The Walkability of Pedestrian Walkways in Adama Town

By

Babu Engida

A Master's Thesis Submitted to the Department of Architecture

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Urban Planning and Design

Office of Graduate Studies

Adama Science and Technology University

Adama, Ethiopia

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APPROVAL OF BOARD OF EXAMINARS

We, the undersigned, members of the Board of Examiners of the final open defense by Mr. **Babu Engida** have read and evaluated his thesis entitled "**The walkability of pedestrian walkways in Adama Town**" and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirement of the **Degree of Masters in Urban Planning and Design.**

______________________	______________	____________
Advisor	Signature	Date
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External Examiner	Signature	Date

DECLARATION

I hereby declare that this MSc Thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

Name: Babu Engida

Signature: ___________________

This MSc Thesis has been submitted for examination with my approval as a thesis advisor.

Name: Prof. Samson Kassahun

Signature: ______________________

Date of Submission: _________________________

ADVISOR APPROVAL SHEET

To: Architecture Department

Subject: Thesis Submission

This is to certify that the thesis entitled "**The Walkability of Pedestrian Walkways in Adama Town**" submitted in partial fulfillment of the requirements for the degree of Master's in "**Urban Planning and Design"**, the Graduate Program of the Department of Architecture, and has been carried out by **Babu Engida** Id. No **PGR/18083/11**, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby he can submit the thesis to the department.

______________________ ___________________ ____________________

Name of Major Advisor	Signature	Date

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Finalizing this thesis has truly a challenge due to the Corona virus (global epidemic), but by handling the process wisely, I convinced myself and has enriched the thesis.

First and foremost, I would like to start by thanking the Almighty God for his guidance, protection, forgiveness, divine provision and brightened direction for my personal and academic journey.

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LIST OF ACRONYMS

ADA = Americas with Disability Act

CAD = Computer Aided Design

CSA = Central Statics Agency

CBD = Central Business District

E = East

FBC = Form Based Codes

GIS = Geographic Information System

GWI = Global Walkability Index

HDB = Housing Development Board

KM = kilometer

LOS = Level of Service

M = meter

MAPS = Microscale Audit of Pedestrian Streetscape

N = North

NE = North East

NW = North West

NEWS = Neighborhood Environment Walkability Index

PAS = Proposed Accessibility Guideline

PEF = Pedestrian Environment Factor

S = South

SW = South West

SE = South East

SPSS = Statistical Package for Social Science

TAZ = Traffic Analysis Zone

TIGER = Topologically Integrated Geographic Encoding and Referencing

US = United State

UV = Ultraviolet

W = West

ABSTRACT

Walkability is the basis for a sustainable urban environment. Walking is socially equitable that is most accessible to the masses, the cheapest, healthiest and efficient mode of transportation. Designing and planning for walking are fundamental for promoting healthy public life, creating sustainable urban areas, improving social life and economy. Urban spaces, such as those in Adama city center has been dominated by a high volume of motorized vehicles, which has subsequently caused the pedestrian space to be discriminated by vehicles. Though the largest portion of the city population travels by walking, pedestrian mobility has been severely compromised especially in the center of the town. Streets in Adama are planned considering automobiles as a primary mode of transport; there is no comfortable setting of walkable streets. The objective of this study is to understand the current situations and walkability of the pedestrian walkways along Tokuma Street to figure out a rational way of planning and designing a walkable built environment in the town. The study conducted both subjective and objective studies to assess the walkability of the sidewalks. Subjective methods were executed to capture the pedestrian walking behaviors and perceptions about the infrastructures of the built environment by conducting a questionnaire survey; thus, the study employed a convenience sampling techniques and executed 384 questionnaire survey. Objective methods were executed to assess the physical walking environment and the climatic condition of Adama town as a whole. Physical walking environment elements; sidewalk conditions, street crossings, safety and comfort of the sidewalks, utilities, on-street, and off-street parking, street amenities, building orientations, pedestrian behaviors, and motorist behaviors were assessed using a walkability checklist. Findings from both subjective and objective dimension analyses indicate that the proximity of destinations, safety, comfort, well-designed pedestrian facilities, and climatic conditions can significantly contribute to the walkability of the walking environment. Finally, the study had assured that Tokuma Street is not safe and it is dangerous for walking, and also the E-W and ENE-WSW Street and S, N, NNW, and SSE facing building orientations are directly exposed to the sun throughout the year which implies that pedestrians and the motorist are highly exposed to disease caused by UV. However, NW-SE, WNW- ESE and NNW-SSE streets and NE & SW, NNE & SSW, and ENE & WSW facing buildings are the optimal orientations for Adama town. Furthermore, S, N, NNW, and SSE facing buildings are recommended to not open large window glazing since the amount of solar radiation expected is high. This being a pilot study, the effects of street orientation on airflow, solar access, aspect ratio, and the effect of urban design on outdoor thermal comfort should be obtained in future studies.

Keywords: walkability; built environment; pedestrian-friendly; sidewalks; pedestrians; environmental-friendly;

CHAPTER ONE

1. Introduction

Walking is the basic transportation means for human and it has a wide range of benefits for human health and well-being. “Walkability is a measure for assessing the level of friendliness of an area is considered as one of the most significant aspects of a livable society and as an imperative means of developing sustainability in urban space” (Southworth, 2005). “Walkability refers to the quality of walking condition and it encompasses the quality of pedestrian features including pathway conditions, safety, traffic speed and flow, comfort and convenience” (Lo, 2009). Although walking is the cheapest, healthiest and efficient means of transportation, after the advent of motorized vehicles, automobiles have occupied urban spaces and the form of many cities has changed according to the requirements of automobiles rather than pedestrians.

Adama is the fast-growing city in a way for more economic, industry, tourism, and residents. The city is a major transportation, trucking, and industrial hub with a growing tourism market in the country. Even though the city is growing, the streets are not pedestrian and environmental-friendly like Hawasa and Bahir Dar cities with their respective limitations. The purpose of this study was to create walkable pedestrian walkways in Adama city by examining the major factors associated with walkability problems and the potential of the study area to bring a walkable urban environment.

1.1. Motivation of the Study

The motivation of the study was because of the following basic reasons: the first was the observation, these streets are poor in quality, design, comfort, safety, and amenities. Secondly, this street is a major walkway for the city but it is not walkable. Finally, to get the Master's degree along with the study's consequential benefits.

1.2. Background of the Study

In the growth of one's country, urban economic activities and movements of peoples and goods measured through its primary transport system. The adequate transport system is required to facilitate an additional choice of the peripheral areas if urban transport provided by the immediate authorities. Comfortable surroundings make a journey by foot pleasant and enjoyable. The quality of the walking environment has become a significant factor in transportation planning and design for American cities (Southworth, 2005). Many tools for measuring the quality of the walking environment have emerged during the past few years, generally called walking audit instruments, they are used widely across the US (Ewing & Handy, 2009). Pedestrians are most at risk in urban areas due in part to a large amount of pedestrian and vehicle activity in urban areas. No matter if the primary mode of transportation is the automobile, bicycle, or public transit; people must walk as a part of the trip, such as from their home to the store or place of employment, and/or to the transit stop. With this in mind, designing safe, accessible, and comprehensive facilities for pedestrians is vital to create walkable walkways.

In Ethiopia, most daily journeys are made on foot for different purposes, even as they did in many other low-income and developing countries. A pedestrian-friendly environment plays a vital role in encouraging walking as a mode of travel, and also provide health and environmental benefits. Adama, the late capital city of Oromia Regional State is a fast-developing city in the country with a total population of 343,212 (CSA, 2009). The city is located in the escarpment base of a Great Rift Valley zone in the East. Although the city is growing, it lacks walkable pedestrian walkways. The study has assessed the walkability of the street in the city by taking one major route (Tokuma Street) as a case study; and draw possible measures based on the findings to make the city walkways pedestrian-friendly.

1.3. Statement of the Problem

Adama, the previous capital city of the Oromia Regional State has also faced the problems caused by excessive automobile usage. Today, the pedestrian-oriented spaces in the CBD of Adama are limited to several streets such as Tokuma Street in the west direction (from Derartu square to the Galma Abba Gada square). The town has no clear policy and guidelines about the sidewalk standards and also lacks strategies to create pedestrian-friendly walking urban environment in the town.

One of the main problems the town facing today is lack of properly planned and designed pedestrian walkways. As can be seen from the condition of the existing streets in the town, is that these elements are not given the needed attention. Looking at the different SP and MP plans for the town at different periods, even though proper streets were proposed, they were not implemented. The low attitudes towards pedestrian walkways in the town, both in government and private sectors, resulted in the diminishing of existing sidewalks. The priority given to the problems for the pedestrian walkways in the town is low. Most part of the government budget for planning goes to housing units, but the town also needs proper pedestrian walkways and pedestrian-friendly built environment in the town. The administration should also pay the needed attention to the existing pedestrian walkways which are facing many problems at the moment.

Tokuma Street is the major street that the city has and it has high traffic volume, but it is not safe and comfortable for walking. The study assessed the physical configuration of the street and its association with walkability by using possible influential walkability criteria collected from the literature. It is one of the principal arterial streets the city has and located at the center of the town in CBD. Even though this street has high traffic volume it is not safe for walking due to; poorly paved, the grade is below the level of the asphalt, lacks street trees and amenities, the sidewalks are using as parking for taxi and automobiles, not accommodative for children's, elders and pedestrians with disabilities, and also, lacks traffic signage and safe crossings. Tokuma Street has the potential to be a walkable street, thus the study examines the current situation of the sidewalks and use it to figure out rational way of planning and design pedestrian-friendly sidewalks.

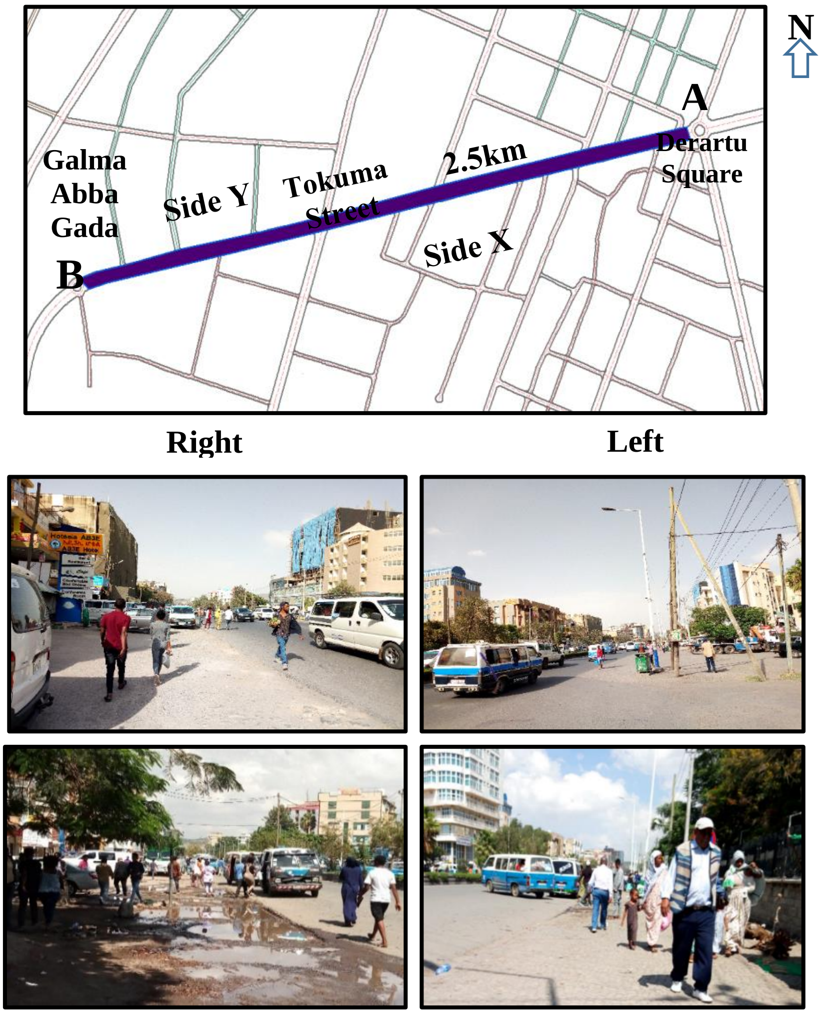


Figure 1.1: Site picture (Source: Own, 2020)

1.4. Research Objectives

General objective

The general objective of the study is to understand the current situations and walkability of the pedestrian walkways in Adama town and use it to figure out a rational way of planning and designing a walkable built environment in the town.

Specific objectives

The specific objectives of the study are categorized into the following five main parts. These are:

I. To assess the pedestrian walking behaviors along the study route.
II. To assess the pedestrian Perceptions on the walkway facilities along the study route.
III. To examine the characteristics of the built environment along the study route.
IV. To assess the effectiveness of existing street orientation against the actual sun path.
V. To recommend the best street orientation based on urban design principles and the actual solar system.

1.5. Research Questions

I. What are the pedestrian walking behaviors along the study routes be characterized?
II. What are the pedestrian perceptions on the walkway facilities along the study routes be characterized?
III. How do the characteristics of the built environment along the study routes meet the needs of the pedestrian while walking on the streets?
IV. How is the effectiveness of existing street orientation against the actual sun path?

1.6. Significance of the Study

The outcome of the study will be very important to insight the following main reasons along the study routes.

- To determine whether the pedestrian walkways along the study routes are safe for pedestrians (children, disabilities, elders) to walk on.
- In addition to advancing knowledge, the finding could be a significant input for plans in the town regarding the provision of this kind of walkable urban environment.
- Assessing the existing walkway facilities, pedestrian behaviors, and perceptions, and also the safety of the walkways would greatly help for plans in the entire town by revealing the hindering factors related to pedestrian's experience of walking habits.

- To insight the concerned government body and the community that walking is the best transportation mode to create livable and walkable urban environments, so that, they pay great emphasis on the provision of safe pedestrian walkways in their plan to make the cities pedestrian-friendly.

Generally, the study will help to motivate further investigation by any stakeholder for supplementary proceedings, provide contributions for policy and strategy development and decision-making in the planning process, it could be a supplementary source of documentation for those who want to make research in related subject areas, can be used for educational purpose, and foremost contributes knowledge on how to create walkable pedestrian walkways in given urban areas.

1.7. Scope of the Study

The study had framed the magnitude of the assessment both thematic and spatial scopes as follows:

Thematic scope

The study had employed both on the left and right side of Tokuma Street which is the main street in Adama town that has high walkability problems. Thematically the study had focused on the walkability of Tokuma street in Adama town by investigating the factors hindering pedestrian's experience of walking habits, the pedestrian behaviors and perceptions about the sidewalk facilities, performance, use, appropriateness, design, comfort, infrastructures, amenities and safety of the pedestrian walkways along the study route. Furthermore, the study had assessed the weather condition of the town and the actual solar sun path to determine the effectiveness of the street orientation.

Spatial Scope

The study had assessed both the left and right side walkways of Tokuma Street from Derartu square (A) until Galma Abba Gada square (B) (2.5 km length and 32m width, but the width is not consistent till to the endpoint) with an uneven sidewalk width (ranging from 8-2m) on both sides of the street. The study executed on Tokuma Street because of time and budget limitations. In addition, it is located at the CBD and exposed for many hazards, needs heavy maintenance and has adequate width from both sides for future growth.

1.8. Description of the Study Area

Adama town lies at an elevation of 1712 meters above sea level and it is located at 8.6^0 N and 39.3^0 E coordinates. The town has mainly flat topography with a grid layout of the street pattern and surrounded by steep mountains. The study executed on both sides of the walkways along Tokuma Street starting from Derartu square to Galma Abba Gada square. The street has 2.5 km length and 32-22m width respectively. And also the sidewalks uneven width ranging from 8-2 m respectively. Additionally, the orientation of Tokuma Street is East-West direction with poor urban design qualities and principle.

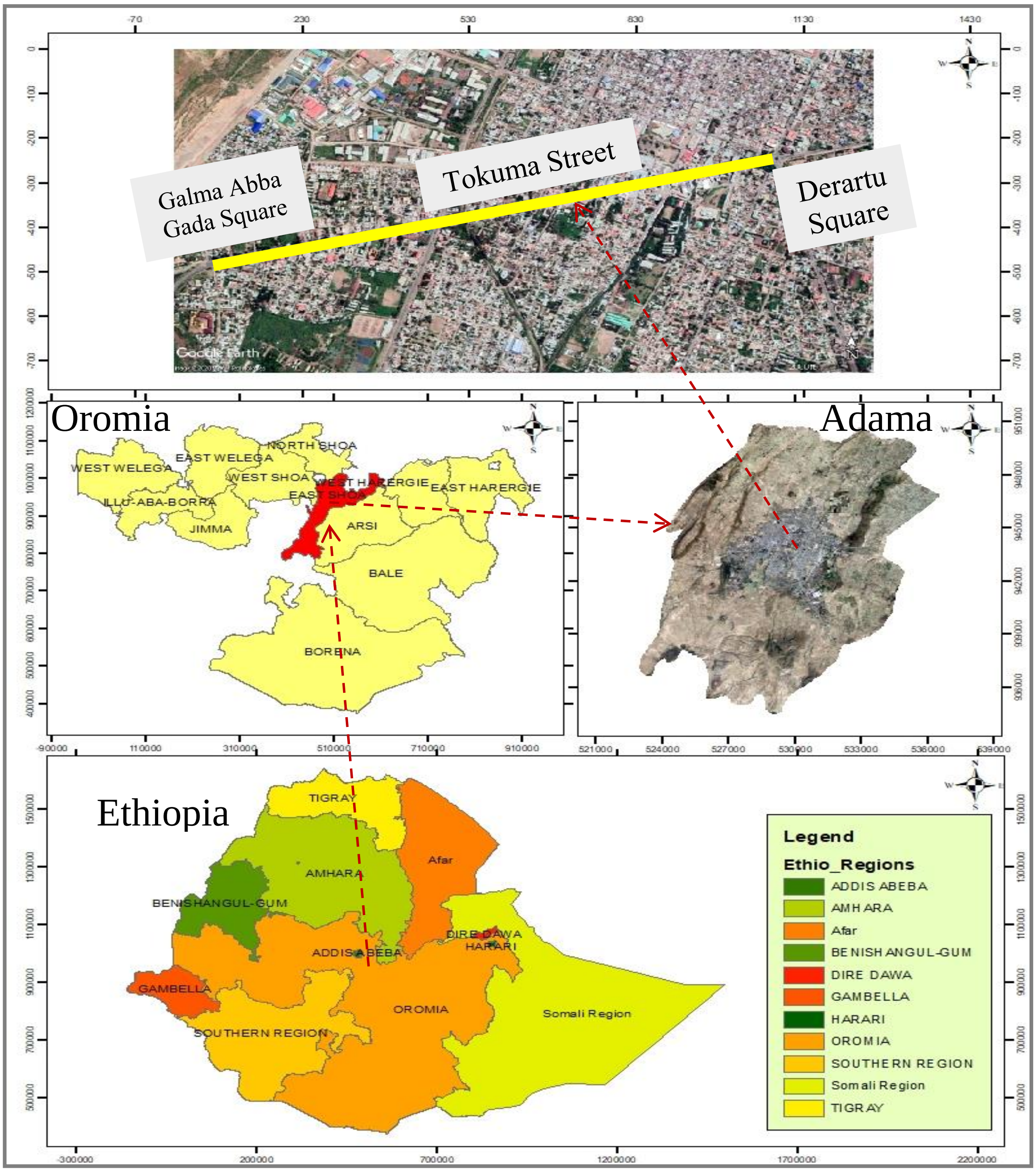


Figure 1.2: Location Map

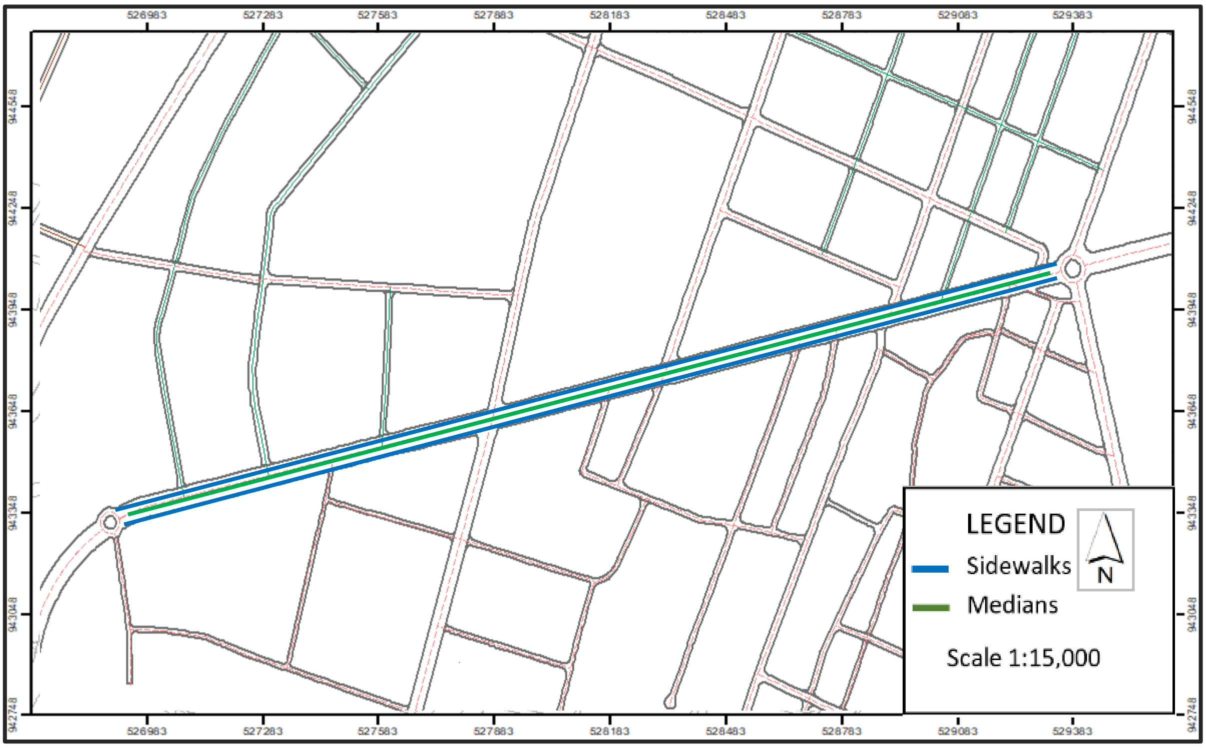


Figure 1.3: Street Orientation of the study area

Figure 1.4: Land-use of the study area

From the above Figure 3.3 and Figure 3.4, the study area has East-West street orientation and it is mainly a commercial corridor.

1.9. Limitation of the Study

The main limitation of the study was the lack of conducting a focus group discussion and key informants due to the global epidemic coronavirus. Thus, the study executed based on the questionnaire for pedestrian perceptions and checklists for the physical walking environment of the street.

1.10. Organization of the Thesis

The thesis is categorized into five chapters. Each chapter systematically and effectively examines the content and data of the study accordingly. The fundamental chapters in the thesis are further demonstrated as follows.

Chapter One: Introduction to the study will introduce the thesis by lighting the main topic of the study, research problems, objectives, questions, significance, scope, and research design in detail.

Chapter Two: Literature Review is a chapter that discusses key definitions relating to walkability, urban centers, and concepts concerning urban design principles, walkability index, theories, and literature on the factors and built walkability features.

Chapter Three: Research Methodology is a chapter that discusses the methodology of the research. The chapter explains the methods used for the study and the process of data collection and analysis in detail.

Chapter Four: Result and Discussion is a chapter that discusses the results of qualitative and quantitative data findings. The subjective qualitative data are analyzed based on a questionnaire survey, field observation notes, and printed documents from different sectors. The objective quantitative data are analyzed based on field observation, measurements of the physical feature of the walking environment, images, aerial photographs, topographic maps, sun path, and shadow analysis. Further, the chapter illustrates a discussion based on the finding of the results.

Chapter Four: Conclusion and recommendation is the concluding part of the thesis. The chapter made a conclusion based on the findings from the literature review, the case study of Tokuma Street, and the results of the discussions. Additionally, the study recommends the best street orientation based on urban design principles and the actual sun path analysis of Adama city.

CHAPTER TWO

2. Literature Review

2.1. Introduction

This chapter discusses different theoretical backgrounds and reviews related literature that has been used to estimate the suitability of the walking environment. Different elements and methodologies are measured in the estimating walkability. Finally, a summary of the literature and gaps in the literature is provided.

2.2. Definition of Terminologies

2.2.1. Pedestrian

According to the Compact Oxford English Dictionary (2006), a pedestrian is “a person walking rather than traveling in a vehicle”.

The American Heritage Dictionary makes no reference to pedestrians as a mode of transport, but simply defines a pedestrian as “a person traveling on foot or a walker”, thereby expanding the definition to those walking for non-transportation purposes such as exercise, recreation, leisure, shopping, social interaction, spiritual rejuvenation, or even fundraising for charity. Grignaffini (as cited in Frankelton, Grassman, Paliaginis, Castrillon, Elgano & Guensler, 2013) outlined that walking is the most primary form of transporting.

2.2.2. Walkability

“Walkability is the extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network” (Southworth, 2005, p. 2-3).

The Wisconsin Pedestrian Policy Plan 2020 describes a walkable community well: “Ultimately, the goal of any effort to facilitate pedestrian travel is walkable communities. A walkable community is thoughtfully planned, designed, or otherwise retrofitted to integrate pedestrian travel into the community’s fabric. In a walkable community, walking is considered a normal transportation choice and is not a distraction or obstacle to motor vehicle traffic”. Walkability is a fundamental concept in sustainable urban design. The benefits of walking can be discussed from three perspectives: economic benefits, social benefits, and environmental benefits (Ariffin & Zahari, 2013).

Jaskiewicz 2001 (as cited in Southworth, 2005) states that simple measures of distance to destinations are not an adequate predictor of walkability. The quality of the path network is key. To encourage walking it is necessary to go beyond utilitarian access. Several qualities of the path network affect the likelihood of walking and can be improved through design. A walkable network has several of the following important attributes:

1. Connectivity of path network, both locally and in the larger urban setting;
2. Linkage with other modes: bus, streetcar, subway, train;
3. Fine-grained and varied land use patterns, especially for local serving uses;
4. Safety, both from traffic and social crime;
5. Quality of path, including width, paving, landscaping, signing, and lighting; and
6. Path context, including street design, visual interest of the built environment, transparency, spatial definition, landscape, and overall employability.

Figure 2.1: walkability Networks

Source: University of Wisconsin Transportation Analysis Team (2011)

2.3. Walkability Elements

Table 2.1: Walkability Elements

	Elements	Details
Walkability elements	Pathway	Properties, design, quality, alleys, shade, lighting, user-friendly, landscaping, maintenance, environment.
	Zebra crossing	Type, location, condition, access, waiting time at traffic lights, safety.
	Street furniture and signage	Street furniture and shade, placement of lamppost, board information, signage.
	Personal safety	Personal safety (day and night time), comfortable social space, fear of crime, fear of motorized vehicles, fear of stray animals.
	Adjacent to traffic flow	Traffic flow along the pedestrian walkway, traffic conditions at a pedestrian crossing, traffic control by authorities.
	Aesthetic and amenities	Aesthetic, availability of amenities, dustbin, public-toilet, public phone, place to rest (bench).

Source: Zainol, Ahmad, Nordin, & Aripin, 2014.

2.4. Walkability and Built Environment

Goffman (2017) state as face-to-face human interactions in a neighborhood is extremely relevant for supporting livability, safety, and control, economic development, participation, and identity. Many researchers like Oscar Newman, William Whyte, and Jan Gehl focus their research on the observation of people in real-life situations to determine how the built environment impacts social wellness (Singh, 2016). The results of their studies helped guide designers to rethink the impact of their plans upon real life.

Whyte (as cited in Singh, 2016) pointed out that people-watching is one of the primary activities shared by different classes of people in public spaces. Simple amusements, such as walking, talking, eating, and sports, also give a street diverse life. Whyte describes that, in democratic streets, a social connection links ground floor building uses to the adjacent street space. A truly walkable street has a healthy relationship between the private or semi-public life inside buildings and the public world outside.

Yeang (2000) state that proposed a useful approach to design the pedestrian environment using the ‘Five C’ principles:

- **Connections**: do good pedestrian routes connect the places where people want to go?
- **Convenience**: are routes direct, and are crossings easy to use? Do pedestrians have to wait more than 10 seconds to crossroads?
- **Convivial**: are routes attractive, well-lit, and safe, and is there variety along the street?
- **Comfortable**: what is the quality and width of the footway, and what obstacles are there?
- **Conspicuousness**: how easy is it to find and follow a route? Are there surface treatments and signs to guide pedestrians?

According to Yeang (2000), if the street is designed for low speeds, pedestrians, cyclists, and vehicles can mix safely. Generally speaking, conventional streets provide the most convenient, direct routes to places that cyclists and pedestrians, like everyone else, want to get to.

2.5. Walkability Assessment Tool

According to Dannenberg and Wendel (2011) walkability has become an ever more important issue in the fields of urban planning, public health, and transportation, researchers have been developing ways to evaluate it quantifiably. Many walkability audit tools now exist, but there is no consensus as to which tool is best for measuring walkability. Moudon and Lee (2003) reviewed over 30 audit instruments for walkability and likeability, and found that no instrument comprehensively assesses the built environment; each is meant to assess only certain parts of the built environment. Some are more geared toward pedestrian safety, for example, while others may focus more on network characteristics or level of service. Besides, the study found that nearly 200 variables from sidewalk width and presence of street crossings to land use type and network density exist across the 30 audit tools to describe the environmental factors related to walkability. This illustrates the wide variety of built environment features that can contribute to creating a walkable community. Additionally, different tools may be appropriate for different situations. For example, some tools rely on GIS information and other existing objective data to analyze an area's walkability; these tools are more appropriate for use by researchers and sometimes by city planners or other professionals.

2.6. Perceptions of the Urban Walking Environment

2.6.1. Pedestrian perceptions towards various sidewalk facilities

Recent studies have examined the relationship between perceived walkability and sidewalk quality, mostly relying on non-quantitative pedestrian facility assessment criteria. Sidewalk width, a buffer between sidewalk and street, and the presence of amenities are predictors of pedestrian travel, perceived safety, and quality of the pedestrian environment. Effective sidewalk width, pavement condition, and material composition were important variables for sidewalk accessibility based on perceived importance to wheelchair users (Marshall and Garrick, 2010).

2.7. Pedestrian Accessibility Guideline

The U.S. Access Board (2002) published a design guide addressing accessibility for pedestrian facilities. Design considerations include sidewalk width, presence of passing areas, running-slopes, cross-slopes, and ramps presence and design. The Accessible Right-of-Way guidelines require a minimum "continuous clear width" to allow sufficient space for persons with disabilities to travel. The minimum "clear width" is three feet; however, walkways less than 5 feet wide must provide sufficient passing spaces every 200 feet. The guidelines establish a maximum running-slope for wheelchairs to travel safely at 5% (except where roadway slope exceeds 5%), with running slope not to exceed roadway slope. Additionally, the Access Board's design guide identified cross-slopes greater than 2% as a barrier to accessibility.

According to the U.S. Access Board (2002) the accessibility design guidelines and technical specifications provide a framework for assessing pedestrian conditions. However, traditional sidewalk data collection methods are time-consuming and resource-intensive for public works departments. New methods are emerging to streamline the sidewalk assessment process and aid agencies in developing their ADA (Americans with Disabilities Act of 1990) transition plans and planning for pedestrian facilities. The Georgia Tech system looks beyond a simple compliant/non-compliant determination by collecting detailed sidewalk inventory data and performing an automated quality assessment for the segments monitored. Both of these elements are needed for pedestrian activity and infrastructure planning (Morin, 1990).

2.8. Pedestrian Behaviors and Perceptions Towards the walking Environment

Human beings affect the environment and they are affected by it. For this interaction to happen, we must perceive that it is, be stimulated by sight, sound, smell, or touch that offers clues about the world around us (Perception involves the gathering, organizing, and making sense of information about the environment. A distinction is generally made between two processes that gather and interpret environmental stimuli - 'sensation' and 'perception' (Carmona et al., 2012). Perception concerns more than just seeing or sensing the urban environment. It refers to the more complex processing or understanding of stimuli. Ittelson (as cited in Carmona et al., 2012) identifies four dimensions of perception, which operate simultaneously.

- **Cognitive:** involves thinking about, organizing, and keeping information. In essence, it enables us to make sense of the environment.
- **Affective:** involves our feelings, which influence the perception of the environment - equally, perception of the environment influences our feelings.
- **Interpretative:** encompasses meaning or associations derived from the environment. In interpreting information, we rely on memory for points of comparison with newly experienced stimuli.
- **Evaluative:** incorporates values and preferences and the determination of 'good' or 'bad'.

Investigating the Human-Environment Behavioral studies can be helpful in walkability analysis due to its convenience for interdisciplinary investigations.

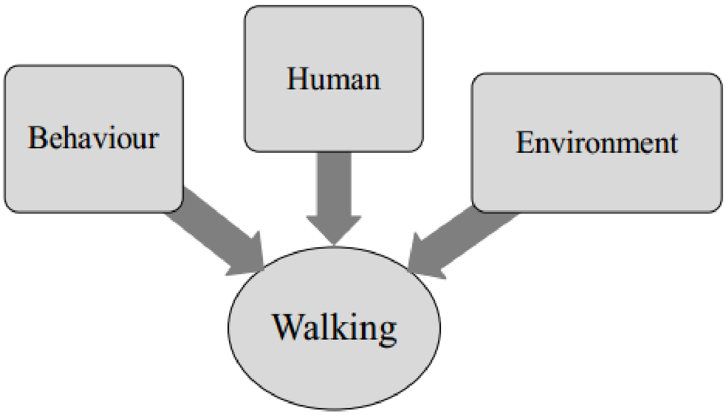


Figure 2.2: Human-Environment-Behavioral relations, influential factors in walking

Source: Carmona, Heath, Oc, & Tiesdell, 2012.

2.9. Pedestrian Infrastructure Planning

To promote walkable neighborhoods, pedestrian infrastructure planning, and design are required. A pedestrian corridor is a pathway that includes segments and nodes (intersections) that provides the right of way to the pedestrian. “To enhance safety while promoting pedestrian flow, crossing facilities such as crosswalks and signals are designed to promote pedestrian visibility and improve the continuity of the pedestrian corridor” (Evans, 2006).To promote national standards in the design and operation of pedestrian facilities, the AASHTO (2000) published the Guide for the Planning, Design, and Operation of Pedestrian Facilities, which sets pathway requirements and desired characteristics for the mobility of pedestrians.
As pedestrian infrastructure becomes the focal point for smart growth development, planning, and decision-making approaches to managing the facilities are becoming a high priority (Evans, 2006). Shah (as cited in Evans, 2006) stated that “during the planning phase, agencies identify and create pedestrian facilities that will be used as walkways in an area of interest based on established planning criteria/guidelines/ standards of an ideal pedestrian walkway.

2.10. Walkability Index

Krambeck and Shah (as cited in Lo, 2006) noted the following components of the Global Walkability Index (GWI).

Table 2.2: Components of the Global Walkability Index (GWI).

components	variables
Safety and security	the proportion of road accidents that resulted in pedestrian fatalities Walking path modal conflict Crossing safety Perception of security from crime Quality of motorist behavior
Convenience and attractiveness	• Maintenance and cleanliness of walking paths • Existence and quality of facilities for blind and disabled persons • Amenities, e.g. coverage, benches, public toilets • Permanent and temporary obstacles on walking paths • Availability of crossings along major roads
Policy support	• Funding and resources devoted to pedestrian planning • Presence of relevant urban design guidelines • Existence and enforcement of relevant pedestrian safety laws and regulations • Degree of public outreach for pedestrian and driving safety and etiquette

Source: Krambeck and Shah (2006), p. 10.)

2.11. Methods of Evaluating Walkability

“Measuring walkability has generally taken two approaches namely subjective and objective studies; i.e. depending on the type of and how the data is collected. Subjective studies focus primarily on the pedestrian experience. Respondents' opinions on their walking environment are obtained from surveys and used to estimate walkability. Objective studies utilize objectively measured data from the field of databases, on infrastructures such as roadway geometry and land use in the built walking environment. The data is then used to assess walkability” (Nyagah, 2015).

2.11.1. Subjective Studies

Subjective studies are typically based on the pedestrian's walking experience. Features in the built environment are measured subjectively by collecting respondents' perceptions of infrastructure such as street connectivity, access to and proximity of adjacent destinations, aesthetics/amenities, and safety risks from traffic and crime. Capturing pedestrian perceptions is typically achieved using surveys. Questions are phrased to elicit respondent opinions on different features in their walking environment. Levi & Clifton (as cited in Nyagah, 2015) stated that using "perception questions is a convenient way to sketch actual walkability conditions". The surveys are implemented by either mailing questionnaires to respondents, making phone calls, or interviewing pedestrians in their walking environment. Below are studies that have used subjective methods to evaluate walkability.

Lin, Sallis, & Nichols (as cited in Nyagah) stated the limitation of subjective studies that is “subjective studies have low reliability when predicting walking behavior”.

2.11.2. Objective Studies

Objective studies are conducted at both micro and macro-level scales. At the macro-level scale, variables in the built environment are aggregated over large areas such as census tracts, assessor parcels, and traffic analysis zones (TAZ). The impacts of aggregated built environment elements on walking for recreational or utilitarian purposes are then evaluated. Built environmental variables are often obtained from field audits, Geographic Information System (GIS) databases, or in combination to examine the built environment. For example, land use types, retail floor area, and assessor acreage can be gotten from local planning agency GIS databases. Social demographic information such as household income, the total population is obtained from the Topologically Integrated Geographic Encoding and Referencing (TIGER) files in the Census Bureau database. Besides, roadway geometry, pedestrian, and traffic volumes used to calculate pedestrian Level of Service (LOS) can be measured from the field or obtained from agency databases (Nyagah, 2015, p.16).

2.12. Conceptual Framework

“The conceptual framework underlying this study considers the role of perceptions as they intervene (or mediate) between the physical features of the environment and walking behavior. Physical features influence the quality of the walking environment both directly and indirectly through the perceptions and sensitivities of individuals. All of these factors' physical features, urban design qualities, and individual reactions may influence the way an individual feels about the environment as a place to walk” (Ewing, & Handy, 2009, p. 4).

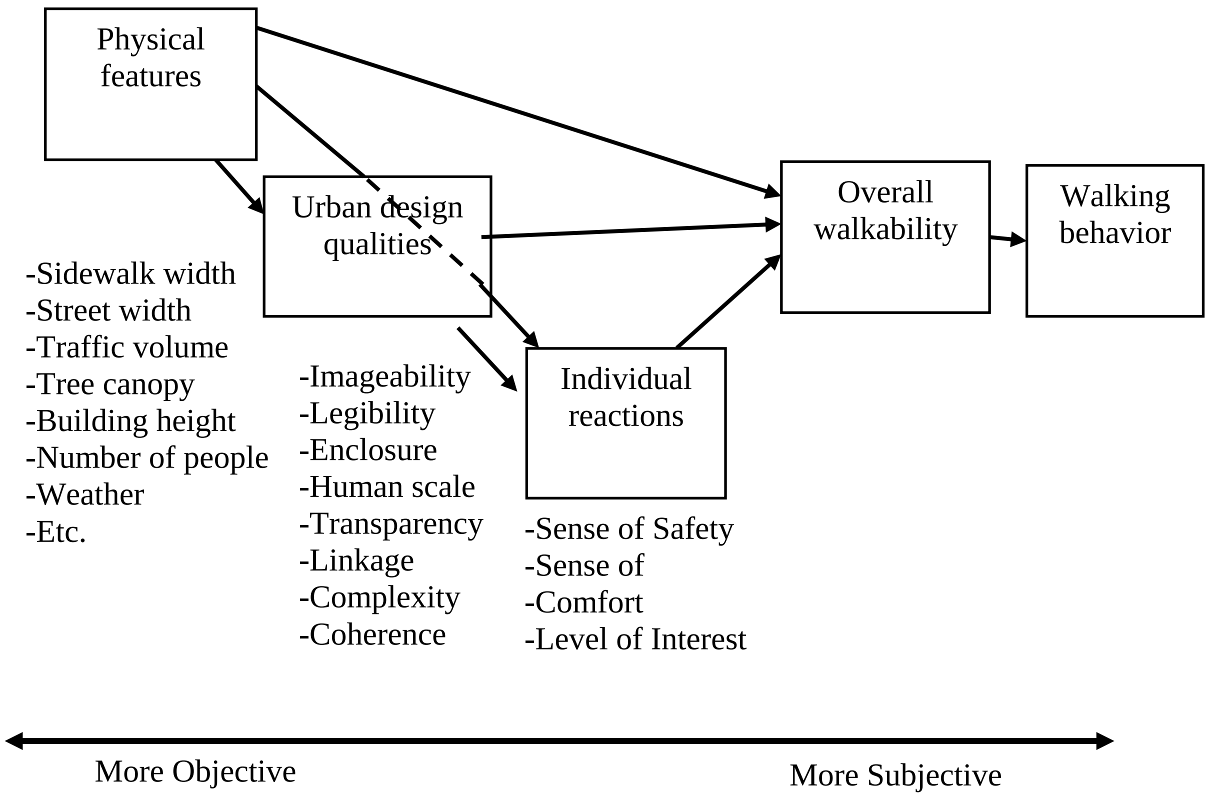


Figure 2.3: Conceptual framework (Ewing, & Handy, 2009)

2.13. Effect of Urban Layout, Street Geometry and Orientation on Shading

According to Shishegar (2013) urban climate is an effective issue on the local and global climates which is influenced by several factors such urban morphology and density, the properties of surfaces and vegetation cover. The inappropriate using of these features could change the microclimate of urban areas. Streets have a significant role in creating the urban microclimates (Huang, et al., 2008). As street geometry and orientation effect the amount of solar radiation received by street surface and also airflow in urban canyons. Urban climate is a serious factor which affects regional and global climates and subsequently urban livability (Srivanit, 2011).

Andreou (2014) stated that urban canyon microclimate is mainly affected by solar access and shading conditions, since solar access affects air and surface temperatures. Canyon geometry and parameters such as street pattern, building height/street width ratio and street orientation define solar access and shading conditions. Thus, they play a critical role in thermal comfort in open spaces and affect mainly the energy performance of buildings (Shisheger, 2013). It has also been suggested that urban geometry is much more significant at the microscale than the thermal performance of materials and the albedo effect (Bourbia & Awbi, 2004).

2.14. Basic pedestrian Walkways Requirements

According to Florida Department of Transportation (1997) all urban sidewalks need the following basic elements for success: adequate width of travel lanes, a buffer from the travel lane, curbing, minimum width, gentle cross-slope (2 percent or less), a buffer to private properties, adequate sight distances around corners and at driveways, shy distances to walls and other structures, a clear path of travel free of street furniture, continuity, a well-maintained condition, ramps at corners, and flat areas across driveways. Sidewalks also require sufficient storage capacity at corners so that the predicted volume of pedestrians can gain access to and depart from signalized intersections in an orderly and efficient manner (AASHTO, 1990).

Minimum Width of Sidewalks

According to Oregon Department of Transportation (1995) sidewalks require a minimum width of 5.0 feet if set back from the curb or 6.0 feet if at the curb face. Any width less than this does not meet the minimum requirements for people with disabilities. Walking is a social activity. For any two people to walk together, 5.0 feet of space is the bare minimum. In some areas, such as near schools, sporting complexes, some parks, and many shopping districts, the minimum width for a sidewalk is 8.0 feet. Thus, any existing 4.0-foot-wide sidewalks often force pedestrians into the roadway in order to talk. Even children walking to school find that a 4.0- foot width is not adequate.

Desirable Sidewalk Width

The desirable width for a sidewalk is often much greater. Some shopping districts require 12, 20, 30, and even 40 feet of width to handle the volumes of pedestrian traffic they encounter. Pennsylvania Avenue in Washington, D.C. has 30-foot sidewalk sections to handle tour bus operations, K Street in Washington, D.C. has 20=foot sections to handle transit off-loading and commercial activity, the commercially successful Paseo de Gracia boulevard in Barcelona, Spain has 36 to 48 feet in most sections (Florida Department of Transportation 1997).

2.15. Empirical Experiences in Developed and Developing Cities

2.15.1. Walking revolution in Sydney

Dobson (2011) stated that Sydney has historically been a walking city. Gadigal people have been walking along its ridgelines for thousands of years. It wasn't until World War I that public transport really changed the character of the city, and after WWII that the car started to dominate planning. Gehl's study of central Sydney in 2007 discovered that the focus on moving cars means Sydney has some of the longest pedestrian waiting times at lights in the world. The solution to these problems is to create spaces and networks and infrastructures for the slow, steady, reliable and human scale experience of walking through the city not a new kind of car.

According to the Department of Infrastructure and Transport (2012) there are six ideas to start the walking revolution: First, make it easy to temporarily close streets. This could begin with trials and pop-up community activation. Reform local council procedures enabling local street closure for neighborhood events, street parties and kid's activities. The regular closure of streets on both small and large scales is a great way to show people how the city can be different. Second, start to close smaller local streets or create shared slow lanes with access only for local residents. Streets with few cars could accommodate the passage of slow traffic when needed by residents, while opening up new spaces for permanent gardens, planting, children's playgrounds and more community space. Third, put human life before time savings. Thirty km/h should become the default speed for local residential streets, with identified traffic corridors and networks going up to 40km/h, 50km/h or even 60km/h. Fourth, start designing cities for children. By making it safe and fun for them to move around the city, we also make it safe and fun for adults and families. Kids and cars don’t mix, so rather than making discrete walled areas for children, let us make big pathways, parks and regions safe for them. Fifth, create a process that begins to charge drivers the real costs of alienating public space for street or public off-street parking. Use this land for public activities, environmental projects, flood mitigation and other mobility modes including bikeways. Lastly, we could expand on research by scholars. Trees and physical shelters could be used to keep people cool during the increasingly hot days.

According to Dobson (2011), the City of Sydney supports walking as a mode of transport to meet the environmental, economic and social objectives set in Sustainable Sydney 2030 and Connecting Our City. Their overarching priorities for walking are to:

i. Make walking quick, convenient and easy
ii. Make walking inviting and interesting
iii. Make walking safe and comfortable
iv. Create a strong walking walkable culture

2.15.2. Designing walkable environment in Singapore using Form Based Codes

According to Zhang et al., 2013, Singapore often tops the rankings as the most livable city in Asia, especially due to its easy access to public amenities, active mobility, including walking and cycling, only accounts for a minority of all ridership in the city-state. Diagnose main problems pertaining to poor walkability of public housing neighborhoods based on a comprehensive review of existing studies and site survey (Yuen, 2011).

The first step consists of an analysis of walkability in Singapore carried out through the review of all the available literature, official reports, online articles, etc., and then cemented by performing site visit to key areas of the city. According to Chan 2015, the aim of this step is twofold; firstly, they intend to assess the willingness of the government to improve walkability by analyzing the current government agenda and efforts towards the improvement of active mobility; and secondly, they analyze and evaluate the present conditions of walkability in Singapore. The analysis focuses on HDB neighborhoods as they represent the predominant urban typology of the city. This step allows for assessing the performance of HDB neighborhoods by listing the most recurrent built environment factors that prevent walkability (Zhang et al., 2013).

Subsequently, they investigated whether FBC could be applied in Singapore and in which ways. Our research performs a review of the limited material available on Form-Based Codes, with aim of mapping strengths and limitations of FBC, and evaluates their applicability in the Asian continent, particularly in the Singapore's HDB neighborhoods. Yuen 2011 stated the opportunities and uncertainties offered by FBC to foster walkable neighborhoods and mixed-use developments are discussed.

Finally, they attempts to propose a series of guidelines for designing walkable and human-scale HDB neighborhoods. Specifically, these guidelines are developed to address the features that prevent active mobility in HDB neighborhoods recognized in the first stage. At the HDB neighborhoods, urban blocks have been mostly developed for the use of car with precincts that are often surrounded and divided by wide, car-based corridors that affect active mobility (Yuen, 2011).

2.16. Summary and Gaps of the Literature

According to Dannenberg and Wendel (2011) walkability has become an ever more important issue in the fields of urban planning, public health, and transportation, researchers have been developing ways to evaluate it quantifiably. Many walkability audit tools now exist, but there is no consensus as to which tool is best for measuring walkability. Investigating the Human-Environment Behavioral studies are very important in walkability analysis due to its convenience for interdisciplinary investigations. Additionally, to promote walkable neighborhoods; pedestrian infrastructure planning and design are required.

Generally, the above-reviewed literature has its perspective and methodologies to investigate the walkability of urban environments. Dominantly the studies has focused on the built environment and human behaviors (land uses, block length, scale, softness, visual complexity, perceptions, connectivity, distance, amenities, and safety) as a major factor for the walkability of walkways. But topography, climatic condition, solar sun path, and temperature of the study areas that have to be in the account to analyze the walkability of an urban environment.

CHAPTER THREE

3. Methodology

3.1. Introduction

This chapter provides details of the study area, the types of data required for the study, sampling techniques, and the methods that were used for gathering the various data along with the tools employed. The chapter also addresses and describes the techniques used to analyze the data that yields answers to the research questions and realize the objectives of the research.

3.2. Methodological Design

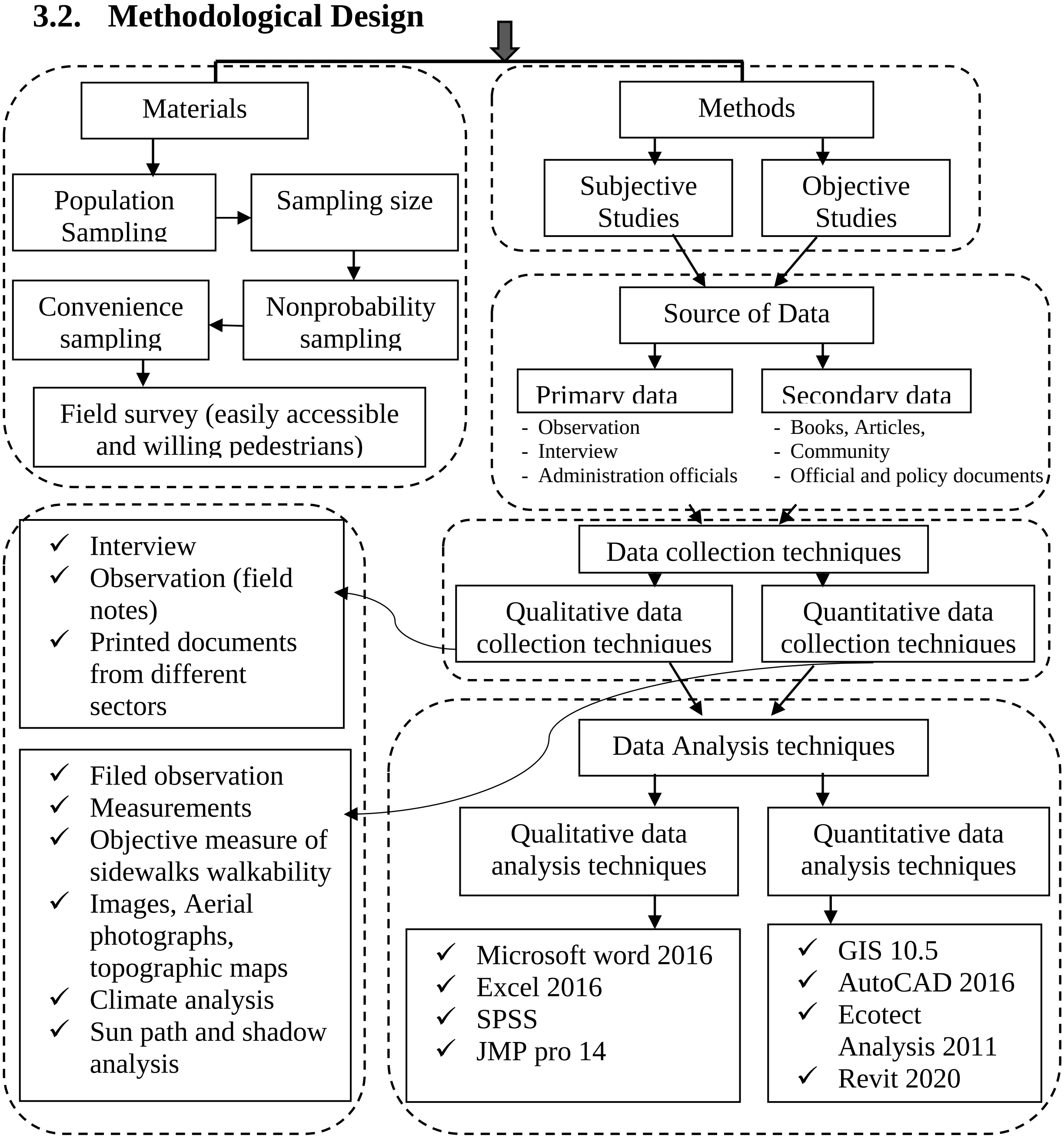


Figure 3.1: Methodological design (Source: Own design, 2020)

3.3. Sampling

The study had conducted an on-site pedestrian interview survey even though the total population is infinite. Thus the study had employed a convenience sampling technique to employ the participants who are easily accessible and convenient for the study. Cochran's formula (1963), had used to determine the sample size since the population size is infinite for street surveys.

$$n = \frac{z^2 pq}{e^2}$$

Where;

n_o = sample size

Z = confidence level at 95% (standard value is 1.96)

P = the estimated proportion of an attribute that is presented in population with 50%

q = 1-p

e = designed level of precision with $\pm$ 5%

$$n_o = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = \frac{(3.84)(0.25)}{(0.0025)} = \underline{\underline{384}}$$

Thus, the study had conducted 384 sample population size randomly those who were convenient and willing for the interview with the following characteristics.

3.4. Source of Data

The study have used both primary and secondary data sources. Primary data like the existing reality on the field (observation), from kebele, city administration and woreda officials and sample selected members are collected through structured and semi-structured questionnaires of open ended type. The secondary data were collected from various policy documents, urban development plans, strategy documents, official documents, project documents, books, articles, community, websites and other important published and unpublished documents relevant for the issue understudy.

3.5. Data Collection Techniques

The study had employed both qualitative and quantitative data collection methods.

2.1.1. Qualitative data collection techniques

The data that was related to concepts, opinions, and values, walking behaviors of people, filed notes from observation of certain activities, and video recordings were collected qualitatively.

Table 3.1: Qualitative data collection techniques

Methods	Description
Observation	To understand whether people what they say to do, and to access unstated knowledge of subjects.
Interview	This involves asking, listening to, and recording answers from an individual or group on a structured, semi-structured, or unstructured format in an in-depth manner.

2.1.2. Quantitative data collection techniques

To investigate the asked and observed numerical data, the quantitative technique was employed. Quantitative data was collected through;

Table 3.2: Quantitative data collection techniques

Methods	Description
Field observation	Direct field observation was employed to understand and describe the character of the study area, to investigate the major problems and potentials of the study area, to survey the width of the walkway, setbacks from buildings, street amenities, and street construction materials.
Image, aerial photographs, and topographic maps.	Images that describe the study area, aerial photographs, and topographic analysis was performed to analyze the suitability of the slope for walking along the study routes.

2.2. Data Analysis Techniques

2.2.1. Qualitative data analysis techniques

The qualitative data interviews, notes, video, audio recordings, images, and text documents were analyzed as follows.

Table 3.3: Qualitative data analysis techniques (own source)

Types	Descriptions	The software's used
Content analysis	The collected data were processed and categorized into verbal or behavioral data to classify, summarize, and organize the data.	SPSS, JMP Pro 14, Excel and Word 2016 were used to analyzing interviews, surveys, and videos).
Narrative analysis	The collected primary qualitative data were revised for the validity and quality of the information.	
Discourse analysis	The interviews and all forms of text data were analyzed.	
Framework analysis	Finally, formalization, identifying a thematic framework, coding, charting, mapping, and interpretation was employed.	

2.2.2. Quantitative data analysis techniques

The data like measurements, statics, and numerical data collected through census, questionnaires, and surveys have analyzed quantitatively using Ecotect 2011, SPSS, and Excel software to analyze and describe the data, maps, diagrams, charts, graphs, text, figures, and tables.

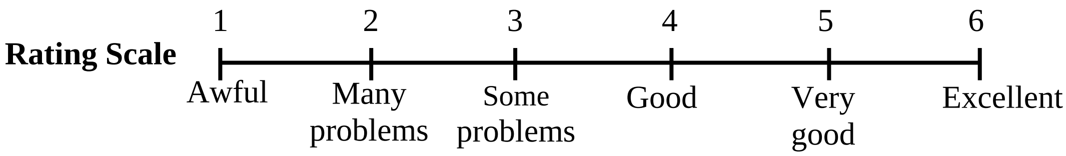
Furthermore, the study had used GIS 10.5 and AutoCAD 2016 software's for working on the general spatial analysis of the study area. Moreover, Revit 2020 used for some detail 3D designs and others like Microsoft office word 2016, PowerPoint 2016 are used for documentation and presentation.

2.3. Validity and Reliability of the Data

For the validity and reliability of the information, the questionnaire was not filled by the respondents themselves but rather by the researcher and six additional data collectors. Since the study was conducted different ideas from the interviews and field observations, the outcome of the study would reflect the actual situation of the walkways along the study routes, thus, the study result would valid and reliable.

2.4. Built Environment Analysis of Tokuma Street

The walkability of the sidewalks executed by adopting the walkability checklist guidance of the ‘Pedestrian and Bicycle Safety Team, Washington, DC. http://safety.fhwa.dot.gov/ped_bike/. Thus, the rating scale for the attributes is:



The average score of each walking environment element describes the situation of Tokuma Street. Hence, the average score from 26-30 is a great neighborhood for walking, 21-25 is pretty good to walk, 16-20 is okay but needs repair, 11-15 needs a lot of works, and 5-10 the sidewalk is a disaster to walk.

CHAPTER FOUR

4. Result and Discussion

4.1. Results

Both the subjective studies of pedestrian perceptions about the infrastructures of the walking environment and the objective studies of the walking built environment results are discussed hereunder.

4.1.1. Background of Survey Respondents

A total of 384 participants, 262 (62.8%) male and 122 (31.2%) female willing pedestrians have participated in the questionnaire survey. The majority of people (72%) were in the age group between 20-40 years as shown in Figure 4.1.

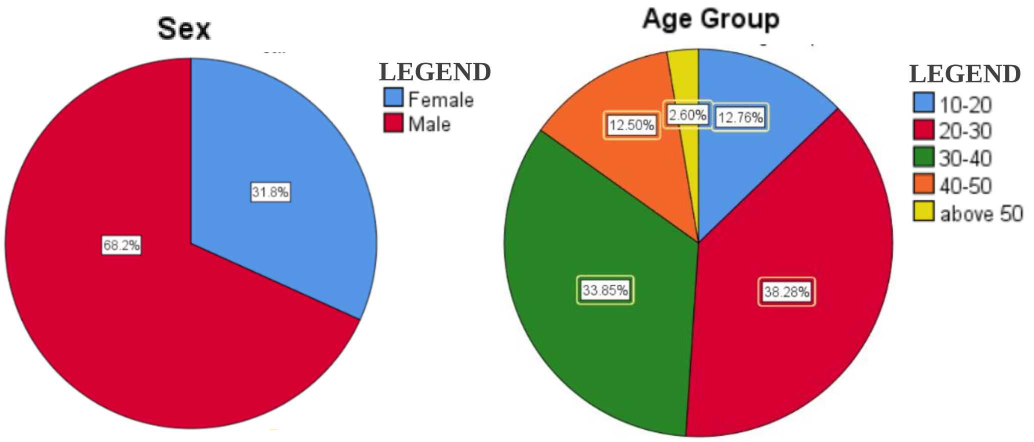


Figure 4.1: Sex and Age group of respondents

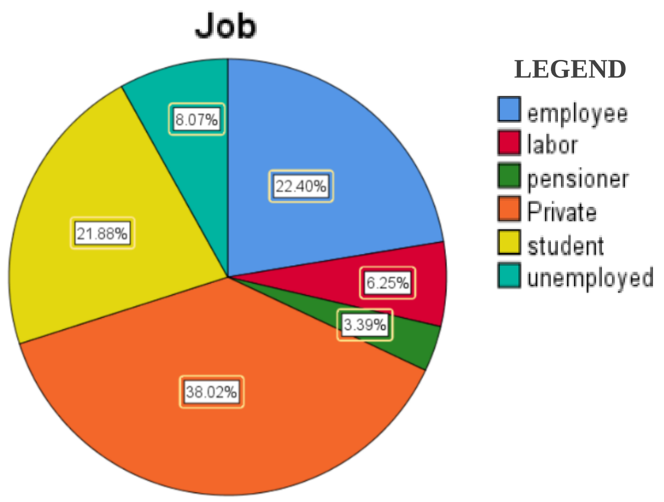


Figure 4.2: Job profile of respondents

Figure 4.2 illustrates the job composing of the respondents, hence, the majority of the respondents were private workers (38%), employees (22.4%) and students (21.9%) respectively.

4.1.2. Subjective Dimensions of Pedestrian Perceptions on the Walkway Environment

Subjective studies were executed to capture the pedestrian perceptions about the infrastructures of the built environment by conducting a questionnaire survey.

4.1.2.1. The pedestrians first choice of transport mode

Among the conducted an on-street survey questionnaire about pedestrians walking behaviors. The study had analyzed as follows:

Table 4.1: Pedestrian choice of transport mode by sex

Sex	Frequency								Grand Total
	No				No				
	Health benefit	To save money	No safe taxi service	Total	High temperature	Not safe to walk	To save time	Total	
Female	34	25	16	75	20	18	9	47	122
Male	83	50	54	187	28	26	21	75	262
Total	117	75	70	262	48	44	30	122	384
	Percentage								
Female	8.9%	6.5%	4.2%	19.6%	5.2%	4.7%	2.3%	12.2%	31.8%
Male	21.6%	13%	14%	48.6%	7.3%	6.8%	5.5%	19.6	68.2%
Total	30.4%	19.5%	18.2%	68.2%	12.5	11.5	7.9%	31.8%	100%

Source: Researcher survey data.

Table 4.1 illustrates the pedestrian choice of transport mode by sex. Among the conducted survey, 68.2% (48.6% men and 19.6 women) respondents chose walking for transport mode. Thus, 48.6 men and 19.6 women are performing their day to day activities through walking. However, 31.8% (19.6% men and 12.2% women) respondents walking is not their choice of transport mode due to different reasons. Among these, 12.5% of them due to high temperature, 11.5% of them due to the walkways are not safe to walk and 7.9% of them use other transport modes to save time.

Table 4.2: Pedestrian choice of transport mode by age group

Age group	Frequency								Grand Total
	Yes				No				
	Health benefit	To save money	No safe taxi service	Total	High temperature	Not safe to walk	To save time	Total	
10-20	13	8	10	31	6	8	4	18	49
20-30	47	34	24	105	18	15	9	42	147
30-40	34	28	29	91	15	12	12	39	130
40-50	17	5	6	28	8	7	5	20	48
Above 50	6	0	1	7	1	2	0	3	10
Total	117	75	70	262	48	44	30	122	384
	Percentage								
10-20	3.4%	2.1%	2.6%	8.1%	1.6%	2.1%	1%	4.7%	12.8%
20-30	12.2%	8.9%	6.3%	27.4%	4.7%	3.9%	2.3%	10.8%	38.3%
30-40	8.9%	7.3%	7.6%	23.8%	3.9%	3.1%	3.1%	10.1%	33.9%
40-50	4.4%	1.3%	1.6%	7.3%	2.1%	1.8%	1.3%	5.2%	12.5%
Above 50	1.5%	0%	0.3%	1.8%	0.3%	0.5%	0%	0.8%	2.6%
Total	30.4%	19.6%	18.4	68.2%	12.6%	11.3%	7.7%	31.8%	100%

Source: Researcher survey data.

Table 4.2 illustrates the pedestrian choice of transport mode by age group. Among the conducted survey, 68.2% of respondents from each age group are using walking for transport mode. Thus, respondents between age groups 20-30 (27.4%), 30-40 (23.8%), 10-20 (8.1%), 40-50 (7.3%), and above 50 (1.8%) years have a high percentage of commuting by walking respectively. However, 31.8% of respondents from each age group are not commuting through walking because of different reasons concerning the condition of the walking environment. Among the respondents age groups 20-30 (10.8%), 30-40 (10.1%), 40-50 (5.2%), 10-20 (4.7%) and above 50 (0.8%) years have high percentage of using other transport mode respectively.

4.1.2.2. Pedestrian walking behaviors

Table 4.3: Pedestrian walking behavior by sex

Sex	Always	Frequently	Sometimes	Rarely	Never	Total
Female	32 (8.3%)	30 (7.8%)	37 (9.6%)	20 (5.2%)	3 (0.8%)	122 (31.8%)
Male	75 (19.5%)	79 (20.6%)	65 (16.9%)	42 (10.9%)	1 (0.3%)	262 (68.2%)
Total	107 (27.8%)	109 (28.4%)	102 (26.5%)	62 (16.1%)	4 (1.1%)	384 (100%)

Source: Researcher survey data.

Table 4.3 illustrates the pedestrian walking behaviors by sex. From a total of 68.2% male and 31.8% female respondents, male pedestrians have a high percentage of walking experiences. Among 68.2% of male respondents, 20.6% of them commute by walking frequently, 19.5% of them walk always, 16.9% of them walk sometimes, 10.9% of commute by walking rarely and 0.3% of them never commute through walking in descending order respectively. Correspondingly, among 31.8% of female respondents, 9.6% of them commute through walking sometimes, 8.3% of them use walking always, 7.9% of the walk frequently, 5.2% of them commute through walking rarely and 0.8% of them never commute through walking in descending order respectively.

Table 4.4: Pedestrian walking behavior by age group

Age group	Always	Frequently	Sometimes	Rarely	Never	Total
10-20	12 (3.1%)	17 (4.4%)	11 (2.9%)	9 (2.3%)	0 (0%)	49
20-30	38 (9.9%)	36 (9.4%)	48 (12.5%)	22 (5.7%)	3 (0.8%)	147
30-40	41 (10.7%)	38 (9.9%)	30 (7.8%)	20 (5.2%)	1 (0.3%)	130
40-50	12 (3.1%)	16 (4.4%)	11 (2.9%)	9 (2.1%)	0 (0%)	48
Above 50	4 (1%)	2 (0.5%)	2 (0.5%)	2 (0.5%)	0 (0%)	10
Total	107 (27.8%)	109 (28.4%)	102 (26.5%)	62 (16.1%)	4 (1.1%)	384 (100%)

Source: Researcher survey data.

Table 4.4 illustrates the pedestrian walking behavior by age group. Respondents composed of different age groups ranging between 10-20 age group 12.7% respondents, 20-30 age group 38.4% respondents, 30-40 age group 33.9% respondents, and 40-50 age group 12.5% respondents and above 50 age group 2.5% pedestrians perceptions conducted. Among the total of 384 respondents from each age group, pedestrians between age groups 20-30, 30-40, 10-20, 40-50, and above 50 years have a high percentage of walking behavior in descending order respectively.

4.1.2.3. Pedestrian Walking Time per Diem

Table 4.5: Pedestrian walking time per diem by sex

Sex	10-15	15-20	20-30	30-45	Above 45	Total
Female	45 (11.7%)	33 (8.6%)	36 (9.4%)	1 (0.3%)	7 (1.8%)	122 (31.8%)
Male	82 (21.4%)	79 (20.6%)	54 (14%)	20 (5.2%)	27 (7%)	262 (68.2%)
Total	127 (33.1%)	112 (29.2%)	90 (23.4%)	21 (5.5%)	34 (8.8%)	384 (100%)

Source: Researcher survey data.

Table 4.5 illustrates the pedestrian walking time per diem by sex. From a total of 68.2% male and 31.8% female respondents, male pedestrians have a high percentage of walking time per diem experiences. Among 68.2% male respondents, 21.4% of them commute by walking from 10-15 minutes per diem, 20.9% of them walk from 15-20 minutes per diem, 14% of them walk from 20-30 minutes per diem, 7% of them commute through walking above 45 minutes per diem and 5.2% of them commute by walking from 30-45 minutes per diem in descending order respectively. Correspondingly, among 31.8% female respondents, 11.7% of them commute through walking from 10-15 minutes per diem, 9.4% of them walk from 20-30 minutes per diem, 8.6% of them walk from 15-20 minutes per diem, 1.8% of them commute through walking above 45 minutes per diem and 0.3% of them commute through walking from 30-45 minutes per diem in descending order respectively.

Table 4.6: Pedestrian walking time per diem by age group

Age group	10-15	15-20	20-30	30-45	Above 45	Total
10-20	14 (3.6%)	13 (3.4%)	17 (4.4%)	0 (0%)	5 (1.3%)	49 (12.7%)
20-30	51 (13.3%)	42 (10.9%)	35 (9.1%)	4 (1%)	15 (3.9%)	147 (38.2%)
30-40	41 (10.7%)	41 (10.7%)	26 (6.8%)	13 (3.4%)	9 (2.3%)	130 (33.9%)
40-50	19 (4.9%)	13 (3.5%)	10 (2.6%)	3 (0.8%)	3 (0.3%)	48 (12.6%)
Above 50	2 (0.5%)	3 (0.8%)	2 (0.5%)	1 (0.3%)	2 (0.5%)	10 (2.6%)
Total	127 (33.1%)	112 (29.2%)	90 (23.4%)	21 (5.5%)	34 (8.8%)	384 (100%)

Source: Researcher survey data.

Table 4.6 illustrates the pedestrian walking time per diem by age group. Respondents composed of different age groups ranging between 10-20 age groups 12.7% respondents, 20-30 age groups 38.2% respondents, 30-40 age groups 33.9% respondents, 40-50 age groups 12.6% respondents, and above 50 age groups 2.6% pedestrian perceptions conducted. Among the total of 384 respondents from each age group, pedestrians between age groups 20-30, 30-

40, 10-20, 40-50, and above 50 years have a High Percentage of walking behavior in descending order respectively.

4.1.2.4. Pedestrian perceptions on safety and comfort about the walkway facilities

Table 4.7: Pedestrian perceptions about the walkway facilities by sex

Sex	No						Total
	Lack of considerations to pedestrians with disabilities	Lack of green infrastructures and shading trees	Lack of properly installed poles and street signs	Lack of buffer	On sidewalk parking and street vendors	Unpleasant open ditch	
Female	17 (4.4%)	43 (11.2%)	11 (2.9%)	21 (5.5%)	18 (4.7%)	12 (3.1%)	122(31.8%)
Male	19 (5%)	93 (24.2%)	23 (6%)	57(14.8%)	42(10.9%)	28 (7.3%)	262(68.2%)
Total	36 (9.4%)	136 (35.4%)	34 (8.9%)	78(20.3%)	60(15.6%)	40(10.4%)	384(100%)

Source: Researcher survey data.

Table 4.7 illustrates the pedestrian perceptions on the walkway facilities by sex. Among the 68.2% male and 31.8% female respondents, they all stated that they are not feel safe and comfortable while walking due to different reasons for the walkway facilities. From 68.2% of male respondents, 24.2% of them due to lack of green infrastructures and shading trees, 14.8% of them due to lack of buffer from the vehicle way and 10.9% of them due to on-street parking and street vendors were the majors among the reasons respectively. Correspondingly, from 31.8% of female respondents, 11.2% of them due to lack of green infrastructures and shading trees, 5.5% of them due to lack of buffer from the vehicle way and 4.7% of them due to on-street parking and street vendors were the majors among the reasons respectively.

Table 4.8: Pedestrian perceptions about the walkway facilities by age group

Age group	No						Total
	Lack of considerations to pedestrians with disabilities	Lack of green infrastructures and shading trees	Lack of properly installed poles and street signs	Lack of buffer	On sidewalk parking and street vendors	Unpleasant open ditch	
10-20	8 (2.1%)	19 (4.9%)	2(0.5%)	5(1.3%)	10(2.6%)	5(1.3%)	49 (12.7%)
20-30	15 (3.9%)	40 (10.4%)	13(3.4%)	37(9.7%)	22(5.7%)	20(5.2%)	147 (38.3%)
30-40	8 (2.1%)	60 (15.6%)	11(2.9%)	23(6%)	21(5.5%)	7(1.8%)	130 (33.9%)
40-50	3 (0.8%)	16 (4.2%)	6(1.6%)	9(2.3%)	7(1.8%)	7(1.8%)	48 (12.5%)
Above 50	2 (0.5%)	1 (0.3%)	2(0.5)	4(1%)	0 (0%)	1(0.3%)	10 (2.6%)
Total	36 (9.4%)	136 (35.4%)	34(8.9%)	78(20.3)	60(15.6%)	40(10.4%)	384

Table 4.8 illustrates the pedestrian perceptions on the walkway facilities by age groups. Among 384 respondents from all age groups, they all stated that they are not feel safe and comfortable while walking due to different reasons for the walkway facilities. Pedestrians from 20-30 age group 38.3%, from 30-40 age group 33.9%, from 10-20 age group 12.7%, from 40-50 age group 12.5% and above 50 age group 2.6% respondents had stated that lack of green infrastructures and shading trees, lack of buffer from the vehicle way and on-street parking and street vendors were the major's reasons respectively.

4.1.2.5. Pedestrians perceptions on the safety of the street crossing

Table 4.9: Pedestrian perceptions on the safety of the street crossing by sex

Sex	No				Total
	High speed of cars at the crossing	Lack of traffic light	Not safe for crossing	Parked cars block the view of traffic	
Female	47 (12.3%)	36 (9.4%)	14 (3.6%)	25 (6.5%)	122 (31.8%)
Male	106 (27.5%)	54 (14.1%)	31 (14.1%)	71 (18.5%)	262 (62.8%)
Total	153 (39.8%)	90 (23.5%)	45 (11.7%)	96 (25%)	384 (100%)

Source: Researcher survey data.

Table 4.9 illustrates the pedestrian perceptions on the safety of the street crossing by sex. All the respondents stated that they do not feel safe crossing the streets due to different reasons for the street crossing facilities. Among 68.2% male respondents, 27.5% of them due to high speed of cars at the crossing, 18.5% of them due to the parked cars blocks the traffic view, 14.1% of them due to lack of traffic light and 8.1% of them due to they do not feel safe to cross the street where the major's reasons respectively. Correspondingly, from 31.8% female respondents, 12.3% of them due to a high speed of cars at the crossing, 9.4% of them due to lack of traffic light, 6.5% of them due to the parked cars block the traffic view and 3.6% of them due to they do not feel safe to cross the street where the major reasons respectively.

Table 4.10: Pedestrian perceptions on the safety of the crossing by age group

Age group	No				Total
	High speed of cars at the crossing	Lack of traffic lights	Not safe for crossing	Parked cars block the view of traffic	
10-20	20 (5.2%)	14 (3.6%)	4 (1%)	11 (2.9%)	49 (12.7%)
20-30	59 (15.4%)	27 (7%)	23 (6%)	38 (9.9%)	147 (38.3%)
30-40	52 (13.5%)	33 (8.6%)	12 (3.1%)	33 (8.6%)	130 (33.8%)
40-50	19 (4.9%)	10 (2.6%)	6 (1.6%)	13 (3.4%)	48 (12.5%)
Above 50	3 (0.3%)	6 (1.6%)	0(0%)	1 (0.3%)	10 (2.7%)
Total	153 (39.8%)	90 (23.4%)	45 (11.7%)	96 (25.1%)	384 (100%)

Source: Researcher survey data.

Table 4.10 illustrates the pedestrian perceptions on the safety of the street crossing by age groups. Among 384 respondents from all age groups, they all stated that they are not feel safe to cross the streets due to different reasons for the street crossing facilities. Pedestrians from 20-30, 30-40, 10-20, 40-50 and above 50 age groups had specified that 39.8% of them due to a high speed of cars at the crossing, 25.1% of them due to parked cars blocks the traffic view, 23.4% of them due to lack of traffic light and 11.7% of them due to the crossing are not safe to cross are the major reasons regarding the street crossing respectively.

4.1.2.6. Pedestrian walking behavior concerning traffic rule

Table 4.11: Pedestrian walking behavior concerning traffic rule by sex

Sex	Frequency									Grand Total
	Yes					No				
	Cross at the crossing	Stoop & look left and right before crossing	To keep me from danger	To respect the rule	Total	Lack of safe crossing	Lack of street signs	Lack of traffic light	Total	
Female	6	22	23	17	68	16	27	11	54	122
Male	15	37	66	28	146	33	48	35	116	262
Total	21	59	89	45	214	49	75	46	170	384
	Percentage									
Female	1.6%	6%	5.7%	4.4%	17.7%	4.2%	7%	2.9%	14.1%	31.8%
Male	3.9%	9.6%	17.2%	7.3%	38%	8.6%	12.5%	9.1%	30.2%	68.2%
Total	5.5%	15.6%	22.9%	11.7%	55.7%	12.8%	19.5%	12%	44.3%	100%

Source: Researcher survey data.

Table 4.11 illustrates the pedestrian walking behavior concerning traffic rule by sex. From a total of 384 respondents, 55.7% of the 38% male and 17.7% female pedestrians are commuting through walking by obeying the traffic rules for different reasons. Thus, 22.9% of them to keep from danger, 15.6% of them stop and look left and right before crossing, 11.7% of them to respect the traffic rule and 5.5% of the cross at the street crossing are the major reasons for both sex categories respectively. But, 44.3% of respondents 30.2% male and 14.1% female pedestrians commute without obeying the traffic rule because of different reasons. So, 19.5% of them lack of street signs, 12.8% of them lack of traffic lights and 12% of them unsafe street crossing are the major reasons respectively for box sex categories to unfollow the traffic rules.

Table 4.12: Pedestrian walking behavior concerning traffic rule by age group

Age group	Frequency									Grand Total
	Yes					No				
	Cross at the crossing	Stoop & look left and right before crossing	To keep me from danger	To respect the rule	Total	Lack of safe crossing	Lack of street signs	Lack of traffic light	Total	
10-20	0	9	10	6	25	6	11	7	24	49
20-30	14	19	35	16	84	22	28	13	63	147
30-40	4	26	27	15	72	17	22	19	58	130
40-50	2	5	11	8	26	3	12	7	22	48
Above 50	1	1	5	0	7	1	2	0	3	10
Total	21	60	88	45	214	49	75	46	170	384
	Percentage									
10-20	0%	2.3%	2.6%	1.6%	6.5%	1.6%	2.9%	1.8%	6.3%	12.8%
20-30	3.6%	4.9%	9.1%	4.2%	21.8%	5.7%	7.3%	3.4%	16.4%	38.2%
30-40	1%	6.8%	7%	4%	18.7%	4.4%	5.8%	4.9%	15.1%	33.8%
40-50	0.5%	1.3%	2.9%	2.1%	6.8%	0.8%	3.1%	1.8%	5.7%	12.5%
Above 50	0.3%	0.3%	1.3%	0%	1.9%	0.3%	0.5%	0%	0.8%	2.7%
Total	5.4%	15.6%	22.8%	11.9%	55.7%	12.8%	19.6%	11.9%	44.3%	100%

Source: Researcher survey data.

Table 4.12 illustrates the percentage of pedestrian walking behavior concerning traffic rule by age group. Among the conducted survey, 55.7% of respondents from each age group are commuting through walking by obeying the traffic rules. Thus, respondents between 20-30, 30-40, 40-50, 10-20, and above 50 age groups have a high percentage of commuting by obeying the traffic rules respectively. However, 44.3% of respondents from each age group are not commuting by obeying the traffic rules. Thus, respondents between 20-30, 30-40, 10-20, 40-50, and above 50 age groups are not commuting by obeying the traffic rules respectively.

4.1.2.7. Pedestrian perceptions of the motorist’s behavior

Table 4.13: Pedestrian perceptions of the motorist’s behavior by sex

Sex	Frequency								Grand Total
	Yes		No						
	They give priority for pedestrians	Total	Backed out of the driveway without looking	Drive too fast	Stops on the sidewalks	They do not give priority for pedestrians	Turned into people crossing the street	Total	
Female	16	16	16	20	4	30	36	106	122
Male	38	38	40	54	7	62	61	224	262
Total	54	54	56	74	11	92	97	330	384
	Percentage								
Female	4.2%	4.2%	4.2%	5.2%	1%	7.8%	9.4%	27.6%	31.8%
Male	9.9%	9.9%	10.4%	14.1%	1.8%	16.1%	15.9%	58.3%	68.2%
Total	14.1%	14.1%	14.6%	19.3%	2.8%	23.9%	25.3%	85.9%	100%

Source: Researcher survey data.

Table 4.13 illustrates the pedestrian perceptions of the motorist’s behavior by sex. From a total of 384 respondents, 85.9% of the 58.3% male and 27.6% female pedestrians stated that the motorists have no good behavior for people commuting by walking. 25.3% motorist turned into people crossing the street, 23.9% they do not give priority for pedestrians and 19.3% drive too fast are the major motorist’s behavior according to the respondent’s perception for both sex categories respectively. But, 14.1% of respondents 9.9% male and 4.2% female pedestrians stated that the motorist has good behavior and gives priority to people.

Table 4.14: Pedestrian perceptions of the motorist's behavior by age group

Age group	Frequency								Grand Total
	Yes		No						
	They give priority for pedestrians	Total	Backed out of the driveway without	Drive too fast	Stops on the sidewalks	They do not give priority for pedestrians	Turned into people crossing the street	Total	
10-20	6	6	8	10	0	12	13	43	49
20-30	22	22	19	32	6	32	36	125	147
30-40	21	21	21	19	4	29	36	109	130
40-50	3	3	7	12	1	16	9	45	48
Above 50	2	2	1	1	0	3	3	8	10
Total	54	54	56	74	11	92	97	330	384
	Percentage								
10-20	1.6%	1.6%	2.1%	2.6%	0%	3.1%	3.4%	11.2%	12.8%
20-30	5.7%	5.7%	4.9%	8.3%	1.6%	8.3%	9.4%	32.5%	38.2%
30-40	5.5%	5.5%	5.5%	4.9%	1%	7.5%	9.4%	28.3%	33.8%
40-50	0.8%	0.8%	1.8%	3.1%	0.3%	4.2%	2.3%	11.7%	12.5%
Above 50	0.5%	0.5%	0.3%	0.3%	0%	0.8%	0.8%	2.2%	2.7%
Total	14.1%	14.1%	14.6%	19.2%	2.9%	24%	25.3%	85.9%	100%

Source: Researcher survey data.

Table 4.14 illustrates the pedestrian perceptions of the motorist's behavior by age group. Among the conducted survey, 85.9% of respondents from each age group stated that motorists have no good behaviors for pedestrians. Thus, respondents between 20-30, 30-40, 10-20, 40-50, and above 50 age groups have a high percentage of explaining about driver's immoral behaviors respectively. However, 14.1% of respondents from each age group stated that motorists have good behaviors for pedestrians.

4.1.2.8. Pedestrian recommendations for the sidewalk to be improve

Table 4.15: Pedestrian recommendations for the sidewalks to be improved by sex

	Frequency								
Sex	Buffering the sidewalks	Improving the surface material	Providing green infrastructures	Providing separated parking	Providing shading trees	Providing sitting areas	Providing street lights	Widening the width of the sidewalks	Total
Female	27	10	15	11	24	8	10	17	122
Male	60	26	31	26	57	14	16	32	262
Total	87	36	46	37	81	22	26	49	384
	Percentage								
Female	7%	2.6%	3.9%	2.9%	6.3%	2.1%	2.6%	4.4%	31.8%
Male	15.6%	6.8%	8.1%	6.8%	14.8%	3.6%	4.2%	8.3%	262%
Total	22.6%	9.4%	12%	9.7%	21.1%	5.7%	6.8%	12.7%	100%

Source: Researcher survey data.

Table 4.15 illustrates the pedestrian recommendations for the sidewalks to be improved by sex. A total of 68.2% male and 31.8% female respondents stated their point of view for the sidewalks to be improved. Among the forwarded recommendations with a high percentage from both sex, categories are: 22.6% of them buffering the sidewalks, 21.1% of them providing shading trees, 12.7% of them widening the width of the sidewalks and 12% of them providing green infrastructures are the major pedestrian improvement ideas for the sidewalks respectively.

Table 4.16: Pedestrian recommendations for the sidewalks to be improved by age group

Age group	Buffering the sidewalks	Improving the surface material	Providing green infrastructures	Providing separated parking	Providing shading trees	Providing sitting areas	Providing street lights	Widening the width of the sidewalks	Total
	Frequency								
10-20	16	3	3	4	10	3	3	7	49
20-30	30	15	19	18	28	7	11	19	147
30-40	36	11	12	13	25	8	10	15	130
40-50	6	6	7	5	14	2	2	6	48
Above 50	1	1	2	1	2	2	0	1	10
Total	89	36	43	41	79	22	26	48	384
	Percentage								
10-20	4.2%	0.8%	0.8%	1%	2.6%	0.8%	0.8%	1.8%	12.8%
20-30	7.8%	3.9%	4.9%	4.7%	7.3%	1.8%	2.9%	4.9%	38.2%
30-40	9.4%	2.9%	3.1%	3.4%	6.5%	2%	2.6%	3.9%	33.8%
40-50	1.6%	1.6%	1.8%	1.3%	3.6%	0.5%	0.5%	1.6%	12.5%
Above 50	0.3%	0.3%	0.5%	0.3%	0.5%	0.5%	0%	0.3%	2.7%
Total	23.3%	9.5%	11.1%	10.7%	20.5%	5.6%	6.8%	12.5%	100%

Source: Researcher survey data.

Table 4.16 illustrates the pedestrian recommendations for the sidewalks to be improved by age group. Among the conducted 384 onsite surveys all respondents from each age group have forwarded recommendations for the sidewalks to be improved from their point of view. Buffering the sidewalks 23.3%, providing shading trees 20.5%, and widening the width of the sidewalks 12.5% is the major recommendation for respondents between 30-40, 20-30, and 10-20 age groups respectively in descending order. But for 40-50 and above 50 age group respondents, providing shading trees, green infrastructures and sitting areas are the most forwarded recommendations respectively.

4.1.3. Objective Dimension Analysis of the Walkway Environment

Objective studies were executed to audit the built walking environment by conducting a field survey through checklists and observations.

Table 4.17: Sidewalks condition analysis

Element	Attributes	Context								Grand Total Score
		Right side			Score	Left side			Score	
		Yes	No	Need Repair		Yes	No	Need Repair		
Sidewalks	Have no street furniture (sittings, traffic lights, street lights, dust bins….)	✓			1	✓			1	8.5
	Sidewalks are blocked by overgrown landscaping, poles, signs, plants, vehicles, etc.	✓			1	✓			2	
	The sidewalk is not continuous	✓			1	✓			2	
	The sidewalk is not wide enough (people cannot easily walk together side-by-side)		✓		2		✓		3	
	Have no buffer between pedestrian and vehicle roadway that separate sidewalks from the street	✓			1		✓		1	
	Have no planted shade producing street trees	✓			1	✓			1	
Total Score					7				10	

Source: Researcher survey data.

Figure 4.3: Site pictures of the sidewalks condition

Table 4.17 and Figure 4.3 illustrates the condition of the sidewalks along Tokuma Street by examining the walking environment features with rating scores. Hence, both the right and left side walkways have scored 7 and 10 points respectively, both sides of the walkways have an average score of 8.5 points which implies that the sidewalks are a disaster for walking.

Table 4.18: The street crossing features condition

Element	Attributes	Context				Grand Total Score
		Yes	No	Need Repair	Score	
Street Crossing	The road is too wide to cross easily	✓			2	9
	Traffic signals do not give enough time to cross the street.	-	-	-	-	
	There is no crosswalk or it is poorly marked.	✓		✓	2	
	I have to walk too far to find a safe, marked crosswalk.	✓			2	
	The intersection does not have a curb ramp for carts, wheelchairs, strollers, walkers, etc.	✓			1	
	Parked cars block the view of traffic	✓			1	
	Does the street have pedestrian crossing signals?		✓	✓	1	
Total Score					9	

Source: Researcher survey data.

Figure 4.4: Site pictures that describe the street crossings conditions

Table 4.18 and Figure 4.4 illustrates the pedestrian crossing condition of Tokuma Street. The crossing is not marked, has no curb ramp for wheelchairs, parked cars block the traffic view, and lacks pedestrian crossing signals. Hence, the street crossing features from both sides have scored 9 points, which implies that the pedestrian crossing is disasters for crossing.

Table 4.19: Safety and comfort of the street for pedestrians

Element	Attributes	Context				Grand Total Score
		Yes	No	Need Repair	Score	
Safety and Comfort	Vehicle speeds are too fast	✓		✓	1	10
	There's too much traffic	✓		✓	1	
	Street lights are few or not present	✓		✓	1	
	There are people on the street who seem threatening	✓			1	
	Unleashed dogs or other loose intimidating animals are present	✓		✓	2	
	There is not enough shade from trees	✓			1	
	There are few or no street trees or other landscaping	✓			1	
	There are vacant lots or rundown buildings	✓			1	
	The street has benches and places to rest		✓		1	
Total Score					10	

Source: Researcher survey data.

Figure 4.5: Site pictures that describe the safety and comfort of the street for pedestrians

Table 4.19 and Figure 4.5 illustrates the safety and comfort of the pedestrian crossing situation of Tokuma Street. The walkways from both sides are not safe and comfortable for pedestrians due to; lack of shading trees, poor surface material, the level of the sidewalks are below the level of the vehicle way, lack of a buffer between the sidewalks and vehicle way, parking on the sideways, lack of traffic signal and high speed of cars. Thus, the safety and comfort of the street for pedestrians from both sides have scored 10 points, which implies that the walkways are a disaster for walking.

Table 4.20: Utility analysis of Tokuma Street

Element	Attributes	Context				Grand Total Score
		Yes	No	Need Repair	Score	
Utilities	Good drainage, away from entrances and walkways		✓	✓	2	5
	Do utilities have visual and environmental quality?		✓	✓	1	
	Do utility lines installed appropriately?		✓	✓	2	
Total Score					5	

Source: Researcher survey data.

Figure 4.6: Site pictures that describe the utility analysis of Tokuma Street

Table 4.20 and Figure 4.6 illustrates the situation of utilities along both sides of Tokuma Street. Thus, the utilities from both sides of the street are not pedestrian-friendly due to; open and unpleasant smell ditches, improperly installed utilities, lack of visual and environmental qualities, and physically obsolete electric powers. Hence, the utility condition of the street from both sides has scored 5 points, which implies that the utilities are a disaster to pedestrians for walking.

Table 4.21: On-street and off-street parking analysis along both side of the walkways

Element	Attributes	Context								Grand Total Score
		Right side			Score	Left side			Score	
		Yes	No	Need Repair		Yes	No	Need Repair		
On-street and Off-street parking	Does the roadway have on-street parking?		✓		2		✓		2	5
	Have a buffer between on-street parking and the roadway?		✓		1		✓		1	
	Do they park cars on the sidewalks?	✓			2	✓			2	
	Do the off-street parking hindering the continuity of sidewalks?	-	-	-	-	-	-	-	-	
Total Score					5				5	

Source: Researcher survey data.

Figure 4.7: Site pictures that describe the situation of parking on both sides of the walkways

Table 4.21 and Figure 4.7 illustrates the parking condition of Tokuma Street. The street lacks proper on-street and off-street parking, hence, vehicles are parked on sidewalks along both sides of the street. However, both the right and left side parking situations have scored 5 and 5 points respectively, both sides of the walkways have an average score of 5 points which implies that the sidewalks are blocked by vehicles and it is a disaster for walking.

Table 4.22: Street amenity analysis of Tokuma Street

Element	Attributes	Context								Grand Total Score
		Right side				Left side				
		Yes	No	Need Repair	Score	Yes	No	Need Repair	Score	
Street Amenities	Do the sidewalks have green elements?		✓		1		✓		1	5
	Do the available plants complement the built environment?		✓		1				1	
	Does the street have street lights?	✓		✓	2	✓		✓	2	
	Do the sidewalks have sittings and dust bins?		✓		1		✓		1	
Total Score					5				5	

Source: Researcher survey data.

Figure 4.8: Site pictures that describe the situation of street amenities

Table 4.22 and Figure 4.8 illustrates the street amenity situation of Tokuma Street. The walkways are not pedestrian and environmentally friendly due to; lack of green elements, street lights, shading trees, sitting areas, dust bins, signage, and buffers. However, both the right and left side street amenity situations have scored 5 and 5 points respectively, both sides of the walkways have an average score of 5 points which implies that the sidewalks lack street amenities and it is a disaster to pedestrians for walking.

Table 4.23: Building orientation analysis of Tokuma Street

Element	Attributes	Context				Grand Total Score
		Yes	No	Need Repair	Score	
Building Orientation	Do buildings create a sense of human scale?		✓	✓	2	8
	Do the buildings interact with the sidewalks?		✓	✓	2	
	Support accessibility to buildings?		✓	✓	2	
	Do the buildings cast shadow to the sidewalks?		✓	✓	2	
Total Score					8	

Source: Researcher survey data.

Figure 4.9: Site pictures that describe the building orientation on both sides of the walkways

Table 4.23 and Figure 4.9 illustrates the building orientation along both sides of Tokuma Street. Thus, the orientation of the building from both side of the street are not pedestrian-friendly due to; lack to create sense of human scale, the building does not interact with sidewalks and cast shadow away to the sidewalks. Hence, the building orientation along both side have scored 8 points, which implies that the buildings are not on the right orientation and it is a disaster to pedestrians for walking.

Table 4.24: Pedestrian behavior analysis on Tokuma Street

Element	Attributes	Context				Grand Total Score
		Yes	No	Need Repair	Score	
Pedestrians Behavior	Do pedestrians walk on the sidewalks?	✓		✓	2	10
	Do pedestrians cross at the crosswalks?	✓		✓	2	
	Stop and look left, right and then left again before crossing the streets?		✓	✓	2	
	Do pedestrians obey all traffic rules?		✓	✓	2	
	Do pedestrians walk against traffic?	✓		✓	2	
Total Score					10	

Source: Researcher survey data.

Figure 4.10: Site pictures that describe the pedestrian's behavior along the walkways

Table 4.24 and Figure 4.10 illustrates the pedestrian's behavior along both sides of the street. Most of the pedestrians along both sides of the sidewalks do not commute following the pedestrian traffic rules. Most of the pedestrians do not cross at the crosswalks, walk against the traffic, do not look right and left before crossing and walking on the vehicle ways. Hence, the pedestrian behavior along both side have scored 10 points, which implies that the pedestrians are not obeying the traffic rules and it is a disaster for walking.

Table 4.25: Driver's behavior analysis on Tokuma Street

Element	Attributes	Context				Grand Total Score
		Yes	No	Need Repair	Score	
Drivers Behavior	Turned into people crossing the street	✓		✓	3	8
	Drivers aren't looking out for people walking, make unexpected turns, or seem hostile.	✓		✓	2	
	Sped up to make it through traffic lights or drove through traffic lights?	-	-	-		
	Drove too fast	✓		✓	3	
Total Score					8	

Source: Researcher survey data.

Figure 4.11: Site pictures that describe the driver's behavior on both sides of the walkways

Table 4.25 and Figure 4.11 illustrates the driver's behavior along both sides of the street. Some of the drivers along both sides of the sidewalks do not drive following the traffic rules. Thus, turned into people crossing the street, drove fast, make unexpected turns, did not look out for people walking, and park on the sidewalks are the major behaviors. Hence, the driver's behavior along both side have scored 8 points, which implies that the driver's behavior is a disaster for walking.

4.1.3.1. Climatic Condition Analysis of Adama Town

4.1.3.1.1. The temperature of Adama Town

Table 4.26: Monthly average temperature data of Adama town from 2015-2019 G.C

year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	Max.Temp	28.1	29.5	29.8	30.7	31.1	31.6	28.3	26.7	27.3	26.9	27.5	26.2
	Min.Temp	13.9	16.4	16.7	17.4	17.3	18.1	17.1	16.5	16	14.7	15	13.3
2016	Max.Temp	27	30.5	31.3	31.7	30.7	30.5	29.5	27.9	28.9	29.9	28	26.9
	Min.Temp	12.6	15.8	17.1	16.2	17.2	18.1	17.4	16.6	16.3	17	15.9	15.5
2017	Max.Temp	28	29.4	32.8	30.3	29.7	29.6	27	27.1	28.3	29.4	27.9	26.6
	Min.Temp	15.7	15.4	19	17.7	17.3	17.5	16.6	17	16.1	15.5	14.8	12.7
2018	Max.Temp	27.9	28.8	31.5	31.3	29.8	31.2	27.5	26.8	27.7	28.6	27.4	26
	Min.Temp	12	15.6	16.9	17.5	17	18.6	16.4	16.7	15.8	15.2	13.7	11.4
2019	Max.Temp	26.8	28.5	30	30.8	29.9	28.8	27.2	27.2	28.8	29.3	28	27.3
	Min.Temp	12.5	14.7	16.1	16.6	16.5	17.5	16.2	16.4	15.5	15.7	15.3	14.4

Source: Eastern and Central Oromia Metrological Service Center, 2020.

Table 4.26 illustrates the monthly average maximum and minimum temperature of Adama town from 2015-2019 G.C. Hence, Adama has maximum average temperature on March 2017, April 2016, June 2015, March 2018, and April 2019 respectively. Correspondingly, the minimum average temperature is in December 2018, January 2019 and 2016, December 2017 and 2015 respectively. Consequently, the annual average maximum and minimum temperature in each month of the year implies that there is no significant difference in the town for the last five successive years.

Table 4.27: Annual mean temperature data of Adama from 2015-2019 G.C.

Year (2015-19)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Annual Mean Temperature	Max.Temp	27.6	29.3	31.1	31	30.2	29.7	29.9	27.1	28.2	28.8	27.8	26.6
	Min.Temp	13.3	15.6	17.2	17.1	17.1	18	16.7	16.6	15.9	15.2	14.9	13.4

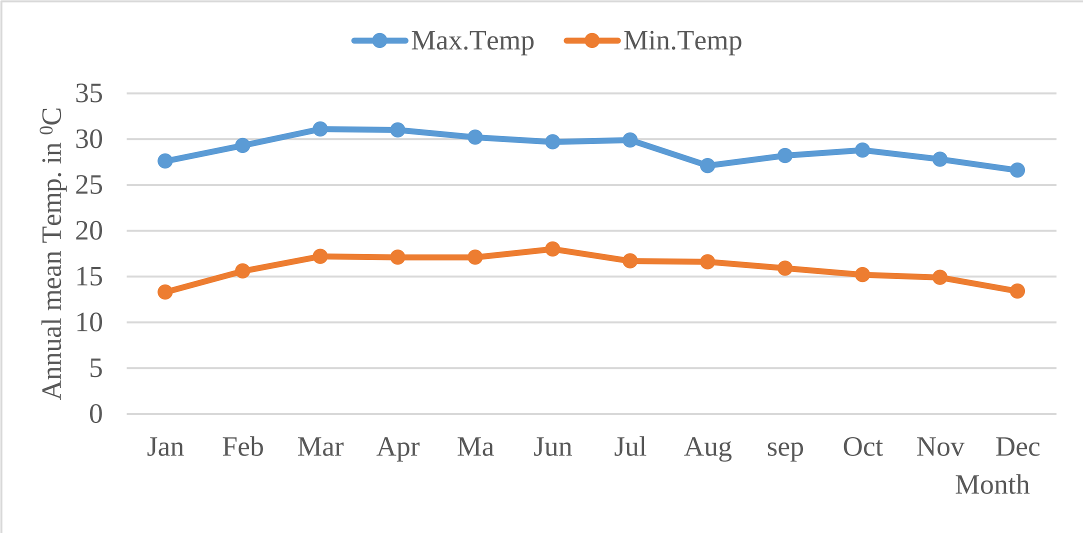


Figure 4.12: Monthly annual mean temperature of Adama from 2015-2019 G.C.

Source: Eastern and Central Oromia Metrological Service Center, 2020.

Table 4.27 and the graph in Figure 4.12 illustrates the monthly annual mean maximum and minimum temperature of Adama town for the last five successive years from 2015-2019 G.C. Thus, Adama has maximum annual mean temperature in March, April, and May respectively. Correspondingly, the minimum annual mean temperature is in January, December, and November respectively. Even though the maximum and minimum annual mean temperatures in each month of the years have no significant differences, March, April, and May are the hottest months, and also January, December, and November months are the lowest temperature in Adama town.

4.1.3.1.2. The sunshine hour of Adama Town

Table 4.28: Monthly average sunshine hour data of Adama town from 2015-2019 G.C.

year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	10.6	9.5	8.5	8.8	7.6	6.8	6.3	6.8	7	8.9	10.5	10.7
2016	10.8	10	7	7.8	8.8	6.8	6.6	6.7	7.2	9.2	10	9.7
2017	10.9	10	8.5	8.2	8.4	7.9	5.2	6.8	7.4	8.3	8.8	10.5
2018	10.7	8.4	8.6	9	8.7	8.7	6.5	6.9	6.6	8.8	9.3	9.8
2019	10.5	9.1	8	6.2	7.4	8.8	7	6.6	8.3	9.1	8.9.	9.9

Source: Source: Source: Eastern and Central Oromia Metrological Service Center, 2020.

Table 4.28 illustrates the monthly average sunshine hour of Adama town for the last five years from 2015-2019 G.C. Adama has maximum sunshine hours on months, January 2017, 2016, 2018, December 2015, and January 2019 respectively. Correspondingly, the minimum sunshine hours are on months, July 2017, 2015, 2018, 2016, and August 2019 respectively. But, the maximum and minimum sunshine hours of Adama town for the last five years are both recorded in January and July 2017 respectively.

Table 4.29: Annual mean a sunshine hour of Adama town from 2015-2019 G.C.

Year (2015-19)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Annual Mean sunshine hour	10.7	9.4	8.1	8	8.2	7.8	6.3	6.8	7.3	8.9	9.5	10.1

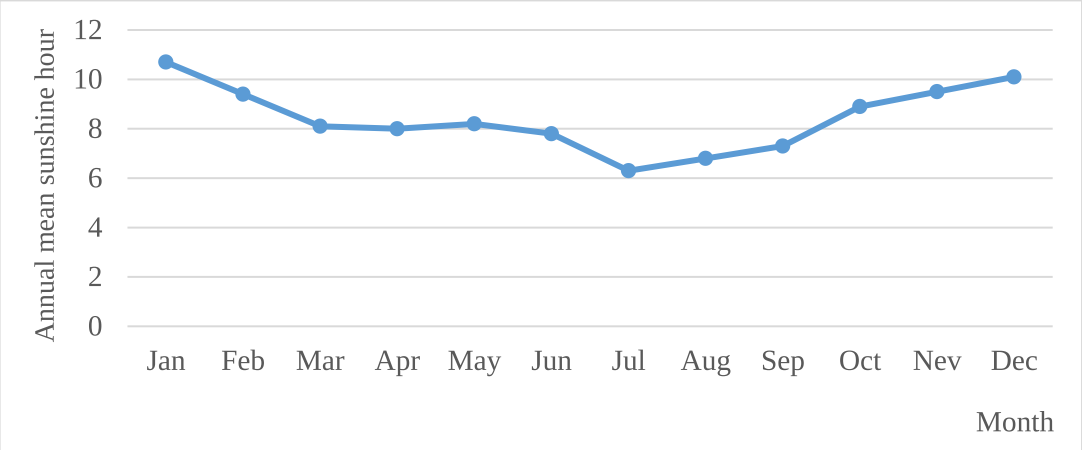


Figure 4.13: Annual mean a sunshine hour of Adama town from 2015-2019 G.C.

Source: Eastern and Central Oromia Metrological Service Center, 2020.

Table 4.29 and the graph in Figure 4.13 illustrates the annual mean sunshine hour of Adama town for the last five years from 2015-2019 G.C. Adama has a maximum annual mean sunshine hour in January, December, and November respectively. Similarly, the minimum annual mean sunshine hour is in July, August, and September respectively. But, the amount of annual mean sunshine hour in each month of the year indicates there is intense sunshine per month which is greater than 6.3 hours per day.

4.1.3.1.3. The rainfall of Adama Town

Table 4.30: Monthly average rainfall data of Adama town from 2015-2019 G.C.

year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	0	4.8	123	7.1	62.3	7.7	211.7	180	150	91.7	8.9	0
2016	0	0	11	180.6	3.6	74.9	131.3	207.9	77.8	2.7	47	1.5
2017	1.3	23	21.7	146	52.5	120.2	345.4	103.9	135	0.9	33.2	0
2018	0	38.9	121.8	36.4	166.4	31.9	225	207.5	198	91	0	0
2019	0	13	0	108.4	42.4	107.6	221.3	179.8	50.3	1.2	15.3	0

Source: Eastern and Central Oromia Metrological Service Center, 2020.

From Table 4.30, Adama has annual maximum precipitation in July 2017, 2018, and 2019 respectively. However, the minimum precipitation is in January, December, and February respectively. Moreover, Adama has an annual driest season in December and January for the last five years. But, the amount of rainfall in each month of year average implies that there is a significant difference in rainfall in the town through the different seasons of the year.

Table 4.31: Annual mean rainfall of Adama town from 2015-2019 G.C.

Year (2015-19)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Annual Mean rainfall	0.3	15.9	55.5	95.7	65.4	68.5	226.9	175.8	122.3	37.5	20.9	0.3

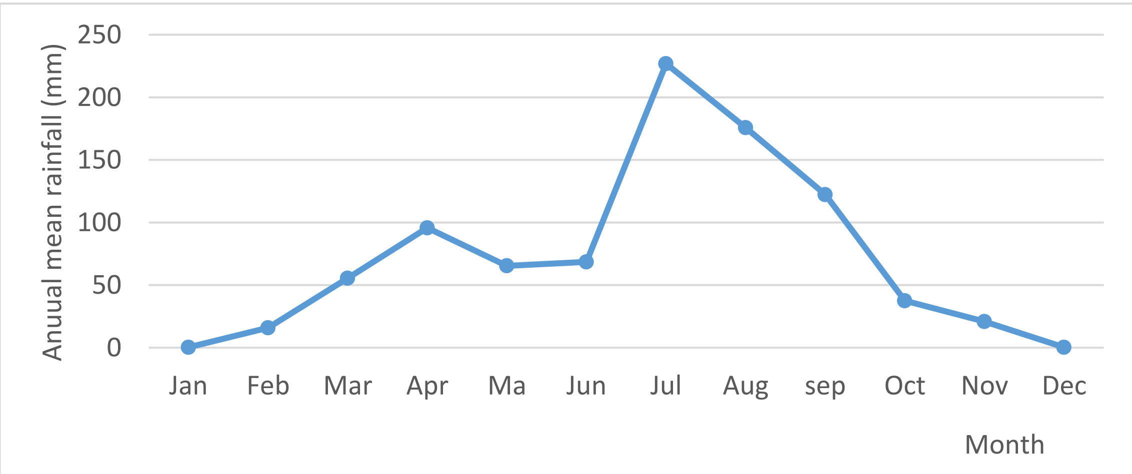


Figure 4.14: Annual mean precipitation of Adama town from 2015-2019 G.C.

Source: Eastern and Central Oromia Metrological Service Center, 2020.

Table 4.31 and the graph in Figure 4.14 illustrates the maximum and minimum annual mean precipitation of Adama town for the last five successive years from 2015-2019 G.C. Thus, Adama has annual mean maximum precipitation in months, July, August, and September respectively. Correspondingly, the minimum annual precipitation is on months, January, December, and February respectively. But, the amount of rainfall in each month of the year means implies that there is a significant difference in rainfall in the town through different months, hence, winter and autumn are the driest seasons in Adama.

4.1.3.1.4. The wind of Adama Town

Table 4.32: Monthly average wind speed data of Adama town from 2015-2019 G.C.

year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	3.2	3.0	3.4	4.0	2.7	2.0	1.6	1.7	1.9	3.5	3.3	3.2
2016	3.6	3.4	3.7	3.9	2.5	2.1	1.7	1.7	1.8	3.4	3.4	3.3
2017	2.9	3.8	3.0	3.9	2.5	2.4	2.1	2.0	1.6	2.9	3.0	3.5
2018	3.4	3.0	2.8	3.3	2.2	1.8	2.2	1.9	1.0	1.5	2.1	2.0
2019	2.1	2.0	2.0	1.4	1.5	1.6	1.7	1.4	1.1	1.8	2.0	2.1

Source: Eastern and Central Oromia Metrological Service Center, 2020.

Table 4.32 illustrates the maximum and minimum monthly wind speed of Adama town for the last five successive years from 2015-2019 G.C. Hence, Adama has maximum wind speed in years, 2015, 2016, and 2017 respectively. On the contrary, the minimum wind speed is in 2018, 2019, and 2016 respectively. The amount of rainfall in each month of year average implies that there is a significant difference in wind speed in the town through different months, hence, wind speed is decreasing for the last five years in Adama.

Table 4.33: Annual mean wind speed of Adama town from 2015-2019 G.C.

Year (2015-19)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Annual mean wind speed in m/s	3.0	3.0	3.0	3.3	2.3	2.0	1.9	1.7	1.5	2.6	2.8	2.8

Source: Eastern and Central Oromia Metrological Service Center, 2020.

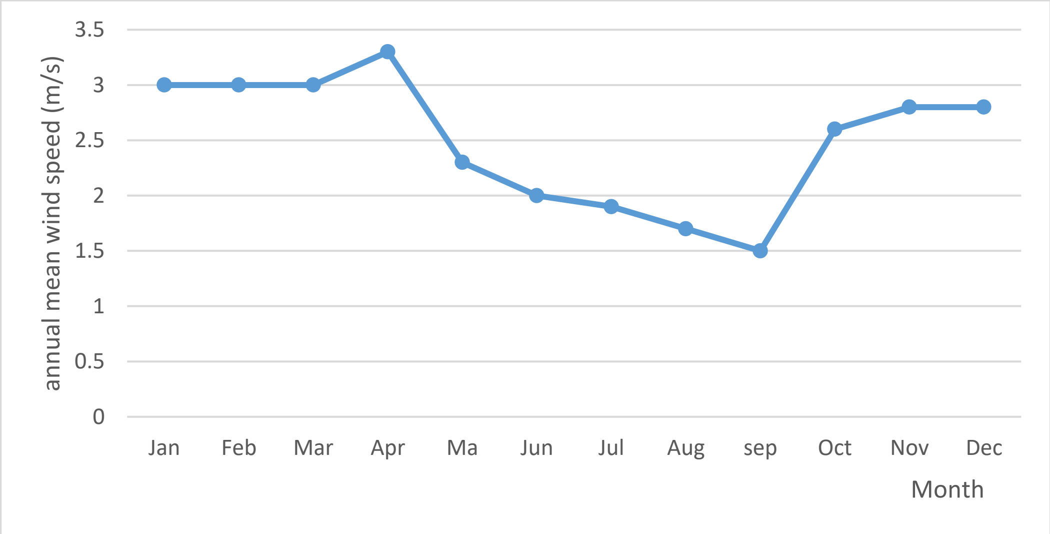


Figure 4.15: Annual mean wind speed of Adama town from 2015-2019 G.C.

Source: Eastern and Central Oromia Metrological Service Center, 2020.

Table 4.33 and the graph in Figure 4.15 illustrate the maximum and minimum annual mean wind speed of Adama town for the last five successive years. So, Adama has maximum wind speed in April, and also in January, February, and March at a similar rate. On the other hand, the minimum annual wind speed is in months, September, August, and July respectively. But, the amount of wind speed in each month implies that there is no significant difference in wind speed in winter and summer seasons for the last five years in the town.

4.1.3.1.5. Sun path analysis of Adama Town

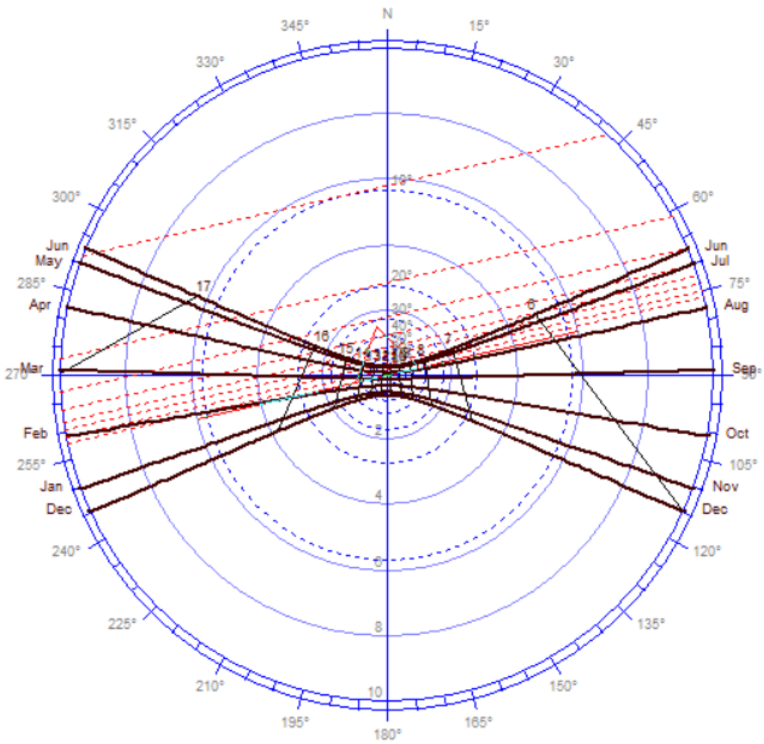


Figure 4.16: Sun path diagram of Adama

Figure 4.16 illustrates the annual sun path diagram of Adama. Using the sun path diagram, shadow direction of the street and the building analyzed for critical hours of each month of the year as discussed in Table 4.51. Existing street width and maximum building height of Adama was taken either side of the street that cast shadow on the street.

Table 4.34: Annual sunrise and sunset in Adama

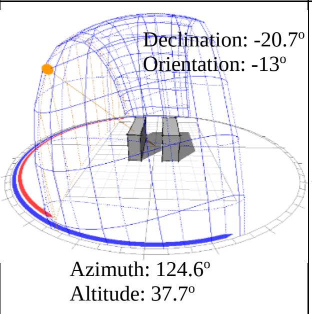
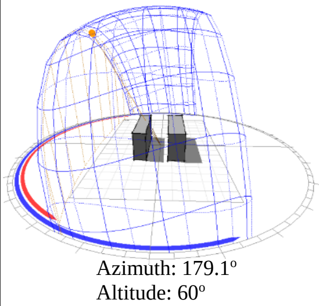
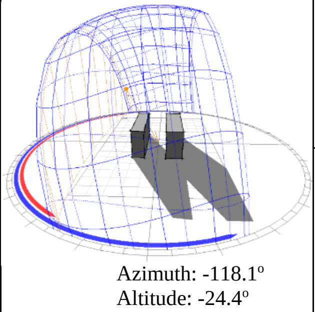
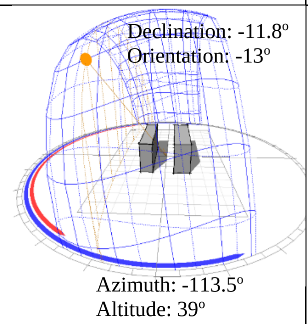
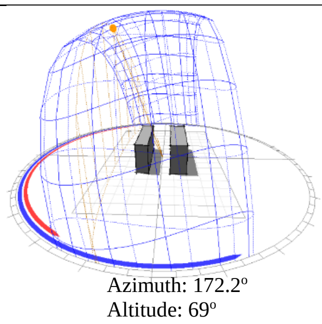
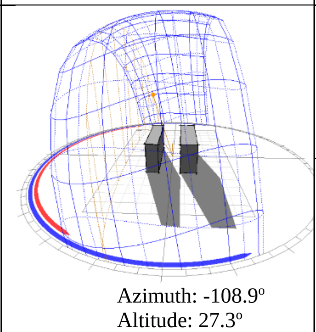
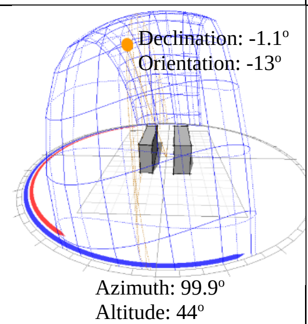
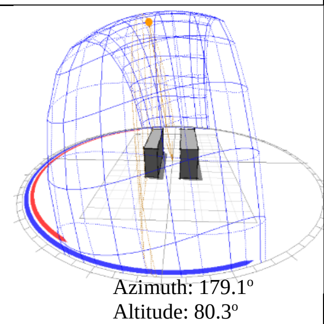
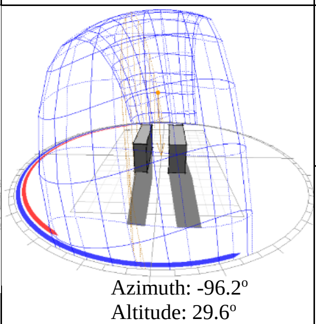
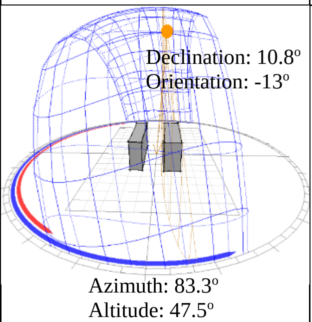
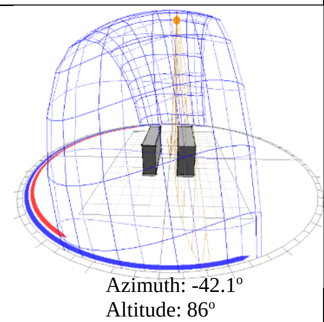
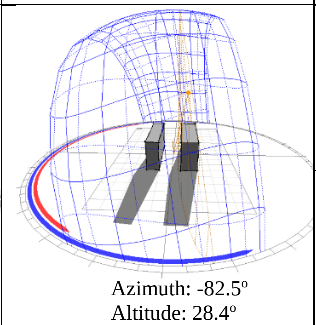
Months	Azimuth		Hours (h)		Altitude	Declination	Hours (h)	
	Sunrise (°)	Sunset (°)	Sunrise AM	Sunset PM	Solar midday	(°)	Night length	Daylight length
Jan 19	112.3	109.2	06:46	06:20	60.5	-20.7	12:26	11.34
Feb 19	102.9	99.9	06:43	06:29	69.5	-11.8	12:14	11:46
Mar 19	92.3	89.8	06:31	06:29	80.3	-1.1	12:02	11:58
Apr 19	79.9	78.6	06:15	06:28	86.1	10.8	11:47	12:13
May 19	70.9	69.6	06:06	06:31	78.4	19.5	11:35	12:25
Jun 19	67.0	65.6	06:08	06:38	74.9	23.4	11:30	12:30
Jul 19	69.6	68.1	06:15	06:42	77.6	21.0	11:33	12:27
Aug 19	77.7	76	06:18	06:34	85.4	13	11:44	12:16
Sept 19	88.1	85.6	06:15	06:17	82.3	1.8	11:58	12:02
Oct 19	100.1	99.5	06:13	06:01	71.8	-9.7	12:12	11:48
Nov 19	109.8	108.8	06:20	05:55	62.8	-19.3	12:25	11:35
Dec 19	114.5	112.8	06:34	06:04	57.8	-23.4	12:30	11:30

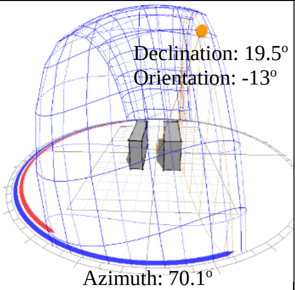
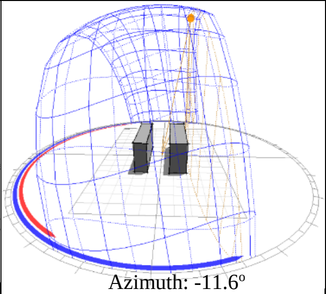
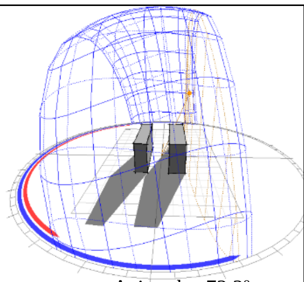
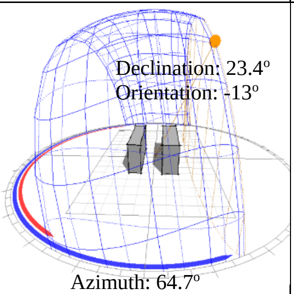
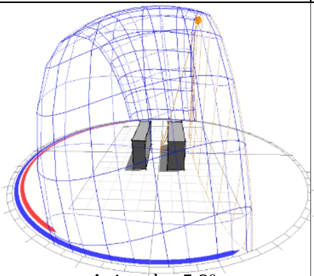
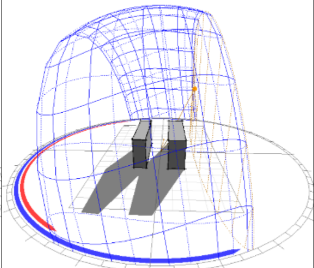
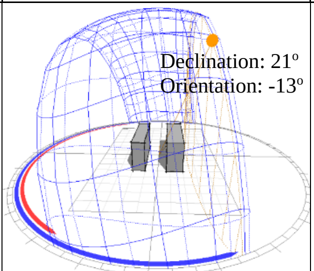
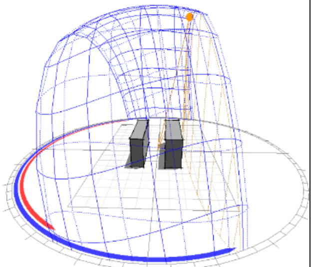
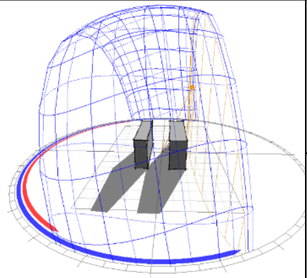
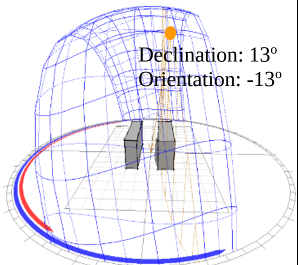
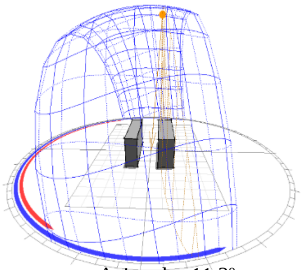
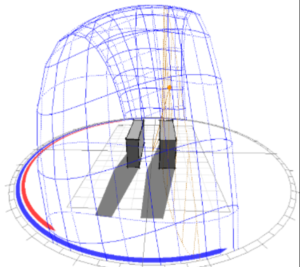
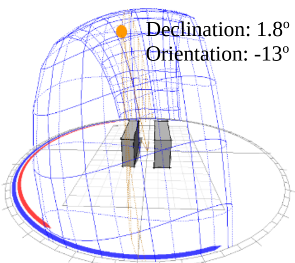
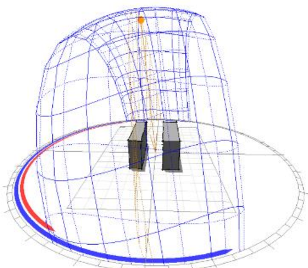
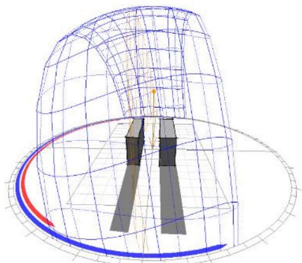
Source: Researcher survey data.

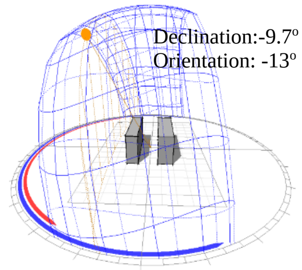
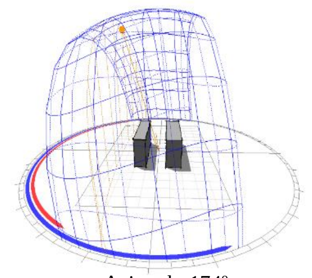
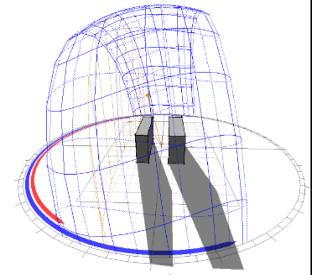
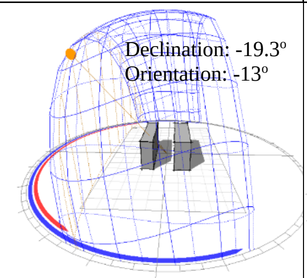
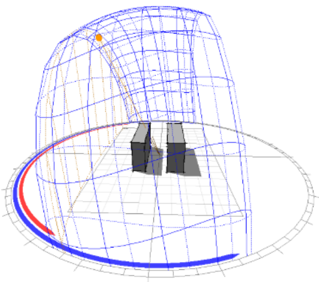
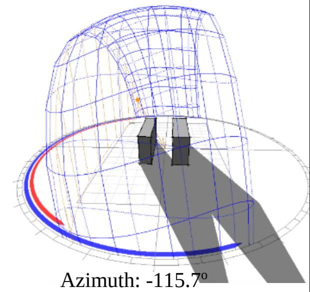
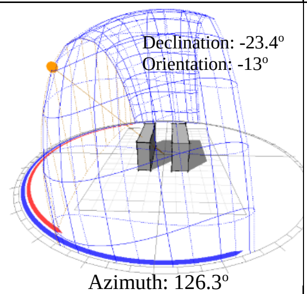
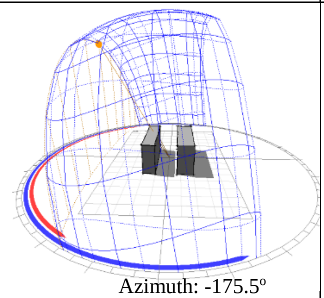
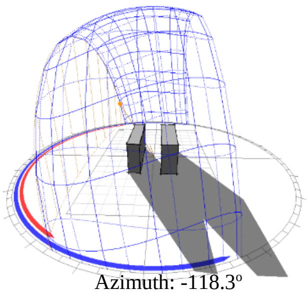
Table 4.34 illustrates the annual sunrise and sunset in Adama. Thus, December has the shortest daylight and longest night, March and September have equal day and night length and June has the longest day and shortest night. But for summer and winter solstice June 19, and December 19, the declination is $+23.4^0$ and -23.4^0 respectively. In June and December Adama experiences 12:30 and 11:30 longest and shortest days of the years respectively. The altitude on solar midday in each month is above 57.8^0 which implies that solar power is high and reaches the ground easily unless other protective measures are taken. Particularly, on April, the altitude of the solar midday is 86.1^0, thus, it is hard to pedestrians to walk in the town, and also, it causes different kind of diseases those are related with the solar radiation.

Sun path analysis is executed to identify the building shadow direction and street orientation (Tokuma Street inclined 77^0 NE and 257^0 SW, thus, the orientation is -13^0) relationship with Adama town coordinates at 8.6^{0}N latitude and 39.3^{0}E longitude concerning the sun path at the 19th day of each month of the year on the critical times. The critical time was observed in Adama at 09:00 AM, 12:00 PM, and 04:00 PM.

Table 4.35: Monthly shadow direction on critical time of Tokuma Street

Month	Time: 09:00 AM	Time: 12:00 PM	Time: 04:00 PM	Shadow direction
January				**Right side** To front **Left side** To behind
February				**Right side** To front **Left side** To behind
March				**Right side** To West & East **Left side** To West & East
April				**Right side** West & East **Left side** West & East

May				**Right side** To behind **Left side** To front
June				**Right side** To behind **Left side** To front
July				**Right side** To west & behind **Left side** To front
August				**Right side** To West & East **Left side** To West & East
September				**Left side** To West & East **Left side** To West & East

October	 Declination:-9.7º Orientation: -13º Azimuth: 111.3º Altitude: 41.2º	 Azimuth: 174º Altitude: 71.6º	 Azimuth: -105.1º Altitude: 28.3º	**Right side** To front **Left side** To behind
November	 Declination: -19.3º Orientation: -13º Azimuth: 122.6º Altitude: 38.4º	 Azimuth: 176.8º Altitude: 42.6º	 Azimuth: -115.7º Altitude: 24.3º	**Right side** To front **Left side** To behind
December	 Declination: -23.4º Orientation: -13º Azimuth: 126.3º Altitude: 34.9º	 Azimuth: -175.5º Altitude: 38.4º	 Azimuth: -118.3º Altitude: 22.9º	**Right side** To front **Left side** To behind

Source: Researcher survey data.

Table 4.35 illustrates the monthly shadow director of the buildings at a critical time on Tokuma Street. The shadow from buildings from both sides of the streets is parallel to the orientation of the existing street, thus, the sidewalks from both sides of the street do not get any shadow in months, March, September, April, and August respectively throughout the critical time of the day. The left side buildings cast shadow away from the sidewalks in months, February, October, November, and December respectively. On the other way, the left side buildings cast shadow to the front side in months, May, June, and July respectively. The right side buildings cast shadow away from the sidewalks in months, May, June, and July. However, the right side building cast shadow to the front side of the sidewalks in December, November, January, and February respectively.

4.2. Discussion

4.2.1. Pedestrian Perceptions of the Walkways along Tokuma Street

Subjective dimensions were executed to analyze the pedestrian perceptions on the sidewalks. Among 384 respondents, 262 of them were using walking for transportation, from these, 28.6% of them were walking frequently, 27.8% of them were using walking always and 26.6% of them were using walking sometimes, and the rest 17% of the respondents use another mode of transportation due to different reasons respectively in all age group. The majority of the respondents 33.1%, 29.2%, and 23.4% of the pedestrians from all age groups were commuting through walking for 10-15, 15-20, and 20-30 minutes per diem respectively.

According to the respondent's perception about the walkway facilities; lack of green infrastructures (35.4%), lack of buffer from the vehicle way (20.5%), on sidewalk parking (15.6%), unpleasant open ditches (10.4%), lack of considerations people with disabilities (9.4%) and improperly installed poles and street lights (8.9%) were the major problems for all age group respondents respectively. Correspondingly, the pedestrians were not feeling safe at the street crossing due to the high speed of cars, parked cars block the view of traffic and lack of traffic light were the majors among the problems. About 55.7% of the respondents from all age groups commute through walking following the traffic rule, but 44.3% of them were not due to the sidewalks lacks street light, signs, safe crossing and traffic lights. Additionally, according to the respondents, the behavior of the motorists was also a big factor for pedestrians walking behavior. Among the stated, the major motorist's behavior was, turned into people walking and crossing the streets (25.3%), they do not give priority for pedestrians (23.9%), and drove too fast (19.3%) are the major problems respectively.

4.2.1.1. Pedestrians Way Concepts for Improvements

Stating all the above subjective perceptions about the sidewalks along both side of the street, respondents have forwarded their recommendations about the walkways to be improved were; buffering the sidewalks (22.6%), providing shading street trees (21.1%), widening the width of the sidewalks (12.7%), providing green infrastructures (12%), providing separated parking and taxi stations, improving the surface material of the sidewalks (9.4%), providing street light (6.8%) and providing sitting areas (5.7%) were the pedestrian's point of view for improvements respectively. Thus, the pedestrian's priority way concept for improvement of the sidewalks is illustrated as follows in Figure 4.49, 4.50, 4.51, 4.52, 4.53, and 4.54 respectively.

Figure 4.17: Pedestrian recommendation (buffering the sidewalks)

Figure 4.18: Pedestrian recommendation (providing shading trees)

Source: Own design, 2020.

Figure 4.19: Pedestrian recommendation (widening the width of sidewalks)

Figure 4.20: Pedestrian recommendations (providing green infrastructures and street lights)

Source: Own design, 2020.

Figure 4.21: Pedestrians recommendation (improving surface material and separated parking)

Figure 4.22: Pedestrians recommendation (providing sitting areas)

Source: Own design, 2020.

4.2.2. The built environment of the Walkways along Tokuma Street

Objective dimension analysis has executed to assess the physical walking environment of Tokuma Street and the climatic condition of Adama town as a whole. Physical walking environment elements; sidewalk conditions, street crossings, safety and comfort of the sidewalks, utilities, on-street, and off-street parking, street amenities, building orientations, pedestrian behaviors, and motorist behaviors were assessed using a walkability checklist and the attributes under each element had rated an average score of 8.5, 9, 10, 5, 5, 5, 8, 10 and 8 points respectively resulting in a total average score of 7.6 points. Thus, the physical walking environment of Tokuma Street has scored an average of 7.6 points which implies that the sidewalks are a disaster for walking and need a lot of works.

The climatic condition of Adama town has assessed for five successive years and the sun path diagram at the coordinate of latitude 8.6^0 N and longitude 39.3^0 E. Using temperature, solar altitude, and shadow directions, the study has identified the critical months that affect walking where the temperature is maximum (March, April, and May), solar altitude is maximum (March, April, May, August, and September) and the shadow direction is away (parallel to the street) from the walkways in both side of the street in (March, April, May, August, and September). Correspondingly, the rainfall is maximum and wind speed is minimum in months, July, August, and September, thus the effect of high solar altitude would be minimized. Consequently, March, April, and May are critical and most uncomfortable months for Tokuma street sidewalks. Additionally, based on the annual maximum and minimum temperature, the optimum building orientation for Adama town will be as follow:

Optimum Orientation

- Location: Adama Town
- Orientation based on average daily incident radiation on a vertical surface.
- Underheated stress: 0.0
- Overheated stress: 854.2
- Compromise: 32.5^0

Weather Tool

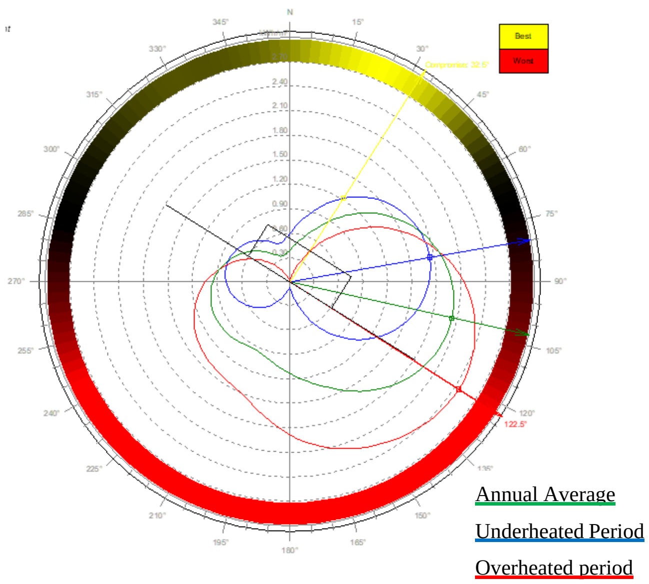


Figure 4.23: Identified optimum orientations for Adama town

Table 4.36: Summary of the street and building orientation for Adama town from shadow direction at Lat. 8.6^0 N and Long 39.3^0 E.

Street Orientation	Months											
	Jan (Getting shadow from)	Feb (Getting shadow from)	Mar (Getting shadow from)	Apr (Getting shadow from)	May (Getting shadow from)	Jun (Getting shadow from)	Jul (Getting shadow from)	Aug (Getting shadow from)	Sep (Getting shadow from)	Oct (Getting shadow from)	Nov (Getting shadow from)	Dec (Getting shadow from)
E-W	S side bldg.	S side bldg.	Neither side bldg.	Neither side bldg.	Neither side bldg.	N side bldg.	N side bldg.	Neither side bldg.	Neither side bldg.	S side bldg.	S side bldg.	S side bldg.
N-S	E side bldg.	E side bldg.	E side bldg.	Both sides	Both sides	Both sides	W side bldg.	W side bldg.	W side bldg.	E side bldg.	E side bldg.	E side bldg.
NE-SW	SE side bldg.	SE side bldg.	SE side bldg.	NW side bldg.	NW side bldg.	NW side bldg.	NW side bldg.	NW side bldg.	NW side bldg.	SE side bldg.	SE side bldg.	SE side bldg.
NW-SE	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	NE side bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	SW side bldg.
NNE-SSW	ESE side bldg.	ESE side bldg.	ESE sides	NNW side bldg.	NNW side bldg.	NNW side bldg.	NNW side bldg.	NNW side bldg.	NNW side bldg.	ESE side bldg.	ESE side bldg.	ESE side bldg.
ENE-WSW	SSE side bldg.	SSE side bldg.	Neither side	Neither side	Neither side	NNW side	NNW side	NNW side	Neither side	SSE side bldg.	SSE side bldg.	SSE side bldg.
NNW-SSE	ENE side bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	WSW side bldg.	WSW side bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	ENE side bldg.
WNW-ESE	SSW side bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	Both sides bldg.	SSW sides bldg.	SSW sides bldg.

The graph in Figure 4.23 and Table 4.36 illustrate the optimum street and building orientations for Adama town. Eight Cardinal Streets and the probable sixteen building orientations discussed based on the sun path at Latitude 8.6^0 N and longitude 39.3^0 E. Thus, NW-SE, WNW- ESE and NNW-SSE streets are the best orientations, however, E-W and ENE-WSW streets are the worst orientations respectively. Moreover, NE & SW, NNE & SSW, and ENE & WSW facing buildings are the optimal building orientations for Adama.

CHAPTER FIVE

5. Conclusion and Recommendations

5.1. Conclusions

The broad scope of this study was to assess the walkability of the built urban environment in which pedestrian walking behavior is influenced by environmental features, perception of the walking environment, and the climatic condition aspects. Survey results described in Chapter four shows that the specific objectives outlined in Chapter one have been achieved. The conclusions are made based on the following observations:

i. Pedestrian perceptions that significantly influenced walking frequency were lack of green infrastructures, buffers from the vehicle way, on-sidewalks parking, improperly installed utilities, lack of consideration people with disabilities, and poor sidewalks surface material. Besides, pedestrians are not feeling safe at the street crossing due to the high speed of cars, parked cars block the traffic views and motorists turned into people walking and crossing, and also they drove fast and do not give priority for pedestrians.

ii. Safety perceptions were directly influenced by the directness of the built environment features, safety-related infrastructures, and transit use. To improve the pedestrian's safety perceptions, safety-related infrastructures along with directness of the built environment features that limit safety hazards can be implemented.

iii. Street amenities and aesthetics perception was influenced by the condition of walking environment infrastructures including directness, continuity, and pleasing environment. Completeness of the physical walking environment is indistinguishable with safety, such that pedestrians don't have to move around obstructions putting them at danger from traffic.

iv. Pedestrian's way concepts for the sidewalks to be improved are buffering the sidewalks, providing street amenities and shading trees, widening the width of the sidewalks and separated parking, improving the sidewalk's surface material and street lights, and also providing sitting areas along the sidewalks are among the majors.

v. Built urban walking environment that significantly influenced the walkability of the sidewalks were poor sidewalk conditions, unsafe and uncomfortable environmental features, on-walkway parking's, lack of street amenities and buffers, building and street orientations, unpleasant and inappropriately installed utilities are the major assessed and identified problems through checklist survey resulting the sidewalks are a disaster for walking and need a lot of work to make the sidewalks walkable.

vi. March, April, and May are the most critical and uncomfortable months for both sides of the sidewalks to pedestrians for walking.

vii. The E-W orientation of Tokuma Street and the N & S facing buildings are the worst orientation for pedestrians since the street is directly exposed to the sun throughout the year.

viii. NW-SE, WNW- ESE, and NNW-SSE streets are the best orientations, but, E-W and ENE-WSW streets are the worst orientations. Moreover, NE & SW, NNE & SSW, and ENE & WSW facing buildings are the optimal building orientations for Adama.

Generally, the conducted subjective studies on pedestrian perceptions about the walking environment, objective studies on the built environment of the sidewalks through checklists, and also the climatic analysis resulted that the study walkways are not pedestrian-friendly and it is dangerous for pedestrians for walking.

5.2. Recommendations

Pedestrian perceptions about the walking environment through questionnaire survey and auditing the physical built environment through checklists were executed in this study to assess the walkability of the walkways. The following is a list of recommendations for Adama town and also for future related research.

- The town should develop policies and strategies that support funding and resource devoting for pedestrian planning to make the town pedestrian-friendly.
- E-W and ENE-WSW oriented streets are directly exposed to the sun throughout the year which implies that pedestrians and the motorist are highly exposed to disease caused by UV. Thus, planting evergreen street trees with a maximum of 6 meters canopy diameter, minimizing the street width and the building setback is recommended.
- NW-SE, WNW-ESE, and NNW-SSE streets are about 83%, 75% and 67% of exposed to the sun throughout the year; thus, these orientations with applying urban design principles are recommended.
- S, N, NNW, and SSE facing buildings are recommended to not open large window glazing since the amount of solar radiation expected is high.
- This being an introductory study, the effects of street orientation on airflow, solar access, aspect ratio, and the effect of urban design on outdoor thermal comfort should be studied in future studies.

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APPENDICES I

How walkable is Tokuma Street? (Pedestrian perception)

Interviewee Name: _	*Sex:* F M (circle one)
Position/job: _	*Age:* 10-20, 20-30, 30-40, 40-50 and above 50 (circle one)
Interviewer Name: _	*Date:* _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

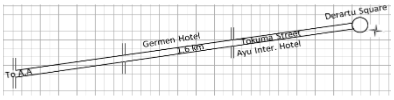
1. Is it walking your favorite mode of transport? A. Yes B. No….Why?
2. How many times a week do you commute by walking to school or work? Why? a. always b. frequently c. sometimes d. rarely e. never
3. How many hours do you walk to school, work or to transit? a. 10-15 munities b. 15-20 munities c. 20-30 munities d. 30-45 munities e. above 45 minutes
4. Do you feel safe and comfortable while walking on the sidewalks? A. Yes B. No... Why?
5. Do you think it is easy to cross the streets? A. yes B. No….Why?
6. Do you follow pedestrian safety rules? A. Yes B. No…..Why?
7. Do drivers behave well to pedestrians? A. Yes B. No…..Why?
8. What is your recommendation for the sidewalks to be improved?

APPENDICES II

Auditing the physical walking environment (Checklist)

Country: *__ETHIOPIA___*   ***Region/State:*** *__OROMIA_____*

City/Town: *__ADAMA_______*



Surface Material: (concrete, paved, brick, Coble stone, earth...)

Location:

Surveyed by: ______________   **Date** ____________________   **Time AM/PM**

Rating Scale: Awful — Many problems — Some problems — Good — Very good — Excellen

Elements to Check	Features to Check	yes	No	Need Repair	Rating	Remarks
1. Sidewalks	Have no street furniture (sittings, traffic lights, street lights, dust bins….)					
	Sidewalks are blocked by overgrown landscaping, poles, signs, plants, vehicles, etc.					
	The sidewalk is not continuous					
	The sidewalk is not wide enough (two people Cannot easily walk together side-by-side)					
	Have no buffer between pedestrian and vehicle roadway that separate sidewalks from the street					
	Have no planted shade producing street trees					
Other problems						
2. Street Crossings	The road is too wide to cross easily					
	Traffic signals do not give enough time to cross the street.					
	There is no crosswalk or it is poorly marked.					
	I have to walk too far to find a safe, marked crosswalk.					
	The intersection does not have a curb ramp for carts, wheelchairs, strollers, walkers, etc.					
	Parked cars block the view of traffic					
	Do the street pedestrian crossing signals?					

	Does the street has the shortest crossing distance?					
Other problems						
3. Pedestrians Behavior	Do pedestrians walk on the sidewalks?					
	Do pedestrians cross at the crosswalks?					
	Stop and look left, right and then left again before crossing the streets?					
	Do pedestrians obey all traffic rules?					
	Do pedestrians walk against traffic?					
Other problems						
4. Driver Behavior	Turned into people crossing the street					
	Drivers aren't looking out for people walking, make unexpected turns, or seem hostile.					
	Sped up to make it through traffic lights or drove through traffic lights?					
	Drove too fast					
Other problems						
5. Safety	Vehicle speeds are too fast					
	There's too much traffic					
	Street lights are few or not present					
	There are people on the street who seem threatening					
	Unleashed dogs or other loose intimidating animals are present					
Other problems						
6. Comfort	There is not enough shade from trees					
	There are few or no street trees or other landscaping					
	There are vacant lots or rundown buildings					
	The street needs benches and places to rest					
Other problems						
7. Utilities	Good drainage, away from entrances and walkways					
	Do utilities have visual and environmental quality?					
	Do utility lines installed appropriately?					
Other problems						
8. On-street parking	Have a buffer between on-street parking and the roadway?					
	Does the roadway has on-street parking?					
	Do they park cars on the sidewalks?					

Other problems						
9. Off-street parking	Do the off-street parking hindering the continuity of sidewalks?					
Other problems						
10. Landscaping	Do the sidewalks have green elements?					
	Do the available plants complement the built environment?					
Other problems						
11. Building Orientation	Do buildings create a sense of human scale?					
	Do the buildings interact with the sidewalks?					
	Support accessibility to buildings?					
Other problems						