking. (Sarah foster, 2008) has used a similar variable in her study and suggested that strong neighbourhood bonds, smart neighbourhood design (street connectivity), easily accessible destinations and proper surveillance could reduce the fear of crime. Therefore such physical features must be included in the city administration plan.

5.1.4.4. Factor extraction for barriers

The factor analysis of barriers for evaluation of city walkability has categorized 12 barriers into 04 lateral factors using varimax rotation based on Eigenvalue greater than '01' as shown in table 17. The 04 lateral factors show a total variance of 63.05%. All these 04 factors are shown in table 18.

Table 18: Factor extraction for barriers

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.975	33.125	33.125	3.975	33.125	33.125
2	1.379	11.491	44.615	1.379	11.491	44.615
3	1.171	9.757	54.372	1.171	9.757	54.372

4	1.042	8.682	63.054	1.042	8.682	63.054

Table 19: Factor analysis matrix for barriers

Sr no.	Barriers	Factor loadings			
		1	2	3	4
B – 11	People sitting on footpaths for chit chat discourage me	.782			
B – 09	Presence of beggars on footpaths	.752			
B – 10	Presence of street vendors on footpaths	.746			
B – 12	The absence of street lights discourage me	.688			
B – 08	Presence of open sewers and gutters beside footpaths	.568			
B – 04	Less gap between footpaths and roads make it unsafe for walking		.786		
B – 02	Poor cleanliness condition of footpaths		.753		
B – 05	Inconvenient to walk due to the dresses I wear			.724	
B – 07	The largeness of the neighbourhood discourages me to walk			.718	
B – 06	Large distances between frequently visited destinations			.697	
B – 01	My physical body stamina does not allow me to walk				.784
B – 03	Can't carry heavy backpacks while walking				.739

The internal reliability of each 04 factor was also checked to see whether all the variables shows maximum reliability and that internal reliability will not increase if a certain variable is deleted. Consequently, no variable was found, offering the possibility of an increase in internal reliability value if deleted.

5.1.4.5. Interpretation for barriers

The factor extraction has placed four factors in cluster 1, three in cluster 2, three in cluster 3 and two in cluster 4. Initial interpretation reveals that the factors involved in these four clusters have the following attributes.

1. Congested streets

The three most effective latent factors extracted from principal component analysis under this group are; people sitting on footpaths for chit chat discourage me ($\bar{X}$ =3.17), presence of beggars on paths ($\bar{X}$ =3.15), the company of street vendors on ways ($\bar{X}$ =3.36), (Shokry, 2015) has also used the similar indicators in his study and concluded that 22% respondents find walking difficult due to presence of street vendors whereas 20 % respondents are irritated by the presence of beggars on streets. In our results, these three barriers show the highest mean value, and more than 50% of respondents are disappointed to walk. (Leila Ghalichi, 2012) has used a similar indicator in her study on Tehran and found out that the presence of hawkers and beggars is influencing walking barriers.

The other two barriers that least affect the respondent walking behaviour are the absence of street lights to discourage me ($\bar{X}$ =2.94) and open sewers and gutters beside footpaths ($\bar{X}$ =2.94). Both these barriers have low mean values, and more than 60% of respondents are not affected by these barriers.

Inclusively all the factors in this group come under administrative issues and need the attention of local and governmental authorities to increase city walkability.

2. Poor maintenance and infrastructure

Another two important latent factors extracted from the principal component analysis are maintenance and infrastructure barriers. These two barriers are less gap between footpaths and roads makes it unsafe for walking ($\bar{X}$ =2.98) and the poor cleanliness condition of trails ($\bar{X}$ =3.32). The high mean score indicates that respondents are not satisfied with the cleanliness condition of the walkways. (Filipe Moura, 2017) also consider pathway cleanliness as a significant indicator that hinders walking and physical activity.

However, 70% of respondents indicate that the distance between footpaths and roads is less than the standard value of 1.5m, making pathways unsafe for walking (PURNIMA PARIDA, 2007). (Noorul Iqhlima Najwa Ismail, 2019) indicates nine qualitative parameters of pedestrian zone design, out of which most are found missing. Similarly, almost all the footpaths are designed without proper furniture and frontage zone, making sidewalks unsafe and prone to accidents. (Ashim Kumar Debnath, 2018) also indicate that 40.7% of collisions occur due to the presence of improper pathway marking and construction.

3. Physical layout/ large neighbourhood

The transportation pattern of residents in a city is highly influenced by the physical practice of the neighbourhood design. The respondents highlighted two important major barriers regarding physical layout as largeness of the neighbourhood discourage walking ($\bar{X}$ =3.74) and large distances between frequently visited destinations ($\bar{X}$ =3.41). The city buildings seem to be compact, but the facilities are scattered. The city is still in the development stages; the physical layout of the buildings is compact in most areas, whereas the facilities are scattered in most of the regions. Basic facilities like schools, markets, and hospitals are not available at walking distances

from most residential areas. More than 50% of respondents also indicate that they do not want to travel by foot due to large spaces between their daily visited places, therefore, giving a high score to these two barriers indicate respondents concerns regarding these layout obstacles

The third barrier of this group is inconvenient to walk due to the dresses I wear ($\bar{X}$ =3.95). The respondents gave a very high mean score indicating that it is not a barrier to walking.

4. Health issues

The two most important health barriers extracted from the PCA are; my physical body stamina doesn't allow me to walk ($\bar{X}$ =4.28), and I can't carry heavy backpacks ($\bar{X}$ =3.17). Both these variables are dependent upon various factors like age, gender, climatic conditions, the purpose of walking etc. Almost 60% of respondents indicate that they are healthy and are full of energy to walk, whereas 54% of respondents find it difficult to walk with heavy bags of stuff.

6. CONCLUSIONS & RECOMMENDATIONS

6.1. Conclusions

It can be seen that many small cities of Pakistan are now expanding both in the context of population and urban development. Transportation sustainability and urban sustainability are the important components of sustainable development. The unplanned urban sprawl of the metropolitan cities of Pakistan are facing numerous issues regarding basic facilities of living, and transportation issue is one of them. The said research highlighted that active modes of transportation like walking must be adopted in cities to achieve sustainable societies.

In the present work, the neighbourhood walkability of the built environment is evaluated in the three different areas of Sargodha, a small city of Punjab. The evaluation is based on the six additional attributes of the neighbourhood. The resident's perception of the availability of basic street facilities is assessed. Incorporating the effects of barriers in neighbourhood walkability has also been addressed to highlight the deterrents in the adaptation of active means of transportation.

Through the use of SPSS, principle component analysis and mean score analysis are performed on 47 indicators and 12 barriers to evaluate street facilities related to walkability. The results indicate that residents are much influenced by the basic street facilities like availability of walkways in an area, presence of facilities like green belts, shades along footpaths, maintenance of pathways etc. All these factors highlighted the administrative issues of their sites regarding the provision of facilities.

The other factors regarding the cleanliness of footpaths, congestion of streets by hawkers and beggars, health issues of respondents and pathways obstructions have been highlighted as major barriers to neighbourhood walkability. Moreover, the response to the final open-ended question shows that residents are not much satisfied by the current street facilities; they are well aware of walking benefits and willingly adopt it as their transport mean.

The outcome from this research highlighted the important administrative issues of the city urban planning department. It can also serve as a guiding tool for policymakers and developers in other small cities of the country. The study also acts as a basic instrument for governing bodies to incorporate the aspects of sustainable mobility in development plans. Furthermore, as the investigation is purely based on resident perception, this research is extremely useful for the target-based achievement of active transportation in the city.

6.2. Recommendations

Following are some of the recommendations which can be added in the further research;

1. Walkability motivators already present in the literature can be added to the questionnaire for more detailed investigation.
2. Other evaluability criteria related to street walkability's administrative and policy issues should be included in further research for detailed analysis.
3. This study can be considered an initial walkability framework that can be applied to other cities for preliminary studies.
4. The established benchmarks of indicators can be further improved by more detailed literature reviews and more advanced statistical techniques for more clear results.

6.3. Limitations

1. Only three large areas of the city are included in the research; other parts of the city can be used for more detailed results.

2. The evaluation criteria based upon residents qualifications and physical fitness (age, height, weight) are measured but cannot be incorporated in the analysis due to incomplete data. Therefore such parameters can be included in further research.

3. The questionnaire design can be further enhanced by the addition of walkability motivators and other observational indicators.

Appendix A

category	Indicator	Benchmark	Reference
Awareness	Residents awareness about sustainable development goals	**Yes / No**	(Dijkstra, 2011)
	Residents know about the physical or mental benefits of walking	**Yes / No**	(Adriana A. Zuniga-Teran, 2017)
	Non-motorized means of transportation	**Yes / No**	(Litman, 2012)
	Walking reduces the risk of heart diseases	**Yes / No**	(Adriana A. Zuniga-Teran, 2017)
Behavioural	Having my car/vehicle is a sign of prosperity	**Yes / No**	(Krambeck, 2006)
	The presence of pedestrians on roads encourages walking	**Yes / No**	(Filipe Moura, 2017)
	People / My friends will not give me respect if I walk	**Yes / No**	(James Leather, 2011)
	Preference should be given to pedestrians over cars on the roads	**Yes / No**	(Gallagher, 2014) (James Leather, 2011)
	I have no interest in Walking because it's inappropriate	**Yes / No**	(Adriana Sousa, 2018)
	I don't walk because I get too sweaty and have hygiene reasons	**Yes / No**	(Adriana Sousa, 2018)
	Walking is time-consuming	**Yes / No** (residents may specify the time consumed during walking)	(Richard L. knoblauch, 1996)
	Harassing and bullying attitude of people	**Yes / No**	(Carolyn McAndrews, 2006)
Physical	Presence of footpaths in an area	**Yes / No.**	(Zohreh Asadi-Shekari, 2014) (Krambeck, 2006)
	Footpaths are separated from roads	**Yes / No.** specify if curb or furnishing zone is present	(Zohreh Asadi-Shekari, 2014)
	Climatic conditions support walking	**Yes / No.**	(Lawrence D. Frank, 2006)
	Walkways in my neighbourhood are not direct/straight		(Krambeck, 2006)

	Presence of resting benches along walkways	Benches should be placed at every 200m to 400m interval Benches should be under the shade The minimum distance of the bench from the face of the curb should be 0.6m and 9 meters from the intersection. A minimum space of 1.2 meters should be provided at the ends of the sitting areas for wheelchairs and strollers.					(Zohreh Asadi-Shekari, 2014)
		Unwalkable The area having none of the above four features	**Minimally walkable** Areas having any one of the four features	**Partially walkable** Areas having any two of the four features	**Adequately walkable** Areas having any three of the four features	**Highly walkable** Areas having all the four features	
	Presence of shady trees along footpaths	**Yes / No.** centre to centre spacing for trees should be 6m to 15m					(James Leather, 2011), (Krambeck, 2006)
	Presence of open sewers	**Yes / No.**					(Krambeck, 2006)
	Quality of Footpaths in my neighbourhood	**Unwalkable** Presence of Dirt or sand	**Minimally walkable** Presence of Gravels or crushed rocks	**Partially walkable** Presence of vegetation cover	**Adequately walkable** Presence of paving bricks	**Highly walkable** Presence of concrete or asphalt	(Krambeck, 2006)
	Footpaths in my neighbourhood are poorly maintained	**Unwalkable** The top surface of the sidewalk is broken down to dirt and slush.	**Minimally walkable** Only some portions of the top surface are broken	**Partially walkable** The top surface is merely broken, and it is uneven and bumpy.	**Adequately walkable** The top surface is intact but difficult to walk due to grass growing between the tiles.	**Highly walkable** A smooth and presented sidewalk with good maintenance.	(Krambeck, 2006)

	Presence of drinking fountains	If drinking water facility is present at every 400m centre to centre spacing or at a minimum of 0.6m from walkways					(Zohreh Asadi-Shekari, 2014)
	Good cleanliness condition of walkways	**Unwalkable** Excess quantity of rubbish and wrappers causing full obstruction of walkways	**Minimally walkable** A small number of wrappers and other litter causing mild obstruction of walkways.	**Partially walkable** A very small amount of wrappers and rubbish is seen on walkways	**Adequately walkable** Rubbish is very little causing no hindrance to pedestrians	**Highly walkable** Pathways are fully cleaned with no litter present	(Krambeck, 2006)
	Presence of drainage holes along pathways	**Unwalkable =0%**	**Minimally walkable >0 to <=25%**	**Partially walkable >25 to <=50%**	**Adequately walkable >50 to <=75%**	**Highly walkable** >75 to <=100%	(Litman T. , Evaluating Non-Motorized Transportation, 2012)
	Rainwater does not accumulate on footpaths	Yes / No. Based upon the criteria of drainage holes along walkways					(Litman T. , Evaluating Non-Motorized Transportation, 2012)
	Presence of alternate ways to reach the destination	Yes / No. Pedestrian paths other than roads are considered					(Terri J. Pikora, 2002)
	Presence of green belts	Yes / No					(Krambeck, 2006)
	Green belts are well maintained in my neighbourhood area						(Krambeck, 2006)
	Presence of public restrooms	Yes / No. if yes, they must be located in gyms, libraries, parks					(Gallagher, 2014)
	Presence of green spaces, parks etc.	Yes / No. walkable if located in the range of 150m to 400m					(Grahn, 1991)
	Availability of public transport	Yes / No. mention the name of public transit					(SuzanneMavoa, 2012)
	Sufficient number of public transit stations	Yes / No					(SuzanneMavoa, 2012)
	Shopping centres are located at walking distance	Yes / No. Walkable if situated within a range of 1000m.					(Hugh Millward, 2013)
	Well-connected public transit and neighbourhood	Yes / No. walkable if located at 400 to 800m					(SuzanneMavoa, 2012)

<table>
<tr><td></td><td>Adequate street lights are available along footpaths</td><td colspan="5">Light poles should be placed at a distance of 0.9meter from the road if the curb is not present.
The minimum centre to centre distance of the poles should be 9meter.
The light should shine all over the walkways
Obstructions like trees and poles etc., should not be present.</td><td rowspan="2">(Krambeck, 2006)</td></tr>
<tr><td></td><td></td><td>Unwalkable

Areas having an absence of the above four characteristics</td><td>Minimally walkable
Areas having the presence of any one of the above four characteristics</td><td>Partially walkable
Areas having the presence of any two of the above four characteristics</td><td>Adequately walkable
Areas having the presence of any three of the above four characteristics</td><td>Highly walkable
Areas having the presence of all of the above four characteristics</td></tr>
<tr><td rowspan="5">security</td><td>Presence of stray animals</td><td colspan="5">Yes / No. If yes, specify the animal name</td><td>(Terri J. Pikora, 2002)</td></tr>
<tr><td>Presence of road markings and signs boards</td><td colspan="5">Yes / No. if yes, then specify the type of marking or signboard</td><td>(Zohreh Asadi-Shekari, 2014)</td></tr>
<tr><td>My neighbourhood is safe for walking at all times of the day</td><td colspan="5">Yes / No</td><td>(Gallagher, 2014)</td></tr>
<tr><td>My Neighborhood is prone to road crimes</td><td colspan="5">Yes / No. Walkable if no crime has been reported.</td><td>(Gallagher, 2014)</td></tr>
<tr><td>Presence of surveillance cameras on streets</td><td colspan="5">1. Presence of any informal temporary activity, newsstands, charging ports, and Wi-Fi locations will attract more people, which means more vigilance.
2. Visibility from the nearby buildings from balconies, terraces, windows or glass façades.
3. Security police patrolling on the streets of campus or presence of guards outside the buildings.
4. Presence of CCTV cameras on the streets</td><td rowspan="2">(Pikora TJ, 2006)</td></tr>
<tr><td></td><td>Unwalkable

Areas having the absence of the above four characteristics</td><td>Minimally walkable
Areas having the presence of any one of</td><td>Partially walkable
Areas having the presence of any two of</td><td>Adequately walkable
Areas having the presence of any three of the above</td><td>Highly walkable
Areas having the presence of all of the</td></tr>
</table>

			the above four characteristics	the above four characteristics	four characteristics	above four characteristics	
	Safety from Theft and crime	Yes / No. streets are only walkable if there are no reports of theft and crime.					(Gallagher, 2014)
Health	Walking keeps us healthy	Yes / No.					(Adriana A. Zuniga-Teran, 2017)
	Walking reduces obesity	Yes / No.					(Adriana A. Zuniga-Teran, 2017)
	Walking keeps us fresh	Yes / No.					(Adriana A. Zuniga-Teran, 2017)
Aesthetic	Graffiti / Paintings are available on sidewalls of footpaths in my neighbourhood	Yes / No. if yes, then specify					(Rachel A Millstein, 2013)
	Wall chalking / Advertising Banners are present on side walls in my neighbourhood	Yes / No					(Rachel A Millstein, 2013)
	Fountains / Rookeries are present beside footpaths in my neighbourhood	Yes / No					(Krambeck, 2006)

Questionnaire for Research

Globally, a lot of efforts had been made to make the cities more livable. In this regard, Walkability is one of the major ingredients to make the cities more livable. The phenomena of walkability depend on various factors like awareness among people, physical attributes of Neighborhood, aesthetic attributes of locality, environmental factors, socioeconomic factors and behavioural characteristics of people. Sustainable cities & communities are one of the integral Sustainable development goals. Unfortunately, no major research and practical steps have been carried out for cities of Pakistan, especially small cities. This research aims to evaluate the walkability phenomena in the town of Sargodha. Currently, Sargodha city is in the earlier stages of becoming a metropolitan. The city is expanding rapidly due to its central location in the province of Punjab. This is high time to integrate walkability in the existing urban form and ongoing development projects.

The following questionnaire has been designed to assist research for **"Evaluation of Walkability in Built Environment in Sargodha city"**. Your sincere support in completing this questionnaire is highly appreciated. Please feel free to add any comment/suggestions at the end or contact me.

The questionnaire has been divided into the following sections

1. Socio-demographic attributes of Respondents
2. Awareness
3. Physical attributes
4. Behavioural attributes of respondents
5. Health / Fitness
6. Safety & Security
7. Barriers for Walkability

Regards:

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Note:-

1. The details provided in the said questionnaire shall be kept confidential
2. The following survey is about the walkability phenomenon in your neighbourhood

Section – 01: Please read the statement carefully before filling the Questionnaire

1. In which area/neighbourhood you live in:

- Cantonment Area
- Bazaar area / Blocks
- Others

2. Email ID (Optional) = ----------
3. Gender = ----------
4. Age (In years) = ----------
5. Qualification = ----------
6. What is your weight (In kgs) = ----------
7. What is your height (In feet and inches)= ----------
8. What is your occupation = ----------
9. Mention at least five places in the city which you visit regularly from home

S/ No	Name of Places	Mode of Travel	Time (Mins)	Distance from Home (Kms)	Alternate Mode of transport (If Willing)
1					
2					
3					
4					
5					

The following statements are to be rated on a 5- point Likert scale. Please select one option only

Sr No	Questions	Not at all aware	Slightly aware	Somewhat aware	Moderately aware	Extremely aware
Awareness						
9	Are you aware of Sustainable Development goals					
10	Are you aware of the physical and mental benefits of Walkability					
11	Are you aware that walkability reduces chances of heart attack and other chronic diseases					
12	Are you aware of the term Non-motorized mode of transport					
Behavioural Attributes						
S/ No	**Questions**	**Strongly agree**	**Agree**	**Indifferent**	**Disagree**	**Strongly Disagree**
13	Having my car / Vehicle is a sign of prosperity					
14	The presence of pedestrians on roads/footpaths encourages me					
15	Preference should be given to pedestrians over cars on the roads					
16	I have no interest in Walking because it's inappropriate					
17	Walking is very time consuming					
18	People / My friends will not give me respect if I walk					
19	I don't walk because I get too sweaty and have hygiene reasons					
20	People have Harassing and bullying behaviour in my neighbourhood					
Physical Attributes						
21	Footpaths are present in my neighbourhood for walking					
16	Footpaths in my neighbourhood are well separated from roads					
17	Climate condition supports walking in my neighbourhood					
18	Shady trees are present beside footpaths in my neighbourhood					
19	Walkways in my neighbourhood are not Direct or straight.					
20	Alternate ways are present in my neighbourhood to reach destinations					

21	Adequate street lights / Lawn lights are available on footpaths in my neighbourhood for walking during the night					
22	Adequate no of resting benches are available beside footpaths in my neighbourhood					
23	Public restrooms are available beside footpaths in my neighbourhood					
24	Sufficient signboards are present on footpaths in my neighbourhood for pedestrians					
25	Rainwater does not accumulate on footpaths in my neighbourhood					
26	Adequate drainage system for rainwater runoff is available on the roads in my neighbourhood					
27	Sufficient facility of Drinking water beside footpaths are available in my neighbourhood					
28	Green belts are present beside footpaths in my neighbourhood					
29	Green belts are well maintained in my neighbourhood					
30	Footpaths in my neighbourhood are of good quality					
31	Footpaths in my neighbourhood are poorly maintained. Damaged portions can be seen.					
32	Footpaths in my neighbourhood are cleaned regularly					
33	Public transport is available in my neighbourhood					
34	Public transport is well connected with other neighbourhoods in the city					
35	A sufficient No of Public transit stations are available in my neighbourhood					
36	A sufficient No of dustbins are available beside footpaths in my neighbourhood					
37	Shopping centres are available at walking distance in my neighbourhood					
38	Green spaces / Parks are available at walking distance in my neighbourhood					
Safety & Security						
39	Surveillance cameras are available on footpaths in my neighbourhood for safety					
40	My neighbourhood is safe for walking at all times of the day					
41	Stray animals are present on footpaths in my neighbourhood					
42	My Neighborhood is prone to road crimes					
43	Road marking is available in my neighbourhood for safe road crossing of pedestrians					

Aesthetic attributes						
44	Graffiti / Paintings are available on sidewalls of footpaths in my neighbourhood					
45	Wall chalking / Advertising Banners are present on side walls in my neighbourhood					
46	Fountains / Rookeries are present beside footpaths in my neighbourhood					
Health & Fitness						
47	Walking keeps you healthy and active					
48	Walking reduces chances of getting obese					
49	Morning Walk keeps you mentally fresh throughout the day					

BARRIERS

Please rate how much the following attribute in your neighbourhood **Discourage** you to use **Walking** as a mode of transportation "within" your neighbourhood.						
Sr No	**Questions**	**Not at all**	**Minimally**	**Partially**	**Adequately**	**Fully**
1	My physical body stamina doesn't allow me to walk					
2	Poor cleanliness condition of footpaths					
3	I can't carry heavy backpack while walking					
4	Less gap between footpaths and roads make it unsafe					
5	It is inconvenient to walk due to dresses that I wear					
6	Large distance between my frequently visited destinations					
7	largeness of the neighbourhood discourage me to walk					
8	Presence of open sewers and gutters beside footpaths discourages me					
9	Presence of beggars on footpaths discourages me					
10	Presence of street vendors on footpaths discourages me					
11	People sitting on footpaths for chit chat discourages me					
12	The absence of street lights discourages me					

In your opinion, how Walking can it be improved in your Neighborhood / Mohalla? ----------
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